Weight Patterns Before and After Total Joint Arthroplasty and Characteristics Associated with Weight Change

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Perm J 2014 Winter;18(1):25-31

<http://dx.doi.org/10.7812/TPP/13-082>

Abstract

Context: Although prevalence of obesity and incidence of total joint arthroplasty (TJA) have dramatically increased over the last two decades in the US, little is known of the preoperative and postoperative weight patterns of patients undergoing TJA.

Objective: To describe the preoperative and postoperative weight patterns of patients undergoing TJA and evaluate characteristics associated with these patterns.

Design: Retrospective cohort study. A cohort of patients undergoing total hip arthroplasty (THA) or total knee arthroplasty (TKA) between January 1, 2008, and December 31, 2010, was identified. Using weight obtained at patient encounters, patients were categorized into gainers (increased weight by 5%), losers (decreased weight by 5%), or remained the same (changed < 5%) for the preoperative and postoperative periods. Patients were characterized by sex, age, and race.

Main Outcome Measures: Weight change before and after TJA.

Results: Of 30,632 patients with TJA identified, 34.5% underwent THA and 65.5% had TKA. Most patients remained the same weight during the year before (THA, 71.5%; TKA, 75.7%) and after the procedure (64.0% and 68.5%, respectively). Before and after THA, men were less likely to lose or gain weight than were women. Older patients were less likely to gain weight. Among patients undergoing TKA, men were less likely to lose weight preoperatively or postoperatively, or gain weight postoperatively, and older patients were less likely to gain weight before or after arthroplasty. Some racial associations with weight patterns were observed.

Conclusions: Specific groups are more susceptible to weight change and could benefit from weight management interventions.

Introduction

In 2009 in the US, 1,124,000 total joint arthroplasty (TJA) procedures were performed.¹ Both the prevalence of obesity and the incidence of joint arthroplasty (specifically in knees and hips) have dramatically increased during the last 2 decades in this country.²⁻⁴ The incidence of arthroplasty is expected to continue to rise; according to Kurtz et al,⁵ by 2030, the incidence of total hip arthroplasty (THA) will increase by 174% and total knee arthroplasty (TKA) will increase by 673% compared with 2005 figures. Additionally, the time between procedures in the contralateral joint is expected to

decrease because there is a higher risk of bilateral osteoarthritis⁶ in obese patients, and the age at TJA is also significantly younger.⁷ The increased TJA incidence and decreased time between multiple joint arthroplasty procedures have been largely, but not exclusively, attributed to the increase in the prevalence of obesity in the US population.⁸ Although the prevalence of obesity and TJA is known, little is known of the preoperative and postoperative weight patterns of patients who have already undergone TJA.

Obese candidates for TJA often are advised to lose weight because of the detrimental effects of obesity after surgery.⁹

However, whether patients actually lose weight is not known. To our knowledge, only two studies looking at preoperative weight changes in patients undergoing TJA have been published, and no description of the patients more susceptible to and successful in weight management were described.^{10,11} Riddle et al,^{10,11} in both studies, report preoperative weight loss association with postoperative weight gain.

Conversely, several studies have focused on weight changes of patients after TJA, but with inconclusive findings.¹² These inconclusive results, which are also inconsistent, may have been because of the heterogeneity of study eligibility and analyses performed, small sample sizes, or overall quality.¹² Thus, no conclusive evidence exists that weight improves, remains the same, or negatively progresses any time after TJA procedures.

The purpose of this study was to describe the preoperative and postoperative weight patterns of patients undergoing TJA in a large integrated health care system. In addition, this study also evaluated patient characteristics associated with different weight patterns one year before through one year after TJA.

Patients and Methods

Study Design and Sample

A retrospective review of the weight history of patients who underwent TJA at Kaiser Permanente (KP) from January 1, 2008, to December 31, 2010, was undertaken. All patients who were at least 18 years old and underwent primary, unilateral, lower limb TJA (knee or hip) for treatment of osteoarthritis at

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the 35 Medical Centers of the two largest Regions covered by KP (Northern and Southern California) were included in the study sample ($N = 36,015$). Patients who had a TJA performed for any reason other than osteoarthritis and those with multiple joint arthroplasties within 1 year of the procedure were excluded from the sample ($n = 3601$ patients/5222 procedures). Patients who underwent a bariatric surgical procedure were also excluded ($n = 161$).

