The Journal of Arthroplasty 40 (2025) S18–S20

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

World Expert Meeting in Arthroplasty 2024

Is There a Threshold Limit for Body Mass Index for Patients Undergoing Primary Total Knee or Total Hip Arthroplasty?

Elizabeth K. Carlino, MD [a], Kyle H. Cichos, PhD [a, b, *], Sultan Al Maskari, MD [c], Federico J. Burgo, MD [d], Richard de Steiger, PhD [e], Seper Ekhtiari, MD [f], Antron Spooner, MD [a], Fatih Yildiz, MD [g], Elie S. Ghanem, MD [h]

[a] Hughston Foundation, Columbus, Georgia
[b] Hughston Clinic, Columbus, Georgia
[c] Department of Orthopaedic Surgery, Oman International Hospital, Muscat, Oman
[d] Department of Orthopedic Surgery, Hospital Universitario Austral, Buenos Aires, Argentina
[e] Department of Surgery, Epworth Healthcare, University of Melbourne, Melbourne, Australia
[f] Division of Orthopaedic Surgery, Department of Surgery, McMaster University, Hamilton, Ontario, Canada
[g] Department of Orthopaedic Surgery, Bezmialem Vakif University, İstanbul, Türkiye
[h] Department of Orthopaedic Surgery, University of Missouri, Columbia, Missouri

ARTICLE INFO

Article history:
Received 20 September 2024
Received in revised form
6 October 2024
Accepted 8 October 2024
Available online 18 October 2024

Keywords:
arthroplasty
hip
knee
BMI
obesity
outcomes

Is There a Threshold Limit for Body Mass Index for Patients Undergoing Primary Total Knee or Total Hip Arthroplasty?

Response/Recommendation: Although most studies show a higher complication rate in patients who have a higher body mass index (BMI), we are unable to determine an exact threshold for BMI in patients undergoing primary total joint arthroplasty (TJA).

Level of Evidence: Moderate.

Expert Vote: Agree (77.8%), Disagree (13.7%), Abstain (8.5%).

Rationale

Results from prior studies indicate an increased rate of complications in patients who have a higher body mass index (BMI) undergoing TJA, though the exact threshold for BMI beyond which complications are unacceptable in these patients remains unknown. There were two recent meta-analyses and systematic reviews that reported patients who have BMI $\geq$ 30 undergoing primary total knee arthroplasty (TKA) and total hip arthroplasty (THA), respectively, had increased risk of revisions (odds ratio (OR) 1.15, 95% confidence interval (CI): 1.08 to 1.24, $P < 0.0001$; OR 1.44, 95% CI: 1.32 to 1.57, $P < 0.001$), deep infections (OR 1.47, 95% CI: 1.27 to 1.69, $P < 0.0001$; OR 2.71, 95% CI: 2.08 to 3.53, $P < 0.001$), superficial infections (OR 1.59, 95% CI: 1.32 to 1.91, $P < 0.0001$; OR 1.99, 95% CI: 1.55 to 2.55, $P < 0.001$), readmissions (OR 1.21, 95% CI: 1.05 to 1.40, $P = 0.009$; OR 1.37, 95% CI: 1.15 to 1.63, $P < 0.001$), and all complications (OR 1.21, 95% CI: 1.06 to 1.38, $P = 0.004$; OR 1.53, 95% CI: 1.30 to 1.80, $P < 0.001$) compared to patients who have BMI < 30 [1,2]. Patients who have BMI $\geq$ 30 undergoing THA also had an increased risk of dislocations (OR 1.72, 95% CI: 1.66 to 1.79, $P <$ 0.001) and reoperations (OR 1.61, 95% CI: 1.40 to 1.85, $P < 0.001$),

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.2024.10.040.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

* Address correspondence to: Kyle H. Cichos, PhD, Hughston Foundation, Hughston Clinic, 6262 Veterans Pkwy, Columbus, GA 31909.

https://doi.org/10.1016/j.arth.2024.10.040

and those undergoing TKA had a higher risk of wound dehiscence (OR 1.46, 95% CI: 1.24 to 1.72, $P < 0.0001$) [1,2]. Meanwhile, there was no difference between BMI groups in risk of VTE, nerve injuries, aseptic loosening, or periprosthetic fracture in either THA or TKA and no increased risk of reoperations in TKA [1,2]. A review of additional literature shows similar results [3–26], but determining a BMI threshold remains challenging.

