Research Article
E-ISSN : 3048-1368

Volume 01, Issue No. 01. 2022
P-ISSN : 3048-1376

The International Journal of Medical Science and Health Research

A Comprehensive Systematic Review of The Relationship between Body Mass Index and The Risk of Implant Failure in Total Knee Arthroplasty

[1] Satya Agung Nugroho, [2] Nazalla Gwen Vaganesha, [3] Agus Saribudaya

[1] General Practitioner, Dr. Soeroto Ngawi Regional General Hospital, Indonesia

[2] Faculty of Medicine, Muhammadiyah University of Yogyakarta, Indonesia

[3] Departement of Orthopaedic and Traumatology, Dr. Soeroto Ngawi Regional General Hospital, Indonesia

Corresponding Email : agungfkums2015@gmail.com

Article History :

Received date : 2022/02/27

Revised date : 2022/04/18

Accepted date : 2022/05/22

Published date : 2022/06/01

E-ISSN :

ISSN 3048-1368

P-ISSN

ISSN 3048-1376

ABSTRACT

Introduction: Total knee arthroplasty (TKA) is a highly successful procedure for end-stage knee osteoarthritis. However, the global rise in obesity presents a significant challenge, as elevated body mass index (BMI) is a suspected risk factor for postoperative complications, particularly implant failure. This systematic review aims to synthesize the existing evidence on the relationship between BMI and the risk of implant failure following primary TKA.

Methods: A systematic review of the literature was conducted following established guidelines. Eighty studies meeting predefined inclusion criteria were selected from 118 screened sources. Inclusion criteria focused on adult primary TKA patients, availability of BMI data, reported implant failure outcomes, and a minimum follow-up of 6 months. Data extraction covered study design, BMI categories, population characteristics, definitions of implant failure, follow-up duration, effect measures, and confounding factors.

Results: The evidence demonstrates a clear dose-response relationship between increasing BMI, particularly at levels ≥40 kg/m², and elevated risk of all-cause revision and infection-related failure. Meta-analyses indicate risk ratios (RR) for all-cause revision rise from 1.19 for severe obesity (BMI ≥35) to 4.75 for super-obesity (BMI ≥50) (Chaudhry et al., 2019). Septic revision risk shows an even stronger association, with RR reaching 3.69 for morbid obesity (BMI ≥40) (Chaudhry et al., 2019). In contrast, the association between BMI and aseptic loosening is inconsistent and generally non-significant. Some studies employing specific implant designs or surgical techniques reported no significant survival differences across BMI groups (Gaillard et al., 2017; Kanna et al., 2021).

Discussion: The relationship between BMI and TKA failure is nuanced, primarily driven by a markedly increased risk of periprosthetic joint infection (PJI) rather than mechanical failure. Reconciling heterogeneous findings requires consideration of BMI threshold effects, failure type specificity, implant/technique considerations, and follow-up duration. The risk appears most clinically significant at BMI ≥40 kg/m². While obesity elevates complication risks, patients across all BMI categories achieve meaningful functional improvements post-TKA.

Conclusion: Elevated BMI, especially morbid and super-obesity, is a significant risk factor for implant failure, predominantly through infectious complications. This should inform preoperative counselling and risk stratification. However, obesity should not be an absolute contraindication for TKA. Future strategies should emphasize optimized surgical techniques, targeted infection prophylaxis, and structured preoperative weight management programs for high-risk patients to improve long-term outcomes.

Keywords: Body Mass Index (BMI); Obesity; Total Knee Arthroplasty (TKA); Implant Failure; Revision Surgery; Periprosthetic Joint Infection (PJI); Systematic Review.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

INTRODUCTION

Background

Total knee arthroplasty (TKA) stands as one of the most successful and cost-effective surgical interventions in modern orthopaedics, reliably alleviating pain and restoring function in patients with end-stage knee osteoarthritis (OA) (Dunbar, Griffin, & Surr, 2012). Its success has led to a dramatic increase in procedure volumes worldwide. Concurrently, the global prevalence of obesity has reached epidemic proportions, making a substantial proportion of TKA candidates classified as overweight or obese (Zonfoly et al., 2021). Obesity is a well-established risk factor for the development and progression of knee OA, thereby increasing the demand for TKA in this population (Pozzobon et al., 2018).

The physiological and biomechanical challenges posed by obesity raise significant concerns regarding its impact on TKA outcomes. Excess body weight increases mechanical stress across the prosthetic joint, potentially leading to accelerated polyethylene wear, implant loosening, and mechanical failure (Bagsby et al., 2017). Furthermore, obesity is associated with a chronic, low-grade inflammatory state, impaired immune function, and technical surgical difficulties such as deeper dissection, longer operative times, and compromised wound healing (Kerkhoffs et al., 2012; Heifner et al., 2019). These factors collectively predispose obese patients to a higher risk of postoperative complications, notably periprosthetic joint infection (PJI) and revision surgery, which are devastating outcomes for patients and impose a heavy economic burden on healthcare systems (Kunutsor et al., 2016; Onggo et al., 2021).

Research Gap

Despite two decades of investigation, the literature on BMI and TKA outcomes remains heterogeneous and sometimes contradictory. While numerous studies and meta-analyses confirm increased complication rates in obese patients, others report no significant difference in implant

E-ISSN : 3048-1368 P-ISSN : 3048-1376

survival or functional outcomes between obese and non-obese cohorts (Amin et al., 2006; Gaillard et al., 2017; Aneja et al., 2020). This inconsistency stems from several factors: variations in BMI categorization (e.g., using a single cutoff of 30 kg/m² versus stratified classes), differing definitions of implant failure, heterogeneity in surgical techniques and implant designs, variable follow-up durations, and inadequate control for confounding comorbidities (Lengkong, 2020; Singh et al., 2021). A comprehensive synthesis that explicitly addresses these sources of heterogeneity, examines the dose-response relationship across the full BMI spectrum, and distinguishes between failure mechanisms (septic vs. aseptic) is necessary to provide clinicians with clear, actionable evidence.

Research Objectives

This systematic review aims to critically appraise and synthesize the current evidence to:

1. Determine the nature and strength of the relationship between preoperative BMI and the risk of implant failure following primary TKA.
2. Investigate the dose-response relationship across WHO BMI categories, with particular focus on morbid (BMI ≥40 kg/m²) and super-obesity (BMI ≥50 kg/m²).
3. Differentiate the risk association for specific failure types, primarily septic (infection-related) versus aseptic (mechanical) failures.
4. Identify modifying factors such as implant design, surgical technique, and preoperative interventions that may mitigate obesity-related risks.
5. Provide evidence-based conclusions and clinical recommendations for the management of obese patients undergoing TKA.

Hypothesis

We hypothesize that there is a significant positive dose-response relationship between increasing BMI and the risk of implant failure after TKA. Specifically, we posit that this relationship is strongest for infection-related failures and becomes clinically substantial at the level of morbid obesity (BMI ≥40 kg/m²). We further hypothesize that modern surgical techniques and implant designs may attenuate, but not eliminate, this elevated risk.

Novelty and Significance

This review offers a novel and detailed synthesis by systematically analyzing 80 studies, with a specific focus on reconciling contradictory findings through an in-depth exploration of effect modifiers. It moves beyond the simple "obese vs. non-obese" dichotomy to provide a granular, risk-stratified analysis across the entire obesity spectrum. By clearly separating the risks for septic and aseptic failure, it offers mechanistic insight. Furthermore, it integrates recent evidence on mitigation strategies, including the role of cementless implants (Le et al., 2020), computer navigation (Kanna et al., 2021), and preoperative optimization (Liljensøe et al., 2019; Dowsey et al., 2022). The findings are significant for clinical practice, informing shared decision-making, preoperative counselling, risk stratification, and the development of targeted perioperative protocols to improve outcomes in the growing population of obese TKA patients.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the relationship between body mass index and the risk of implant failure in total knee arthroplasty.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Population - Adult Primary TKA**: Does the study include adult patients (≥18 years) who underwent primary total knee arthroplasty?
- **BMI Data Available**: Does the study report BMI measurements or provide body weight/height data that allows BMI calculation?
- **Implant Failure Outcomes**: Does the study report implant failure outcomes, revision surgery rates, or implant-related complications?
- **BMI-Implant Failure Relationship**: Does the study provide sufficient data to assess the relationship between BMI and implant failure?
- **Follow-up Duration**: Does the study report a follow-up period of at least 6 months post-surgery?
- **Primary vs Revision Surgery**: Is the study focused on primary knee arthroplasty rather than revision knee arthroplasty as the primary procedure?
- **Total vs Partial Knee Replacement**: Does the study focus on total knee arthroplasty rather than exclusively on unicompartmental knee arthroplasty or partial knee replacement?
- **Sample Size Adequacy**: Does the study include 10 or more patients (i.e., is it not a case report or case series with fewer than 10 patients)?
- **Implant Failure Definition**: Does the study provide a clear definition or measurement of implant failure?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

Research Article Volume 01, Issue No. 01. 2022
E-ISSN : 3048-1368 P-ISSN : 3048-1376

Element	P (Population)	I (Intervention/Exposure)	C (Comparison/Context)	O (Outcome)
Keyword 1	Total knee arthroplasty patients	Body mass index	Normal weight	Implant failure
Keyword 2	TKA recipients	BMI	Non-obese	Revision surgery
Keyword 3	Knee replacement patients	Obesity	Lower BMI	Prosthesis failure
Keyword 4	Arthroplasty, knee, total	Overweight	Healthy weight	Arthroplasty failure

The Boolean MeSH keywords inputted on databases for this research are: *("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*

Data extraction

- **Study Design**:

  Extract the study design type (e.g., cohort study, case-control study, randomized controlled trial, systematic review/meta-analysis) and specify whether it was prospective or retrospective for observational studies.

