The Journal of Arthroplasty xxx (2022) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Self-Reported Health of Severely Obese US Adults With Osteoarthritis

David C. Landy, MD, PhD [a, *], Jonathan D. Grabau, MD [a], K. Keely Boyle, MD [b], Michael P. Ast, MD [c], James A. Browne, MD [d], Cale A. Jacobs, PhD [a], Stephen T. Duncan, MD [a], Eric M. Hecht, MD PhD [e]

[a] Department of Orthopaedic Surgery, University of Kentucky, Lexington, Kentucky
[b] Department of Orthopaedic Surgery, University of Buffalo, Buffalo, New York
[c] Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, New York
[d] Department of Orthopaedic Surgery, University of Virginia, Charlottesville, Virginia
[e] Institute of Etiological Research, Boca Raton, Florida

ARTICLE INFO

Article history:
Received 18 April 2022
Received in revised form
11 June 2022
Accepted 18 June 2022
Available online xxx

Keywords:
obesity
morbid
osteoarthritis
preoperative care
satisfaction

ABSTRACT

Background: Severe obesity is associated with complications following arthroplasty, leading surgeons to increasingly counsel patients regarding weight loss. For patients seeking arthroplasty, learning that severe obesity may be a relative contraindication to surgery can create a challenging clinical interaction. We sought to describe the self-reported health of United States (US) adults who had severe obesity and osteoarthritis (OA) to better understand patient perspectives.

Methods: The National Health and Nutrition Examination Survey, a nationally representative sample of the US population, was used to identify adult participants who had a body mass index (BMI) over 35 and an OA diagnosis. In total, 889 participants representing a US population of 9,604,722 were included. Self-reported health was dichotomized as poor to fair versus good to excellent. Analyses were weighted to produce national estimates. Associations between obesity severity and patient characteristics with self-reported health were assessed.

Results: Of US adults with a BMI over 35 and OA diagnosis, 64% rated their health as good or better. For adults who had a BMI over 45, 55% still reported their health as good or better. The strongest predictors of self-reported health were measures of physical functioning. Only 37% of participants who had much difficulty walking a quarter mile rated their health as good or better compared to 86% without difficulty ($P < .001$).

Conclusion: Approximately two-thirds of patients who have severe obesity and OA do not perceive their health as compromised and consider decreased physical function as the primary driver of decreased health. This suggests that counseling about the association between obesity and overall health may improve shared decision making and that patient satisfaction metrics may be difficult to interpret in these clinical situations.

Osteoarthritis (OA) resulting in activity limitation affects more than 32 million adults in the United States (US), with the hip and knee being the most commonly affected joints [1,2]. Management of hip and knee OA is initially focused on symptom control through nonoperative strategies such as analgesics, physical therapy, assist device use, and weight loss. When these strategies fail to provide adequate quality of life, total joint arthroplasty (TJA) may become the only remaining treatment option. Obesity is one of the leading risk factors for hip and knee OA [3–6]. In the US, 12% of adults between 40 and 59 years of age are severely obese, defined as a

There was no source of external funding for this work.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to https://doi.org/10.1016/j.arth.2022.06.018.

* Address correspondence to: David C. Landy, MD, PhD, Department of Orthopaedic Surgery, University of Kentucky, 740 S. Limestone, Suite K-419, Lexington, KY 40513.

https://doi.org/10.1016/j.arth.2022.06.018
0883-5403/

body mass index (BMI) greater than 40 [7]. This has created a situation where many patients who have failed nonoperative treatment for OA and referred for orthopaedic evaluation are severely obese.

Unfortunately, patients who have severe obesity have a higher rate of postoperative complications following TJA, including a roughly 4-fold higher rate of infection which may increase even further with more severe obesity [8–13]. Managing these complications including periprosthetic infections can be difficult for patients and adds billions of dollars of cost per year in the US alone [14,15]. This has led severe obesity to be increasingly used as a relative contraindication to TJA despite a lack of alternative treatment options [16–19]. Many surgeons recommend that patients delay elective joint arthroplasty surgery until they can achieve a desired BMI in an effort to improve a modifiable risk factor [20]. Although these decisions may at times be made by payers and hospital systems, surgeons often end up conveying this message, which can create a challenging clinical interaction especially in situations where limited resources for weight management exist.

