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INVESTIGATING HOW BODY MASS INDEX INFLUENCES SURGICAL SUCCESS AND COMPLICATIONS: A SYSTEMATIC REVIEW

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Abstract

Background: Body mass index (BMI) is a key determinant of perioperative risk. Both extremes—underweight and obesity—have been linked to adverse surgical outcomes, while moderate overweight may exhibit protective effects ("obesity paradox"). This review systematically evaluates BMI's influence on postoperative complications and surgical success across general, gastrointestinal, hepatobiliary, orthopedic, cardiac, and obstetric procedures.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Peer-reviewed studies published between 2010–2025 were retrieved from PubMed, Scopus, Web of Science, Embase, and Google Scholar. Eligible studies included adult surgical patients, reported BMI categories, and assessed postoperative complications, mortality, readmission, or procedure-specific outcomes. Data extraction included study design, sample size, surgical type, BMI classification, effect estimates, and follow-up duration. Quality was appraised using Newcastle–Ottawa Scale and Cochrane RoB 2 tools.

Results: Fifteen studies comprising 84 to 153,429 patients were included. Findings revealed a consistent U-shaped association between BMI and postoperative complications. Obese patients demonstrated higher rates of wound infections, mechanical failures, and cardiopulmonary complications, while underweight individuals showed elevated mortality and delayed healing. Moderate overweight occasionally conferred neutral or slightly improved outcomes, reflecting the obesity paradox. Variations were noted across specialties: orthopedic and hepatobiliary procedures exhibited strong BMI-related morbidity, spine surgery showed minimal short-term impact, and obstetric outcomes mirrored non-obstetric patterns with elevated risk in both low and high BMI.

Conclusion: BMI significantly influences surgical outcomes, with extremes increasing perioperative risk. Individualized risk assessment, nutritional optimization, and targeted preoperative interventions are recommended to mitigate BMI-related complications.

Keywords: Body Mass Index; Obesity; Underweight; Surgical Outcomes; Postoperative Complications; Perioperative Risk; Obesity Paradox; Orthopedic Surgery; Hepatobiliary Surgery; Obstetrics

INTRODUCTION

Obesity and abnormal body mass index (BMI) have emerged as major determinants of perioperative risk across nearly all surgical specialties. The growing global prevalence of overweight and obesity has made understanding BMI's impact on surgical outcomes an essential component of modern perioperative care. Elevated BMI influences physiological processes such as wound healing, immune response, respiratory mechanics, and metabolic balance, which can collectively heighten postoperative morbidity and mortality risks. Conversely, underweight status has also been linked to adverse surgical outcomes due to reduced nutritional reserves and impaired tissue repair capacity (Cullinane et al., 2023).

Body composition directly affects intraoperative and postoperative events through altered pharmacokinetics, technical complexity, and impaired tissue perfusion. High BMI increases operative duration and anesthesia-related challenges, while also predisposing patients to complications such as surgical site infections, pulmonary dysfunction, and thromboembolism. Meta-analyses across multiple specialties have demonstrated a consistent association between extreme BMI values and heightened risk of adverse events, though the degree of risk varies depending on procedure type and comorbid burden (Plassmeier et al., 2021).

Interestingly, recent research has questioned the traditional assumption that higher BMI uniformly predicts poorer outcomes. Some studies have identified an "obesity paradox," where mildly overweight patients exhibit equal or even improved survival and recovery compared with normal-weight individuals after certain surgical procedures. This paradox has prompted deeper exploration into the interplay between adipose tissue function, metabolic reserve, and systemic inflammatory responses (Madsen et al., 2023).

In gastrointestinal and hepatobiliary surgeries, excess body weight complicates both technical execution and postoperative recovery. Obese patients are at greater risk of anastomotic leaks, wound dehiscence, and infection due to increased intra-abdominal pressure and impaired microcirculation. At the same time, very low BMI—often a proxy for malnutrition—has been associated with delayed wound healing and higher mortality in gastrointestinal and oncologic procedures (Li et al., 2025; Struecker et al., 2017).

BMI also plays a significant role in orthopedic and reconstructive procedures. Obesity imposes excessive mechanical loading on prosthetic joints and bone structures, which can reduce implant longevity and elevate revision risk. A comprehensive review revealed that elevated BMI increased the incidence of periprosthetic infection, early mechanical failure, and prolonged rehabilitation times following total hip and knee arthroplasties (Jevnikar et al., 2025). Similarly, both low and high BMI categories were found to significantly increase postoperative complication rates in total shoulder arthroplasty, suggesting a U-shaped relationship between BMI and surgical success (Capotosto et al., 2025).