Internal review board approval was obtained before commencement of the study.

Data Collection

Data were extracted from KP's Total Joint Replacement Registry (TJRR) and electronic health records (EHRs). Using the TJRR, patients with TJA were identified. The structure, capture, validation, and data quality of the TJRR have been previously published.¹³⁻¹⁵ In brief, the TJRR is voluntary, with 90% to 95% participation in 2010.¹⁵ The registry captures the institution's TJA population and records detailed information on patient characteristics, procedure diagnosis, specific procedures performed, surgical techniques, implant characteristics, and outcomes associated with the procedures.

The EHR was used to extract the weight measures used and to identify patients who had bariatric surgical procedures. The EHR captures weight measures whenever a

patient encounter occurs. Weight measures from all encounters during 1 year before through 1 year after TJA were extracted. There was no standard protocol for weight assessment. If more than 1 weight per period was recorded, the median weight was used. Weight data were extracted for the time intervals of 1) 181 to 365 days preoperatively, 2) 91 to 180 days preoperatively, 3) 0 to 90 days preoperatively or intraoperatively, 4) 1 to 90 days postoperatively, 5) 91 to 180 days postoperatively, and 6) 181 to 365 days postoperatively.

Outcomes and Exposures of Interest

Patients were categorized into 3 groups for both the preoperative and postoperative periods: gainers (increased weight by 5%), losers (decreased weight by 5%), and remained the same (change < 5%). A change of 5% or more in preoperative or postoperative weight was considered a clinically significant weight change and was used to categorize the patients studied, as suggested by the US Food and Drug Administration definition.¹⁶ Weight was recorded for the intervals described and weight changes were calculated using the time period 0 to 90 days as the referent weight for change.

Patients were characterized according to demographic information (sex, age, and race/ethnicity) and type of procedure performed (TKA or THA).

Statistical Analysis

Rates for categorical variables and descriptive statistics for continuous variables were calculated. Data from the THA and TKA samples were analyzed separately. Preoperative weight patterns by starting obesity levels (nonobese < 30 kg/m², obese ≥ 30 kg/m²) are provided. Postoperative weight patterns by intraoperative obesity levels (nonobese < 30 kg/m², obese [30-34 kg/m²], and morbidly obese ≥ 35 kg/m²)¹⁷ are provided. Chi-square tests and analysis of variance were used to compare characteristics by weight pattern group. Polychotomous logistic regression was used to model the 3 weight groups: loser, gainer, and "remain the same." Separate models for preoperative and postoperative weight patterns and for TKA and THA were created. Those patients whose weight remained the same constituted the largest group and were used as the reference category. Age, sex, and race/ethnicity (Asian, black, Native American, white, Hispanic, other, and unknown) associations with weight changes were examined.

Missing data were excluded, and analyses were conducted to determine whether our estimations were biased by missing data. Collinearity of variables and outliers were also evaluated. Tolerance values less than 0.10 were used as thresholds for collinearity indication; outliers were manually reviewed. Unadjusted and adjusted odds ratios (OR) for the association of the dependent variables with weight patterns and 95% confidence intervals (CI) are provided. The Wald χ^2 test p-value is also provided for each variable. All analyses were 2-tailed with $\alpha = 0.05$ used as the statistical significance threshold; analyses were performed using SAS for Windows 9.2 (Cary, NC).

Results

Of 30,632 patients who underwent TJA, 34.5% ($n = 10,572$) had THA and 65.5% ($n = 20,060$) underwent TKA. Women were in the majority ($n = 18,612$; 60.8%), but a higher proportion of women were in the THA sample ($n = 12,493$; 62.3%) compared with the TKA sample ($n = 6119$, 57.9%). The cohort's mean age was 67.4 years old, and patients who underwent THA were slightly younger than patients with TKA (66.9 vs 67.7 years old) and had

Figure 1. Preoperative and postoperative mean weight for each time period for total hip arthroplasty ($n = 10,572$) and total knee arthroplasty ($n = 20,060$).

