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The Impact of Obesity on the Outcomes of Spinal Fusion Surgery: A Systematic Review

Dr. Wael M. Alzahrani, MD [1], Aljoharah Abdullah Alqahtani [2], Alkhalid, Khalid Naif A [3], Raghad Mahdi M Al-Awn [4], Samirah S Alharbi [5], Abdulelah Mohammed Abu Hassan [6], Faisal Mohammed M Alqahtani [7], Meshari Abdulmalik Althobaiti [8], Moodhy Othman Aldehsenah [9], Anwar Khalid Alruwaili [10]

1- Associate professor & consultant of orthopedic surgery, Department of Surgery, College of Medicine, Najran University, Najran, Saudi Arabia.
2- Medical intern, Umm alqura university college of medicine, Riyadh, Saudi Arabia.
3- Medical intern, Jouf university, college of medicine, Sakaka Aljouf, Saudi Arabia
4- Medical Intern, King Khalid University, Abha, Saudi Arabia
5- Medical intern, Taibah University, Medina, Saudi Arabia
6- Intern, Medical intern, University of Almaarefa, Riyadh, Saudi Arabia
7- Medical student, King khalid university, Abha, Kingdom of Saudi Arabia
8- Intern, Jeddah, Saudi Arabia
9- Medical intern, Qassim University, Unaizah college of Medicine, Qassim, Saudi Arabia
10- Internal medicine senior registrar, North Medical Tower at Arar in Saudi Arabia

Abstract

Objectives: To evaluate the impact of obesity on the outcomes of spinal fusion surgery, an increasingly common procedure for various spinal pathologies.

Methods: A thorough search across four databases identified 724 relevant publications. After removing duplicates using Rayyan QCRI and screening for relevance, 391 full-text articles were reviewed, with 7 studies ultimately meeting the criteria for inclusion.

Results: We included seven studies with a total of 1454 patients who underwent spinal fusion surgery, and nearly half of them 734 (50.5%) were males. Obesity impacts several outcomes in spinal fusion surgery. While it does not significantly affect operative times or self-reported outcomes, it is associated with longer hospital stays and increased intraoperative blood loss. Elevated BMI is an independent predictor of extended hospitalization and postoperative complications in long-segment fusions. Although obesity generally does not influence pain scores, readmission rates, or reoperation rates, morbidly obese patients experience more perioperative challenges, such as higher costs, longer surgeries, and more frequent complications.

Conclusion: Obesity significantly impacts perioperative outcomes in spinal fusion surgery, particularly in terms of blood loss, hospital stay, and postoperative complications. While long-term outcomes such as reoperation and readmission rates are not heavily influenced by BMI, the immediate perioperative period presents notable challenges. Addressing these through preoperative planning, enhanced perioperative management, and postoperative care tailored to obese patients can improve surgical outcomes and recovery. Given the rising prevalence of obesity, these findings are critical for optimizing care for this growing patient population.

Keywords: Obesity; Spinal Fusion Surgery; Surgical Outcomes; Complications; Systematic review.

Introduction

Obesity has reached epidemic levels globally, with the World Health Organization estimating that in 2022, over 1.9 billion adults were classified as overweight, with 650 million qualifying as obese. This growing prevalence of obesity raises significant concerns in various areas of healthcare, particularly regarding surgical outcomes. One procedure increasingly scrutinized in this context is spinal fusion surgery, a common intervention for various spinal disorders, including degenerative disc disease, spinal stenosis, and spondylolisthesis [1].

Spinal fusion surgery aims to stabilize the spine by joining two or more vertebrae, often to alleviate pain, restore function, and prevent further spinal deformity. The procedure typically involves the use of bone grafts and, in many cases, metal instrumentation to facilitate the fusion process. The anticipated outcomes of the surgery include pain relief, enhanced mobility, and improved quality of life. However, achieving these outcomes can be complicated by various patient-specific factors, one of the most critical being body weight [2].

Obesity significantly alters the physiological landscape of the body, which can adversely affect the surgical process and recovery. Patients with a higher body mass index (BMI) often present with comorbid conditions, such as diabetes, hypertension, and sleep apnea, which complicate the perioperative environment. These conditions can lead to increased surgical risk, prolonged recovery times, and greater rates of complications [3].