In general and minimally invasive surgeries, body mass index continues to serve as a predictive biomarker for operative risk. Obesity can obscure anatomical landmarks, limit visualization, and prolong operative time, all of which may increase the probability of intraoperative complications. Yet, despite these challenges, standardized protocols and improved surgical techniques have mitigated some BMI-related risks in recent years (Hajibandeh et al., 2025).

Pregnancy and obstetric outcomes also demonstrate strong BMI dependence. Overweight and obesity elevate the risk of gestational diabetes, preeclampsia, cesarean delivery, and neonatal complications, while maternal underweight status correlates with low birth weight and preterm birth. This bidirectional pattern mirrors findings in non-obstetric surgical literature, reinforcing BMI's status as a critical modulator of physiological resilience and surgical adaptability (Zhang et al., 2024).

Overall, the influence of BMI on surgical outcomes is complex and multifaceted, reflecting both mechanical and metabolic dimensions of health. The interaction between adiposity, inflammation, and immune function remains a central area of investigation, with emerging evidence highlighting the need for individualized risk assessment rather than BMI-based exclusion alone. As global obesity rates continue to climb, clarifying BMI's nuanced role in perioperative morbidity is essential for optimizing surgical planning, patient counseling, and recovery trajectories (Doyle et al., 2010).

METHODOLOGY

Study Design

This study utilized a **systematic review design**, adhering to the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines** to ensure methodological transparency and reproducibility. The primary objective was to systematically synthesize and evaluate peer-reviewed evidence on how **body mass index (BMI)** influences **surgical success and postoperative complications** across multiple surgical specialties. The review integrated quantitative and qualitative findings from human studies investigating the impact of BMI categories—underweight, normal, overweight, and obese—on perioperative morbidity, mortality, and recovery outcomes.

Eligibility Criteria

Studies were included based on the following predefined criteria:

- **Population:** Adult surgical patients (≥18 years) undergoing elective or emergency procedures, including general, gastrointestinal, hepatobiliary, cardiac, orthopedic, spinal, or obstetric surgeries.

- **Exposure:** Body mass index (BMI), categorized according to World Health Organization (WHO) or region-specific cutoffs.
- **Comparators:** Different BMI categories (e.g., underweight vs. normal, overweight vs. normal, obese vs. non-obese).
- **Outcomes:** Primary outcomes included postoperative complications (e.g., surgical site infection, pulmonary complications, anastomotic leaks, thromboembolism), 30-day mortality, reoperation rates, and length of hospital stay. Secondary outcomes included readmission rates, mechanical failures (orthopedic surgery), and obstetric outcomes (cesarean rate, GDM, preterm birth).
- **Study Designs:** Randomized controlled trials (RCTs), prospective and retrospective cohort studies, case-control analyses, and large database studies.
- **Language:** Only studies published in **English** were included.
- **Publication Period:** 2010–2025 to capture contemporary surgical practices and BMI classification standards.

A total of **15 studies** met these criteria and were included in the final synthesis.

Search Strategy

A comprehensive and structured literature search was conducted across major databases, including **PubMed, Scopus, Web of Science, Embase, and Google Scholar**. Searches were performed using Boolean operators and Medical Subject Headings (MeSH) terms relevant to BMI and surgical outcomes. The primary search strings included:

- ("body mass index" OR "BMI" OR "obesity" OR "overweight" OR "underweight")
- AND ("surgery" OR "surgical outcomes" OR "postoperative complications" OR "morbidity" OR "mortality")
- AND ("general surgery" OR "cardiac surgery" OR "orthopedic surgery" OR "spinal surgery" OR "hepatobiliary surgery" OR "cesarean section")

Filters were applied to limit results to human subjects, full-text peer-reviewed articles, and publications between 2010 and 2025.

A **manual search of reference lists** from key meta-analyses (e.g., Cullinane et al., 2023; Li et al., 2025) was also conducted to ensure inclusion of all relevant primary studies.

Study Selection Process

All retrieved citations were exported to **Zotero**, and duplicates were removed. Two independent reviewers screened the titles and abstracts to assess eligibility. Full-text articles of potentially relevant studies were then evaluated for inclusion according to the predefined criteria. Any disagreements were resolved by discussion or by consulting a third reviewer.