- **BMI Categories**:

  Extract the specific BMI categories or cutoff values used to define different weight groups in the study (e.g., normal weight <25 kg/m², overweight 25-29.9 kg/m², obese ≥30 kg/m²,

E-ISSN : 3048-1368 P-ISSN : 3048-1376

morbidly obese ≥40 kg/m²). Include the exact numerical ranges and how many groups were analyzed.

- **Study Population**:

  Extract key characteristics of the TKA patient population, including:

  - Total sample size
  - Age range or mean age
  - Gender distribution
  - Primary indication for TKA (e.g., osteoarthritis, rheumatoid arthritis)
  - Exclusion criteria related to BMI or other relevant factors

- **Implant Failure Definition**:

  Extract how the study defined implant failure or poor outcomes related to implant performance, including:

  - Primary endpoints (e.g., revision surgery, aseptic loosening, implant survival)
  - Secondary endpoints related to implant success/failure
  - Specific criteria used to diagnose failure
  - Whether failure was all-cause or cause-specific (e.g., infection vs. mechanical failure)

- **Follow-up Duration**:

  Extract the follow-up period for assessing implant failure outcomes, including:

  - Mean or median follow-up time
  - Minimum and maximum follow-up periods
  - Loss to follow-up rates by BMI group if reported
  - Time points at which outcomes were assessed

E-ISSN : 3048-1368 P-ISSN : 3048-1376

- **BMI-Failure Relationship**:

  Extract the main findings regarding the relationship between BMI and implant failure risk in TKA, including:

  - Effect measures (odds ratios, risk ratios, hazard ratios) with 95% confidence intervals
  - Statistical significance (p-values)
  - Direction of association (higher BMI = increased/decreased/no change in failure risk)
  - Dose-response relationship if reported (e.g., risk across multiple BMI categories)
  - Specific failure types most associated with BMI

- **Confounding Variables**:

  Extract information about confounding factors that were controlled for or considered in the analysis of BMI-implant failure relationship, including:

  - Patient factors (age, gender, comorbidities, activity level)
  - Surgical factors (surgeon experience, implant type, surgical technique)
  - Statistical adjustment methods used
  - Variables that remained significant confounders

- **Key Limitations**:

  Extract the main study limitations that could affect the validity of BMI-implant failure relationship findings, including:

  - Selection bias issues
  - Measurement bias for BMI or outcomes
  - Confounding that could not be controlled
  - Loss to follow-up issues

- Author-reported limitations relevant to BMI-failure relationship

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	*("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*	1
Semantic Scholar	*("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*	250
Springer	*("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*	21
Google Scholar	*("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*	306
Wiley Online Library	*("Total knee arthroplasty patients" OR "TKA recipients" OR "Knee replacement patients" OR "Arthroplasty, knee, total") AND ("Body mass index" OR "BMI" OR "Obesity" OR "Overweight") AND ("Normal weight" OR "Non-obese" OR "Lower BMI" OR "Healthy weight") AND ("Implant failure" OR "Revision surgery" OR "Prosthesis failure" OR "Arthroplasty failure")*	18

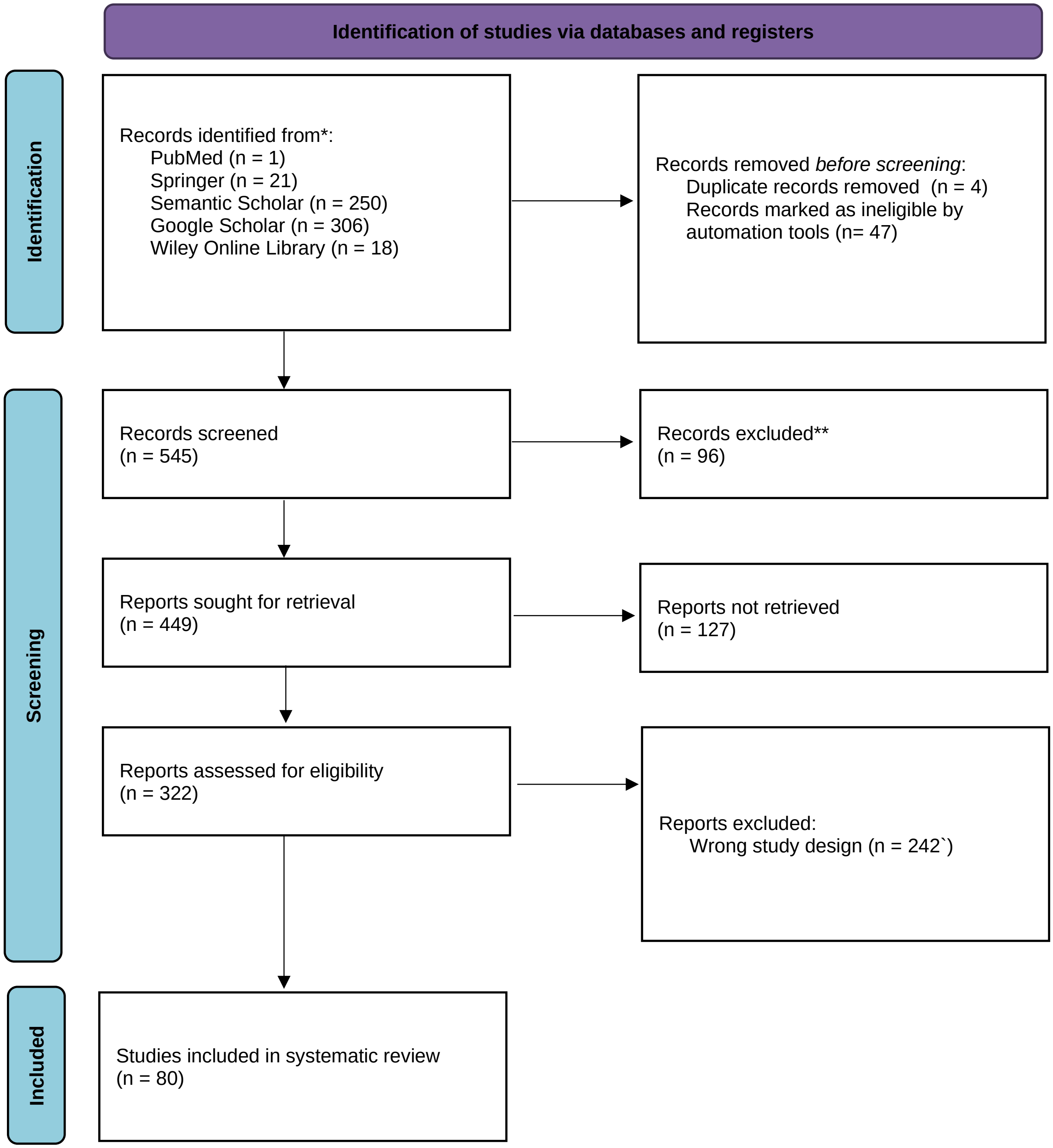

Figure 1. Article search flowchart

Research Article Volume 01, Issue No. 01. 2022
E-ISSN : 3048-1368 P-ISSN : 3048-1376

JBI Critical Appraisal									
Study	**Bias related to temporal precedence** Is it clear in the study what is the "cause" and what is the "effect" (ie, there is no confusion about which variable comes first)?	**Bias related to selection and allocation** Was there a control group?	**Bias related to confounding factors** Were participants included in any comparisons similar?	**Bias related to administration of intervention/exposure** Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	**Were there multiple measurements of the outcome, both pre and post the intervention/exposure?**	**Were the outcomes of participants included in any comparisons measured in the same way?**	**Were outcomes measured in a reliable way?**	**Bias related to participant retention** Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	**Statistical conclusion validity** Was appropriate statistical analysis used?
Hai-bo Si et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
W. S. Abdelmegied et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mark J. McElroy et al., 2013	✓	✓	✓	✗	✓	✗	✓	✓	✓

L. Boyce et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Gaillard et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kunal Aneja et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Joshua T. Steere et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. A. Collins et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
Joost van Tilburg et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Riku A. Palanne et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bedrettin Akar et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Hakkalamani et al., 2010	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Amin et al., 2006	✓	✓	✓	✗	✓	✗	✓	✓	✓
N. Maffulli et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
G. Kerkhoffs et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓

H. Chaudhry et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Vandana Ayyar et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Lengkong et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Amr Ibrahim Salem Zonfoly et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
K. K. Boyle et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
L. Condell et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Agarwala et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ahmet Atilla Abdioğlu et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sandeep Patel et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
K. Daniilidis et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Junlong Zhong et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓

E-ISSN : 3048-1368 P-ISSN : 3048-1376

S. Ersozlu et al., 2008	✓	✓	✓	✗	✓	✗	✓	✓	✓
Giang Truong Le et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Deren T. Bagsby et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kai Sun et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
John J. Heifner et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Huan Wang et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dipak Suthar et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Onggo et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Troy B. Puga et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jin-qiang Du et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
B. Unver et al., 2009	✓	✓	✓	✗	✓	✗	✓	✓	✓
Yunping Ma et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Hai-feng Li et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Núñez et al., 2011	✓	✓	✓	✗	✓	✗	✓	✓	✓
B. Chalidis et al., 2010	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jingli Xu et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Philip Charles Drohat et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Kunutsor et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Raju Vaishya et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
L. Rouquette et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sheng Xu et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Dowsey et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. D. Helo et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Yoo et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓

Bmc Musculoskeletal Disorders et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mbbs Moneet Gill et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Katherine A. Lygrisse et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
G. Stathakos et al., 2011	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Helo et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Keeney et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Yushy Zhou et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
G. Murvai et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Q. Song et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
K. Giesinger et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Collins et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Robson Rocha Da Silva et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. Zeni et al., 2010	✓	✓	✓	✗	✓	✗	✓	✓	✓
T. O. Smith et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
D. Pozzobon et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Liljensøe et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Torres-Claramunt et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Vivek Singh et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ma Yan et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
L. Lozano et al., 2008	✓	✓	✓	✗	✓	✗	✓	✓	✓
E. Goudie et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Sattari et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Taunton et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓

L. Lau et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Mirghasemi et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Shariff et al., 2011	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Lyons et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Kanna et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Richard E. Jones et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dunbar et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

This systematic review includes 80 sources examining the relationship between body mass index (BMI) and implant failure risk following total knee arthroplasty (TKA).

