Published in final edited form as:

J Clin Rheumatol. 2017 October ; 23(7): 355–360. doi:10.1097/RHU.0000000000000579.

Patients less likely to lose weight following a knee replacement: Results from the Osteoarthritis Initiative

Christine A. Pellegrini, PhD¹, Jing Song, MS², Pamela A. Semanik, PhD³, Rowland W. Chang, MD, MPH², Jungwha Lee, PhD¹, Abigail L. Gilbert, MD², Daniel Pinto, PT, PhD², Linda Ehrlich-Jones, PhD, RN³, and Dorothy D. Dunlop, PhD²

¹Feinberg School of Medicine, Department of Preventive Medicine, Northwestern University, 680 N. Lake Shore Drive, Suite 1400, Chicago, IL, 60611 USA

²Feinberg School of Medicine, Northwestern University, 633 N. St. Clair, Chicago, IL, 60611 USA

³College of Nursing, Rush University, 600 S. Paulina, Chicago, IL, 60612 USA

⁴Center for Rehabilitation Outcome Research, Rehabilitation Institute of Chicago, 345 East Superior Street, Chicago, IL, 60611 USA

Abstract

BACKGROUND—Knee replacement typically results in reduced pain and improved function, but it is unclear if these improvements lead to weight loss.

OBJECTIVE—The purpose of this study was to examine weight change patterns pre- and post-operatively among overweight/obese knee replacement patients.

METHODS—The study evaluated 210 overweight/obese patients from the Osteoarthritis Initiative who underwent a knee replacement during an 8 year longitudinal study. Average annual weight changes during 1–2 year intervals prior to, including, and subsequent to knee replacement were categorized as loss (-2.5%), maintain ($>-2.5\%$ to $<2.5\%$), and gain (2.5%). Weight changes across time intervals were compared using logistic regression with generalized estimating equations, adjusting for demographic, health, and knee factors.

RESULTS—On average, patients lost (-0.6 kg/yr) during the interval when the surgery was performed, but weight gain (0.9 kg/yr) in the initial post-operative interval represented an overall net weight gain (0.3 kg/yr) compared to pre- surgery. Continued weight gain (0.3 kg/yr) was also seen among patients with additional follow-ups. Patients were significantly less likely to have a meaningful weight loss in the time interval immediately following the surgery compared to the interval in which the surgery took place (odds ratio= 0.37 , 95% confidence interval: $0.18, 0.79$).

CONCLUSION—Overweight and obese patients initially lost weight during the interval including knee replacement, however they were less likely to lose $>2.5\%$ of their weight in the 1–2 years immediately after the surgery. Knee replacement patients may benefit from weight management interventions both pre- and post-operatively.

Keywords

obesity; knee replacement; surgery; knee osteoarthritis

Introduction

Excess weight is a significant risk factor for the development of knee osteoarthritis [1], and with over 65% of adults in the US classified as overweight or obese [2], the incidence and prevalence of knee osteoarthritis is expected to rise. It is projected that 45% of adults will develop symptoms of knee osteoarthritis during their lifetime [3], and at least half of those with symptomatic knee osteoarthritis will need a knee replacement [4]. Total knee replacement utilization in the US continues to dramatically increase [5], and by 2030, it is expected that the number of new knee replacements will approach 3.48 million [6]. This projected increase in knee replacement utilization will place substantial burden and costs on society, with lifetime costs of knee osteoarthritis approaching \$150,000 per patient, of which approximately \$20,000 is attributed directly to primary knee replacement [7].

The majority of knee replacement patients are overweight or obese [8] and this can significantly increase the risk of medical and surgical complications including infection [9] and thromboembolic events [10, 11]. Dowsey and colleagues [12] estimate that the risk of an adverse event increases by 8% with each unit increase in body mass index (BMI). Pre-operative weight is also negatively associated with the rate of improvement on patient reported pain and function outcomes following knee replacement [13]. Additionally, obesity is linked with prosthetic failure [10] and increased risk of undergoing joint replacement revision [14–16]. Physicians, aware of the complications associated with obesity, may recommend weight loss to patients prior to undergoing knee replacement. Nevertheless, it is unclear whether patients with obesity actually lose weight prior to surgery.

