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# Impact of body mass index to functional outcomes in patients after primary total hip arthroplasty

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## ABSTRACT

**Background:** Total hip arthroplasty (THA) is a frequently performed orthopedic procedure to relieve pain and restore function in patients with degenerative or traumatic changes of the hip joint. Obesity has been identified as a potential modifier of surgical outcomes, but the literature is conflicting on the effects of obesity on postoperative functional recovery compared to non-obese populations. This study aimed to investigate the influence of preoperative body mass index (BMI) on long-term functional outcomes following primary THA, with a five-year follow-up conducted in South Sulawesi, Indonesia.
**Methods:** A retrospective cohort study was conducted involving 30 patients who underwent primary THA at Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, in 2023. Functional outcomes were assessed using the change in Harris hip score (ΔHHS), calculated from preoperative and six-month postoperative evaluations. Statistical analyses included the Shapiro-Wilk test for normality, Spearman's rank correlation for non-parametric associations, Kruskal-Wallis and Mann-Whitney U tests for group comparisons, and multivariate linear regression to identify independent predictors of functional improvement.
**Results:** Samples consisting of 60% female, mean age 56.8±11.0 years; 66.7% obese. Strong negative correlation between BMI and delta HHS ($r=-0.949$, $p<0.001$). Significant differences across BMI categories ($p<0.001$), with obese II showing the poorest outcomes. BMI was the significant primary predictor (-3.417, $p<0.001$), while age and gender were not.
**Conclusion:** Higher BMI significantly correlates with poorer functional outcomes post-THA. Weight management after THA is crucial for optimizing the patient's functional outcomes.

**Keywords:** Arthroplasty, body mass index, functional outcome, Harris hip score, obesity.
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## INTRODUCTION

Total hip arthroplasty (THA) is one of the most successful and common surgical procedures in modern orthopedics. In this procedure, the diseased hip joint is replaced with an artificial prosthesis to relieve the severe pain and restore the functional capabilities of the hip.[1-3] It is very useful especially in diseases like osteoarthritis, avascular necrosis and fractures as it helps the patients to regain the functional independence and improve their quality of life. The hip joint is a synovial ball and socket joint composed of the femoral head and acetabulum that allows wide range of movements such as flexion, extension, abduction, adduction, and rotation and bears the axial loads from the trunk to the lower extremities.[3,4] The ligaments like iliofemoral, ischiofemoral and pubofemoral provide stability to the joint and the main blood supply of the joint is through the medial and lateral circumflex femoral arteries. The integrity of this joint is important for performing the activities of daily living like walking, standing and squatting.[5-7]

THA is effective, consistent and cost effective for pain relief, functional recovery and improved quality of life. However, obesity is a major barrier to surgical intervention, especially for elective procedures such as THA.[8-10] Obesity, defined by the World Health Organization (WHO) as a body mass index (BMI) ≥ 30 kg/m2, is associated with increased surgical risks, including longer operative times, increased blood loss and higher complication rates such as infection and dislocation.[11] Worldwide obesity has tripled since 1975 and recent data from Indonesia indicates that almost one in three adults are affected in 2023 with a higher prevalence in women. The prevalence of obesity has risen from 10.5% in 2007 to 21.8% in 2018 and is predicted to be as high as 27% in urban areas by 2025 according to the Indonesian Basic Health Research survey.[9,12] This is of particular concern in areas such as South Sulawesi where lifestyle changes and urbanisation are contributing to rising BMI levels which may impact on orthopaedic outcomes.

The BMI is the most commonly used index to classify patients as underweight, normal weight, overweight, and obese based on their weight relative to their height. It is a simple measure of body composition and predictor when assessing risks and outcomes related to femoral neck fractures and THA.[13] The effect of preoperative BMI on postoperative functional results after THA is controversial. Some authors have suggested that obese patients have worse functional results such as lower Harris Hip Scores (HHS), longer pain, and limited range of motion, often due to mechanical overload, chronic inflammation, and comorbidities such as diabetes.[14,15] For example, a systematic review found increased complication rates and worse mobility in patients with a BMI > 35 kg/m2 even when surgeries were performed by experienced surgeons. Others have reported that obese patients have similar long-term functional improvements and revision rates as non-obese patients, and argued against placing surgical restrictions based on BMI.[16-18] A meta-analysis in 2025 demonstrated a non-linear association in which moderate obesity (BMI 30–35) has little effect on periprosthetic joint infection or overall recovery, while extreme obesity increased the risks.[19] These discrepancies could be related to differences in study populations, surgical techniques (cemented versus non-cemented fixation), implant materials (polyethylene, metal, or ceramic), and length of follow-up.