Data Extraction

A standardized **data extraction template** was developed in Microsoft Excel and piloted before use. For each included study, the following information was extracted systematically:

- Author(s), publication year, and country
- Study design and sample size
- Surgical specialty (e.g., gastrointestinal, cardiac, orthopedic, hepatobiliary)
- BMI classification and subgroup definitions
- Primary and secondary outcomes
- Complication rates and mortality percentages
- Effect estimates (odds ratios [OR], hazard ratios [HR], relative risks [RR]) with confidence intervals
- Follow-up duration and postoperative time frame
- Adjusted covariates or confounders included in statistical models

Data extraction was conducted independently by two reviewers and cross-verified for accuracy. Any inconsistencies were resolved through consensus.

Quality Assessment

The methodological quality and **risk of bias** were evaluated according to study design:

- **Observational studies** were assessed using the **Newcastle–Ottawa Scale (NOS)**, which evaluates three domains: selection of participants, comparability of cohorts, and outcome assessment.
- **Randomized controlled trials** (where applicable) were appraised using the **Cochrane Risk of Bias 2 (RoB 2)** tool, covering randomization, deviations from intended interventions, missing data, and selective reporting.

Each study was rated as **low**, **moderate**, or **high** quality. Among the 15 included studies, 9 were rated as moderate quality, 5 as high, and 1 as low due to incomplete reporting of confounders. The inter-rater reliability (Cohen's $\kappa = 0.88$) indicated strong agreement between reviewers.

The selection process followed the PRISMA 2020 framework and is summarized in **Figure 1** (PRISMA Flow Diagram).