It is unknown the extent to which patients who have severe obesity and OA consider their health to be compromised. It is possible that many of these patients consider themselves to be in good health and view OA as their most pressing medical issue. This lack of shared understanding may create a barrier to effective communication between patients and surgeons. Limited insight may also predispose some clinical encounters to misunderstanding and unmet expectations. This is especially important as satisfaction surveys and consumer responses gain importance in the evaluation and reimbursement of medical care. Understanding the potential for poor patient experiences is important for not only improving the quality of care, but also for ensuring appropriate evaluations [21,22].

We sought to describe the self-reported health of US adults who had severe obesity and OA to understand the perspective of such patients. This information may inform strategies for improving shared decision making and understanding patient satisfaction metrics.

Materials and Methods

The National Health and Nutrition Examination Survey (NHANES) is a nationally representative, cross-sectional sample of the noninstitutionalized, civilian US population. Participants are selected through a complex, multistage, probability sampling design. In the first stage, counties are randomly selected. In the second stage, specific areas of the counties, such as city blocks, are randomly selected. Households within these areas are then randomly selected. Individuals within these households are then randomly selected to participate. Each participant is given a sampling weight based on their likelihood of having been selected that allows for national estimates to be produced based on the sample.

Selected participants are interviewed by field staff using a mobile examination center that allows for the standardized collection of information such as height and weight as well as additional testing. The survey is currently performed over 2-year cycles by the Centers for Disease Control and Prevention. Given that not all questions are asked across each cycle, we used data across 4 cycles representing the timeframe from January 1, 2011 to December 31, 2018.

Using these NHANES data, we included for analysis participants who were 40 years of age or older and reported that a doctor or other health professional told them they had arthritis (MCQ160a asks, “Has a doctor or other health professional ever told you that you had arthritis?”). Only patients who described their specific type of arthritis as OA or unknown (MCQ195 follows MCQ160a and asks, “Which type of arthritis was it?”) and who had a BMI measured as over 35, consistent with severe obesity, were included. As a part of NHANES, the height and weight of participants is measured in a standardized manner including a digital scale.

Demographic, clinical, and functional characteristics of the included sample are described using the absolute number of participants as well as the weighted number this represents in the US population with percentages provided for the weighted results. Age was categorized into 10-year groups for all analyses so that its effect would not be forced to be linear. Race and Hispanic ethnicity were combined into a single variable. Education was grouped as less than high school, high school degree, or more than high school.

BMI was categorized across obesity thresholds of 35, 40, and 45. These thresholds were selected as they have been proposed thresholds for limiting access to TJA and also because they allowed for an adequate sample size and appropriate precision of association estimates. Other comorbidities examined were diabetes mellitus, smoking, congestive heart failure, heart attack, and stroke. These questions are asked using questions like that for heart attack, MCQ160e which asks, “Ever told you had heart attack?”.

In total, 889 participants 40 years of age or older with OA and a BMI greater than 35 were included, representing a US population of 9,604,722. Participants tended to be females in their fifties and sixties though there was considerable variation across demographic characteristics (Table 1). These patients often had other medical comorbidities and impaired function (Table 2). For example, 31% of these patients had diabetes and 9% had congestive heart failure.

Functional outcomes examined were the ability to walk a quarter mile without assistance (PFQ061b asks, “By yourself and without using any special equipment, how much difficulty do you have walking a quarter of a mile?”) and ability to climb 10 stairs without assistance (PFQ061c asks, “By yourself and without using any special equipment, how much difficulty do you have walking up 10 steps without resting?”).

Self-reported health was measured in NHANES using a Likert-like scale including 5 possibilities: poor, fair, good, very good, and excellent through question HUQ010 which asks, “Would you say your health in general is?”. This measure was then dichotomized with poor and fair health grouped versus good, very good, and excellent health.