Research indicates that obesity is associated with a higher incidence of surgical site infections (SSIs). Adipose tissue has an impaired vascular supply, which can lead to less effective wound healing and increased likelihood of infection. The presence of excess fat also creates a physical barrier during surgery, making visualization and access to the surgical field more challenging for surgeons. This complexity can lead to longer operative times, thereby increasing the risk of complications during and after surgery [4].

Moreover, the impact of obesity extends to the body's inflammatory response. Elevated adipose tissue can lead to systemic inflammation, which may adversely affect the healing process post-surgery. As a result, obese patients may experience significant delays in achieving successful spinal fusion, with studies indicating that non-union rates (the failure of bones to fuse together) are higher in individuals with obesity, ultimately leading to worse clinical outcomes [5].

The biomechanical dynamics in obese patients also play a critical role in surgical outcomes. Increased body weight puts additional stress on the spine, which can lead to mechanical failure of spinal constructs, especially when fusion is aimed at stabilizing degenerative changes. The biomechanical properties of bone components in obese patients, including bone density and quality, can be affected by the metabolic changes associated with obesity. This can complicate the surgical process, as achieving solid fusion may become more challenging, further elevating the risks associated with the procedure [6].

Additionally, patients who are obese often have altered gait patterns and increased loading on the spine, which can exacerbate pre-existing conditions and lead to new or worsening spinal problems post-surgery. In this context, the biomechanical forces exerted on the fused area can impact the success of the surgical intervention profoundly, raising concerns regarding long-term outcomes and patient satisfaction [7].

In addition to the physiological and biomechanical repercussions, obesity can also pose psychological and social challenges that affect surgical outcomes. Patients with obesity often face discrimination and stigma, which can lead to lower levels of self-esteem and increased anxiety, potentially impacting their motivation to adhere to post-operative rehabilitation protocols. Mental health issues, such as depression, which are more prevalent in obese populations, can also hinder recovery and rehabilitation efforts post-surgery [8].

Furthermore, the logistical challenges associated with obesity, such as difficulties in accessing healthcare services and complications related to postoperative mobility, can significantly affect recovery outcomes. These factors underline the importance of a multidisciplinary approach in managing obese patients undergoing spinal fusion surgery, emphasizing the need for mental health support, nutrition counseling, and specialized rehabilitation services 8].

Given the profound impact of obesity on surgical outcomes, addressing this issue preoperatively is of utmost importance. Effective weight management strategies prior to surgery can significantly improve potential

outcomes. Studies suggest that even modest weight loss can lead to improved surgical results, with decreases in complication rates and enhanced healing outcomes [10].

Preoperative education about the benefits of weight loss, coupled with tailored nutritional plans and structured exercise regimes, can be pivotal in preparing patients for surgery. In cases where significant weight loss is required for optimal surgical outcomes, collaboration with weight management specialists, including dietitians and bariatricians, can create a comprehensive plan aimed at achieving healthy weight criteria before surgery. In addition, implementing strategies to optimize overall health prior to undergoing spinal fusion—such as better management of comorbid conditions—can help minimize risks. Ensuring that patients quit smoking, control diabetes, and manage hypertension can enhance recovery and contribute to better surgical success rates.

The primary aim of this systematic review is to evaluate and synthesize the existing body of literature concerning the impact of obesity on outcomes following spinal fusion surgery.

Study Objectives:

1. To compile and analyze relevant research studies that investigate the effects of obesity on postoperative outcomes in spinal fusion surgery.
2. To identify common perioperative complications associated with obesity and their implications for surgical success and patient recovery.
3. To evaluate the effectiveness of different intervention strategies aimed at reducing the impact of obesity on surgical outcomes.
4. To provide evidence-based recommendations for clinicians regarding preoperative counseling, risk assessment, and patient management tailored to the obese population undergoing spinal fusion surgery.