Study	BMI Categories	Sample Size	Follow-up Duration
Hai-bo Si et al., 2015	Non-obese <30, Obese ≥30, Morbidly obese ≥40 kg/m²	20,988 TKAs	≥5 years

Study	BMI Categories	Sample Size	Follow-up Duration
W. S. Abdelmegied et al., 2020	Non-obese <30, Obese ≥30 kg/m²	Not mentioned	≥2 years
Mark J. McElroy et al., 2013	Obese 30-40, Morbidly obese 40-50 kg/m²	Not mentioned	Mean 5 years
L. Boyce et al., 2019	Morbidly obese ≥40, Non-obese ≤30 kg/m²	624 morbidly obese, 9,449 non-obese TKAs	Mean 4.8-5.2 years
R. Gaillard et al., 2017	Normal <25, Overweight 25-30, Moderately obese 30-35, Severely obese ≥35 kg/m²	1,059 TKAs	Mean 61.7 months
Kunal Aneja et al., 2020	Normal 18.5-25, Overweight 25-30, Obese 30-40 kg/m²	259 patients	Up to 3 years
Joshua T. Steere et al., 2018	Obese ≥35 kg/m²	178 TKAs in 143 patients	Mean 34 months
R. A. Collins et al., 2012	Non-obese <30, Mildly obese 30-35, Highly obese ≥35 kg/m²	445 TKRs	Up to 9 years
Joost van Tilburg et al., 2022	Morbidly obese vs non-obese	1,031 morbidly obese, 9,797 non-obese	≥2 years mean

Study	BMI Categories	Sample Size	Follow-up Duration
Riku A. Palanne et al., 2022	BMI ≤40 kg/m²	294-399 patients	12 months
Bedrettin Akar et al., 2021	Nonobese <30, Obese 30-39.9 kg/m²	776 patients	Mean 48 months
S. Hakkalamani et al., 2010	Non-obese vs Obese 30-40 kg/m²	150 patients	5 years
A. Amin et al., 2006	Non-obese 15-30, Obese >30 kg/m²	328 TKRs	60 months
N. Maffulli et al., 2019	Moderately obese 30-35, Severely obese >35 kg/m²	120 patients	Mean 3 years
G. Kerkhoffs et al., 2012	Non-obese <30, Obese ≥30 kg/m²	Up to 15,276 patients	>5 years for revision
H. Chaudhry et al., 2019	Normal <25, Severe ≥35, Morbid ≥40, Super-obese ≥50 kg/m²	37 studies	Not mentioned
Vandana Ayyar et al., 2012	Non-obese <30, Obese ≥30 kg/m²	171 patients	12 months
A. Lengkong et al., 2020	Normal <25, Obese ≥30, Morbidly obese ≥40 kg/m²	Not mentioned	1-5 years
Amr Ibrahim Salem Zonfoly et al., 2021	Morbidly obese vs non-obese	3,138 patients	Average 5 years

Study	BMI Categories	Sample Size	Follow-up Duration
K. K. Boyle et al., 2017	Obese ≥30 kg/m^2	325 patients	Not mentioned
L. Condell et al., 2019	Obese >40, Non-obese <40 kg/m^2	192,891 patients	Not mentioned
S. Agarwala et al., 2020	Non-obese <30, Obese 30-40 kg/m^2	52 patients	Mean 17-18 months
Ahmet Atilla Abdioğlu et al., 2020	Overweight, Class I-III obesity	Not mentioned	Minimum 24 months
Sandeep Patel et al., 2017	Morbidly obese	Not mentioned	43.8-73.6 months
K. Daniilidis et al., 2016	<25, 25-30, 30-40, >40 kg/m^2	199 patients, 230 TKAs	Not mentioned
Junlong Zhong et al., 2020	Normal <25, Overweight 25-30, Obese ≥30, Morbidly obese ≥40 kg/m^2	505,303 arthroplasties	Not mentioned
S. Ersozlu et al., 2008	Non-obese <30, Obese ≥30, Morbidly obese ≥40 kg/m^2	48 patients, 96 knees	Minimum 2 years
Giang Truong Le et al., 2020	High BMI patients	Not mentioned	Not mentioned

Study	BMI Categories	Sample Size	Follow-up Duration
Deren T. Bagsby et al., 2017	Morbidly obese	Not mentioned	Not mentioned
Kai Sun et al., 2017	Normal vs high BMI	33,778 patients	≥5 years
John J. Heifner et al., 2019	Obese ≥30, Severely obese ≥35 kg/m²	7,081 patients	90 days to 5.7 years
Huan Wang et al., 2021	WHO BMI categories	Not mentioned	Not mentioned
Dipak Suthar et al., 2017	Morbidly obese >40, Non-obese <30 kg/m²	100 patients	1 year
J. Onggo et al., 2021	Non-obese <30, Obese ≥30, Morbidly obese ≥40 kg/m²	3,106,381 TKAs	Not mentioned
Troy B. Puga et al., 2021	Variable BMI categories	Not mentioned	Not mentioned
Jin-qiang Du et al., 2014	Non-obese ≤25, Overweight 25.1-27, Obesity 27.1-30, Morbidly obese >30 kg/m²	148 patients	Not mentioned
B. Unver et al., 2009	Non-obese <30, Obese ≥30 kg/m²	186 patients	12 months
Yunping Ma et al., 2022	Underweight vs normal weight	Not mentioned	Not mentioned

Study	BMI Categories	Sample Size	Follow-up Duration
Hai-feng Li et al., 2020	Normal 18-24.9, Overweight, Obese	157 patients	Not mentioned
M. Núñez et al., 2011	Severe/morbidly obese vs nonobese	120 patients	12 months
B. Chalidis et al., 2010	Obese ≥30 kg/m²	100 patients	2 years
Jingli Xu et al., 2020	Obese vs non-obese, Morbidly obese vs non-morbidly obese	3,204,887 patients	Not mentioned
Philip Charles Drohat et al., 2018	Obese 30-40, Morbidly obese >40 kg/m²	Not mentioned	3 months to 14 years
S. Kunutsor et al., 2016	Normal <25, Overweight 25-29, Obese 30-34, Severely obese 35-40, Morbidly obese >40 kg/m²	62,087 primary TKAs	0 to 5.7 years
Raju Vaishya et al., 2016	Non-morbidly obese <40, Morbidly obese ≥40 kg/m²	5,159 TKRs	12-64.8 months
L. Rouquette et al., 2019	Obesity as comorbidity	57 patients	Not mentioned
Sheng Xu et al., 2018	Control <30, Obese ≥30 kg/m²	126 patients	10 years
M. Dowsey et al., 2022	Class II obesity ≥35 kg/m²	82 patients	Median 24-27 months
M. D. Helo et al., 2018	Multiple BMI groups	75 patients	1 year

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Study	BMI Categories	Sample Size	Follow-up Duration
J. Yoo et al., 2018	<25, 25-30, ≥30 kg/m²	371 cases	Mean 361 weeks
Bmc Musculoskeletal Disorders et al., 2020	Morbidly obese ≥40 kg/m²	3,045,096 patients	Not mentioned
Mbbs Moneet Gill et al., 2020	Weight loss intervention groups	50,672 intervention, 1,446,755 control	90 days
Katherine A. Lygrisse et al., 2022	BMI ≥35 kg/m²	230 patients	3 months
G. Stathakos et al., 2011	Morbidly obese >40 kg/m²	38 patients	Mean 13.8 months
M. Helo et al., 2019	Normal 18.5-24.9, Overweight 25-34.9, Obese 35-39.9, Morbidly obese ≥40 kg/m²	74 patients	3 months
J. Keeney et al., 2019	BMI >35 kg/m²	398 patients	Mean 2 years
Yushy Zhou et al., 2020	Obese patients	Not mentioned	Not mentioned
G. Murvai et al., 2020	Normal 18.5-25, Overweight 25-40 kg/m²	730 patients	6 months

Study	BMI Categories	Sample Size	Follow-up Duration
Q. Song et al., 2022	Obese patients	360 patients	Not mentioned
K. Giesinger et al., 2021	<25, 25-29.9, 30-34.9, 35-39.9, ≥40 kg/m²	1,565 patients	12 months
J. Collins et al., 2017	<25, 25-29.9, 30-34.9, 35-39.9, ≥40 kg/m²	633 patients	24 months
Robson Rocha Da Silva et al., 2014	Obesity as factor	Not mentioned	Not mentioned
J. Zeni et al., 2010	Obese vs non-obese	106 patients	2 years
T. O. Smith et al., 2016	Bariatric surgery patients	23,348 patients	Not mentioned
D. Pozzobon et al., 2018	Obese vs non-obese	Not mentioned	Not mentioned
A. Liljensøe et al., 2019	Obese patients with weight loss intervention	76 patients	1 year postoperatively
R. Torres-Claramunt et al., 2016	<30, ≥30 kg/m²	689 patients	5 years
Vivek Singh et al., 2021	<30, 30-34.9, 35-39.9, ≥40 kg/m²	1,075 patients	2 years