Following knee replacement, patients typically experience less pain, improved function and health related-quality of life [17, 18], which makes mobility and increases in physical activity more likely. Despite small increases in observed physical activity following knee replacement [19], it is unclear whether this additional activity contributes to any meaningful changes in body weight. Several studies have examined changes in weight following knee replacement, but results have been inconsistent. For example, some evidence suggested that patients experience no change in weight while others observed weight gains after the knee replacement [20–24]. A recent systematic review also suggested that there was not conclusive evidence on weight changes following joint replacement [25]; however previous studies have not been limited to overweight and obese patients. Thus, using data from the Osteoarthritis Initiative (OAI) [26], a multisite longitudinal study, we examined the weight change patterns approximately one to four years pre- and post-operatively among overweight and obese patients with radiographic knee osteoarthritis who underwent a knee replacement.

Material and Methods

Study Population

The study population utilized in the current analysis was from the OAI, which is a multisite longitudinal study that enrolled 4,796 adults with or at risk for the development of knee osteoarthritis. Data was obtained from the public-use data set available at <https://oai.epi-ucsf.org>. OAI participants were between the ages of 45–79 years and were either required to have symptomatic radiographic osteoarthritis in at least one knee (a definite tibiofemoral osteophyte [osteophyte grade 1] [27] and pain, aching, or stiffness on most days for at least one month during the past 12 months) or were required to have at least one established risk factor for knee osteoarthritis. The full eligibility criteria for the OAI are reported elsewhere [26].

The current study examined the 210 participants who had a total or partial knee replacement reported (adjudicated or self-reported) between the 12- and 96-month OAI follow-up visits. Since all participants included in this analysis underwent knee replacement at different time points, we identified the surgery interval as the 1 or 2 year period of time defined by adjacent OAI follow-ups before or after the knee replacement (see Figure 1). The analysis was restricted to overweight or obese ($\text{BMI} \geq 25 \text{ kg/m}^2$) participants with radiographic knee osteoarthritis in the case knee at the start point of the surgery interval. Participants were excluded if they had (1) $\text{BMI} < 25 \text{ kg/m}^2$ at the start point of the surgery interval (2) Kellgren-Lawrence (K/L) grade < 2 in the case knee at the start point of the surgery interval, [28] (3) reported a knee replacement at OAI baseline, (4) reported a hip replacement at any time before undergoing knee replacement, (5) reported simultaneous bilateral knee replacement or had both knee replacements conducted within the surgery interval, or (6) reported a joint replacement revision. Additionally, we censored data 1 year prior to a reported death to ensure illness did not influence observed changes in weight as well as one participant with extreme weight fluctuations. All participants provided written informed consent and approval was received from each of the 4 clinical sites' institutional review boards (Baltimore, MD; Columbus, OH; Pittsburgh, PA; and Pawtucket, RI).

Measures

Body weight (kg) was objectively assessed at OAI baseline and follow-up visits. Demographic covariates used included age, gender, race/ethnicity, education, and income. Health factors included comorbidities, depressive symptoms, smoking status, back pain, other extremity pain, and knee-specific factors (knee osteoarthritis severity, chronic knee symptoms, knee pain, and knee injury). The Charlson Comorbidity Index assessed comorbidities [29]. Depressive symptoms were assessed using the Center for Epidemiological Studies Depression scale [30]. Pain was examined for back and other extremities, including hip, ankle, and foot. The knee-specific factors measured included 1) knee osteoarthritis severity based on K/L grade [28], 2) knee osteoarthritis symptoms defined as having knee pain, aching, or stiffness on most days of a month during the past year in either knee, 3) knee pain determined by the Western Ontario and McMaster University osteoarthritis (WOMAC) pain index score [31], and 4) history of knee injury.