Table 1
Demographic Characteristics of Included Participants Who Have Severe Obesity and Osteoarthritis, 40 y of Age and Older.

Characteristic	Unweighted, N	Weighted, N (%)
Gender		
Women	616	6,501,231 (68)
Men	273	3,103,492 (32)
Age (y)		
40-49	141	1,595,609 (17)
50-59	219	2,932,799 (31)
60-69	316	2,950,616 (31)
70-79	165	1,682,769 (18)
>79	48	442,929 (5)
Race/ethnicity		
White, N-H	393	7,093,007 (74)
Black, N-H	266	1,246,012 (13)
Hispanic	183	815,617 (8)
Other	47	450,086 (5)
Education[a]		
Less than high school	214	1,368,446 (14)
High school degree	522	6,218,251 (65)
College degree or more	151	2,010,134 (21)

N-H, non-Hispanic.
[a] There were missing data for education (N = 2).

Table 2
Clinical and Functional Characteristics of Included Participants Who Have Severe Obesity and Osteoarthritis, 40 y of Age and Older.

Characteristic	Unweighted, N	Weighted, N (%)
Obesity by BMI		
35-39.9	477	5,333,467 (56)
40-44.9	224	2,122,399 (22)
45+	188	2,148,856 (22)
Comorbidities		
Diabetes	315	2,936,750 (31)
Smoking	125	1,217,066 (13)
CHF	95	825,309 (9)
Heart attack	75	712,742 (7)
Stroke	51	442,084 (5)
Walk quarter mile[a]		
Unable or much difficulty	420	3,705,017 (39)
Some difficulty	125	1,405,080 (15)
No difficulty	344	4,494,626 (47)
Climb 10 stairs[a]		
Unable or much difficulty	372	3,117,732 (32)
Some difficulty	120	1,346,930 (14)
No difficulty	397	5,140,061 (54)

BMI, body mass index; CHF, congestive heart failure.
[a] Patients having to use an assist device were assumed to have much difficulty or be unable to do so.

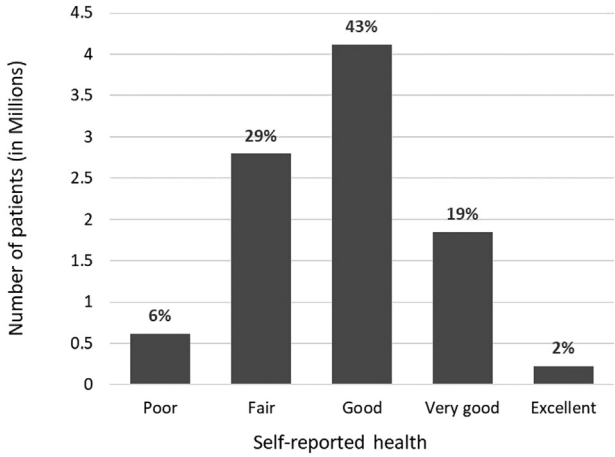

Fig. 1. Self-reported health of included participants with severe obesity and osteoarthritis, 40 years of age and older. Bars represented the expected population in the United States with these inclusion criteria and responses. Percentages are also included.

Univariable associations among demographic, clinical, and functional characteristics with self-reported health were assessed using frequencies and chi-squared tests. Logistic regressions were used to assess multivariable associations. For multivariable models, obesity severity was included along with the strongest demographic, clinical, and functional predictors. Odds ratios and CIs were reported.

For the strongest functional predictor, the proportion of patients who attributed their decreased function specifically to arthritis was assessed. Sensitivity analyses were then conducted in which only decreased function specific to arthritis was included in the multivariable model. Additionally, participants who had a diagnosis of OA were then compared to participants who did not have a diagnosis of arthritis, stratified by obesity severity, with chi-squared tests used to assess statistical significance.