Study	BMI Categories	Sample Size	Follow-up Duration
Ma Yan et al., 2022	Bariatric surgery patients	Not mentioned	Not mentioned
L. Lozano et al., 2008	Severely obese >35 kg/m²	70 patients	Not mentioned
E. Goudie et al., 2017	Obese ≥30, Morbidly obese ≥40 kg/m²	1,879 patients	Not mentioned
S. Sattari et al., 2020	Bariatric surgery patients	2,876,547 patients	90 days to 1 year
M. Taunton et al., 2019	Obese patients	Not mentioned	2-15 years
L. Lau et al., 2020	Obese ≥30, Class I 31.6, Class III 43.8 kg/m²	198 patients	1 year
S. Mirghasemi et al., 2017	Multiple BMI groups	Not mentioned	Not mentioned
R. Shariff et al., 2011	BMI measured	91 patients	1 year
M. Lyons et al., 2019	Normal, Overweight, Obese	1,790 patients	12 months
R. Kanna et al., 2021	Non-obese <30, Obese ≥30 kg/m²	78+79 knees	5 years
Richard E. Jones et al., 2016	Obese >30, >35, >40 kg/m²	Not mentioned	Not mentioned

Study	BMI Categories	Sample Size	Follow-up Duration
Dunbar et al., 2012	BMI as predictor	Not mentioned	Not mentioned

The included studies represent a substantial evidence base with systematic reviews incorporating hundreds of thousands of TKA procedures. Follow-up periods ranged from 3 months to 14 years, with most studies reporting minimum 2-year follow-up for revision outcomes. BMI categorization varied considerably across studies, though the WHO classification (normal <25, overweight 25-29.9, obese ≥30, morbidly obese ≥40 kg/m²) was most commonly employed.

Effects of BMI on Implant Failure Risk

Revision Surgery Rates

Study	BMI Comparison	Effect Measure	Statistical Significance	Failure Type
Boyce et al., 2019	Morbidly obese ≥40 vs Non-obese ≤30	Revision rate 7% vs 2%	p<0.001	All-cause revision
van Tilburg et al., 2022	Morbidly obese vs Non-obese	RR 1.48 (95% CI: 0.98-2.24)	p=0.06	All-cause revision
van Tilburg et al., 2022	Morbidly obese vs Non-obese	RR 1.44 (95% CI: 0.64-3.25)	p=0.37	Aseptic revision
van Tilburg et al., 2022	Morbidly obese vs Non-obese	RR 2.22 (95% CI: 0.89-5.57)	p=0.09	Septic revision

Study	BMI Comparison	Effect Measure	Statistical Significance	Failure Type
Kerkhoffs et al., 2012	Obese ≥30 vs Non-obese	OR 1.30 (95% CI: 1.02-1.67)	Significant	All-cause revision
Kerkhoffs et al., 2012	Obese ≥30 vs Non-obese	OR 1.79 (95% CI: 1.15-2.78)	Significant	Long-term revision
Chaudhry et al., 2019	Severe obesity ≥35 vs Normal	RR 1.19 (95% CI: 1.03-1.37)	p=0.02	All-cause revision
Chaudhry et al., 2019	Morbid obesity ≥40 vs Normal	RR 1.93 (95% CI: 1.27-2.95)	p<0.001	All-cause revision
Chaudhry et al., 2019	Super-obesity ≥50 vs Normal	RR 4.75 (95% CI: 2.12-10.66)	p<0.001	All-cause revision
McElroy et al., 2013	Morbidly obese vs Obese vs Non-obese	Survivorship: 88% vs 95% vs 97%	Significant	Implant survival
Lengkong et al., 2020	Obese vs Non-obese	OR 1.30 for revision TKA	Significant	All-cause revision

The evidence consistently demonstrates a dose-response relationship between increasing BMI and revision risk. The meta-analysis by Chaudhry et al. showed that risk ratios for all-cause revision increased progressively from 1.19 in severely obese patients to 4.75 in super-obese patients compared to normal weight individuals. McElroy et al. reported that at mean 5-year follow-up, morbidly obese patients had significantly lower implant survivorship (88%) than obese patients (95%) and nonobese patients (97%).

Infection-Related Failure

Study	BMI Comparison	Effect Measure	Statistical Significance	Infection Type
Si et al., 2015	Obese ≥30 vs Non-obese	Increased risk	Significant	Any infection, superficial infection
Si et al., 2015	Morbidly obese ≥40 vs Non-obese	Higher risk	Significant	Deep infection
Kerkhoffs et al., 2012	Obese ≥30 vs Non-obese	OR 1.90 (95% CI: 1.46-2.47)	Significant	Any infection
Kerkhoffs et al., 2012	Obese ≥30 vs Non-obese	OR 2.38 (95% CI: 1.28-4.55)	Significant	Deep infection
Chaudhry et al., 2019	Severe obesity ≥35 vs Normal	RR 1.49 (95% CI: 1.28-1.72)	p<0.001	Septic revision
Chaudhry et al., 2019	Morbid obesity ≥40 vs Normal	RR 3.69 (95% CI: 1.90-7.17)	p<0.001	Septic revision
Chaudhry et al., 2019	Super-obesity ≥50 vs Normal	RR 4.58 (95% CI: 1.11-18.91)	p=0.04	Septic revision
Xu et al., 2020	Obese vs Non-obese	OR 1.51 (95% CI: 1.30-1.74)	Significant	PJI

Study	BMI Comparison	Effect Measure	Statistical Significance	Infection Type
Xu et al., 2020	Morbidly obese vs Non-morbidly obese	OR 3.27 (95% CI: 2.46-4.34)	Significant	PJI
Kunutsor et al., 2016	BMI ≥30 vs <30	RR 1.60 (95% CI: 1.29-1.99)	Significant	PJI
Kunutsor et al., 2016	BMI ≥35 vs <35	RR 1.53 (95% CI: 1.22-1.92)	Significant	PJI
Kunutsor et al., 2016	BMI ≥40 vs <40	RR 3.68 (95% CI: 2.25-6.01)	Significant	PJI
Jones et al., 2016	BMI >35	6.7x more likely infection	Significant	Infection
Jones et al., 2016	BMI >40	3.35x higher revision rate	Significant	Deep infection revision
Zhong et al., 2020	Increasing BMI	J-shaped relationship	Pnon-linearity<0.001	PJI

Infection-related failure demonstrated the strongest and most consistent association with elevated BMI across studies. Kerkhoffs et al. found that obese patients had nearly double the odds of any infection (OR 1.90) and more than double the odds of deep infection requiring surgical debridement (OR 2.38). The dose-response meta-analysis by Zhong et al. revealed a significant J-shaped non-linear relationship between BMI and periprosthetic joint infection risk. Notably, the risk of septic revision increased dramatically with higher BMI categories, with super-obese patients showing a risk ratio of 4.58 compared to normal weight patients.

Aseptic Loosening

Study	BMI Comparison	Effect Measure	Statistical Significance	Notes
Si et al., 2015	Obese vs Non-obese	No difference	Not significant	≥5 year follow-up
Chaudhry et al., 2019	All obesity categories	No significant difference	p>0.05	Aseptic revision
Boyle et al., 2017	Cemented vs Uncemented in obese	99.4% vs 99.3% survivorship	p=0.94	Tibial component
Steere et al., 2018	Obese with/without tibial stem	No failures	Not significant	Aseptic loosening
Bagsby et al., 2017	Morbidly obese	Increased risk	Significant	Aseptic tibial failures

In contrast to infection-related outcomes, aseptic loosening showed less consistent association with BMI. The meta-analysis by Chaudhry et al. found no significant differences in risk of aseptic revision across obesity categories. Similarly, Si et al. reported no differences in aseptic loosening with follow-up of 5 years or more between obese and non-obese patients. However, Bagsby et al. noted increased risk of aseptic tibial failures specifically in morbidly obese patients, suggesting that extreme obesity may still affect mechanical implant longevity.

Studies Reporting No Significant BMI-Failure Association

Study	BMI Categories	Main Finding	Follow-up

Study	BMI Categories	Main Finding	Follow-up
Gaillard et al., 2017	4 groups by BMI	No difference in 10-year survival (p=0.4)	61.7 months
Aneja et al., 2020	3 groups by BMI	BMI does not adversely affect outcomes	3 years
Collins et al., 2012	3 groups by BMI	No difference in implant survival	9 years
Amin et al., 2006	Obese vs Non-obese	No significant difference (p>0.2)	5 years
Boyle et al., 2017	Obese ≥30	No difference in survivorship	Short-mid term
Daniilidis et al., 2016	4 groups by BMI	No significant correlation	Not mentioned
Agarwala et al., 2020	Obese vs Non-obese	No failures observed	17-18 months
Kanna et al., 2021	Obese vs Non-obese	No influence on mid-term results	5 years

Several studies found no significant association between BMI and implant failure. Gaillard et al. reported that obesity did not affect mid-term implant survival using cementless, posterior-stabilized, rotating-platform implants (p=0.4 for 10-year survival). Collins et al. found no difference in overall complication rates or implant survival between obese and non-obese groups at nine years. These findings suggest that with appropriate implant selection and surgical technique, satisfactory outcomes can be achieved regardless of BMI.