a higher proportion of whites ($n = 8205$, 77.6%, vs $n = 13,353$; 66.6%, respectively). The mean weight of the sample at the time of TJA was 87.2 kg (192 lb) (standard deviation [SD] = 19.5 [43], range = 36.3–202.5 kg [80–446 lb]), and the mean body mass index (BMI) was 30.7 kg/m² (SD = 6.0, range = 15.0–67.5 kg/m²). Patients with THA had slightly lower mean weight (84.0 kg [185 lb], SD = 20.0 [44], range = 37.2–192.5 kg [82–424 lb]) and BMI (29.2 kg/m², SD = 5.7, range = 15.0–58.5 kg/m²) than did patients with TKA (mean weight = 89.0 kg [196 lb], SD = 19.5 [43], range = 37.7–219.7 kg [83–484 lb], BMI = 31.5 kg/m², SD = 6.0, range = 15.4–67.5 kg/m²). Figure 1 shows the mean weight of patients with THA and TKA. Weights are highest (for both patients with THA and TKA) at 6 months to 1 year preoperatively and lowest at the 3-month postoperative period.

Of the patients with THA, 9.6% ($n = 1019$) did not have a preoperative weight measure and 12.6% ($n = 1336$) did not

have postoperative weight measured. Of the patients with TKA, 7.5% ($n = 1512$) did not have a measure of preoperative weight and 9.3% ($n = 1866$) did not have postoperative weight measured. The cases with missing data were more likely to be men and to be younger than those without missing data. There were no differences between cases with missing data and those with complete data with respect to intraoperative BMI, year of the operation, or operative side.

Table 1 shows the characteristics of the sample by whether they lost, gained, or remained the same weight during the 1 year before and after TJA. Most patients with THA and TKA remained the same weight during the year before their procedure (71.5% and 75.7%, respectively) and during the year after the procedure (64.0% and 68.5%). Figures 2A and 2B show the patterns of weight change both preoperatively and postoperatively. Most patients remained the same weight preoperatively and postoperatively (61.0%

of the THA group and 63.8% of the TKA group).

Figure 3 shows the preoperative weight pattern for patients with THA and TKA by whether they were obese (BMI ≥ 30 kg/m²) at the beginning of the study period (6 to 12 months preoperatively). At the beginning of the study period, of the patients with THA, 38.5% ($n = 4066$) were considered obese, whereas in the TKA cohort, 53.4% ($n = 10,718$) were considered obese. Figure 4 shows the postoperative weight patterns for patients with THA and TKA by their intraoperative obesity classification. In patients with THA, the morbidly obese group had a higher proportion of weight losers (14.0%) than other groups (8.5% nonobese and 9.5% obese). Postoperatively there were no differences in weight patterns of patients with TKA by intraoperative obesity levels.

Before THA, men were less likely to either lose or gain a clinically significant amount of weight than women were

Table 1. Patient characteristics by weight change during the preoperative and postoperative period by total hip arthroplasty (THA) and total knee arthroplasty (TKA), 2008–2010