All statistical analyses were performed using SAS Version 9.4 (SAS Institute, Cary, NC) with appropriate survey-specific commands selected and cluster, strata, and weight information used. The weighting was adjusted for the inclusion of multiple cycles. An alpha threshold of 0.05 was selected for precision estimates and no adjustments were made for examining multiple predictor variables.

Results

Of US adults over years of age with a BMI over 35 and OA diagnosis, most (64%) rated their health as good or better (Fig. 1). As the level of obesity increased, self-reported health decreased, although 55% of participants who had a BMI of 45 or greater still reported their health as good to excellent (Table 3).

Although age, gender, and race did not have strong univariable associations with self-reported health, higher education was associated with an increased self-reported health (Table 4). Medical comorbidities had univariable associations with self-reported health with a history of heart attack being the strongest clinical predictor of decreased self-reported health. Regarding univariable associations with self-reported health, difficultly walking a quarter mile was the strongest predictor of decreased self-reported health. Multivariable analysis demonstrated findings consistent with the univariable analysis (Table 5).

Of patients reporting functional limitations, 72% reported they were specifically due to arthritis. Sensitivity analyses including only decreased physical functioning due to arthritis showed that this remained a strong predictor of self-reported health with participants having much difficulty walking a quarter mile being less likely to rate their health as good to excellent (odds ratio, 0.24; 95% CI, 0.15-0.38).

Among patients who had a BMI greater than 35, a diagnosis of arthritis was associated with decreased self-reported health when stratified by obesity severity (Table 6).

Discussion

Given US trends regarding the obesity epidemic, life expectancy, and functional expectations, it is likely that patients who have OA and severe obesity will continue to present to orthopaedic surgeons with an interest in TJA. Understanding how to optimize this challenging clinical interaction is important. This study described the self-reported health of a representative sample of US adults who had OA and severe obesity, finding that two-thirds describe their health favorably and that functional limitations are the main driver of decreased self-reported health.

Even among US adults who have OA and a BMI over 45, over half described their health as good or better. Many patients who have severe obesity seeking OA treatment may not perceive their health as compromised despite well-established associations between severe obesity and poor health outcomes including not only complications following TJA, but even all-cause mortality [8–12,23]. Higher morbidity in association with obesity has been observed for diabetes, cardiac disease, stroke, respiratory problems, some types of cancers, and mental health disorders such as depression [24]. For patients who consider their health to be good, it may be surprising to learn that their obesity is a relative contraindication to TJA and how their obesity is associated with their risk of complications. At present, it may be helpful for surgeons to not assume that patients enter these encounters with such an understanding.

Although the presence of medical comorbidities, such as cardiovascular disease and stroke, were associated with decreased self-reported health, measures of physical functioning were most strongly associated. This potential lack of insight regarding overall health status is an important finding and identifies a potential barrier to communication. This further underscores the importance of helping patients to understand the association between severe obesity and general health. It is likely that many patients

Table 3
Association of Participant Obesity Severity With Self-Reported Health.

Obesity Class	Self-Reported Health					*P* Value
	Poor	Fair	Good	Very Good	Excellent	
	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	
BMI						
35-39.9	278,516 (5)	1,252,425 (23)	2,271,837 (43)	1,396,901 (26)	133,788 (3%)	
40-44.9	115,060 (5)	791,170 (37)	940,097 (44)	207,750 (10)	68,321 (3)	
45+	225,454 (10)	750,523 (35)	905,232 (42)	243,287 (11)	24,361 (1)	<.001

BMI, body mass index.

will assume that TJA and improved function will result in improved general health. Although medical comorbidity, OA, and physical function are associated, these relationships are complex. For instance, patients should not assume they will lose weight after TJA which is a common misperception [25–28]. Future research is needed to understand how best to communicate this complex information. This association was reinforced by results suggesting that an OA diagnosis itself was associated with decreased self-reported health even after stratifying by obesity severity.

Table 4
Univariable Associations of Participant Characteristics With Self-Reported Health.