Complication Rates

Study	BMI Comparison	Complication Rate	Statistical Significance
McElroy et al., 2013	Nonobese vs Obese vs Morbidly obese	9% vs 15% vs 22%	All significantly different
van Tilburg et al., 2022	Morbidly obese vs Non-obese	RR 1.56 (95% CI: 0.98-2.48)	p=0.06
Boyce et al., 2019	Morbidly obese vs Non-obese	Higher overall complications	Significant
Akar et al., 2021	Obese vs Non-obese	Higher risk of specific complications	Significant for some

Complication rates demonstrated a clear gradient with increasing BMI. McElroy et al. reported complication rates of 9%, 15%, and 22% for nonobese, obese, and morbidly obese patients respectively, with all differences being statistically significant. Specific complications more frequently associated with obesity included aseptic loosening, septic loosening, and medial retinaculum detachment.

Synthesis

The relationship between BMI and implant failure risk following TKA demonstrates important nuances that require careful interpretation beyond simple dichotomous conclusions.

Reconciling Heterogeneous Findings

The apparent contradiction between studies showing significant BMI-failure associations and those showing no relationship can be explained by several factors:

BMI Threshold Effects: Studies that found significant associations typically compared morbidly obese patients (BMI ≥40 kg/m²) against normal or non-obese controls. The meta-analysis by Chaudhry et al. demonstrated a clear dose-response relationship, with risk ratios increasing from 1.19 for severe obesity to 4.75 for super-obesity. In contrast, studies finding no significant difference often combined all obese patients into a single group (BMI ≥30 kg/m²) or studied populations with lower obesity severity. This suggests that the risk threshold for implant failure may be substantially higher than BMI 30 kg/m², with the most clinically meaningful increases occurring at BMI ≥40 kg/m².

Failure Type Specificity: The distinction between septic and aseptic failure is critical. Multiple high-quality meta-analyses consistently demonstrated significantly elevated risk of septic revision in obese patients, while aseptic revision showed no significant association across obesity categories. This mechanistic distinction suggests that obesity-related failure is primarily driven by increased infection susceptibility rather than mechanical factors. The biological mechanisms underlying this association likely include impaired wound healing, prolonged operative times, increased dead space in subcutaneous tissues, and metabolic factors associated with adiposity.

Implant and Technique Considerations: Studies employing specific implant designs or surgical techniques showed attenuated BMI effects. Gaillard et al. found no survival difference using cementless posterior-stabilized rotating-platform implants across BMI categories. Kanna et al. reported equivalent outcomes using computer-navigated gap-balancing TKA in obese versus non-obese patients. This suggests that modern implant designs and precise surgical techniques may partially mitigate obesity-related risks.

Follow-up Duration: Studies with longer follow-up periods tended to show more pronounced BMI effects. Collins et al. reported sustained improvements at nine years but noted lower function scores in highly obese patients, while short-term studies more frequently found no significant differences. This temporal pattern suggests that BMI-related complications may accumulate over time, particularly for infection which can present as delayed failure.

E-ISSN : 3048-1368
P-ISSN : 3048-1376

Clinical Implications by BMI Category

For patients with **BMI 30-35 kg/m²**, the evidence suggests modestly elevated complication risk but generally good functional outcomes. Multiple studies demonstrated that obese patients achieve significant improvements in pain and function comparable to non-obese patients, though absolute functional scores may remain lower.

For patients with **BMI 35-40 kg/m²**, infection risk becomes notably elevated (RR 1.49-1.60 for septic complications). Prophylactic measures such as preoperative optimization and negative pressure wound therapy may provide benefit in this population.

For patients with **BMI ≥40 kg/m²**, the evidence consistently demonstrates substantially elevated risks. The risk ratio for septic revision approaches 3.69, and implant survivorship may be reduced to 88% at 5 years compared to 97% in non-obese patients. Weight loss interventions, including bariatric surgery, may reduce perioperative complications in this population, though evidence regarding long-term implant outcomes remains limited.

For patients with **BMI ≥50 kg/m²** (super-obese), the risk magnifies further with risk ratios exceeding 4.5 for both all-cause and septic revision. The limited data available for this population suggests that careful preoperative counseling and consideration of weight optimization strategies is particularly important.

Methodological Considerations Affecting Interpretation

Several factors limit definitive conclusions. First, heterogeneity in BMI categorization across studies complicates direct comparisons. Second, many studies did not adequately control for obesity-related comorbidities that independently increase complication risk. Third, the retrospective nature of most included studies introduces potential selection and surveillance biases. Finally, publication bias favoring significant findings may inflate effect estimates.

The evidence supports the conclusion that elevated BMI, particularly at levels ≥40 kg/m², is associated with increased risk of implant failure following TKA, driven primarily by infectious complications rather than mechanical factors. However, obese patients consistently achieve clinically meaningful functional improvements following TKA, and with appropriate implant selection, surgical technique, and perioperative optimization, acceptable outcomes can be achieved across BMI categories.

DISCUSSION

This systematic review of 80 studies provides a comprehensive and nuanced analysis of the relationship between BMI and implant failure risk following TKA. The central finding is that the association is not uniform but is heavily influenced by the severity of obesity, the type of failure, and contextual factors related to surgery and patient management.

The Dominant Role of Infection in Obesity-Related Failure

The most consistent and robust evidence from this synthesis points to periprosthetic joint infection (PJI) as the primary driver of increased implant failure in obese patients. The data reveal a striking dose-response relationship, where the risk of septic revision escalates dramatically with higher BMI categories. Meta-analyses demonstrate that while severely obese patients (BMI ≥35) have a 49% increased risk (RR 1.49), this risk soars to 269% (RR 3.69) in the morbidly obese (BMI ≥40) and 358% (RR 4.58) in the super-obese (BMI ≥50) compared to normal-weight individuals (Chaudhry et al., 2019). This pattern is corroborated by multiple large-scale studies (Kerkhoffs et al., 2012; Si et al., 2015; Xu et al., 2020; Zhong et al., 2020).

The biological plausibility for this strong association is well-founded. Obesity is characterized by a state of chronic inflammation, with adipose tissue secreting pro-inflammatory cytokines such as TNF-α and IL-6, which can impair immune cell function and wound healing (Heifner et al., 2019). Technical factors during surgery are also contributory: thicker subcutaneous tissue necessitates deeper dissection, creates larger dead space, and often prolongs operative time—all established risk factors for surgical site infection (Kerkhoffs et al., 2012). Furthermore, local adiposity, particularly around the knee, may be a more direct mechanical and physiological risk

E-ISSN : 3048-1368 P-ISSN : 3048-1376

factor than BMI alone, potentially explaining some of the heterogeneity in findings (Heifner et al., 2019). The J-shaped non-linear relationship reported by Zhong et al. (2020) suggests the risk accelerates non-linearly at the highest BMI levels, underscoring the exceptional vulnerability of the super-obese population.

The Aseptic Loosening Conundrum: Mechanistic Dissociation

In stark contrast to infection, the evidence linking BMI to aseptic loosening—a primarily mechanical failure mode—is weak and inconsistent. Major meta-analyses found no significant increase in the risk of aseptic revision across obesity categories (Chaudhry et al., 2019). Long-term studies with follow-up exceeding five years also reported no difference in rates of aseptic loosening between obese and non-obese groups (Si et al., 2015; Collins et al., 2012). This mechanistic dissociation is critical for clinical understanding. It suggests that while the increased mechanical load from obesity is a theoretical concern, modern implant designs, improved polyethylene, and secure fixation techniques (both cemented and cementless) are largely sufficient to withstand these forces over the mid- to long-term in most obese patients (Boyle et al., 2017; Gaillard et al., 2017).

However, this does not imply a complete absence of risk. Some studies focusing specifically on extreme populations have noted increased rates of aseptic tibial failures in the morbidly obese, potentially pointing to failure modes related to exceptional loads or bone quality issues in this subset (Bagsby et al., 2017). This highlights that while the *average* risk may not be elevated, the extremes of the obesity spectrum may still present unique mechanical challenges.

Reconciling Heterogeneity: Thresholds, Techniques, and Time

The apparent contradiction between studies reporting significant BMI-failure associations and those finding no relationship can be resolved by examining key moderating variables.

1. **BMI Threshold Effects:** The most important reconciling factor is the BMI threshold used for comparison. Studies that report "no significant difference" often compare a combined

obese group (BMI ≥30) to a non-obese group (Amin et al., 2006; Daniilidis et al., 2016). This dilutes the pronounced risk observed in the highest BMI categories. The present analysis clearly demonstrates that the risk gradient is shallow in the overweight and Class I obesity range but steepens markedly beyond BMI 35-40 kg/m². Therefore, studies with a higher proportion of morbidly obese patients are more likely to detect a significant effect (Boyce et al., 2019; van Tilburg & Andersen, 2022).

2. **Surgical Technique and Implant Design as Effect Modifiers:** Evidence suggests that advancements in surgical technique and implant technology can mitigate obesity-related risks. Studies utilizing computer-navigated surgery for precise alignment and gap balancing found equivalent mid-term outcomes between obese and non-obese patients (Kanna et al., 2021). Similarly, the use of specific implant designs, such as cementless rotating-platform knees, has been associated with excellent survivorship independent of BMI (Gaillard et al., 2017). The debate on cemented versus cementless fixation in high-BMI patients continues, with recent reviews suggesting cementless TKA may be a viable alternative, potentially reducing long-term failure risks (Le et al., 2020). Furthermore, prophylactic measures like the use of tibial stem extensions in obese patients are being evaluated to enhance stability, though evidence is still evolving (Zhou et al., 2020).