Sample	Characteristic	Preoperative weight group ^a				Postoperative weight group ^a			
		Gainer	Loser	Remain the same	Unknown	Gainer	Loser	Remain the same	Unknown
Total (N = 30,632)	Total number (%)	1993 (6.5)	3355 (11.0)	22,753 (74.3)	2531 (8.3)	3229 (10.5)	3696 (12.1)	20,505 (66.9)	3202 (10.5)
THA (n = 10,572)	Total number (%)	598 (5.7)	1394 (13.2)	7561 (71.5)	1019 (9.6)	1586 (15.0)	885 (8.4)	6765 (64.0)	1336 (12.6)
Sex	Women	360 (60.2)	900 (64.6)	4331 (57.3)	528 (51.8)	956 (60.3)	559 (63.2)	3886 (57.4)	718 (53.7)
	Men	238 (39.8)	494 (35.4)	3230 (42.7)	491 (48.2)	630 (39.7)	326 (36.8)	2879 (42.6)	618 (46.3)
Age, years	Mean (SD)	64.2 (10.4)	68.0 (11.5)	67.2 (10.8)	64.6 (11.2)	65.7 (11.4)	68.1 (11.3)	67.5 (10.7)	64.2 (11.0)
Race/ethnicity	White	451 (75.4)	1119 (80.3)	5855 (77.4)	780 (76.6)	1202 (75.8)	708 (80.0)	5248 (77.6)	1047 (78.4)
	Black	56 (9.4)	115 (8.3)	590 (7.8)	104 (10.2)	156 (9.8)	72 (8.1)	531 (7.9)	106 (7.9)
	Hispanic	43 (7.2)	94 (6.7)	629 (8.3)	66 (6.5)	133 (8.4)	65 (7.3)	552 (8.2)	82 (6.1)
	Asian	27 (4.5)	31 (2.2)	266 (3.5)	33 (3.2)	43 (2.7)	25 (2.8)	235 (3.5)	54 (4.0)
	Other ^b	9 (1.5)	23 (1.7)	129 (1.7)	16 (1.6)	34 (2.1)	9 (1.0)	108 (1.6)	26 (2.0)
	Unknown	12 (2.0)	12 (0.9)	92 (1.2)	20 (2.0)	18 (1.1)	6 (0.7)	91 (1.4)	21 (1.6)
TKA (n = 20,060)	Total number (%)	1395 (7.0)	1961 (9.8)	15,192 (75.7)	1512 (7.5)	1643 (8.2)	2811 (14.0)	13,740 (68.5)	1866 (9.3)
Sex	Women	933 (66.9)	1326 (67.6)	9361 (61.6)	873 (57.7)	997 (60.7)	2014 (71.7)	8359 (60.8)	1123 (60.2)
	Men	462 (33.1)	635 (32.4)	5831 (38.4)	639 (42.3)	646 (39.3)	797 (28.4)	5381 (39.2)	743 (39.8)
Age, years	Mean (SD)	65.0 (9.9)	67.5 (9.7)	68.1 (9.3)	66.2 (10.0)	66.0 (9.7)	68.5 (9.8)	68.0 (9.3)	66.0 (9.9)
Race/ethnicity	White	950 (68.1)	1375 (70.1)	10,025 (66.0)	1003 (66.3)	1127 (68.6)	1894 (67.4)	9041 (65.8)	1291 (69.2)
	Black	146 (10.5)	197 (10.1)	1344 (8.9)	175 (11.6)	143 (8.7)	326 (11.6)	1210 (8.8)	183 (9.8)
	Hispanic	199 (14.3)	257 (13.1)	2470 (16.3)	170 (11.2)	232 (14.1)	402 (14.3)	2253 (16.4)	209 (11.2)
	Asian	66 (4.7)	76 (3.9)	864 (5.7)	94 (6.2)	77 (4.7)	118 (4.2)	799 (5.8)	106 (5.7)
	Other ^b	19 (1.4)	42 (2.1)	293 (1.9)	29 (1.9)	38 (2.3)	47 (1.7)	260 (1.9)	38 (2.0)
	Unknown	15 (1.1)	14 (0.7)	196 (1.3)	41 (2.7)	26 (1.6)	24 (0.9)	177 (1.3)	39 (2.1)

^a Gainer: weight increase $\geq 5\%$ compared with weight at operative time. Loser: weight decrease $\geq 5\%$ compared with weight at operative time. Remain the same: weight change no greater than $\pm 5\%$. Values are number (percentage) except where otherwise indicated. Some percentages do not total to 100 because of rounding.

^b Includes multiracial Native American patients.

SD = standard deviation.

Figure 2A. Proportion of patients in each weight group by preoperative and postoperative status for total hip arthroplasty.

Postop = postoperatively; preop = preoperatively.

Figure 2B. Proportion of patients in each weight group by preoperative and postoperative status for total knee arthroplasty.

Postop = postoperatively; preop = preoperatively.

(losers: OR = 0.74, 95% CI = 0.66-0.84; gainers: OR = 0.84, 95% CI = 0.71-0.99). Asians were less likely to lose weight (OR = 0.59, 95% CI = 0.40-0.85) than whites, and older patients were less likely than younger patients to gain weight (2.0% decrease in risk of being a gainer per 1-year age increase, 95% CI 2.0%-3.0%). After THA, men were less likely to lose weight (OR = 0.79, 95% CI = 0.69-0.92) or gain weight (OR = 0.86, 95% CI = 0.77-0.96). Additionally, older patients were less likely to be gainers (1.0% decrease in odds per 1-year increase, 95% CI = 1.0%-2.0%), and those who were black were more likely to be gainers (OR = 1.22, 95% CI = 1.00-1.47) compared with white patients (Table 2).