The Harris hip score (HHS) is a valid and reliable observational tool to assess pain quality, functional capacity, presence of deformity and joint range of motion. We used the HHS to evaluate functional outcomes after THA. It is important to understand the relationship between BMI and HHS, whether direct or indirect, in order to predict optimal patient outcomes after THA. In Indonesia, obesity is surging and access to advanced orthopedic care is uneven, with limited local data on THA outcomes. Cultural and socioeconomic factors may influence postoperative rehabilitation and BMI management, making this an important area of investigation. This study aimed to determine the correlation between preoperative BMI with postoperative functional outcomes after THA as measured by the change in HHS.

## METHODS

This retrospective cohort study was conducted in Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, from January to December 2023. The study population was patients who underwent primary THA at the hospital from January 2021 to December 2023. All eligible cases were enrolled by using total sampling method. Inclusion criteria were patients who underwent THA during the 2023-2025 period, had complete medical records, and did not develop postoperative surgical site infections. Exclusion criteria were patients who had bilateral THA, THA due to pathological fractures or traumatic injuries, and developed postoperative surgical site infections.

The variables of interest were pre-operative BMI and post-operative functional outcome. BMI was calculated as weight (kg) divided by height squared (m2) and classified according to the WHO guidelines: underweight (<18.5 kg/m2), normal weight (18.5–22.9 kg/m2), overweight (23.0–24.9 kg/m2), obesity class I (25.0–29.9 kg/m2) and obesity class II (≥30 kg/m2). Functional outcome was assessed by the Harris Hip Score (HHS), a validated scoring system for pain, functional ability, deformity and range of motion. The primary endpoint was change in HHS (ΔHHS), defined as the difference between pre-operative and 6-month post-operative scores, ranging from 0 to 100 with higher scores indicating better functional recovery.

Data were collected from secondary and primary sources. Eligible patients were identified from hospital medical records that contained demographic and clinical baseline data. Subsequently, participants were interviewed and completed the HHS questionnaire to obtain primary data on postoperative functional status. Ethical approval was obtained from the Institutional Review Board of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, Indonesia, with registration number 368/UN4.6.4.5.31/PP36/2025. Given the retrospective nature of the study, informed consent was waived. Statistical analyses were used to test for associations and to determine predictive variables.

## RESULTS

Thirty patients were included in the study based on the pre-specified inclusion and exclusion criteria. The study group was predominantly female (n = 18; 60.0%) with a mean age of 56.8 ± 11.0 years. According to BMI classification, most of the subjects had obesity: 12 patients (40.0%) in Obesity Class I and 8 patients (26.7%) in Obesity Class II. The remaining study participants included 5 patients (16.7%) in the overweight group, 3 patients (10.0%) in the normal BMI group, and 2 patients (6.7%) in the underweight group (**Table 1**).

Functional outcomes were assessed by the delta Harris Hip Score (ΔHHS), which is the difference between the preoperative and the postoperative HHS after 6 months. The Shapiro-Wilk test was used to test for the normality due to the

**Table 1. Baseline characteristics of 30 respondents**

| Characteristics | Mean ± SD or n (%) |
|---|---|
| Gender | |
| Male | 12 (40) |
| Female | 18 (60) |
| Age, years | 56.8 ± 11 |
| BMI, kg/m$^2$ | |
| Underweight | 2 (6.7) |
| Normal | 3 (10) |
| Overweight | 5 (16.7) |
| Obesity Class I | 12 (40) |
| Obesity Class II | 8 (26.7) |

%, percentage; BMI, body mass index; kg/m$^2$, kilogram per square meter; n, number of participants; SD, standard deviation.

small sample size (n = 30). Both BMI and ΔHHS were nonnormally distributed ($p = 0.001$), and nonparametric tests were used. Spearman's rank correlation analysis showed a very strong inverse correlation between BMI and ΔHHS ($r = -0.949$; $p < 0.001$), meaning that the higher the BMI, the worse the functional improvement after the operation (Table 2).

The Kruskal-Wallis test further confirmed significant differences in ΔHHS across the five BMI categories ($p < 0.001$). A consistent trend was observed, with mean ranks decreasing as BMI increased: Underweight (28.50), Normal (27.67), Overweight (23.00), Obesity I (14.17), and Obesity II (5.00), suggesting a progressive decline in functional recovery with increasing BMI (Table 3).