Methods

This study followed the guidelines set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [11] to conduct a systematic review of the effects of obesity on the outcomes of spinal fusion surgery. A thorough electronic search was performed across various databases, includng PubMed, Web of Science, SCOPUS, and Science Direct, to identify relevant English-language studies that explore the impact of obesity on spinal fusion surgery outcomes. The search utilized keywords related to obesity and spinal fusion. Two independent reviewers evaluated the search results, selected eligible studies, extracted relevant data, and assessed the quality of the included research utilizing recognized assessment tools.

Eligibility Criteria:

Inclusion criteria consisted of studies that specifically investigate the effects of obesity on surgical outcomes following spinal fusion procedures, including but not limited to complications, recovery times, and overall success rates. Eligible studies must be published in English and encompass a range of clinical settings, including both adult and pediatric populations.

Exclusion criteria involved studies that do not directly assess the impact of obesity on spinal surgery outcomes, such as those focusing solely on non-surgical interventions, studies with insufficient data pertaining to obesity metrics, or those that lack appropriate control groups. Additionally, case reports, reviews, and conference abstracts were excluded to ensure the review is based on high-quality, peer-reviewed research.

Data Extraction

To ensure the accuracy of the search results for the study validation were conducted using Rayyan (QCRI) [12]. The titles and abstracts obtained from the search were evaluated for relevance against the predetermined inclusion and exclusion criteria. Studies that fulfilled the inclusion criteria underwent a thorough review by the research team. Any disagreements among reviewers were settled through consensus. Key information for each study, including titles, authors, publication year, study location, participant demographics, gender distribution, and relevant epidemiology and risk factors associated with obesity and surgical outcomes, were recorded using a standardized data extraction form. Additionally, an independent assessment tool was developed to evaluate the risk of bias in the included studies.

Data Synthesis Strategy

In order to provide a qualitative evaluation of the research findings and components, summary tables were generated using data extracted from relevant studies. Once the data collection for the systematic review is complete, the optimal approach for utilizing the data from the included studies were determined.

Quality review

We utilized the ROBINS-I technique to evaluate the risk of bias because it allows for extensive assessment of confounding, which is significant because bias owing to omitted variables is common in studies in this field. The ROBINS-I tool is intended to evaluate non-randomized investigations and can be applied to cohort designs in which participants exposed to various staffing levels are monitored over time. Two reviewers separately assessed the risk of bias for each paper, and disagreements were resolved through group discussion [12].

Results

The specified search strategy yielded 724 publications **(Figure 1).** After removing duplicates (n =333), 391 trials were evaluated based on title and abstract. Of these, 85 failed to satisfy eligibility criteria, leaving just 83 full-text articles for comprehensive review. Two records were identified through citation search and only 83 were accepted into our review. A total of 7 satisfied the requirements for eligibility with evidence synthesis for analysis, all of them were retrospective [14-20].

Sociodemographic and clinical outcomes

We included seven studies with a total of 1454 patients who underwent spinal fusion surgery, and nearly half of them 734 (50.5%) were males. Our population included two categories; non-obese patients 894 (61%) who have a BMI <30 kg/m^2 and obese patients 556 (39%) a BMI >30 kg/m^2. All of the include studies were conducted in the USA [14-20].

Obesity has been shown to affect various outcomes in spinal fusion surgery. In patients undergoing one- and two-level lumbar interbody fusions, obesity may not directly influence surgery or non-operative operating room times, but it is associated with prolonged hospital stays and increased intraoperative blood loss [14]. For patients who undergo long-segment fusions, a higher BMI serves as a significant predictor for extended hospitalization durations and a greater occurrence of postoperative complications at both one and two years [15].

Interestingly, in complex spinal surgeries involving at least seven levels of fusion, obesity did not seem to affect patient-reported pain scores, readmission rates, or overall surgical outcomes. However, for patients with severe obesity, there was an increase in postoperative challenges, such as higher operative costs, longer surgeries, and more frequent complications during recovery. Though obesity contributed to greater rates of complications and increased blood loss, it did not affect reoperation rates or the total length of hospital stay for most patients [19, 20].