3. **Follow-up Duration:** The temporal pattern of failure is crucial. Infection-related failures often present earlier, while aseptic loosening typically manifests later. Studies with short-term follow-up (<2 years) may capture the early infection risk but miss later mechanical failures, potentially underestimating the overall risk in obese patients (Agarwala et al., 2020). Conversely, the fact that aseptic loosening differences do not strongly emerge even in long-term studies (>9 years) reinforces the conclusion that mechanical failure is not the primary BMI-related concern (Collins et al., 2012; Sheng Xu et al., 2018).

Clinical Implications and Stratified Management

The synthesized evidence supports a stratified, risk-adaptive approach to TKA in obese patients rather than a blanket policy.

- **Patients with BMI 30-35 kg/m²:** These patients have a modestly elevated risk, primarily for infection. They should receive standard preoperative optimization and can expect excellent functional outcomes and implant survivorship comparable to non-obese patients (Aneja et al., 2020; Giesinger et al., 2021). Aggressive denial of surgery in this group is not supported by evidence.
- **Patients with BMI 35-40 kg/m²:** The infection risk becomes more substantial. Enhanced prophylactic measures are warranted, such as strict glycemic control, consideration of negative pressure wound therapy (NPWT) (Lygrisse et al., 2022; Song et al., 2022), and possibly the use of antibiotic-loaded bone cement. Thorough preoperative counselling about the increased complication risk is essential.
- **Patients with BMI ≥40 kg/m² (Morbidly Obese):** This group carries a significantly elevated risk for major complications and revision surgery. A comprehensive preoperative optimization program is mandatory. This should include multidisciplinary evaluation and strong encouragement for weight loss. Evidence suggests that structured weight loss interventions, including bariatric surgery prior to TKA, can effectively reduce the risk of postoperative complications, particularly PJI (Liljensøe et al., 2019; Dowsey et al., 2022; Sattari et al., 2020; BMC Musculoskeletal Disorders et al., 2020). Surgeons should employ meticulous technique, consider implants with enhanced fixation (e.g., stems), and utilize all available infection prevention strategies.
- **Patients with BMI ≥50 kg/m² (Super-Obese):** For these patients, the risks are magnified. TKA should be approached with extreme caution. Preoperative weight loss is strongly recommended and may be considered a prerequisite for elective surgery in many centers. The decision to operate must involve careful consideration of the high probability of complications against the severity of the patient's disability.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Limitations and Future Directions

This review acknowledges several limitations in the underlying evidence base. First, most included studies are retrospective, introducing potential selection and information bias. Second, heterogeneity in defining and reporting complications complicates pooling of data. Third, many studies inadequately adjust for critical confounders like diabetes, cardiovascular disease, and nutritional status, which are collinear with obesity (Murvai et al., 2020). Finally, there is a relative paucity of high-quality prospective studies or RCTs specifically targeting surgical and perioperative management in obese TKA patients.

Future research should focus on: 1) Prospective, stratified cohorts with long-term follow-up across detailed BMI categories; 2) Randomized trials evaluating the efficacy of specific mitigation strategies (e.g., NPWT types, antibiotic protocols, implant selections) in obese populations; 3) Investigations into the role of local adiposity and body composition metrics, which may be more predictive than BMI alone; and 4) Cost-effectiveness analyses of preoperative weight loss programs in the TKA pathway.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This systematic review confirms a significant and graded relationship between increasing body mass index (BMI) and the risk of implant failure following total knee arthroplasty (TKA). The elevated risk is predominantly driven by a substantially increased susceptibility to periprosthetic joint infection (PJI), which exhibits a strong dose-response relationship, becoming particularly pronounced at BMI levels ≥40 kg/m². In contrast, the risk of aseptic mechanical loosening is not consistently associated with BMI, suggesting modern implants and techniques are resilient to the increased mechanical loads. While obesity elevates complication rates, it is crucial to recognize that patients across all BMI categories, including the morbidly obese, experience significant and clinically meaningful improvements in pain and function after TKA. Therefore, obesity should be viewed as a modifiable risk factor rather than an absolute contraindication to surgery.

Recommendations

Based on the synthesized evidence, the following recommendations are proposed for clinical practice and future research:

1. **Risk-Stratified Patient Counselling:** Preoperative counselling must be individualized and reflect the stratified risk. Patients with BMI ≥35 kg/m², and especially ≥40 kg/m², should be explicitly informed of their significantly elevated risk for infection and revision surgery as part of the shared decision-making process.

2. **Preoperative Optimization Mandate:** A formal preoperative optimization pathway is essential for patients with obesity, particularly those with BMI ≥35 kg/m². This should include:

    - **Weight Management:** Strongly encourage and support weight loss through multidisciplinary programs. For patients with BMI ≥40 kg/m², referral for bariatric surgery evaluation should be considered, as it has been shown to reduce postoperative complication risks (Dowsey et al., 2022; Sattari et al., 2020).

    - **Comorbidity Management:** Aggressive control of diabetes, optimization of nutritional status, and management of other obesity-associated comorbidities (Murvai et al., 2020).

3. **Enhanced Intraoperative and Perioperative Strategies:** For high-BMI patients (≥35 kg/m²), surgeons should consider:

    - Employing meticulous surgical technique with emphasis on soft tissue handling and hemostasis.

- Utilizing available technologies like computer navigation to ensure precise alignment.
- Considering implant selection carefully (e.g., potential use of stems, rotating platforms) based on patient anatomy and bone quality.
- Implementing enhanced infection prophylaxis protocols, which may include the use of antibiotic-loaded bone cement, dilute povidone-iodine irrigation, and negative pressure wound therapy for incision management (Keeney et al., 2019; Lygrisse et al., 2022).

4. **Standardized Reporting and Future Research:** The orthopaedic research community should adopt standardized reporting of BMI using WHO categories and clear definitions of complications. Future high-quality prospective studies and RCTs are needed to directly compare the effectiveness of different surgical techniques, implants, and perioperative bundles specifically in obese patient cohorts to establish definitive best-practice guidelines.

REFERENCES

A. Amin, J. Patton, R. Cook, and I. Brenkel. "A COMPARISON OF CLINICAL OUTCOME AND COMPLICATION RATES IN OBESE AND NON-OBESE PATIENTS FOLLOWING TOTAL KNEE REPLACEMENT FOR OSTEOARTHRITIS," 2006.

A. Lengkong. "The Impact of Obesity on Total Knee Arthroplasty Outcomes: A Systematic Review." *Jurnal Sehat Indonesia (JUSINDO)*, 2020.

A. Liljensøe, J. Laursen, H. Bliddal, K. Søballe, and I. Mechlenburg. "Weight Loss Intervention Before Total Knee Replacement: A 12-Month Randomized Controlled Trial." *Scandinavian Journal of Surgery*, 2019.

Ahmet Atilla Abdioğlu, and Gökhan Peker. “Comparison of Bilateral Cementless Total Knee Arthroplasty Results Between Patients in Different BMI Groups.” *Archives of Orthopaedic and Trauma Surgery*, 2020.

Amr Ibrahim Salem Zonfoly, Alaa Ahmed Moustafa Elngehy, Mohamed Hamdy Mohamed Abdelh Younis, and Ahmad Hassan Zaki Eissa. “Primary Total Knee Arthroplasty in Obese Patients; A Systematic Review.” *Zagazig University Medical Journal*, 2021.

B. Chalidis, G. Petsatodis, A. Christodoulou, J. Christoforidis, P. Papadopoulos, and J. Pournaras. “Is Obesity a Contraindication for Minimal Invasive Total Knee Replacement? A Prospective Randomized Control Trial.” *Obesity Surgery*, 2010.

B. Unver, V. Karatosun, Serkan Bakırhan, and İ. Gunal. “Effects of Total Knee Arthroplasty on Body Weight and Functional Outcome,” 2009.

Bedrettin Akar, Yusuf Oztürkmen, Mehmet B. Balioglu, Fatih Uğur, and Erhan Şükür. “The Effect of Obesity on Simultaneous Bilateral Knee Arthroplasty Surgery.” *Journal of the American Academy of Orthopaedic Surgeons. Global Research & Reviews*, 2021.

Bmc Musculoskeletal Disorders, D. D. Mauro, G. Balato, E. Festa, A. D. Cristo, L. Marasco, G. Loffredo, et al. “Role of Bariatric Surgery in Reducing Periprosthetic Joint Infections in Total Knee Arthroplasty. A Systematic Review and Meta-Analysis.” *BMC Musculoskeletal Disorders*, 2020.

D. Pozzobon, P. Ferreira, F. Blyth, G. Machado, and Manuela L. Ferreira. “Can Obesity and Physical Activity Predict Outcomes of Elective Knee or Hip Surgery Due to Osteoarthritis? A Meta-Analysis of Cohort Studies.” *BMJ Open*, 2018.

Deren T. Bagsby, K. Issa, Langan S. Smith, R. Elmallah, Logan E Mast, S. Harwin, Michael A Mont, Samrath J. Bhimani, and A. Malkani. “Response to Letter to the Editor on "Cemented Vs Cementless Total Knee Arthroplasty in Morbidly Obese Patients".” *Journal of Arthroplasty*, 2017.

Dipak Suthar, and T. Vegad. “Assessment of Total Knee Replacement in Obese Patients and Nonobese Patients: A Comparative Study,” 2017.