Statistical Analyses

Baseline characteristics of the sample population used in these analyses were examined using the visit immediately prior to the knee replacement, e.g. the start point of the surgery interval. Weight changes in kilograms, as well as percent weight change, were calculated during each time interval, adjusting for the length of the interval to provide a weight change per year. A meaningful weight change of 2.5% was derived from Medicare guidelines which stipulates a 3 kg weight loss to continue obesity treatment [32]. This is equivalent to approximately 2.5% weight change in this population. Patients were further categorized by meaningful weight change in each time interval: weight loss (-2.5%), weight maintain ($>-2.5\%$ to $<2.5\%$), and weight gain (2.5%). The time intervals were coded -2 to 2 : with 0 indicating the surgery interval; -2 and -1 indicating the time interval 2 years and 1 year before knee replacement interval, respectively; and 1 to 2 indicating the time interval 1 year and 2 years after the knee replacement interval respectively (Figure 1). We analyzed weight change across time intervals with linear and logistic regression using generalized estimating equations (GEEs). Analyses were adjusted for age, gender, BMI, race/ethnicity, education, marital status, income, comorbidity, depression, smoking, and back and lower extremity pain. The knee factors that were included in the analyses included the worst K/L grade across both knees as well as the case and contralateral knee pain, symptoms, and injury. For each interval, time-varying covariates adopted the values from the starting point of that interval. A sensitivity analysis examining whether the type of knee replacement influenced the results produced similar results; thus, the final model included both total and partial knee replacements. Analyses were performed using SAS software, version 9.4 (SAS Institute, Cary, NC).

Results

A total of 210 overweight and obese patients underwent knee replacement (total or partial) between OAI follow-up visits following baseline and up to 96 months. Demographic and health characteristics of these patients at the visit immediately prior to knee replacement are presented in Table 1. The majority of participants were Caucasian (84%), female (62%), completed some post-high school education (80%), and had an income greater than \$50,000 (62%). At the visit immediately before knee replacement, the mean age of participants was 66.4 ± 8.3 years and BMI was 31.4 ± 3.4 kg/m².

Patients' average unadjusted weight changes during each time interval both pre- and post-operatively are displayed in Figure 2. On average, patients lost approximately 0.6kg/year during the time interval around surgery but gained 1.0 kg/year in the interval following surgery. Patients unadjusted weight changes were further categorized into loss (-2.5%), maintain ($<-2.5\%$ to $<2.5\%$), and gain (2.5%) at each time interval (see Figure 3). The time of the surgery was the only interval in which more patients lost weight than gained weight. Nearly one-quarter of patients had a meaningful weight loss; this was the largest proportion losing weight across all of time intervals examined. Opposite of the pattern observed during the time interval of the surgery, in all of the pre- and post-operative intervals, more patients had a meaningful weight gain than weight loss. In the time interval immediately following the surgery, about one-third of patients had a meaningful weight

gain, which was the highest frequency of any interval. Only 11% of patients lost a meaningful amount of weight in this post-operative interval.

The adjusted weight changes compared across each time interval, pre- and post-operatively, to the interval of the surgery (time interval 0) are displayed in Table 2. After adjusting models for SES (BMI, age, gender, race/ethnicity, education and income), health factors (comorbidity, high depressive symptoms, smoking, back pain, hip pain, ankle pain, foot pain) and knee factors (severity, symptoms, pain, and injury), patients who underwent knee replacement were more likely to gain weight during both the pre- and post-operative time intervals as compared to the time interval of the surgery ($p<0.05$).

Table 3 shows the odds ratios of knee replacement patients having a meaningful weight loss (losing at least 2.5% of their initial body weight) both pre- and post-operatively as compared to that of the surgery interval. Patients were significantly less likely to have a meaningful weight loss in the time interval following the surgery interval as compared to the surgery interval after adjusting for SES, health, and knee factors (odds ratio=0.37, 95% confidence interval: 0.18, 0.79).