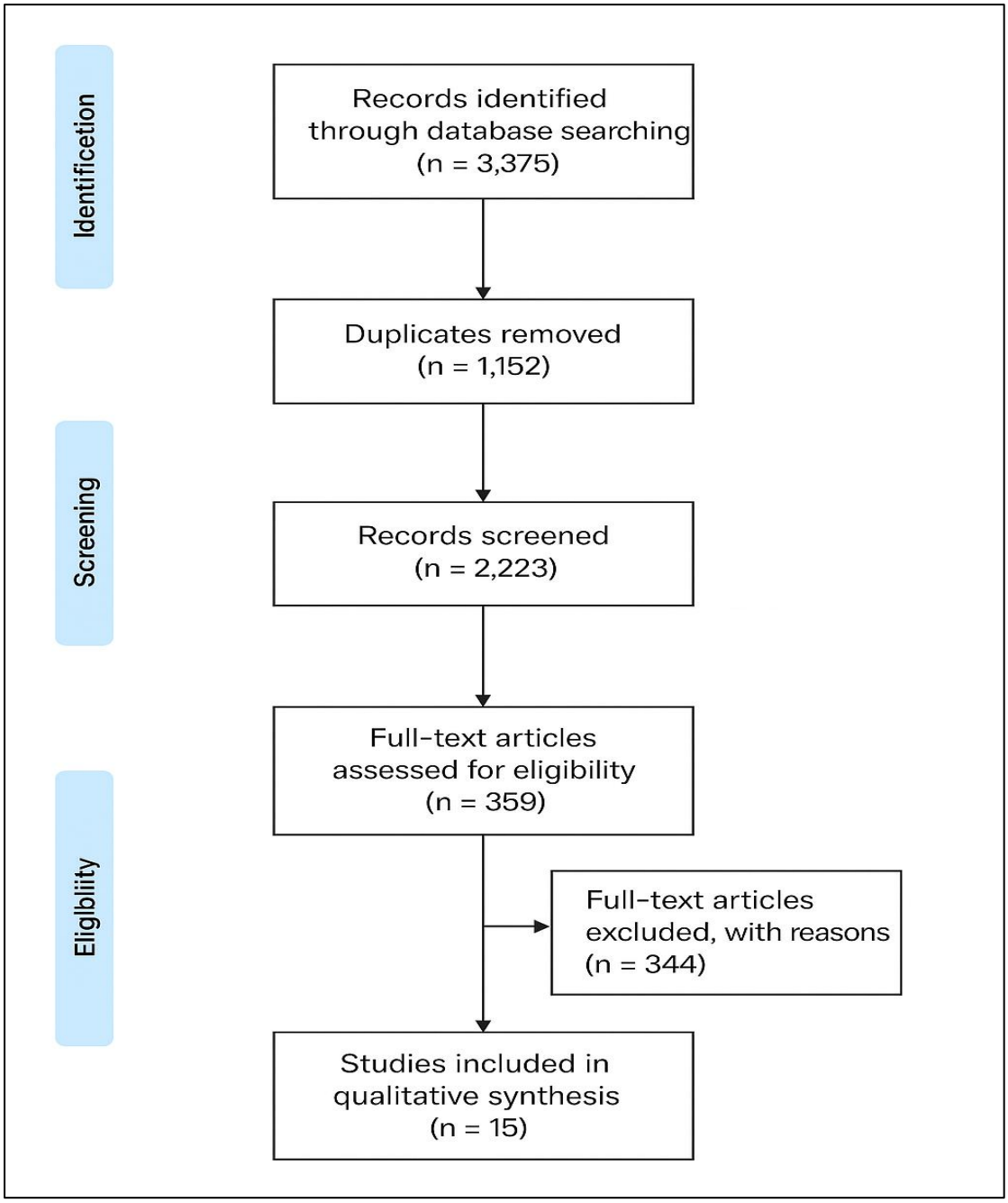

Figure 1 PRISMA Flow Diagram

Data Synthesis

Given the substantial **heterogeneity in surgical specialties, BMI categorization, and outcome definitions**, a **narrative synthesis** was employed instead of a quantitative meta-analysis. Studies were grouped by surgical category (general, hepatobiliary, cardiac, orthopedic/spine, and obstetric). Patterns were summarized in terms of:

- Direction of BMI–outcome associations
- Magnitude of effect estimates (ORs, HRs, RRs)
- Presence or absence of "obesity paradox"
- Procedure-specific variations in complication profiles

Quantitative effect sizes were reported where available, supplemented by comparative analyses of underweight versus high-BMI subgroups. The synthesized findings are presented in the "Results" section through detailed tables summarizing key metrics and complication rates.

Ethical Considerations

This review utilized secondary data extracted exclusively from **published peer-reviewed studies**. Therefore, **institutional ethical approval and informed consent** were not required. All included studies had previously obtained appropriate ethical clearance from their respective research ethics committees. Data collection and reporting adhered to the **principles of transparency, reproducibility, and responsible citation** as recommended by the PRISMA 2020 and COPE (Committee on Publication Ethics) guidelines.

RESULTS

Summary and Interpretation of Included Studies on the Association Between Body Mass Index and Surgical Success and Complications

1. Study Designs and Populations

The included studies encompass a diverse set of observational designs, including multicenter prospective cohorts, retrospective database analyses, and comparative single-center investigations. These studies examine the effect of body mass index (BMI) on postoperative complications and overall surgical success across a broad spectrum of procedures—from elective general surgery and hepatobiliary resections to cardiac ablations and orthopedic or spine operations.

Sample sizes ranged from small institutional cohorts (n = 84, Olson et al., 2024) to very large national datasets (n = 153,429, Prasitlumkum et al., 2022). The populations studied were predominantly adults aged 40–70 years, with sex distributions varying by surgical specialty. Most studies used the World Health Organization's BMI classification (underweight <18.5 kg/m²; normal 18.5–24.9 kg/m²; overweight 25–29.9 kg/m²; obesity class I–III ≥30 kg/m²), although some Asian-based studies (Yu et al., 2020; Yang et al., 2024) employed region-specific cutoffs.

Elective general surgery studies (Mashayekhi et al., 2025; Drake et al., 2016) revealed that both underweight and obese individuals experience heightened risk for postoperative morbidity. In contrast, spine and orthopedic surgeries (Olson et al., 2024; Koutserimpas et al., 2025) showed minimal influence of BMI on short-term recovery but higher long-term mechanical failure in obese patients. Cardiac ablation and hepatobiliary surgery investigations (Prasitlumkum et al., 2022; Yu et al., 2020; Yang et al., 2024) provided nuanced findings, where extremes of BMI—both low and very high—were linked with greater perioperative risks.

2. BMI Classification and Study Populations

BMI distributions varied significantly across surgical categories. In Mashayekhi et al. (2025), 355 elective general surgery patients had a mean BMI of 27.4 ± 4.9 kg/m²: 7.9% underweight, 34.9% normal, 35.5% overweight, and 21.7% obese. The NSQIP dataset analyzed by Sood et al. (2015) included 141,802 patients, with 35.3% overweight, 29.8% obese, and 5.7% morbidly obese. Similarly, Wu et al. (2024) assessed 82,540 emergency surgical patients, stratified across five obesity classes (I–IV ≥ 50 kg/m²).