Dunbar, Griffin, and G. Surr. “PRE-OPERATIVE FACTORS THAT PREDICT OUTCOME AFTER TOTAL KNEE REPLACEMENT: A SYSTEMATIC REVIEW,” 2012.

E. Goudie, C. Robinson, P. Walmsley, and I. Brenkel. “Changing Trends in Total Knee Replacement.” *European Journal of Orthopaedic Surgery & Traumatology*, 2017.

G. Kerkhoffs, E. Servien, Warren R Dunn, D. Dahm, Jos A. M. Bramer, and Daniel Haverkamp. “The Influence of Obesity on the Complication Rate and Outcome of Total Knee Arthroplasty: A Meta-Analysis and Systematic Literature Review.” *Journal of Bone and Joint Surgery. American Volume*, 2012.

G. Murvai, T. Ghitea, and Simona Cavalu. “Comparing Metabolic Preconditioning and Diabetes As Risk Factors in Knee Arthroplasty Complications.” *Cureus*, 2020.

G. Stathakos, I. Koutroumpas, N. Manidakis, G. Hatzipavlis, K. Balalis, and P. Katonis. “009 COMPARATIVE STUDY OF EXTRAMEDULLARY AND INTRAMEDULLARY TECHNIQUES FOR THE ALIGNMENT OF THE TIBIAL COMPONENT OF TOTAL KNEE ARTHROPLASTIES IN OBESE PATIENTS,” 2011.

Giang Truong Le, B. V. van Duren, K. Ilo, R. Berber, H. Matar, and B. Bloch. “Cementless TKA Use as an Alternative to Cemented TKA in High BMI Patients: A Systematic Review and Meta-analysis.” *Journal of Experimental Orthopaedics*, 2020.

H. Chaudhry, Karthikeyan E. Ponnusamy, L. Somerville, R. Mccalden, J. Marsh, and E. Vasarhelyi. “Revision Rates and Functional Outcomes Among Severely, Morbidly, and Super-Obese Patients Following Primary Total Knee Arthroplasty: A Systematic Review and Meta-Analysis.” *JBJS Reviews*, 2019.

Hai-bo Si, Yi Zeng, B. Shen, Jing Yang, Zong-ke Zhou, P. Kang, and F. Pei. “The Influence of Body Mass Index on the Outcomes of Primary Total Knee Arthroplasty.” *Knee Surgery, Sports Traumatology, Arthroscopy,* 2015.

Hai-feng Li, San-jun Gu, Kerong Song, Yu Liu, Jian Wang, Jianbing Wang, and Qudong Yin. “The Influence of Obesity on Clinical Outcomes Following Primary Total Knee Arthroplasty: A Prospective Cohort Study.” *Knee (Oxford),* 2020.

Huan Wang, M. Qiong, and Baoan Ma. “Analysis of the Influence of BMI on the Outcome After Total Knee Arthroplasty,” 2021.

J. Collins, Laurel A. Donnell-Fink, Heidi Y. Yang, Ilana M. Usiskin, Emma C. Lape, John Wright, J. Katz, and E. Losina. “Effect of Obesity on Pain and Functional Recovery Following Total Knee Arthroplasty.” *Journal of Bone and Joint Surgery. American Volume*, 2017.

J. Keeney, J. Cook, Stacee W Clawson, A. Aggarwal, and J. Stannard. “Incisional Negative Pressure Wound Therapy Devices Improve Short-Term Wound Complications, but Not Long-Term Infection Rate Following Hip and Knee Arthroplasty.” *Journal of Arthroplasty*, 2019.

J. Onggo, James Jia Ming Ang, Jason D Onggo, R. D. de Steiger, and R. Hau. “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 Journal of Surgery*, 2021.

J. Yoo, H. Oh, Sang-Hoon Park, Jin-Kyu Kim, and Sang-Hee Kim. “Does Obesity Affect Clinical and Radiological Outcomes in Minimally Invasive Total Knee Arthroplasty? Minimum 5-Year Follow-up of Minimally Invasive TKA in Obese Patients.” *Clinics in Orthopedic Surgery*, 2018.

J. Zeni, and L. Snyder-Mackler. “Most Patients Gain Weight in the 2 Years After Total Knee Arthroplasty: Comparison to a Healthy Control Group.” *Osteoarthritis and Cartilage*, 2010.

Jingli Xu, Zheng-Rong Liang, Peng Yang, and Qing-Wen Zhang. “A Protocol for Systematic Review and Meta-Analysis,” 2020.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

Jin-qiang Du, Yao-zu Gao, Zhi-qiang Zhang, and Xiao-chun Wei. “[Effects of Body Mass Index on Postoperative Outcome in Patients with Osteoarthritis After Total Knee Arthroplasty].” *Zhongguo Gu Shang = China Journal of Orthopaedics and Traumatology*, 2014.

John J. Heifner, Philip A. Sakalian, Robert J. Rowland, and Arturo Corces. “Local Adiposity May Be a More Reliable Predictor for Infection Than Body Mass Index Following Total Knee Arthroplasty: A Systematic Review.” *Journal of Experimental Orthopaedics*, 2019.

Joost van Tilburg, and Mikkel Rathsach Andersen. “Mid- to Long-Term Complications and Outcome for Morbidly Obese Patients After Total Knee Arthroplasty: A Systematic Review and Meta-Analysis.” *EFORT Open Reviews*, 2022.

Joshua T. Steere, M. Sobieraj, C. DeFrancesco, C. Israelite, C. Nelson, and A. Kamath. “Prophylactic Tibial Stem Fixation in the Obese: Comparative Early Results in Primary Total Knee Arthroplasty.” *Knee Surgery and Related Research*, 2018.

Junlong Zhong, Bin Wang, Yufeng Chen, Huizi Li, Nan Lin, Xianghe Xu, and Huading Lu. “Relationship Between Body Mass Index and the Risk of Periprosthetic Joint Infection After Primary Total Hip Arthroplasty and Total Knee Arthroplasty.” *Annals of Translational Medicine*, 2020.

K. Daniilidis, D. Yao, G. Gosheger, Corinna Berssen, T. Budny, R. Dieckmann, and S. Höll. “Does BMI Influence Clinical Outcomes After Total Knee Arthroplasty?” *Technology and Health Care*, 2016.

K. Giesinger, JM Giesinger, DF Hamilton, J. Rechsteiner, and A. Ladurner. “Higher Body Mass Index Is Associated with Larger Postoperative Improvement in Patient-Reported Outcomes Following Total Knee Arthroplasty.” *BMC Musculoskeletal Disorders*, 2021.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

K. K. Boyle, S. Nodzo, Joseph T. Ferraro, David J. Augenblick, Sonja Pavlesen, and M. Phillips. "Uncemented Vs Cemented Cruciate Retaining Total Knee Arthroplasty in Patients With Body Mass Index Greater Than 30." *Journal of Arthroplasty*, 2017.

Kai Sun, and Hui Li. "Body Mass Index as a Predictor of Outcome in Total Knee Replace: A Systemic Review and Meta-Analysis." *Knee (Oxford)*, 2017.

Katherine A. Lygrisse, Greg M. Teo, Vivek Singh, Nishanth Muthusamy, R. Schwarzkopf, and Long William. "Comparison of Silver-Embedded Occlusive Dressings and Negative Pressure Wound Therapy Following Total Joint Arthroplasty in High BMI Patients: A Randomized Controlled Trial." *Archives of Orthopaedic and Trauma Surgery*, 2022.

Kunal Aneja, Ponnanna Karineravanda Machaiah, Supreet Bajwa, and Ravi Teja Rudraraju. "A Multicentre Retrospective Study of the Impact of Body Mass Index on Clinical and Functional Outcomes of Total Knee Arthroplasty: An Indian Prospective." *Journal of Orthopaedic Reports*, 2020.

L. Boyce, A. Prasad, M. Barrett, S. Dawson-Bowling, S. Millington, S. Hanna, and P. Achan. "The Outcomes of Total Knee Arthroplasty in Morbidly Obese Patients: A Systematic Review of the Literature." *Archives of Orthopaedic and Trauma Surgery*, 2019.

L. Condell, Charles N. Wallace, and F. Condon. "AB081. SOH23ABS_016. Is Total Knee Replacement Surgery Warranted in the Obese Patient: A Systematic Review." *Mesentery and Peritoneum*, 2019.

L. Lau, P. Chan, Tak Wai David Lui, Siu-Wai Choi, Elaine Au, T. Leung, M. Luk, et al. "Preoperative Weight Loss Interventions Before Total Hip and Knee Arthroplasty: A Systematic Review of Randomized Controlled Trials." *Arthroplasty*, 2020.

L. Lozano, J. Segur, F. Maculé, M. Núñez, P. Torner, F. Castillo, and S. Suso. "Intramedullary Versus Extramedullary Tibial Cutting Guide in Severely Obese Patients Undergoing Total Knee

Replacement: A Randomized Study of 70 Patients with Body Mass Index >35 Kg/M2." *Obesity Surgery*, 2008.

L. Rouquette, R. Erivan, B. Pereira, S. Boisgard, S. Descamps, and G. Villatte. "Tibiofemoral Dislocation After Primary Total Knee Arthroplasty: A Systematic Review." *International Orthopaedics*, 2019.

M. D. Helo, I. F. Akhtiamov, F. Said, I. Gilmutdinov, A. Yousef, A. Abdullah, and R. G. Kuznetsova. "Early Functional Results of Total Knee Arthroplasty in Patients with Alimentary Obesity." *N.N. Priorov Journal of Traumatology and Orthopedics*, 2018.