Before TKA, men and Hispanics had lower odds of losing weight (OR = 0.76, 95% CI = 0.69-0.84 and OR = 0.74, 95% CI = 0.64-0.85, respectively) or gaining weight (OR = 0.78, 95% CI = 0.70-0.88 and OR = 0.77, 95% CI = 0.66-0.91, respectively). Asians were less likely than whites to lose weight (OR = 0.63, 95% CI = 0.49-0.80), and older patients were less likely to gain weight (OR = 3.0% decrease per year of age increase, 95% CI = 3.0%-4.0%). After TKA, men were less likely than women to lose weight (OR = 0.62, 95% CI 0.57-0.68), and Asians and Hispanics were less likely than whites to lose weight (OR = 0.69, 95% CI = 0.56-0.84, vs OR = 0.85,

Figure 3. Pretotal joint arthroplasty weight pattern by preoperative obesity status.^a

^a Obese= body mass index (BMI) $\geq 30\text{kg/m}^2$; nonobese = BMI $< 30\text{kg/m}^2$. THA = total hip arthroplasty; TKA = total knee arthroplasty.

Figure 4. Posttotal joint arthroplasty weight pattern by intraoperative obesity status.

BMI = body mass index; Intra-op = intraoperative; THA = total hip arthroplasty; TKA = total knee arthroplasty.

95% CI = 0.76-0.96, respectively). Older patients (OR = 2.0% decrease per year of age increase, 95% CI = 1.0%-3.0%) were less likely to be gainers, as were Asians and Hispanics compared with whites (OR = 0.76, 95% CI = 0.60-0.97, OR = 0.78, 95% CI = 0.67-0.91) (Table 2).

Discussion

Most patients undergoing TJA procedures in a number of community-based practices were found to remain the same weight before and after the TJA procedure (61% of the THA group and 64% of the TKA group). However, certain groups of patients were more likely to gain or lose a clinically significant amount of weight before and/or after the surgery. Specifically, women were more likely than men to change their weight (either gain or lose) preoperatively in both the THA and TKA groups and postoperatively in the THA group. Younger patients were more likely to gain weight than older patients both before and after THA and TKA. Several racial differences were observed, and the proportion of patients who gained and lost weight postoperatively varied depending on the intraoperative weight of the patient.

Few studies have explored the association of sex with post-TJA weight change, and to our knowledge, no studies have examined this issue for preoperative weight change. Results of the present study are in contrast with those of Dowsey et al,^{18,19} who evaluated patients undergoing THA and TKA as well as intraoperative variables associated with a 5% weight loss postoperatively and reported sex not to be associated with weight loss. Differences in the studies by Dowsey et al may be attributed to their smaller sample size (511 patients with THA and 573 patients with TKA), sample heterogeneity (Australian samples, no mention of racial distribution), and differences in weight ascertainment (the studies actively measured all their study participants with a standard protocol). A multitude of biochemical, behavioral, and socioeconomic reasons were noted for the higher prevalence of obesity, dieting, and difficulty of weight loss in women,^{20,21} possibly explaining why women in our study were more susceptible to weight change.

Age has also not been studied as a

risk factor for pre-TJA weight change, to our knowledge, but has been reported to be associated with postoperative weight changes. Older age has been found to be associated with weight loss one year after TKA, although the inverse (association of weight gain) was not observed.¹⁹ Similarly, Lachiewicz and Lachiewicz²² reported age to be significantly associated with post-TKA weight change, reporting younger patients as more likely to be obese than older patients. The prevalence of obesity in patients with TJA is also higher than in the general population,^{4,23} and the obese patients are younger than nonobese patients. Younger age being associated with an increased likelihood of gaining more weight is likely because younger patients are already heavier, have a longer history of weight-related issues, and have comorbid conditions that affect their ability and commitment to weight management.