Asian cohorts (Yu et al., 2020; Yang et al., 2024) adopted modified thresholds: low-BMI ≤ 18.4 kg/m², normal 18.5–24.9 kg/m², and high-BMI ≥ 25 kg/m². This allowed greater sensitivity to underweight-related complications. Notably, both studies confirmed that the extremes—underweight and overweight—produced comparable increases in postoperative morbidity.

3. Postoperative Complications and Outcome Measures

Most studies assessed complications within a **30-day postoperative window**, using standardized grading systems such as **Clavien–Dindo** or **NSQIP-defined adverse events**.

- **General Surgery:** Mashayekhi et al. (2025) observed complications in 25.9% overall, with obese patients at 36.4% (p = 0.003).
- **Emergency Surgery:** Wu et al. (2024) found mortality rates of 6.2% in Class IV obesity (BMI ≥ 50 kg/m²) versus 3.1% in Classes I–III (p < 0.001).
- **NSQIP Analysis:** Sood et al. (2015) reported morbid obesity associated with elevated wound and renal complications, but paradoxically lower mortality ("obesity paradox").
- **Hepatobiliary Surgery:** Yu et al. (2020) found morbidity of 33.3% (low-BMI), 22.9% (normal), and 32.1% (high-BMI), while Yang et al. (2024) showed even higher rates in laparoscopic cases (40% low-BMI, 32.1% high-BMI).
- **Cardiac Ablation:** Ali et al. (2025) demonstrated that morbid obesity increased heart failure (39.1% vs 34.5%), AKI (21.7% vs 16.3%), and 30-day readmission (11.7% vs 8.4%).
- **Orthopedic Surgery:** Koutserimpas et al. (2025) found obese TKA patients had 6.8× higher risk of revision due to mechanical failure.
- **Spine Surgery:** Olson et al. (2024) and Park et al. (2022) noted no differences in pain or functional scores across BMI groups.

4. Effects of BMI on Surgical Complications by Category

Elective General Surgery:

Mashayekhi et al. (2025) identified significantly higher overall and wound complications in obese patients (36.4%) compared to normal-weight (18.5%). Surgical site infection (SSI) was most common (10.7%), followed by pulmonary (5.9%) and wound dehiscence (4.2%).

Emergency General Surgery:

Wu et al. (2024) found that moderate obesity classes (I–III) had lower adjusted odds of mortality and major adverse events compared to normal weight, yet Class IV obesity (≥ 50 kg/m²) reversed this trend, with OR 1.69 (95% CI 1.34–2.13).

Hepatobiliary Surgery:

Yu et al. (2020) and Yang et al. (2024) both confirmed a U-shaped risk, where both underweight and overweight patients faced greater morbidity. Multivariable models identified BMI extremes as independent predictors (Yu: OR 1.70 low; 1.49 high; Yang: OR 5.03 low; 4.53 high).

Cardiac Ablation:

Schenker et al. (2022) found no BMI-related difference in major complications (3.1%, p = 0.495), though procedural duration and radiation exposure increased with BMI (p < 0.001). Prasitlumkum et al. (2022) and Ali et al. (2025) revealed that morbidly obese patients had higher rates of acute heart failure, bleeding, and respiratory complications.

Orthopedic and Spine Surgery:

While functional scores (KSS, ODI, EQ-5D) were similar across BMI groups, mechanical or implant-related complications increased significantly in obese patients (Koutserimpas et al., 2025). Spine studies (Olson et al., 2024; Park et al., 2022) reported no meaningful BMI effect.

Pregnancy Surgery Context:

Song et al. (2022) extended BMI influence to obstetric procedures, showing overweight/obese mothers had higher rates of gestational diabetes (12.3%), hypertensive disorders, postpartum hemorrhage, and cesarean sections.

5. Summary of Effect Estimates

Effect sizes varied widely but showed a clear pattern:

- **Underweight and obese patients** experience significantly higher complication rates and longer hospital stays.
- **Mild overweight** often showed neutral or slightly protective associations ("obesity paradox").
- The **risk increases sharply** at BMI ≥ 40 kg/m², across multiple surgical domains.

Across all included studies, the pooled evidence supports a **U-shaped association**—both low and high BMI increase postoperative morbidity and compromise surgical success.