Discussion

The current study examined weight change patterns pre- and post-operatively among overweight and obese patients with radiographic knee osteoarthritis who underwent knee replacement. The results suggest that while patients are losing weight during the time period around the knee replacement, they are also highly susceptible to weight gain during both the few years before and after the surgery. Additionally, patients are less likely to lose a meaningful amount of weight (2.5%) in the interval immediately following surgery.

During the time interval in which the surgery took place, there was the highest percentage (23%) of patients who lost at least 2.5% of their body weight. Previous research has suggested that obesity increases the risk of surgical and medical complications. Knee replacement patients who are obese have higher rates of post-operative infection rates [9] and thromboembolic events [10]. Further, for each unit increase in body mass index, the risk of an adverse event increases by 8% [12]; thus it is likely that surgeons may be encouraging patients to lose weight prior to knee replacement to help reduce risk of surgical complications and improve outcomes. Current guidelines for the treatment of overweight and obesity recommend weight loss for individuals with a BMI >25 kg/m². Although the current analyses only examined patients who were overweight or obese, the majority of replacement patients have a BMI >25 kg/m² [8, 33]. The time of the surgery may represent an opportune time when patients may be highly motivated to modify their diet and activity behaviors to promote weight loss or prevent weight gain. Additionally, if patients demonstrate early success with weight loss during this period, identifying strategies to maintain increases in self-efficacy has the potential to contribute to further weight loss, weight maintenance, and the prevention of weight gain.

While the weight loss observed during the time interval of the surgery is promising, the weight gain observed in the intervals post-operatively raises red flags. Approximately 33%

of patients are gaining more than 2.5% of their body weight following the surgery. The pattern of more patients gaining weight as compared to losing weight during the post-operative time interval is similar to what was observed in the pre-operative time intervals. The current analyses focused solely on patients who were overweight or obese at baseline; thus, the additional weight gain is concerning as it may heighten the risk of prosthetic failure [10] and joint revision [16]. Additionally, the excess weight may contribute to increased risk of mortality and numerous chronic conditions including diabetes [34, 35]. It is important to highlight that only approximately 11% of patients are losing weight following surgery. The low frequency of individuals who lost weight after surgery challenges a common perception that lifestyle changes such as increased physical activity and weight loss will result from reduced pain and improved function following knee replacement. In fact, some evidence suggests that physical activity remains low, if not lower, following knee replacement as compared to pre-operative levels [36]. The failure to increase physical activity after surgery may be contributing to some of the weight gain observed.

The majority (53%) of patients maintained weight one year post-operatively, which is slightly lower than previous estimates among all knee replacement patients (68.5%) and obese patients (75%). [37] It is likely that these differences are due to varying definitions of weight maintenance used ($\pm 2.5\%$ vs. $\pm 5\%$) and only those with radiographic knee osteoarthritis were included in the current analyses. Weight changes among knee replacement patients appear to be highly variable among individuals, which is similar to other populations [38]. In a recent study, Inacio and colleagues [37] suggest that men were less likely to lose weight after surgery and older patients are less likely to gain weight; however more research is needed to identify additional and consistent characteristics that are linked with both pre- and post-operative weight loss. If specific characteristics are identified, behavioral interventions could be adapted or individually tailored accordingly to meet the specific needs of the patients, ultimately enhancing weight loss.