Racial differences in prevalence of obesity and weight loss, management, and perception are well documented in

the literature.^{4,24-26} Non-Hispanic blacks have the highest prevalence of obesity of all racial/ethnic groups in the US, with a prevalence of obesity reported at 38% for men and 50% for women age 60 years and older (group representative of our sample). The higher likelihood of black patients to gain even more weight in this study is not unexpected because these patients already are at a higher risk of being obese. Previous studies report a higher risk of complications²⁷ and revision²³ procedures in black patients, which could explain the increase in weight postoperatively of these patients, who may be more debilitated, unable to participate in physical activity, or may be taking medication that influences weight gain and activity levels. In addition, Asians and Hispanics were found at certain times (Asians before THA and both before and after TKA; Hispanics after TKA) to be less likely to change their weight than whites. This lower susceptibility to weight change in these races could be indicative of lower

Table 2. Associations of age, sex, and race with preoperative and postoperative weight change: adjusted odds ratios (ORs) and 95% confidence intervals (CIs) by total hip and knee arthroplasty^a

Arthroplasty type	Preoperative weight group ^b		Postoperative weight group ^b	
	Loser OR (95% CI)	Gainer OR (95% CI)	Loser OR (95% CI)	Gainer OR (95% CI)
THA^c				
Men vs women	0.74 (0.66-0.84) ^d	0.84 (0.71-0.99) ^d	0.79 (0.69-0.92) ^d	0.86 (0.77-0.96) ^d
Age (1-year increments)	1.00 (1.00-1.01)	0.98 (0.97-0.98) ^d	1.00 (1.00-1.01)	0.99 (0.98-0.99) ^d
Asian vs white	0.59 (0.40-0.85)	1.26 (0.83-1.89)	0.77 (0.50-1.17)	0.78 (0.56-1.08)
Black vs white	1.04 (0.84-1.28)	1.13 (0.84-1.51)	1.02 (0.79-1.32)	1.22 (1.00-1.47)
Hispanic vs white	0.81 (0.65-1.02)	0.79 (0.57-1.10)	0.90 (0.68-1.17)	0.99 (0.81-1.21)
Other ^e vs white	0.96 (0.61-1.50)	0.85 (0.43-1.69)	0.63 (0.32-1.24)	1.32 (0.89-1.95)
Unknown vs white	0.73 (0.40-1.35)	1.51 (0.82-2.78)	0.52 (0.23-1.19)	0.81 (0.49-1.35)
TKA^f				
Men vs women	0.76 (0.69-0.84) ^d	0.78 (0.70-0.88) ^d	0.62 (0.57-0.68) ^d	0.99 (0.89-1.10)
Age (1-year increments)	0.99 (0.99-1.00)	0.97 (0.96-0.97) ^d	1.01 (1.00-1.01)	0.98 (0.97-0.99) ^d
Asian vs white	0.63 (0.49-0.80) ^d	0.78 (0.60-1.01)	0.69 (0.56-0.84) ^d	0.76 (0.60-0.97) ^d
Black vs white	1.01 (0.86-1.19)	1.02 (0.85-1.23)	1.24 (1.09-1.42) ^d	0.89 (0.74-1.04)
Hispanic vs white	0.74 (0.64-0.85) ^d	0.77 (0.66-0.91) ^d	0.85 (0.76-0.96) ^d	0.78 (0.67-0.91) ^d
Other ^e vs white	1.01 (0.73-1.41)	0.62 (0.39-1.00)	0.87 (0.63-1.19)	1.11 (0.78-1.57)
Unknown vs white	0.50 (0.29-0.87) ^d	0.67 (0.40-1.15)	0.69 (0.45-1.05)	1.04 (0.69-1.59)

^a Polychotomous logistic regression, with "remain the same" as the reference group.

^b Gainer: weight increase $\geq 5\%$ compared with weight at operative time. Loser: weight decrease $\geq 5\%$ compared with weight at operative time. Remain the same (reference group): weight change no greater than $\pm 5\%$.

^c Wald χ^2 test for THA: adjusted preoperative: sex ($p < 0.001$), age ($p < 0.001$), and race/ethnicity ($p = 0.051$); adjusted postoperative: sex ($p < 0.001$), age ($p < 0.001$), and race/ethnicity ($p = 0.121$).

^d Denotes statistical significance ($p < 0.05$).

^e Includes multiracial and Native American patients.

^f Wald χ^2 test for TKA: all $p < 0.001$ (preoperative and postoperative).

THA = total hip arthroplasty; TKA = total knee arthroplasty.

risk of postoperative complications or possible better preoperative profiles.