Characteristic	Self-Reported Health		*P* Value
	Fair or Poor	Good to Excellent	
	Weighted, N (%)	Weighted, N (%)	
Gender			
Female	2,293,210 (35)	4,208,020 (65)	
Male	1,119,937 (36)	1,983,555 (64)	.87
Age			
40-49	617,963 (39)	977,646 (61)	
50-59	945,473 (32)	1,987,326 (68)	
60-69	1,121,510 (38)	1,829,106 (62)	
70-79	503,394 (30)	1,179,375 (70)	
80+	224,807 (51)	218,122 (49)	.19
Race/ethnicity			
White, N-H	2,284,548 (32)	4,808,459 (68)	
Black, N-H	505,690 (41)	740,323 (59)	
Hispanic	469,824 (58)	345,794 (42)	
Other	153,807 (34)	296,999 (66)	<.001
Education			
Less than high school	872,729 (64)	495,717 (36)	
High school degree	2,122,669 (34)	4,095,582 (66)	
College degree or more	412,484 (21)	1,597,651 (79)	<.001
Diabetes			
No	1,755,563 (28)	4,459,0115 (62)	
Yes	1,657,495 (49)	1,732,559 (51)	<.001
Smoking			
No	2,826,478 (34)	5,561,179 (66)	
Yes	586,670 (48)	630,396 (52)	.05
CHF			
No	2,883,546 (33)	5,893,987 (67)	
Yes	529,601 (64)	295,707 (36)	<.001
Heart attack			
No	2,960,534 (33)	5,927,739 (67)	
Yes	452,613 (64)	260,129 (36)	<.001
Stroke			
No	3,073,542 (34)	6,087,033 (66)	
Yes	339,606 (77)	102,478 (23)	<.001
Walk quarter mile			
No difficulty	637,805 (14)	3,856,821 (86)	
Some difficulty	447,319 (32)	957,760 (68)	
Much difficulty or unable	2,328,024 (63)	1,376,993 (37)	<.001
Climb 10 stairs			
No difficulty	909,012 (18)	4,231,049 (82)	
Some difficulty	505,751 (38)	841,180 (62)	
Unable or much difficulty	1,998,386 (64)	1,119,346 (36)	<.001

N-H, non-Hispanic; CHF, congestive heart failure.

Patients who have OA and severe obesity are likely referred for TJA because nonsurgical options have failed to provide sufficient symptom relief. Weight loss is a key strategy for decreasing OA symptoms, improving gait mechanics, and decreasing the likelihood of complications after TJA [11,28–32]. Weight loss can be challenging and many patients may have limited resources to help with weight management. In addition to education on the health impact of obesity, future research and public health work is needed to pair patients with severe obesity and an interest in weight loss with programs that may help. This may ultimately be a favorable time at which to connect patients with such plan. Further work is also needed to define the extent to which weight loss actually modifies the risks following TJA [33].

These results also highlight a potential limitation of using patient satisfaction surveys or customer rating systems to evaluate the quality of medical care. In some health care systems, referral to an orthopaedic surgeon and evaluation for TJA may not even be accessible to patients with severe obesity. How such referral patterns either enhance or hinder access to weight loss programs and interest in these is unknown. For those patients who do present for surgical evaluation, it is understandable that they may be discouraged or even dissatisfied to learn that their weight is a relative contraindication to TJA. This may be especially difficult for patients who have been told TJA is their only remaining treatment option and have not been previously counseled regarding their weight. Quality care measures intended to assess physician performance may be biased against practices with such high-risk patients. Previous work is limited but has shown that patients' perception of care may correlate better with interpersonal communication than quality [34–37]. In the clinic setting, being a return visit appears to be the strongest known predictor of satisfaction [38,39]. Prior work in TJA has shown only a weak association

Table 5
Multivariable Associations of Participant Characteristics With Self-Reported Health.