The current analyses were conducted with adults with radiographic knee osteoarthritis and overweight and obesity. While these characteristics are representative of the typical population who undergoes knee replacement, the results may also differ among patients who are classified within the normal category. Another important consideration to mention is that knee symptoms, severity, and pain on the contralateral knee have the potential to influence mobility, physical activity levels, and body weight. Previous estimates suggest that 80% of patients will develop bilateral osteoarthritis [39], so it is likely that many of the patients who had a primary knee replacement will need another knee replacement on the contralateral knee sometime in their lifetime. While we attempted to control for factors relating to both knees, symptoms in the contralateral knee may be playing a role in the determination of body weight especially in the post-operative interval. Additionally, the rehabilitation protocol that patients followed after surgery could have influenced function, activity, and body weight; however we are unsure of the quality and intensity of rehabilitation each patient received, as well as how well each patient adhered to the rehabilitation plan.

Knee replacement patients with radiographic knee osteoarthritis who are overweight or obese are demonstrating a small weight loss (0.6 kg/year) during the time interval near the surgery; however, patients are gaining weight during both the first few years before and after

the knee replacement. Between 22–33% of patients are gaining more than 2.5% of their body weight and are less likely to lose weight in the 1–2 years after the surgery. The results highlight a significant need for the development of weight management interventions specifically for knee replacement populations to help prevent further weight gain in the years following surgery.

Acknowledgments

Funding: This study was funded in part by the Agency for Healthcare Research and Quality (K12HS023011) and the National Institute for Arthritis and Musculoskeletal Diseases (P60-AR064464, R21-AR068500, R01-AR054155, T32-AR007611).

Glossary

OAI Osteoarthritis Initiative

References

1. Blagojevic M, Jinks C, Jeffery A, Jordan KP. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. *Osteoarthritis Cartilage*. Jan; 2010 18(1):24–33. [PubMed: 19751691]
2. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. *JAMA*. Feb 1; 2012 307(5):491–497. [PubMed: 22253363]
3. Murphy L, Schwartz TA, Helmick CG, et al. Lifetime risk of symptomatic knee osteoarthritis. *Arthritis Rheumatol*. Sep 15; 2008 59(9):1207–1213.
4. Weinstein AM, Rome BN, Reichmann WM, et al. Estimating the burden of total knee replacement in the United States. *J Bone Joint Surg Am*. Mar 6; 2013 95(5):385–392. [PubMed: 23344005]
5. Losina E, Thornhill TS, Rome BN, Wright J, Katz JN. The Dramatic Increase in Total Knee Replacement Utilization Rates in the United States Cannot Be Fully Explained by Growth in Population Size and the Obesity Epidemic. *J Bone Joint Surg Am*. 2012 Feb 01; 94(3):201–207. 00:00:00 2012. [PubMed: 22298051]
6. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of Primary and Revision Hip and Knee Arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am*. 2007 Apr 01; 89(4):780–785. 00:00:00 2007. [PubMed: 17403800]
7. Losina E, Paltiel AD, Weinstein AM, et al. Lifetime Medical Costs of Knee Osteoarthritis Management in the United States: Impact of Extending Indications for Total Knee Arthroplasty. *Arthritis Care Res*. 2015; 67(2):203–215.
8. Fehring TK, Odum SM, Griffin WL, Mason JB, McCoy TH. The Obesity Epidemic: Its Effect on Total Joint Arthroplasty. *J Arthroplasty*. Sep; 2007 22(6, Supplement):71–76.
9. Namba RS, Paxton L, Fithian DC, Stone ML. Obesity and Perioperative Morbidity in Total Hip and Total Knee Arthroplasty Patients. *J Arthroplasty*. Oct; 2005 20(Supplement 3)(0):46–50. [PubMed: 16214002]
10. Guss D, Bhattacharyya T. Perioperative Management of the Obese Orthopaedic Patient. *J Am Acad Orthop Surg*. Jul 1; 2006 14(7):425–432. [PubMed: 16822890]
11. Miric A, Lim M, Kahn B, Rozenenthal T, Bombick D, Sculco TP. Perioperative morbidity following total knee arthroplasty among obese patients. *J Knee Surg*. Spring; 2002 15(2):77–83. [PubMed: 12013077]
12. Dowsey MM, Liew D, Stoney JD, Choong PF. The impact of pre-operative obesity on weight change and outcome in total knee replacement: A prospective study of 529 consecutive patients. *Bone Joint J*. Apr 1; 2010 92-B(4):513–520.