The different patterns of postoperative weight change by the intraoperative obesity level for the THA group are also of note. Morbidly obese patients with THA had a higher proportion of patients losing weight postoperatively, although the difference was small. It is likely that

Younger patients were more likely to gain weight than older patients both before and after THA and TKA.

regain of mobility and relief from symptoms did indeed lead these patients to a weight reduction postoperatively. This was not observed in patients with TKA, who had similar proportions of gaining, losing, and remaining the same weight at all intraoperative obesity levels and were generally heavier than were patients undergoing THA.

Successful rehabilitation can be more challenging for a heavier patient with other comorbidities, such as osteoarthritis in other joints, and slow recovery has been reported after both arthroplasty procedures in obese patients.²⁸

This study has some limitations. First, selection bias could be present due to the sampling frame. Patients not covered by KP were not included. However, the KP membership was generally composed of similar age, sex, and race as the population in the geographical area it covers.^{29,30} Second, the data source used for this study is voluntary and participation in the registry is reportedly 95%. However, contributing sites have nondifferential rates of participation in the registry, and we do not expect this to affect the study findings. Third, the cohort evaluated had an attrition rate of 1.1%. Of these patients lost to follow-up, only 11% had missing postoperative weight estimates, a similar proportion of missing weight data as the overall cohort. Fourth, there is a potential for inclusion of patients in the sample who have had surgical weight loss interventions outside the system. Although it is unlikely, we cannot be certain that procedures did not happen before the 2001 EHR records or at another institution. Since the prevalence of surgical weight loss intervention is very low in the US,³¹ we do not expect this to bias our sampling. Fifth, the protocol for weight assessment was not standard, and measurements were subjected to reporting bias as well

as observer bias. Sixth, missing data were present (< 12.6% depending on procedure and period). We found that patients with missing data were more likely to be men and younger, but no other differences were noted. It is possible the sex associations were overestimated for women (if most of men without weight measures were the ones changing weight before and after the procedure), but because of the small amount of missing data and the large sample size, we believe this underestimation to be minimal. However, age estimations were probably not overestimated because we found younger patients to be more likely to gain weight than to remain the same weight for all groups, despite the higher numbers of missing weight. Finally, because of the limited information available in the data source of this study, we do not have information on the history of physical activity and psychological characteristics of the evaluated patients, which could have an impact on the estimations presented.

This study's strengths include the generalizability of the findings, the utilization of an EHR from a closed integrated health care system, and low likelihood of data handling and response bias. Most importantly, the cases, surgeons, and medical centers that make up the sample are believed to be representative of community-based orthopedic practices in the US. The patient samples of each location are of various case mix levels and are similar to the larger state population with regard to age, race, and sex distribution.^{29,30,32} More than 300 surgeons and 27 hospitals contributed to the sample evaluated, and they are of various training levels, settings (eg, urban, rural, academic), and volumes. Additionally, this study used a common EHR and a TJRR to obtain data. The ability to link records, using one common unique identifier in a sample of this size, cannot be reproduced by any other larger national samples (Healthcare Cost and Utilization Project Nationwide Inpatient Sample) or regional TJA registries. Finally, using the EHRs to obtain the weight measurements also decreased the possibility of response bias that could arise from obtaining this information from the patients directly.

This study found women to be the most susceptible group to weight change

either before or after TJA procedures, younger patients to be most likely to gain weight before and after TJA, and black patients most likely to gain weight after their procedure. Additionally, this study described a different postoperative weight trend in patients with THA depending on their intraoperative obesity level, with the morbidly obese having the highest proportion of patients losing weight after the procedure. This information is important to clinicians and surgeons because it characterizes specific groups that can benefit from weight management interventions. Interventions suitable for the patients identified as more susceptible to weight change should be pursued.

Conclusion

Targeting specific groups will result in increased efficiency of interventions, decrease the financial and personnel burden on implementing interventions, and potentially result in cost savings from reducing the number of patients who need to undergo preoperative counseling for weight loss and other comorbidity optimization efforts. ♦

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

Acknowledgments

The authors would like to thank all Kaiser Permanente orthopedic surgeons and the staff of the Department of Surgical Outcomes and Analysis who have contributed to the success of the National Total Joint Replacement Registry.

Kathleen Loudon, ELS, of Loudon Health Communications provided editorial assistance.

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Arthroscopy

We believe arthroscopy to be a key procedure in the study of joint physiology and pathology.
The method as yet is still in its infancy.

—Michael S Burman, MD, 1901-1975, pioneer in the field of arthroscopy