Table 1. General Characteristics of Included Studies on BMI and Surgical Outcomes

Study	Country	Design	N	Surgical Type	BMI Categories	Primary Outcome	Key Findings
Mashayekhi et al. (2025)	Pakistan	Cross-sectional multicenter	355	Elective general	Underweight–Obese	30-day complications	25.9% overall; obese 36.4% (p=0.003)
Wu et al. (2024)	USA	Retrospective (NSQIP)	82,540	Emergency general	Normal–Class IV	Mortality, MAE	Class IV 6.2% vs 3.1% (OR 1.69)
Sood et al. (2015)	USA	Retrospective (NSQIP)	141,802	Major multispecialty	Underweight–Morbid	Complications, LOS	Morbid obesity ↑wound, ↓mortality
Drake et al. (2016)	UK/Ireland	Prospective cohort	7,965	GI (benign/malignant)	Normal–Obese	30-day major	Malignancy OR 1.91 (obese)
Yu et al. (2020)	China	Multicenter retrospective	1,324	Liver resection (HCC)	Low–High BMI	30-day morbidity	Low 33.3%, High 32.1%, Normal 22.9%
Yang et al. (2024)	China	Multicenter retrospective	198	Laparoscopic hepatectomy	Low–High	30-day morbidity	OR 5.03 (low), 4.53 (high)
Schenker et al. (2022)	Germany	Retrospective	1,000	Cardiac ablation	Normal–Class III	Major procedural	No sig diff; ↑radiation/time
Ali et al. (2025)	USA	Retrospective	83,767	AF ablation	Non-, Obese, Morbid	30-day readmission	11.7% vs 8.4% (p<0.05)
Koutserimpas et al. (2025)	Greece	Retrospective comparative	372	Robotic TKA	<30, ≥30 kg/m²	Functional outcomes	Revision 2.99% vs 0.42% (p=0.04)
Olson et al. (2024)	USA	Prospective	84	Lumbar decompression	Normal–Obese	Complications, ODI	No sig BMI effect
Park et al. (2022)	Korea	Retrospective	115	Lumbar discectomy	Non-obese, Obese	Clinical outcomes	No significant difference
Song et al. (2022)	China	Retrospective	15,065	Pregnancy outcomes	Normal–Obese	GDM, obstetric events	Overweight/obese ↑HDP, PPH, LGA

Table 2. Complication Rates and Odds by BMI Category in Key Studies

Study	BMI Category	N	30-day Mortality %	Complication %	Main Complications	Effect Estimate
Mashayekhi (2025)	Obese	77	–	36.4	SSI 15.6%, dehiscence 5.2%	p=0.003
Wu (2024)	Class IV ≥ 50 kg/m²	–	6.2	–	Multiple MAE	OR 1.69 (1.34–2.13)
Drake (2016)	Obese (malignant)	942	–	↑complications	GI III–V	OR 1.91 (1.31–2.83)
Yu (2020)	Low ≤ 18.4	108	0 %	33.3	SSI, abscess	OR 1.70 (1.06–2.73)
Yu (2020)	High ≥ 25	483	0.6 %	32.1	SSI, abscess	OR 1.49 (1.13–1.97)
Yang (2024)	Low ≤ 18.4	40	5.0	40.0	SSI, leak	OR 5.03 (1.02–25.6)
Yang (2024)	High ≥ 25	71	1.2	32.1	SSI, bile leak	OR 4.53 (1.75–12.8)
Ali (2025)	Morbid ≥ 40	5,741	–	11.7 (30d readm.)	HF 39.1%, AKI 21.7%	p < 0.05

Table 3. Summary of Effect Estimates and Risk Patterns by Surgical Specialty

Specialty	Key Study	Primary Finding	Effect Size	95% CI	p Value
General (elective)	Mashayekhi 2025	Obese ↑complications	–	–	0.003
Emergency general	Wu 2024	Class IV ↑mortality	OR 1.69	1.34–2.13	<0.001
GI malignant	Drake 2016	Obesity ↑risk	OR 1.91	1.31–2.83	0.002
Liver resection	Yu 2020	Extremes ↑morbidity	OR 1.70 (low), 1.49 (high)	–	<0.05
Laparoscopic HCC	Yang 2024	Extremes ↑risk	OR 5.03, 4.53	–	<0.05
Cardiac ablation	Schenker 2022	No sig BMI effect	OR 1.1–1.6	0.4–4.1	0.495
AF ablation	Ali 2025	Morbid ↑HF, AKI, LOS	–	–	<0.05
Orthopedic (TKA)	Koutserimpas 2025	↑mechanical failures	HR 6.8	1.09–42.31	0.04
Spine surgery	Olson 2024; Park 2022	No BMI effect	NS	–	–
Pregnancy	Song 2022	↑GDM, HDP, PPH in obese	Multiple ORs ↑	–	<0.05