Notable barriers to the identification of an appropriate BMI threshold include appreciable heterogeneity in study design and lack of control of confounding variables. There is significant variability in BMI grouping across studies. Comparison of patients who have a BMI $\geq$ 30 to BMI <30 often overestimates complication rates in a large portion of patients, as evidenced by reports from studies that further stratify groups at higher BMI [11,12,15]. One study that further separated patients who have a BMI > 30, > 40, and > 50 reported an increased risk of complications following primary THA in only the BMI > 40 and > 50 groups when compared to BMI < 30. In addition, they reported an increased risk of PJI at 1- and 2-year postoperatively in the BMI > 50 groups when compared to the BMI > 40 group [12]. However, many studies only compare high BMI groups to patients who have normal BMI, and very few studies assess the risk of TJA complications associated with a lower-than-normal BMI [27].

There are two studies that utilized stratum-specific likelihood ratio to group patients according to BMI thresholds when comparing major complications within 30 days postoperatively. The first identified four BMI thresholds in patients undergoing TKA: 19 to 33, 34 to 38, 39 to 50, and >50. Compared to patients who have BMI 19 to 33, there was an increased risk of 30-day major complications with a BMI 34 to 38 (OR 1.1), BMI 39 to 50 (OR 1.3), and BMI > 50 (OR 2.1) [28]. The second identified four BMI thresholds in patients undergoing THA: 19 to 31, 32 to 37, 38 to 49, and $\geq$ 50. Compared to patients who have BMI 19 to 31, there was an increased risk of major 30-day complications with a BMI of 32 to 37 (OR 1.2), BMI 38 to 49 (OR 1.6), and BMI $\geq$ 50 (OR 2.5) [29]. Still, the stratified groups in each study were only compared to their respective control group, and the clinical relevance of these 30-day postoperative outcomes is unclear.

Studies also rarely adjusted for potential confounders, rendering difficulty in separating BMI as an independent variable. Most studies only adjusted for age, sex, and CCI/ECI either via matched cohorts or through multivariable regression analysis [3–5,9,10]. While several others adjusted for diabetes, none differentiated between those who were controlled versus uncontrolled [4,13,16,17,24]. Several studies adjusted for additional variables, though most did not include pertinent confounders with known associations with the reported postoperative outcomes [6,11,13,16,17]. Relevant perioperative variables associated with high risk for postoperative complications were absent from most studies, including— among others— preoperative albumin, HbA1c, operative duration, and DVT prophylaxis.

Studies that analyzed the functional and patient-reported outcome measures following TJA also have highly discordant BMI groupings, and are therefore difficult to interpret collectively. Many studies in our review reported no difference in postoperative improvement, including knee flexion, VAS pain scores, and patient-reported outcome measures, between BMI groups [17,22–26]. Meanwhile, some reported a greater improvement in higher BMI groups compared to the nonobese BMI group [7,14].

Given the incongruity in the literature across all BMI groups, BMI as a standalone screening tool and an absolute contraindication to surgery without considering all relevant patient factors is not recommended. Further studies that adequately control for pertinent confounding variables with increased risk of complications are necessary to assess the independent association of BMI with TJA outcomes and create a working algorithm for patient screening. Therefore, we cannot recommend a specific BMI threshold to utilize as a screening for postoperative complications but rather emphasize incorporating BMI as a component of the comprehensive preoperative clinical assessment that encompasses more impactful patient-related variables. However, we do caution surgeons when contemplating surgery for morbidly obese and super obese patients to conduct a thorough assessment of associated comorbidities including anemia, malnutrition, metabolic syndrome, and other significant risk factors, as these variables are likely to be associated with these higher BMI categories and significantly increase the risk of postoperative complications.

CRediT authorship contribution statement

Elizabeth K. Carlino: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Kyle H. Cichos:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sultan Al Maskari:** Writing – review & editing, Visualization, Investigation, Conceptualization. **Federico J. Burgo:** Writing – review & editing, Visualization, Investigation, Conceptualization. **Richard de Steiger:** Writing – review & editing, Visualization, Methodology, Investigation, Conceptualization. **Seper Ekhtiari:** Writing – review & editing, Visualization, Investigation, Conceptualization. **Antron Spooner:** Writing – review & editing, Investigation, Data curation. **Fatih Yildiz:** Writing – review & editing, Visualization, Investigation, Conceptualization. **Elie S. Ghanem:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization.