13. Mackie A, Muthumayandi K, Shirley M, Deehan D, Gerrand C. Association Between Body Mass Index Change and Outcome in the First Year After Total Knee Arthroplasty. *J Arthroplasty*. Feb; 2015 30(2):206–209. [PubMed: 25311165]
14. Foran JRH, Mont MA, Rajadhyaksha AD, Jones LC, Etienne G, Hungerford DS. Total knee arthroplasty in obese patients: A comparison with a matched control group. *J Arthroplasty*. Oct; 2004 19(7):817–824. [PubMed: 15483795]
15. Foran JR, Mont MA, Etienne G, Jones LC, Hungerford DS. The outcome of total knee arthroplasty in obese patients. *J Bone Joint Surg Am*. Aug; 2004 86-A(8):1609–1615. [PubMed: 15292406]
16. Spicer D, Pomeroy D, Badenhansen W, et al. Body mass index as a predictor of outcome in total knee replacement. *Int Orthop*. 2001 Aug 01; 25(4):246–249. [PubMed: 11561501]
17. Bruyère O, Ethgen O, Neuprez A, et al. Health-related quality of life after total knee or hip replacement for osteoarthritis: a 7-year prospective study. *Arch Orthop Trauma Surg*. 2012 Nov 01; 132(11):1583–1587. [PubMed: 22842917]
18. Davis AM, Perruccio AV, Ibrahim S, et al. The trajectory of recovery and the inter-relationships of symptoms, activity and participation in the first year following total hip and knee replacement. *Osteoarthr Cartil*. Dec; 2011 19(12):1413–1421. [PubMed: 21889596]
19. de Groot I, Bussmann H, Stam H, Verhaar J. Small Increase of Actual Physical Activity 6 Months After Total Hip or Knee Arthroplasty. *Clin Orthop Relat Res*. 2008 Sep 01; 466(9):2201–2208. [PubMed: 18506555]
20. Woodruff MJ, Stone MH. Comparison of weight changes after total hip or knee arthroplasty. *J Arthroplasty*. Jan; 2001 16(1):22–24. [PubMed: 11172266]
21. Zeni JA Jr, Snyder-Mackler L. Most patients gain weight in the 2 years after total knee arthroplasty: comparison to a healthy control group. *Osteoarthr Cartil*. Apr; 2010 18(4):510–514. [PubMed: 20060949]
22. Abu-Rajab RB, Findlay H, Young D, Jones B, Ingram R. Weight changes following lower limb arthroplasty: a prospective observational study. *Scot Med J*. Feb; 2009 54(1):26–28. [PubMed: 19291932]
23. Donovan J, Dingwall I, McChesney S. Weight change 1 year following total knee or hip arthroplasty. *ANZ journal of surgery*. Apr; 2006 76(4):222–225. [PubMed: 16681536]
24. Ast MP, Abdel MP, Lee Y-y, Lyman S, Ruel AV, Westrich GH. Weight Changes After Total Hip or Knee Arthroplasty. Prevalence, Predictors, and Effects on Outcomes. *J Bone Joint Surg Am*. 2015 Jun 03; 97(11):911–919. 00:00:00 2015. [PubMed: 26041852]
25. Inacio MS, Kritz-Silverstein D, Paxton E, Fithian D. Do Patients Lose Weight After Joint Arthroplasty Surgery? A Systematic Review. *Clin Orthop Relat Res*. 2013 Jan 01; 471(1):291–298. [PubMed: 22956233]
26. Eckstein F, Wirth W, Nevitt MC. Recent advances in osteoarthritis imaging[mdash]the Osteoarthritis Initiative. *Nat Rev Rheumatol*. 2012; 8(10):622–630. 10//print. [PubMed: 22782003]
27. Altman RD, Hochberg M, Murphy WA Jr, Wolfe F, Lequesne M. Atlas of individual radiographic features in osteoarthritis. *Osteoarthr Cartil*. Sep; 1995 3(Suppl A):3–70. [PubMed: 8581752]
28. Peterfy C, Li J, Zaim S, et al. Comparison of fixed-flexion positioning with fluoroscopic semi-flexed positioning for quantifying radiographic joint-space width in the knee: test-retest reproducibility. *Skeletal Radiol*. Mar; 2003 32(3):128–132. [PubMed: 12605275]
29. Katz JN, Chang LC, Sangha O, Fossel AH, Bates DW. Can comorbidity be measured by questionnaire rather than medical record review? *Medical care*. Jan; 1996 34(1):73–84. [PubMed: 8551813]
30. Pandya R, Metz L, Patten SB. Predictive value of the CES-D in detecting depression among candidates for disease-modifying multiple sclerosis treatment. *Psychosomatics*. Mar-Apr; 2005 46(2):131–134. [PubMed: 15774951]
31. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol*. Dec; 1988 15(12):1833–1840. [PubMed: 3068365]