Characteristic	Self-Reporting Good to Excellent Health
	Odds Ratio (95% CI)
Obesity class, BMI	
35-39.9	1.00 (Reference)
40-44.9	0.62 (0.36-1.07)
45+	0.59 (0.35-0.99)
Education	
Less than high school	1.00 (Reference)
High school degree	3.13 (1.92-5.09)
College degree or more	4.99 (2.02-12.35)
Heart attack	
No	1.00 (Reference)
Yes	0.39 (0.20-0.76)
Walk quarter mile	
No difficulty	1.00 (Reference)
Some difficulty	0.41 (0.22-0.77)
Much difficulty or unable	0.12 (0.07-0.21)

BMI, body mass index.

Table 6
Association of an Arthritis Diagnosis With Self-Reported Health Stratified by Participant Obesity Severity.

Obesity Class	Self-Reported Health					*P* Value
	Poor	Fair	Good	Very Good	Excellent	
	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	Weighted, N (%)	
35-39.9						
Arthritis	278,516 (5)	1,252,425 (23)	2,271,837 (43)	1,396,901 (26)	133,788 (3)	
No arthritis	196,467 (3)	1,442,390 (21)	3,065,656 (44)	1,931,250 (28)	271,022 (4)	<.001
40-44.9						
Arthritis	115,060 (5)	791,170 (37)	940,097 (44)	207,750 (10)	68,321 (3)	
No arthritis	83,239 (3)	1,040,475 (32)	1,505,124 (46)	525,318 (16)	95,577 (3)	<.001
45+						
Arthritis	225,454 (10)	750,523 (35)	905,232 (42)	243,287 (11)	24,361 (1)	
No arthritis	70,469 (4)	500,577 (31)	775,467 (48)	258,570 (16)	8,946 (1)	.02

BMI, body mass index.

between patient satisfaction with care at the time of TJA and outcomes at 2 years postoperatively with initial satisfaction largely driven by pain [34,35].

The results presented should be viewed in light of several limitations. Using NHANES data, it is not possible to know which specific joints were affected by OA. For instance, patients could have shoulder OA, hip OA, or both. Limiting the sample to patients who have OA and difficulty walking or climbing stairs likely selected for primarily patients with knee or hip OA though other affected joints are potentially included. Similarly, it is not possible to know the radiographic severity of OA. Limiting the sample to patients with functional limitations likely selected for patients who had more severe disease; however, this cannot be quantified. It is also not possible to know what prior treatments these patients had for their OA. Although these limitations are present, it is not clear if this would bias study results. For instance, patients who have ankle and knee OA and have the same functional limitations may not have dissimilar views of their self-reported health. Likewise, patients with radiographically moderate and severe OA who have the same functional limitations may not have dissimilar views of their self-reported health. A key strength of this study is the quality of NHANES data. It uses a robust population-based cluster random selection method in order to collect data from a sample representative of the entire US population. Data are collected with rigorous quality control and quality assurance measures. For example, height and weight are collected accurately by trained staff persons.

Conclusions

Approximately two-thirds of patients who have severe obesity and OA do not perceive their health to be compromised and view their functional limitations from OA as the primary driver of their health. This can create a disconnect between patients and orthopaedic surgeons when it comes to consideration of weight as a risk factor and relative contraindication for a TJA. Although future studies are needed to better understand how to best manage these patients, it is necessary to counsel patients on the association between obesity and overall health so that they and their providers can have treatment discussions with a shared understanding of underlying health. These results also suggest that patient satisfaction metrics may be difficult to interpret in these clinical situations which warrants further study given their increasing use.