However, self-reported outcomes in two studies, such as pain and general recovery, do not appear to be affected by obesity. Operative times, hospital stays, and complication rates were found to be comparable between obese and non-obese patients, although obese patients did experience higher blood loss during surgery. Despite this, the amount of blood lost and the length of hospital stay did not vary significantly between the two groups [16, 17, 18].

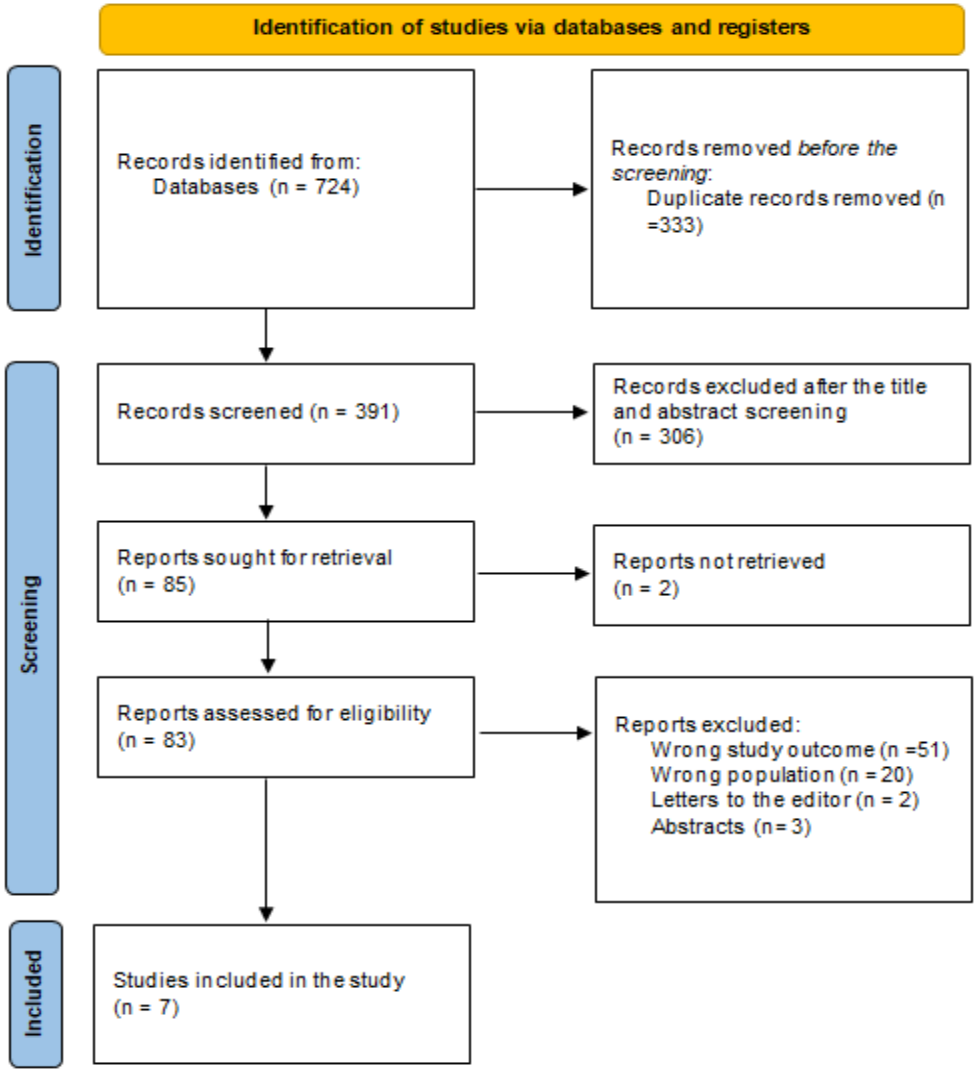

Figure (1): PRISMA flowchart [13].

Table (1): Outcome measures of the included studies

Study ID	Country	Study design	Sociodemographic	BMI<30 (non-obese)	BMI >30 (obese)	Mean BMI (kg/m^2)	Key findings
Villavicencio et al., 2019 [14]	USA	Retrospective cohort	Mean age: 64 Males: 89 (51.7%)	119	53	34.9 ± 4.5	In patients participating in one- and two-level transforaminal lumbar interbody fusions, obesity may not affect surgery or non-operative OR times, but it was linked to longer hospital stays and increased intraoperative blood loss.
McClendon et al., 2014 [15]	USA	Retrospective cohort	Mean age: 59.5 Males: 52 (27.5%)	82	55	29.8	In patients undergoing long-segment fusions, elevated BMI is an independent predictor of the duration of hospitalization and all sequelae at one and two years.