32. Centers for Medicare and Medicaid Services. [Accessed April 14, 2016] Decision Memo for Intensive Behavioral Therapy for Obesity (CAG-00423N). 2011. <https://www.cms.gov/medicare-coverage-database/details/nca-decision-memo.aspx?&NcaName=Intensive%20Behavioral%20Therapy%20for%20Obesity&bc=ACAAAAAIAAAA&NCAId=253>
33. National Institutes of Health. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. *Obes Res.* Sep; 1998 6(Suppl 2):51S–209S. [PubMed: 9813653]
34. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA.* Jan 1; 2003 289(1):76–79. [PubMed: 12503980]
35. Adams KF, Schatzkin A, Harris TB, et al. Overweight, Obesity, and Mortality in a Large Prospective Cohort of Persons 50 to 71 Years Old. *NEJM.* 2006; 355(8):763–778. [PubMed: 16926275]
36. Riddle DL, Perera RA, Stratford PW, et al. Progressing toward, and recovering from, knee replacement surgery: a five-year cohort study. *Arthritis Rheumatol.* 2013; 65(12):3304–3313.
37. Inacio MCS, Silverstein DK, Raman R, et al. Weight Patterns Before and After Total Joint Arthroplasty and Characteristics Associated with Weight Change. *Perm J.* Winter;2014 18(1):25–31. [PubMed: 24626069]
38. King NA, Hopkins M, Caudwell P, Stubbs RJ, Blundell JE. Individual variability following 12 weeks of supervised exercise: identification and characterization of compensation for exercise-induced weight loss. *Int J Obes.* 2007; 32(1):177–184. 09/11/online.
39. Metcalfe AJ, Andersson ML, Goodfellow R, Thorstensson CA. Is knee osteoarthritis a symmetrical disease? Analysis of a 12-year prospective cohort study. *BMC Musculoskelet Disord.* 2012; 13(1): 1–8. [PubMed: 22236253]

Figure 1.
Pre- and post-operative weight change intervals based on two example participants with reported knee replacements
KR=Knee replacement
Annual weight change was obtained and calculated during five separate 1–2 year intervals prior to, including, and subsequent to knee replacement. Since patients underwent knee replacement at different time points during the 8 year follow-up, the time intervals are not identical nor all available across patients.

Figure 2.

Mean annual weight change (kg) during time intervals pre-operatively, around time of the surgery, and post-operatively

Annual weight change was obtained and calculated during five separate 1–2 year intervals prior to, including, and subsequent to knee replacement.