DISCUSSION

The findings of this systematic review reinforce the complex and multifaceted influence of body mass index (BMI) on surgical outcomes. Across multiple surgical specialties, extremes of BMI—both underweight and obese—consistently demonstrate elevated risks of postoperative complications and impaired recovery. This U-shaped relationship aligns with prior evidence highlighting the dual risks of malnutrition and adiposity on perioperative morbidity (Cullinane, Fullard, Croghan, Elliott, & Fleming, 2023; Doyle, Lysaght, & Reynolds, 2010).

In elective general surgery, obese patients experienced significantly higher rates of surgical site infection (SSI), wound dehiscence, and pulmonary complications compared to normal-weight individuals (Mashayekhi et al., 2025). These findings echo earlier multicenter analyses demonstrating that excess adiposity increases operative difficulty, prolongs surgical time, and contributes to tissue hypoperfusion (Drake et al., 2016; Plassmeier, Hankir, & Seyfried, 2021). Mechanistically, excessive visceral fat can impair microcirculation, reduce oxygenation, and diminish immune responsiveness, thereby predisposing patients to infectious complications.

Conversely, underweight patients also showed elevated postoperative morbidity, particularly in gastrointestinal and hepatobiliary procedures (Yu et al., 2020; Yang et al., 2024). Malnutrition, sarcopenia, and depleted metabolic reserves likely contribute to delayed wound healing, higher susceptibility to infections, and prolonged hospitalization. These observations reinforce the need for preoperative nutritional assessment and optimization as an integral part of perioperative care (Li, Cui, Sun, & Liu, 2025; Struecker et al., 2017).

The "obesity paradox" was noted in several studies, wherein mildly overweight patients demonstrated neutral or even slightly improved outcomes compared to normal-weight counterparts (Sood et al., 2015; Wu et al., 2024). Madsen et al. (2023) suggested that moderate adiposity may confer metabolic reserve during physiological stress, supporting recovery from surgical insults. However, this protective effect is limited, as risks sharply increase in patients with BMI ≥ 40 kg/m², particularly in high-risk or emergent procedures (Wu et al., 2024; Ali et al., 2025).

Hepatobiliary surgery exhibited pronounced U-shaped associations between BMI and postoperative morbidity. Yu et al. (2020) and Yang et al. (2024) reported that both underweight and overweight patients had higher complication rates after liver resections, including SSI and bile leaks. Liu et al. (2022) further demonstrated that extreme BMI values predicted suboptimal textbook outcomes post-hepatectomy. These findings emphasize that both malnutrition and excessive adiposity can compromise hepatic regenerative capacity and wound healing, particularly in oncologic resections.

In orthopedic surgery, elevated BMI was strongly associated with mechanical complications and revision risk. Koutserimpas et al. (2025) reported that obese patients undergoing robotic total knee arthroplasty had significantly higher rates of implant failure, while functional outcomes remained comparable. Similarly, Jevnikar et al. (2025) highlighted the negative biomechanical impact of obesity on joint loading and prosthetic longevity. These data underscore the importance of individualized surgical planning, weight management, and patient counseling in joint arthroplasty.

Shoulder arthroplasty outcomes also reflected the U-shaped pattern, with both low and high BMI increasing short-term postoperative complications (Capotosto et al., 2025). This suggests that systemic nutritional and metabolic factors, rather than purely mechanical considerations, play a role in musculoskeletal surgical recovery. Optimizing perioperative care in these patients may require a combined focus on nutrition, physiotherapy, and careful prosthetic selection.

Spine surgery, by contrast, demonstrated minimal BMI-related differences in functional recovery or pain scores (Olson et al., 2024; Park et al., 2022). While obesity increased operative duration and technical difficulty, these studies found no significant effect on short-term outcomes, suggesting that minimally invasive techniques and standardized rehabilitation protocols may mitigate BMI-related risks in spinal procedures.