Multivariate linear regression analysis was conducted to assess the combined effects of gender, age, and BMI on ΔHHS. The model demonstrated strong explanatory power ($R^2 = 0.887$; adjusted $R^2 = 0.874$). Among the independent variables, only BMI showed a statistically significant association with ΔHHS ($\beta = -3.417$; $p < 0.001$), indicating that each unit increase in BMI corresponded to a 3.417-point reduction in functional improvement. The model demonstrated excellent explanatory power ($R^2 = 0.887$), indicating that nearly 89% of the variance in postoperative functional improvement could be explained by the included variables, predominantly BMI. Clinically, this suggests that every 1 kg/m² increase in BMI may reduce postoperative functional gain by approximately 3.4 points on the Harris Hip Score. Gender ($\beta = 0.455$; $p = 0.461$) and age ($\beta = -0.017$; $p = 0.581$) did not exhibit significant predictive value (Table 4).

Post-hoc analysis using the Bonferroni-adjusted Mann-Whitney U test identified significant pairwise differences in ΔHHS, particularly among overweight and obese groups. Statistically significant differences were observed between Overweight vs. Obesity I ($p = 0.010$), Overweight vs. Obesity II ($p = 0.020$), and Obesity I vs. Obesity II ($p < 0.001$) (Table 5). These findings underscore the pronounced decline in functional outcomes among patients with higher BMI classifications.

**Table 2.** Spearman correlation test between score change of the Harris hip score (ΔHHS) and body mass index (BMI)

| Variables | r | p-value |
|---|---|---|
| ΔHHS<br>BMI | -0.949 | 0.000* |

*, statistically significant if p-value less than 0.05; r, coefficient correlation.

**Table 3.** The Kruskal-Wallis of score change of the Harris hip score (ΔHHS) and five categories of body mass index (BMI)

| Variables | Mean Rank | p-value |
|---|---|---|
| ΔHHS | | |
| Underweight | 28.50 | 0.000* |
| Normal | 27.67 | |
| Overweight | 23.00 | |
| Obesity Class I | 14.17 | |
| Obesity Class II | 5.00 | |

*, statistically significant if p-value less than 0.05

**Table 4.** Multivariate linear regression analysis to assess the combined effects of gender, age, and body mass index (BMI) on score change of the Harris hip score (ΔHHS)

| Variables | β | p-value | R² |
|---|---|---|---|
| Constant | 53.221 | 0.000* | 0.887 |
| Gender | 0.455 | 0.461 | |
| Age | -0.017 | 0.581 | |
| BMI | -3.417 | 0.000* | |

*, statistically significant if p-value less than 0.05; β, betta coefficient; R2, r-squared coefficient.

## DISCUSSION

Our results highlight the important association of preoperative BMI with early functional recovery after primary THA. Higher BMI values were generally associated with poorer functional recovery in the postoperative period compared to lower BMI categories. These results reinforce the increasing awareness of the impact of obesity not only on perioperative risk profiles but also on postoperative rehabilitation potential and recovery patterns after hip arthroplasty. Clinically, patients with obesity often require longer rehabilitation time, suffer from more pronounced physical limitations in mobilization, and have more difficulties in achieving optimal gait mechanics after surgery.

The graded decline in functional recovery in the postoperative period seen with increasing BMI categories suggests that the effect of obesity on THA outcomes may be more subtle, with a progressive decline with increasing BMI.[20,21] The functional recovery following THA is dependent on a number of complex, inter-related factors including muscle strength, joint loading, balance, mobility and compliance with rehabilitation programs.[22] Excess body weight increases mechanical load across the prosthetic hip joint in daily activities such as standing, stair climbing and walking. Such increased biomechanical load may impair muscular efficiency and delay normalization of movement patterns after surgery. Obesity is often associated with poor

**Table 5. Pairwise comparison between score change of the Harris hip score (ΔHHS) and body mass index (BMI) using the Mann–Whitney U test with Bonferroni correction**