References

[1] Onggo JR, Ang JJM, Onggo JD, de Steiger R, Hau R. Greater risk of all-cause revisions and complications for obese patients in 3 106 381 total knee arthroplasties: a meta-analysis and systematic review. ANZ J Surg 2021;91:2308–21. https://doi.org/10.1111/ans.17138.

[2] Onggo J, Onggo J, De Steiger R, Hau R. Greater risks of complications, infections, and revisions in the obese versus non-obese total hip arthroplasty population of 2,190,824 patients: a meta-analysis and systematic review. Osteoarthritis Cartilage 2020;28:31–44.

[3] Abdulla I, Mahdavi S, Khong H, Gill R, Powell J, Johnston KD, et al. Does body mass index affect the rate of adverse outcomes in total hip and knee arthroplasty? A retrospective review of a total joint replacement database. Can J Surg 2020;63:E142–9. https://doi.org/10.1503/cjs.006719.

[4] Correa-Valderrama A, Stangl-Herrera W, Echeverry-Vélez A, Cantor E, Ron-Translateur T, Palacio-Villegas JC. Relationship between body mass index and complications during the first 45 days after primary total hip and knee replacement: a single-center study from south America. Clin Orthop Surg 2019;11:159–63. https://doi.org/10.4055/cios.2019.11.2.159.

[5] Friedman RJ, Hess S, Berkowitz SD, Homering M. Complication rates after hip or knee arthroplasty in morbidly obese patients. Clin Orthop Relat Res 2013;471:3358–66. https://doi.org/10.1007/s11999-013-3049-9.

[6] Jeschke E, Gehrke T, Günster C, Heller K-D, Leicht H, Malzahn J, et al. Reoperation and complication rates after hip and knee replacement surgery in 1 046 145 obese patients. Dtsch Arztebl Int 2023;120:501–2. https://doi.org/10.3238/arztebl.m2023.0067.

[7] Namba RS, Paxton L, Fithian DC, Stone ML. Obesity and perioperative morbidity in total hip and total knee arthroplasty patients. J Arthroplasty 2005;20:46–50. https://doi.org/10.1016/j.arth.2005.04.023.

[8] Acuña AJ, Forlenza EM, Serino 3rd J, Terhune EB, Della Valle CJ. Body mass index does not drive the risk for early postoperative instability after total hip arthroplasty: a matched cohort analysis. J Arthroplasty 2024;39(9S2):S301–305.e3. https://doi.org/10.1016/j.arth.2024.03.023.

[9] Aggarwal VA, Sambandam SN, Wukich DK. The impact of obesity on total knee arthroplasty outcomes: a retrospective matched cohort study. J Clin Orthop Trauma 2022;33:101987. https://doi.org/10.1016/j.jcot.2022.101987.