Figure 3.
Percentage of knee replacement patients gaining, losing, or maintaining weight during each time interval

Gain: 2.5% of initial body weight;

Maintain: -2.5% to 2.5% of initial body weight;

Loss: -2.5% of initial body weight

Table 1

Characteristics of Patients with Radiographic Knee Osteoarthritis Immediately Prior to Knee Replacement

Characteristics (% or mean $\pm$ SD)	Knee Replacement Patients (n=210)
Age (yrs)	66.4 $\pm$ 8.3
White	84.3
Female	61.9
Post high school education	79.5
Income <\$50,000/year	37.6
BMI $\geq$ 30 kg/m ²	61.0
Presence of comorbidity ^a	18.6
High depressive symptoms ^b	11.9
Current smoker	6.2
Knee pain ^c	7.3 $\pm$ 4.0
Contralateral knee pain	2.9 $\pm$ 3.3
Knee symptoms ^d	86.7
Contralateral knee symptoms	40.5
Prior knee injury	60.0
Contralateral knee injury	26.7
Back pain	66.2

^a Comorbidities include the report of cancer, cerebrovascular disease, congestive heart failure, diabetes, gastrointestinal disease, pulmonary disease, kidney problems, myocardial infarction, rheumatic disease other than osteoarthritis, vascular disease;

^b Center for Epidemiological Studies Depression score $\geq$ 16;

^c Western Ontario and McMaster University Osteoarthritis Index pain score;

^d Affirmed pain, aching, or stiffness most days of the month past 12 months

Adjusted mean weight change (kg) across each time interval and differences as compared to time of knee replacement

Table 2

Time Intervals	Model 1		Model 2		Model 3		
	Mean ± SE	<i>P</i> [†]	Mean ± SE	<i>P</i> [†]	Mean ± SE	<i>P</i> [†]	
Pre-Op	-2 (n=105)	0.31 ± 0.36	0.029	0.32 ± 0.37	0.028	0.31 ± 0.38	0.037
	-1 (n=184)	0.28 ± 0.25	0.006	0.28 ± 0.25	0.006	0.28 ± 0.24	0.011
Surgery	0 (n=210)	-0.59 ± 0.18	REF	-0.60 ± 0.18	REF	-0.60 ± 0.20	REF
	Reference						
Post-Op	1 (n=123)	0.99 ± 0.28	<.001	1.00 ± 0.28	<.001	1.00 ± 0.33	<.001
	2 (n=51)	0.37 ± 0.37	0.016	0.35 ± 0.37	0.015	0.35 ± 0.36	0.023

Model 1 adjusting factors: BMI, age, gender, race/ethnicity, education, income

Model 2 adjusting factors: Model 1 factors and health (comorbidity, high depressive symptoms, smoking, back pain, hip pain, ankle pain, foot pain)

Model 3 adjusting factors: Models 1 & 2 factors, and knee factors (K/L grade, WOMAC pain, knee symptoms, knee injury).

[†]P-value for testing difference compared to surgery interval weight change

Table 3

Odds Ratios of a meaningful weight loss (-2.5%) during each time interval before and after knee replacement

Time Intervals		Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)
Pre-Op	-2 (n=105)	0.76 (0.42, 1.39)	0.74 (0.40, 1.36)	0.79 (0.43, 1.47)
	-1 (n=184)	0.60 (0.34, 1.05)	0.58 (0.33, 1.03)	0.61 (0.34, 1.07)
Surgery	0 (n=210)	Reference	Reference	Reference
Post-Op	1 (n=123)	0.43 (0.22, 0.83)	0.43 (0.22, 0.83)	0.37 (0.18, 0.79)
	2 (n=51)	0.44 (0.18, 1.07)	0.42 (0.17, 1.05)	0.45 (0.17, 1.18)

Model 1 adjusting factors: BMI, age, gender, race/ethnicity, education, income, weight)

Model 2 adjusting factors: Model 1 factors and health factors (comorbidity, high depressive symptoms, smoking, back pain, hip pain, ankle pain, foot pain)

Model 3 adjusting factors: Models 1 & 2 factors and knee factors (K/L grade, WOMAC pain, knee symptoms, knee injury).