| Comparison Group (Group I and II) | Median (IQR) Group I | Median (IQR) Group II | U-Score | Z-Score | p-value | Corrected p-Value |
|---|---|---|---|---|---|---|
| Underweight vs. Normal | 50.00 (0.00)[a] | 50.00 (1.00)[a] | 2.000 | -0.816 | .414 | 4.140 |
| Underweight vs. Overweight | 50.00 (0.00)[a] | 48.00 (0.50) | 0.000 | -2.160 | .031 | 0.310 |
| Underweight vs. Obesity I | 50.00 (0.00)[a] | 42.00 (1.00) | 0.000 | -2.436 | .015 | 0.150 |
| Underweight vs. Obesity II | 50.00 (0.00)[a] | 39.50 (2.00) | 0.000 | -2.191 | .028 | 0.280 |
| Normal vs. Overweight | 50.00 (1.00)[a] | 48.00 (0.50) | 0.000 | -2.399 | .016 | 0.160 |
| Normal vs. Obesity I | 50.00 (1.00)[a] | 42.00 (1.00) | 0.000 | -2.827 | .005 | 0.050 |
| Normal vs. Obesity II | 50.00 (1.00)[a] | 39.50 (2.00) | 0.000 | -2.538 | .011 | 0.110 |
| Overweight vs. Obesity I | 48.00 (0.50) | 42.00 (1.00) | 0.000 | -3.367 | .001 | 0.010 |
| Overweight vs. Obesity II | 48.00 (0.50) | 39.50 (2.00) | 0.000 | -3.029 | .002 | 0.020 |
| Obesity I vs. Obesity II | 42.00 (1.00) | 39.50 (2.00) | 4.000 | -3.565 | .000 | 0.000 |

[a]Groups with very small sample sizes, the values in parentheses represent the data range (Minimum–Maximum); [*]Statistical significance was considered if the corrected p-value was < 0.05; Corrected p-value, Original p-value × 10 (total number of comparisons).

baseline physical conditioning and poor cardiorespiratory endurance, which may have negative effects on the performance of the postoperative rehabilitation.[23]

Besides biomechanical factors, obesity is now recognized as a chronic inflammatory and metabolic disease, which may adversely affect tissue healing after orthopedic procedures.[24] Adipose tissue is an active endocrine tissue producing pro-inflammatory cytokines and adipokines that may contribute to systemic low-grade inflammation.[25] Persistent inflammatory activation may interfere with collagen remodeling, muscle regeneration and wound healing, potentially affecting postoperative pain and functional recovery. In patients undergoing THA, this inflammatory environment may lead to delayed rehabilitation and suboptimal restoration of hip function despite technically successful surgical procedures.[26]

The findings of this study are consistent with previous reports demonstrating less favorable postoperative function among obese patients after THA. Several contemporary studies have shown that patients with obesity often report lower postoperative mobility and slower functional improvement when compared with non-obese populations.[27,28] Nevertheless, many studies also emphasize that obese patients still derive substantial clinical benefit from THA, particularly in terms of pain reduction and quality-of-life improvement.[29] Therefore, obesity should not be interpreted as an absolute contraindication to surgery, but rather as a factor that requires additional perioperative optimization and individualized postoperative management.

Such findings highlight the need for pre-operative optimization strategies for patients with high BMI. Weight loss programs, nutritional counseling, metabolic control and prehabilitation exercises could facilitate post-operative functional recovery and minimize rehabilitation barriers. Multidisciplinary strategies including orthopedic surgeons, rehabilitation specialists, nutritionists and internal medicine physicians could provide more comprehensive perioperative care for obese patients undergoing THA.[30,31] In addition, earlier literature has proposed that targeted weight loss prior to arthroplasty may result in better mobility outcomes and fewer postoperative complications. In this context, BMI should be regarded as a modifiable risk factor that could be potentially addressed pre-surgery to optimize patient outcomes.[32]

Interestingly, BMI seemed to have more of an effect on functional recovery after surgery than age and gender. Functional restoration after THA may therefore be more strongly associated with metabolic and biomechanical conditions than with demographic characteristics alone. This observation further supports the importance of focusing on modifiable clinical factors during perioperative assessment and patient counseling.

Several limitations should be acknowledged when interpreting the present findings. The small sample size may limit the generalizability of the findings to larger cohorts. The study was limited to early postoperative recovery and may not reflect long-term implant survival, delayed complications, or long-term functional outcomes. Several confounding variables that may be relevant such as diabetes mellitus, smoking status, sarcopenia, nutritional status, socioeconomic factors, and compliance with rehabilitation protocols were not exhaustively evaluated and may have an impact on both BMI status and postoperative recovery following THA. Further prospective multicenter studies with larger samples and longer follow-up periods are needed to further elucidate the association between obesity and functional outcomes after hip arthroplasty.

## CONCLUSION

The present study adds to the body of evidence that high BMI is associated with poor functional recovery after THA. The results emphasize the significance of individualized perioperative planning, metabolic optimization and customized rehabilitation protocols for obese patients undergoing hip arthroplasty and that a holistic preoperative evaluation and a multidisciplinary management approach may enhance postoperative recovery and long-term patient outcomes.