References

[1] GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2018;392:1789–858.
[2] Hawker GA. Osteoarthritis is a serious disease. Clin Exp Rheumatol 2019;37(Suppl 120):3–6.
[3] Aspden RM. Obesity punches above its weight in osteoarthritis. Nat Rev Rheumatol 2011;7:65–8.
[4] Felson DT, Anderson JJ, Naimark A, Walker AM, Meenan RF. Obesity and knee osteoarthritis. The framingham study. Ann Intern Med 1988;109:18–24.
[5] Issa RI, Griffin TM. Pathobiology of obesity and osteoarthritis: integrating biomechanics and inflammation. Pathobiol Aging Age Relat Dis 2012;2:17470. https://doi.org/10.3402/pba.v2i0.17470.
[6] Koonce RC, Bravman JT. Obesity and osteoarthritis: more than just wear and tear. J Am Acad Orthop Surg 2013;21:161–9.
[7] Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity and severe obesity among adults: United States, 2017–2018. NCHS Data Brief, no 360. Hyattsville, MD: National Center for Health Statistics; 2020. p. 1–8.
[8] Belmont Jr PJ, Goodman GP, Waterman BR, Bader JO, Schoenfeld AJ. Thirty-day postoperative complications and mortality following total knee arthroplasty: incidence and risk factors among a national sample of 15,321 patients. J Bone Joint Surg Am 2014;96:20–6.
[9] Chaudhry H, Ponnusamy K, Somerville L, McCalden RW, Marsh J, Vasarhelyi EM. Revision rates and functional outcomes among severely, morbidly, and super-obese patients following primary total knee arthroplasty: a systematic review and meta-analysis. JBJS Rev 2019;7:e9.
[10] D'Apuzzo MR, Novicoff WM, Browne JA. The John Insall Award: morbid obesity independently impacts complications, mortality, and resource use after TKA. Clin Orthop Relat Res 2015;473:57–63.
[11] Fournier MN, Hallock J, Mihalko WM. Preoperative optimization of total joint arthroplasty surgical risk: obesity. J Arthroplasty 2016;31:1620–4.
[12] Kapadia BH, Berg RA, Daley JA, Fritz J, Bhave A, Mont MA. Periprosthetic joint infection. Lancet 2016;387:386–94.
[13] Werner BC, Higgins MD, Pehlivan HC, Carothers JT, Browne JA. Super obesity is an independent risk factor for complications after primary total hip arthroplasty. J Arthroplasty 2017;32:402–6.
[14] Premkumar A, Kolin DA, Farley KX, Wilson JM, McLawhorn AS, Cross MB, et al. Projected economic burden of periprosthetic joint infection of the hip and knee in the United States. J Arthroplasty 2021;36:1484–1489.e3.
[15] Brochin RL, Phan K, Poeran J, Zubizarreta N, Galatz LM, Moucha CS. Trends in periprosthetic hip infection and associated costs: a population-based study assessing the impact of hospital factors using national data. J Arthroplasty 2018;33:S233–8.
[16] Adhikary SD, Liu WM, Memtsoudis SG, Davis CM, Liu J. Body mass index more than 45 kg/m^2 as a cutoff point is associated with dramatically increased postoperative complications in total knee arthroplasty and total hip arthroplasty. J Arthroplasty 2016;31:749–53.
[17] Foreman CW, Callaghan JJ, Brown TS, Elkins JM, Otero JE. Total joint arthroplasty in the morbidly obese: how body mass index >/=40 influences patient retention, treatment decisions, and treatment outcomes. J Arthroplasty 2020;35:39–44.
[18] Ricciardi BF, Giori NJ, Fehring TK. Clinical faceoff: should orthopaedic surgeons have strict BMI cutoffs for performing primary TKA and THA? Clin Orthop Relat Res 2019;477:2629–34.
[19] Sherman WF, Patel AH, Kale NN, Freiberger CM, Barnes CL, Lee OC. Surgeon decision-making for individuals with obesity when indicating total joint arthroplasty. J Arthroplasty 2021;36:2708–2715.e1.
[20] Workgroup of the American Association of Hip and Knee Surgeons Evidence Based Committee. Obesity and total joint arthroplasty: a literature based review. J Arthroplasty 2013;28:714–21.
[21] Goldman AH, Kates S. Pay-for-performance in orthopedics: how we got here and where we are going. Curr Rev Musculoskelet Med 2017;10:212–7.
[22] Elliott MN, Beckett MK, Lehrman WG, Cleary P, Cohea CW, Giordano LA, et al. Understanding the role played by Medicare's patient experience points system in hospital reimbursement. Health Aff (Millwood) 2016;35:1673–80.