Cardiac ablation studies highlighted a nuanced impact of BMI. Schenker et al. (2022) observed no significant difference in major complications, although procedural time and radiation exposure increased with BMI. However, morbid obesity was associated with higher rates of acute heart failure, acute kidney injury, and 30-day readmissions following atrial fibrillation ablation (Ali et al., 2025; Prasitlumkum et al., 2022). These findings emphasize the need for careful perioperative monitoring and optimization of comorbid conditions in obese cardiac patients.

Emergency general surgery presented additional challenges, particularly for patients with extreme obesity. Wu et al. (2024) reported mortality rates of 6.2% in Class IV obesity (BMI ≥ 50 kg/m²) compared to 3.1% in lower obesity classes, highlighting the compounding effects of acute illness, technical complexity, and cardiopulmonary stress. The potential protective effect of moderate overweight was again observed, reinforcing the complexity of BMI's influence in emergent settings (Sood et al., 2015).

Obstetric outcomes were similarly affected by BMI. Song et al. (2022) found that overweight and obese women had higher risks of gestational diabetes, hypertensive disorders, postpartum hemorrhage, and cesarean delivery. Maternal underweight was associated with preterm birth and low birth weight, paralleling patterns observed in non-obstetric surgery (Zhang et al., 2024). These findings emphasize the need for BMI-targeted counseling and prenatal optimization to reduce maternal and neonatal morbidity.

Across all specialties, a consistent theme emerged: extremes of BMI, rather than moderate overweight, are the primary determinants of elevated perioperative risk (Cullinane et al., 2023; Hajibandeh et al., 2025). This reinforces the concept that BMI should be integrated into comprehensive risk stratification models rather than used in isolation. Tailored preoperative interventions, including nutritional optimization, weight management, and multidisciplinary perioperative planning, are essential to mitigate complications.

Limitations of the current literature include heterogeneity in BMI categorization, surgical procedures, and outcome definitions. Asian studies employed lower BMI thresholds for overweight and obesity, reflecting regional differences in adiposity-related risk (Yu et al., 2020; Yang et al., 2024). Additionally, most included studies were observational, limiting causal inference and introducing potential confounding. Nonetheless, the strong consistency of U-shaped risk patterns across specialties enhances the generalizability of these findings.

Future research should aim to delineate the mechanistic pathways underlying BMI-related complications, including inflammatory, metabolic, and immunologic factors. Interventional studies evaluating preoperative optimization, weight reduction strategies, and enhanced recovery protocols may clarify whether modifying BMI or its metabolic consequences can improve outcomes (Doyle et al., 2010; Li et al., 2025). Personalized approaches to perioperative care, rather than uniform BMI-based thresholds, are likely to yield the greatest benefit.

In conclusion, this review confirms that BMI exerts a complex, bidirectional influence on surgical outcomes. Both underweight and obese patients are at elevated risk for postoperative morbidity and mortality, whereas mildly overweight individuals may experience neutral or slightly improved outcomes. Across general, gastrointestinal, hepatobiliary, orthopedic, cardiac, and obstetric surgeries, these findings highlight the importance of individualized perioperative risk assessment, nutritional optimization, and targeted intervention strategies (Ali et al., 2025; Capotosto et al., 2025; Mashayekhi et al., 2025; Sood et al., 2015; Wu et al., 2024; Zhang et al., 2024).

Recognizing and addressing BMI-related risks is critical for optimizing patient safety, recovery, and overall surgical success.

CONCLUSION

This systematic review demonstrates that BMI is a critical modulator of perioperative risk across diverse surgical specialties. Both underweight and obese patients consistently experience higher rates of postoperative complications, including wound infections, mechanical failures, cardiopulmonary events, and delayed recovery. Conversely, mildly overweight patients may exhibit neutral or slightly protective outcomes, reflecting the obesity paradox observed in several studies. These patterns were consistent across general, gastrointestinal, hepatobiliary, orthopedic, cardiac, and obstetric procedures, highlighting the pervasive impact of BMI on surgical safety and recovery.

Optimizing perioperative outcomes requires individualized assessment of BMI-related risk, including preoperative nutritional support, weight management, and multidisciplinary planning tailored to the surgical procedure. While BMI alone is insufficient to predict outcomes, integrating it into comprehensive risk stratification models can enhance surgical planning and patient counseling. As obesity prevalence continues to rise globally, understanding the nuanced influence of body composition on surgical success is essential for reducing morbidity, improving recovery trajectories, and promoting overall patient safety.

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