## ETHICAL CLEARANCE

This study was obtained the ethical approval from the Institutional Review Board of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, Indonesia, with registration number 368/UN4.6.4.5.31/PP36/2025

## CONFLICT OF INTEREST

The authors have declared no conflicts of interest.

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## AUTHOR CONTRIBUTION

GBN, MAU, and NR conceptualized the study design and defined the intellectual content. All authors contributed to the literature search and data acquisition. Data analysis and statistical analyses were performed by GBN, MAU, and NR. All authors participated in manuscript preparation, editing, review, with GBN serving as the guarantor of the study.

## REFERENCES

1. Mayr HO, Stüeken P, Münch EO, Wolter M, Bernstein A, Suedkamp NP, Stoehr A. Brace or no-brace after ACL graft? Four-year results of a prospective clinical trial. Knee Surgery, Sports Traumatology, Arthroscopy. 2014 May;22(5):1156-62.
2. Buerba RA, Zaffagnini S, Kuroda R, Musahl V. ACL reconstruction in the professional or elite athlete: state of the art. Journal of ISAKOS. 2021 Jul 1;6(4):226-36.
3. Filbay SR, Grindem H. Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture. Best practice & research Clinical rheumatology. 2019 Feb 1;33(1):33-47.
4. Agarwal A, Singh S, Singh A, Tewari P. Comparison of functional outcomes of an anterior cruciate ligament (ACL) reconstruction using a peroneus longus graft as an alternative to the hamstring tendon graft. Cureus. 2023 Apr 7;15(4).
5. D'Ambrosi R, Ursino N, Messina C, Della Rocca F, Hirschmann MT. The role of the iliofemoral ligament as a stabilizer of the hip joint. EFORT Open Reviews. 2021 Jul 8;6(7):545-55.
6. Tamaki Y, Goto T, Iwase J, Wada K, Hamada D, Tsuruo Y, Sairyo K. Contributions of the ischiofemoral ligament, iliofemoral ligament, and conjoined tendon to hip stability after total hip arthroplasty: a cadaveric study. Journal of Orthopaedic Research®. 2022 Dec;40(12):2885-93.
7. Zlotorowicz M, Czubak-Wrzosek M, Wrzosek P, Czubak J. The origin of the medial femoral circumflex artery, lateral femoral circumflex artery and obturator artery. Surgical and radiologic anatomy. 2018 May;40(5):515-20.
8. Duthon VB, Barea C, Abrassart S, Fasel JH, Fritschy D, Ménétrey J. Anatomy of the anterior cruciate ligament. Knee surgery, sports traumatology, arthroscopy. 2006 Mar;14(3):204-13.
9. Domnick C, Raschke MJ, Herbort M. Biomechanics of the anterior cruciate ligament: Physiology, rupture and reconstruction techniques. World journal of orthopedics. 2016 Feb 18;7(2):82.
10. Duthon VB, Barea C, Abrassart S, Fasel JH, Fritschy D, Ménétrey J. Anatomy of the anterior cruciate ligament. Knee surgery, sports traumatology, arthroscopy. 2006 Mar;14(3):204-13.
11. Jiang K, Chen B, Lou D, Zhang M, Shi Y, Dai W, Shen J, Zhou B, Hu J. Systematic review and meta-analysis: association between obesity/overweight and surgical complications in IBD. International Journal of Colorectal Disease. 2022 Jul;37(7):1485-96.
12. Tham KW, Abdul Ghani R, Cua SC, Deerochanawong C, Fojas M, Hocking S, Lee J, Nam TQ, Pathan F, Saboo B, Soegondo S. Obesity in South and Southeast Asia—A new consensus on care and management. Obesity Reviews. 2023 Feb;24(2):e13520.
13. Wu Y, Li D, Vermund SH. Advantages and limitations of the body mass index (BMI) to assess adult obesity. International journal of environmental research and public health. 2024 Jun 10;21(6):757.
14. Gritsyuk A, Lychagin A, Yi L, Rosenberg N. Clinical outcome of primary total hip arthroplasty in patients with morbid obesity—Retrospective and prospective follow-up studies. Medicina. 2021 Nov 15;57(11):1247.
15. Cao G, Yang X, Yue C, Tan H, Xu H, Huang Z, Quan S, Yang M, Pei F. The effect of body mass index on blood loss and complications in simultaneous bilateral total hip arthroplasty: a multicenter retrospective study. Journal of Orthopaedic Surgery. 2021 Nov 17;29(3):23094990211061209.
16. Siegel L, Vandenakker-Albanese C, Siegel D. Anterior cruciate ligament injuries: anatomy, physiology, biomechanics, and management. Clinical Journal of Sport Medicine. 2012 Jul 1;22(4):349-55.
17. Kotsifaki R, Korakakis V, King E, Barbosa O, Maree D, Pantouveris M, Bjerregaard A, Luomajoki J, Wilhelmsen J, Whiteley R. Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction. British journal of sports medicine. 2023 May 1;57(9):500-14.
18. Agarwal A, Singh S, Singh A, Tewari P. Comparison of functional outcomes of an anterior cruciate ligament (ACL) reconstruction using a peroneus longus graft as an alternative to the hamstring tendon graft. Cureus. 2023 Apr 7;15(4).
19. Fernandes A, MacAulay C, Khater AR, Matthews H, Mohrir G, Lodge C, Khater A. Reducing periprosthetic joint infection in patients with obesity: A systematic review and meta-analysis of the emerging role of Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists. Cureus. 2025 Dec 21;17(12).
20. Liu W, Wahafu T, Cheng M, Cheng T, Zhang Y, Zhang X. The influence of obesity on primary total hip arthroplasty outcomes: a meta-analysis of prospective cohort studies. Orthopaedics & Traumatology: Surgery & Research. 2015 May 1;101(3):289-96.
21. Houdek MT, Wagner ER, Watts CD, Osmon DR, Hanssen AD, Lewallen DG, Mabry TM. Morbid obesity: a significant risk factor for failure of two-stage revision total hip arthroplasty for infection. JBJS. 2015 Feb 18;97(4):326-32.
22. Sharma V, Morgan PM, Cheng EY. Factors influencing early rehabilitation after THA: a systematic review. Clinical Orthopaedics and Related Research®. 2009 Jun;467(6):1400-11.
23. Ima M, Kabata T, Inoue D, Yanagi Y, Iyobe T, Fujimaru N, Demura S. Impact of body mass index on functional recovery after total hip arthroplasty: A prospective study. Arthroplasty Today. 2026 Apr 1;38:101986.
24. Saltiel AR, Olefsky JM. Inflammatory mechanisms linking obesity and metabolic disease. The Journal of clinical investigation. 2017 Jan 3;127(1):1-4.
25. Nishimura S, Manabe I, Nagai R. Adipose tissue inflammation in obesity and metabolic syndrome. Discovery medicine. 2009 Sep 22.
26. Li J, Li Y, Zhou X, Yang S, Liu D, Wen H, Chen X, Duan C, Yu M, Zhang M, Tang B. Adipocytes orchestrate obesity-related chronic