M. Dowsey, W. Brown, Angela Cochrane, P. Burton, D. Liew, and P. Choong. "Effect of Bariatric Surgery on Risk of Complications After Total Knee Arthroplasty." *JAMA Network Open*, 2022.

M. Helo, I. F. Akhtiamov, A. Emelin, I. Gilmutdinov, G. M. Faizrakhmanova, and T. Kilmetov. "Functional State of Patients with an Increased Body Mass Index in the Early Rehabilitation Period After Total Knee Joint Arthroplasty (Preliminary Report)." *Genij Ortopedii*, 2019.

M. Lyons, Fracs Australia, David Carmody Mbbs, J. Roe, Martina RN Australia, and B. Gooden. "National Trends of Cemented and Uncemented Total Knee Arthroplasty: 2018-2020." *Journal of ISAKOS*, 2019.

M. Núñez, L. Lozano, E. Núñez, S. Sastre, José Luis del Val, and S. Suso. "Good Quality of Life in Severely Obese Total Knee Replacement Patients: A Case-Control Study." *Obesity Surgery*, 2011.

M. Taunton. "What's New in Adult Reconstructive Knee Surgery." *Journal of Bone and Joint Surgery. American Volume*, 2019.

Ma Yan, Gang Zheng, Zhixiong Long, Qingyun Pan, Xiaohui Wang, Yuan Li, and C. Lei. "Does Bariatric Surgery Really Benefit Patients Before Total Knee Arthroplasty? A Systematic Review and Meta-Analysis." *International Journal of Surgery*, 2022.

Mark J. McElroy, R. Pivec, K. Issa, S. Harwin, and Michael Mont. “The Effects of Obesity and Morbid Obesity on Outcomes in TKA.” *The Journal of Knee Surgery*, 2013.

Mbbs Moneet Gill, Daniel Kevin Llanera MSc, Timothy Lindsay, T. Tan, Frcp MB ChB, FRCPath Alex Liddle PhD, and C. Izzi-Engbeaya. “SUN-790 Associations Between Weight Loss Pre-Hip Or Pre-Knee Arthroplasty And Peri- And Post-Operative Outcomes.” *Journal of the Endocrine Society*, 2020.

N. Maffulli. “Faculty Opinions Recommendation of Do Stemmed Tibial Components in Total Knee Arthroplasty Improve Outcomes in Patients with Obesity?” 2019.

Philip Charles Drohat, M. Kiehl, and Charles F Mess. “The Effect of Obesity on the Outcome of Total Knee Arthroplasties in Arthritic Patients.” *Journal of Student-Scientists' Research*, 2018.

Q. Song, Dong Li, Yan Zhao, Guangmin Zhang, Donglong Shang, Linhao Fan, and Xiao-qian Dang. “Negative Pressure Wound Therapy Reduces the Incidence of Postoperative Wound Dehiscence and Surgical Site Infections After Total Knee Arthroplasty in Patients with Obesity.” *Medicine*, 2022.

R. A. Collins, P. Walmsley, A. Amin, I. Brenkel, and R. Clayton. “Does Obesity Influence Clinical Outcome at Nine Years Following Total Knee Replacement?” *Journal of Bone and Joint Surgery-British Volume*, 2012.

R. Gaillard, T. Gaillard, S. Denjean, and S. Lustig. “No Influence of Obesity on Survival of Cementless, Posterior-Stabilised, Rotating-Platform Implants.” *Archives of Orthopaedic and Trauma Surgery*, 2017.

R. Kanna, Ananth Brasanna, G. Shetty, and Chandramohan Ravichandran. “No Influence of Obesity on Mid-Term Clinical, Functional, and Radiological Results After Computer-Navigated Total Knee Arthroplasty Using a Gap Balancing Technique.” *Journal of Clinical Orthopaedics and Trauma*, 2021.

R. Shariff, M. Rathinam, A. Gulam, O. Wainwright, and McNicholas Michael James. “The Effect of Total Knee Arthroplasty on Body Mass Index—A Prospective Study,” 2011.

R. Torres-Claramunt, P. Hinarejos, J. Leal-Blanquet, J. Sánchez-Soler, Raquel Marí-Molina, L. Puig-Verdié, and J. Monllau. “Does Obesity Influence on the Functional Outcomes of a Total Knee Arthroplasty?” *Obesity Surgery*, 2016.

Raju Vaishya, V. Vijay, D. Wamae, and A. Agarwal. “Is Total Knee Replacement Justified in the Morbidly Obese? A Systematic Review.” *Cureus*, 2016.

Richard E. Jones. “THE MORBIDLY OBESE PATIENT: TRUTHS AND CONSEQUENCES,” 2016.

Riku A. Palanne, Mikko Rantasalo, A. Vakkuri, K. Olkkola, T. Vahlberg, and Noora Skants. “Fat Tissue Is a Poor Predictor of 1 Year Outcomes After Total Knee Arthroplasty: A Secondary Analysis of a Randomized Clinical Trial.” *Scandinavian Journal of Surgery*, 2022.

Robson Rocha Da Silva, Ayrton André Melo Santos, José de Sampaio Carvalho Júnior, and M. Matos. “Quality of Life After Total Knee Arthroplasty: Systematic Review☆☆☆.” *Revista Brasileira de Ortopedia*, 2014.

S. Agarwala, Y. Wagh, and M. Vijayvargiya. “Is Obesity a Contraindication for Simultaneous Bilateral Total Knee Arthroplasty? A Prospective Case–Control Study.” *SICOT-J*, 2020.

S. Ersozlu, T. Akkaya, A. Ozgur, O. Sahin, I. Senturk, and R. Tandoğan. “Bilateral Staged Total Knee Arthroplasty in Obese Patients.” *Archives of Orthopaedic and Trauma Surgery*, 2008.

S. Hakkalamani, P. Mereddy, M. Nixon, R. Finley, and N. Donnachie. “BODY MASS INDEX DOES IT AFFECT THE OUTCOME IN PRIMARY TKA: A PROSPECTIVE 5-YEAR STUDY,” 2010.

E-ISSN : 3048-1368 P-ISSN : 3048-1376

S. Kunutsor, M. Whitehouse, A. Blom, and A. Beswick. “Patient-Related Risk Factors for Periprosthetic Joint Infection After Total Joint Arthroplasty: A Systematic Review and Meta-Analysis.” *PLoS ONE*, 2016.

S. Mirghasemi, M. Maltenfort, R. Tabatabaee, M. R. Rasouli, S. Rashidinia, and J. Parvizi. “EFFECT OF OBESITY ON OUTCOME OF TOTAL JOINT ARTHROPLASTY: A SYSTEMATIC REVIEW,” 2017.

S. Sattari, Ali Reza Sattari, Christopher G. Salib, Hytham S. Salem, Daniel Hameed, Jeremy Dubin, and Michael A. Mont. “Total Knee Arthroplasty with or Without Prior Bariatric Surgery: A Systematic Review and Meta-Analysis.” *Journal of Arthroplasty*, 2020.

Sandeep Patel, and Tungish Bansal. “Letter to the Editor on "Cemented Vs Cementless Total Knee Arthroplasty in Morbidly Obese Patients".” *Journal of Arthroplasty*, 2017.

Sheng Xu, J. Chen, N. Lo, S. Chia, D. Tay, H. Pang, Ying Hao, and S. Yeo. “The Influence of Obesity on Functional Outcome and Quality of Life After Total Knee Arthroplasty: A TEN-YEAR FOLLOW-UP STUDY.” *The Bone & Joint Journal*, 2018.

T. O. Smith, T. Aboelmagd, C. Hing, and A. J. MacGregor. “Does Bariatric Surgery Prior to Total Hip or Knee Arthroplasty Reduce Post-Operative Complications and Improve Clinical Outcomes for Obese Patients? Systematic Review and Meta-Analysis.” *The Bone & Joint Journal*, 2016.

Troy B. Puga, Alan D. Lam, Claire Ferguson, McKenna W. Box, John Badylak, and John T. Riehl. “Body Mass Index (BMI) and Associations of Periprosthetic Fracture Risk After TKA: A Systematic Review.” *Journal of Orthopaedic Reports*, 2021.

Vandana Ayyar, R. Burnett, F. Coutts, M. L. Van der Linden, and T. Mercer. “The Influence of Obesity on Patient Reported Outcomes Following Total Knee Replacement.” *Arthritis*, 2012.

E-ISSN : 3048-1368
P-ISSN : 3048-1376

Vivek Singh, D. Yeroushalmi, Katherine A. Lygrisse, Trevor G. Simcox, W. Long, and R. Schwarzkopf. "The Influence of Obesity on Achievement of a 'Forgotten Joint' Following Total Knee Arthroplasty." *Archives of Orthopaedic and Trauma Surgery*, 2021.

W. S. Abdelmegied, A. Sallam, and M. M. Ahmed. "Effect of BMI on Complications Rate, Reoperation and Functional Outcome After Total Knee Arthroplasty, A Systematic Review of Literature." *The Quarterly Journal of Medicine*, 2020.

Yunping Ma, and Qiu Shen. "Impact of Being Underweight on Peri-Operative and Post-Operative Outcomes of Total Knee or Hip Arthroplasty: A Meta-Analysis." *World Journal of Clinical Cases*, 2022.

Yushy Zhou, S. Rele, and Osama Elsewaisy. "Does the Use of Tibial Stem Extensions Reduce the Risk of Aseptic Loosening in Obese Patients Undergoing Primary Total Knee Arthroplasty: A Systematic Review and Meta-Analysis." *Knee (Oxford)*, 2020.