[10] Aggarwal VA, Sambandam S, Wukich D. The impact of obesity on total hip arthroplasty outcomes: a retrospective matched cohort study. Cureus 2022;14:e27450. https://doi.org/10.7759/cureus.27450.
[11] Ashkenazi I, Thomas J, Lawrence KW, Meftah M, Rozell JC, Schwarzkopf R. The impact of obesity on total hip arthroplasty outcomes when performed by high-volume surgeons-A propensity matched analysis from a high-volume Urban center. J Arthroplasty 2024;39:1412–8. https://doi.org/10.1016/j.arth.2024.02.066.
[12] Chen Z, Sax OC, Bains SS, Salib CG, Paulson AE, Verma A, et al. Super-obese patients are associated with significant infection burden after total hip arthroplasty. Hip Int 2023;33:806–11. https://doi.org/10.1177/11207000221144740.
[13] Matar HE, Pincus D, Paterson JM, Aktar S, Jenkinson R, Ravi B. Early surgical complications of total hip arthroplasty in patients with morbid obesity: propensity-matched cohort study of 3683 patients. J Arthroplasty 2020;35:2646–51. https://doi.org/10.1016/j.arth.2020.04.044.
[14] Singh V, Yeroushalmi D, Lygrisse KA, Schwarzkopf R, Davidovitch RI. Impact of obesity on the forgotten joint score following primary total hip arthroplasty. J Arthroplasty 2021;36:1342–7. https://doi.org/10.1016/j.arth.2020.10.027.
[15] Curtis A, Manara J, Doughty B, Beaumont H, Leathes J, Putnis SE. Severe obesity in total knee arthroplasty occurs in younger patients with a greater healthcare burden and complication rate. Knee 2024;46:27–33. https://doi.org/10.1016/j.knee.2023.11.010.
[16] Nelson CL, Elkassabany NM, Kamath AF, Liu J. Low albumin levels, more than morbid obesity, are associated with complications after TKA. Clin Orthop Relat Res 2015;473:3163–72. https://doi.org/10.1007/s11999-015-4333-7.
[17] Siegel MA, Patetta MJ, Fuentes AM, Haleem AS, Forsthoefel CW, Sood A, et al. Long-term postoperative total knee arthroplasty flexion scores in relation to body mass index. J Knee Surg 2022;35:782–7. https://doi.org/10.1055/s-0040-1718601.
[18] Wall CJ, Vertullo CJ, Kondalsamy-Chennakesavan S, Lorimer MF, de Steiger RN. A prospective, longitudinal study of the influence of obesity on total knee arthroplasty revision rate: results from the Australian orthopaedic association national joint replacement registry. J Bone Joint Surg Am 2022;104:1386–92. https://doi.org/10.2106/JBJS.21.01491.
[19] Hrnack SA, Skeen N, Xu T, Rosenstein AD. Correlation of body mass index and blood loss during total knee and total hip arthroplasty. Am J Orthop (Belle Mead NJ) 2012;41:467–71.
[20] Lozano LM, Tió M, Rios J, Sanchez-Etayo G, Popescu D, Sastre S, et al. Severe and morbid obesity (BMI $\geq$ 35 kg/m(2)) does not increase surgical time and length of hospital stay in total knee arthroplasty surgery. Knee Surg Sports Traumatol Arthrosc 2015;23:1713–9. https://doi.org/10.1007/s00167-014-3002-9.
[21] Prohaska MG, Keeney BJ, Beg HA, Swarup I, Moschetti WE, Kantor SR, et al. Preoperative body mass index and physical function are associated with length of stay and facility discharge after total knee arthroplasty. Knee 2017;24:634–40. https://doi.org/10.1016/j.knee.2017.02.005.
[22] Goh GS, Zeng GJ, Tay DK-J, Lo N-N, Yeo S-J, Liow MHL. Does obesity lead to lower rates of clinically meaningful improvement or satisfaction after total hip arthroplasty? A propensity score-matched study. Hip Int 2022;32:610–9. https://doi.org/10.1177/1120700020974656.
[23] Li H, Gu S, Song K, Liu Y, Wang J, Wang J, et al. The influence of obesity on clinical outcomes following primary total knee arthroplasty: a prospective cohort study. Knee 2020;27:1057–63. https://doi.org/10.1016/j.knee.2020.03.009.
[24] Maniar RN, Maniar PR, Singhi T, Gangaraju BK. WHO class of obesity influences functional recovery post-TKA. Clin Orthop Surg 2018;10:26–32. https://doi.org/10.4055/cios.2018.10.1.26.
[25] Overgaard A, Lidgren L, Sundberg M, Robertsson O, W-Dahl A. Patient-reported 1-year outcome not affected by body mass index in 3,327 total knee arthroplasty patients. Acta Orthop 2019;90:360–5. https://doi.org/10.1080/17453674.2019.1604940.
[26] Torres-Claramunt R, Hinarejos P, Leal-Blanquet J, Sánchez-Soler JF, Marí-Molina R, Puig-Verdié L, et al. Does obesity influence on the functional outcomes of a total knee arthroplasty? Obes Surg 2016;26:2989–94. https://doi.org/10.1007/s11695-016-2233-x.
[27] Smith EL, Shahien AA, Chung M, Stoker G, Niu R, Schwarzkopf R. The obesity paradox: body mass index complication rates vary by gender and age among primary total hip arthroplasty patients. J Arthroplasty 2020;35:2658–65. https://doi.org/10.1016/j.arth.2020.04.094.
[28] Agarwal AR, Harris AB, Pearson ZC, Thakkar SC, Golladay GJ. A novel method for stratification of 30-day major complication risk using body mass index thresholds for patients undergoing total knee arthroplasty: a national cohort of 443,157 patients. J Arthroplasty 2023;38:1032–6. https://doi.org/10.1016/j.arth.2023.02.051.
[29] Harris AB, Wang KY, Reddy R, Agarwal AR, Rao SS, Golladay GJ, et al. A novel method for stratification of major complication risk using body mass index thresholds for patients undergoing total hip arthroplasty: a national cohort of 224,413 patients. J Arthroplasty 2022;37:2049–52. https://doi.org/10.1016/j.arth.2022.04.030.