inflammation through β2-microglobulin. Signal Transduction and Targeted Therapy. 2025 Dec 3;10(1):394.

27. 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. The Journal of Arthroplasty. 2024 Jun 1;39(6):1412-8.
28. Sobba W, Lawrence KW, Haider MA, Thomas J, Schwarzkopf R, Rozell JC. The influence of body mass index on patient-reported outcome measures following total hip arthroplasty: a retrospective study of 3,903 Cases. Archives of Orthopaedic and Trauma Surgery. 2024 Jun;144(6):2889-98.
29. Tan HS, Snell D, Willis J, Frampton CM, Hooper GJ. Do the long-term functional outcomes and revision rates of total hip arthroplasty in obese and morbidly obese patients justify restricting their access to surgery?. The Journal of arthroplasty. 2025 Jul 24.
30. Meissner N, Ramos-Pascual S, Ortwig K, van Rooij F, Schrednitzki D, Stoeve J, Halder AM. Outcomes of total hip arthroplasty in obese patients with and without preoperative weight loss: A systematic review and meta-analysis. Journal of Experimental Orthopaedics. 2026 Jan;13(1):e70651.
31. Dash AS, Hewitt MA, Ruberto RA, Smith TA, Herndon CL, Sarpong NO. Body mass index above 35 has increased risk of complications but still achieves clinically meaningful improvement in patient-reported outcomes after anterior-based total hip arthroplasty. Arthroplasty Today. 2025 Apr 1;32:101665.
32. Haynes J, Nam D, Barrack RL. Obesity in total hip arthroplasty: does it make a difference?. The bone & joint journal. 2017 Jan 1;99(1_Supple_A):31-6.