[23] Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. JAMA 2013;309:71–82.
[24] National Institutes of Health. National heart, lung, and blood Institute in cooperation with the national Institute of diabetes and digestive and kidney diseases. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report [Internet]. 1998 Sep [cited 2013 Jan 17]. NIH Publication no. 98-4083. Available from: http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf [accessed 07.02.22].
[25] Liu SY, Zhu WT, Chen BW, Chen YH, Ni GX. Bidirectional association between metabolic syndrome and osteoarthritis: a meta-analysis of observational studies. Diabetol Metab Syndr 2020;12:38. https://doi.org/10.1186/s13098-020-00547-x.
[26] Williams A, Kamper SJ, Wiggers JH, O'Brien KM, Lee H, Wolfenden L, et al. Musculoskeletal conditions may increase the risk of chronic disease: a systematic review and meta-analysis of cohort studies. BMC Med 2018;16:167. https://doi.org/10.1186/s12916-018-1151-2.
[27] Ast MP, Abdel MP, Lee YY, 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;97:911–9.
[28] Kandil A, Novicoff WM, Browne JA. Obesity and total joint arthroplasty: do patients lose weight following surgery? Phys Sportsmed 2013;41:34–7.
[29] Christensen R, Astrup A, Bliddal H. Weight loss: the treatment of choice for knee osteoarthritis? A randomized trial. Osteoarthritis Cartilage 2005;13:20–7.
[30] Richette P, Poitou C, Garnero P, Vicaut E, Bouillot JL, Lacorte JM, et al. Benefits of massive weight loss on symptoms, systemic inflammation and cartilage turnover in obese patients with knee osteoarthritis. Ann Rheum Dis 2011;70:139–44.
[31] Li JS, Tsai TY, Clancy MM, Li G, Lewis CL, Felson DT. Weight loss changed gait kinematics in individuals with obesity and knee pain. Gait Posture 2019;68:461–5.
[32] Mellion KM, Grover BT. Obesity, bariatric surgery, and hip/knee arthroplasty outcomes. Surg Clin North Am 2021;101:295–305.
[33] Middleton AH, Kleven AD, Creager AE, Hanson R, Tarima SS, Edelstein AI. Association between nonsurgical weight loss from body mass index >40 to body mass index <40 and complications and readmissions following total hip arthroplasty. J Arthroplasty 2022;37:518–23.
[34] Chang JT, Hays RD, Shekelle PG, MacLean CH, Solomon DH, Reuben DB, et al. Patients' global ratings of their health care are not associated with the technical quality of their care. Ann Intern Med 2006;144:665–72.
[35] Rao M, Clarke A, Sanderson C, Hammersley R. Patients' own assessments of quality of primary care compared with objective records based measures of technical quality of care: cross sectional study. BMJ 2006;333:19. https://doi.org/10.1136/bmj.38874.499167.7C.
[36] Mohamed NS, Gwam CU, Etcheson JI, Castrodad IMD, Gitarts SL, Jetty AS, et al. Pain intensity: how Press Ganey survey domains correlate in total knee arthroplasty patients. J Knee Surg 2020;33:48–52.
[37] Kahlenberg CA, Gibbons JAB, Mehta BY, Antao VC, Lai EY, Do HT, et al. Satisfaction with the process vs outcome of care in total hip and knee arthroplasty. J Arthroplasty 2022;37:419–24.
[38] Tisano BK, Nakonezny PA, Gross BS, Martinez JR, Wells JE. Depression and non-modifiable patient factors associated with patient satisfaction in an academic orthopaedic outpatient clinic: is it more than a provider issue? Clin Orthop Relat Res 2019;477:2653–61.
[39] Wells J, Batty M, Box H, Nakonezny PA. Effect of Patient Body Mass Index. Recommendation for weight modification, and nonmodifiable factors on patient satisfaction. J Am Acad Orthop Surg 2020;28:e448–55.