Rosen et al., 2008 [16]	USA	Prospective cohort	Mean age: 54.6 Males: 56 (50.6%)	72	35	28.7 ± 7.1	Self-reported outcomes are unaffected by obesity. Operative times, hospital stays, and complication rates were comparable for fat and non-obese individuals; however, the estimated blood loss was higher for obese patients.
Truong et al., 2022 [17]	USA	Retrospective cohort	Mean age: 68.6 Males: 26 (41.9%)	34	27	35.35 ± 1.81	The amount of blood lost during surgery, the duration of the procedure, and the length of hospital stay did not significantly differ between the non-obesity and obese groups.
Elsamadicy et al., 2019 [18]	USA	Retrospective cohort	Mean age: 51.8 Males: 81 (73.2%)	79	33	35.1 ± 4.5	Obesity has no discernible impact on 30-day readmission rates, patient-reported pain scores, or surgical outcomes following complex spinal surgery involving at least seven levels of fusion.
Kieser et al., 2022 [19]	USA	Retrospective cohort	Mean age: 63 Males: 6 (9.5%)	30	30	33.2 ± 3.6	Compared to patients with a normal BMI, obese patients have greater rates of complications, poorer sagittal correction, higher blood loss, and lower post-operative functional scores. Obesity, however, had no effect on reoperation rates, length of hospital stay, or operating hours.
Higgins et al., 2016 [20]	USA	Retrospective cohort	Mean age: 59.6 Males: 424 (52.9%)	478	323	NM	For patients having spine fusions, obesity and morbid obesity have a major influence on the perioperative treatment. In particular, patients who are morbidly obese have higher overall operation costs, longer operating durations, and more postoperative problems than patients who are simply obese.

Table (2): Risk of bias assessment using ROBINS-I

Study ID	Bias due to confounding	Bias in the selection of participants into	Bias in the classification of interventions	Bias due to deviations from the intended interval	Bias due to missing data	Bias in the measurement of outcomes	Bias in the selection of reported result	Overall bias
Villavicencio et al., 2019 [14]	Low	Low	Mod	Low	Low	Low	Mod	Low
McClendon et al., 2014 [15]	Low	Low	Low	Low	Mod	Low	Mod	Low
Rosen et al., 2008 [16]	Low	Low	Low	Low	Low	Mod	Low	Low
Truong et al., 2022 [17]	Mod	Low	Low	Low	Mod	Mod	Low	Moderate
Elsamadicy et al., 2019 [18]	Mod	Mod	Low	Mod	Low	Low	Mod	Moderate
Kieser et al., 2022 [19]	Mod	Low	Mod	Low	Low	Mod	Low	Moderate
Higgins et al., 2016 [20]	Mod	Mod	Low	Low	Low	Mod	Low	Moderate

Discussion

The findings from this systematic review highlight the multifaceted impact of obesity on spinal fusion surgery outcomes. We found that obesity in spinal fusion surgery is linked to longer hospital stays and increased intraoperative blood loss, particularly in one- and two-level lumbar fusions. In long-segment fusions, higher BMI predicts extended hospitalization and more postoperative complications [14, 15]. In complex spinal surgeries with seven or more levels of fusion, obesity did not impact pain scores, readmission rates, or overall outcomes. However, severe obesity led to more postoperative challenges, including higher costs, longer surgeries, and increased complications, though reoperation rates and hospital stay lengths remained unaffected [19, 20].

In obese patients, lumbar fusion necessitates a big incision to penetrate the thicker-than-normal adipose tissue. More blood loss and an elevated risk of infection would be anticipated as a result of this increased exposure. In line with our results, **Lingutla *et al.*** and **Xu *et al.*** reported that obese individuals experience more problems, longer recovery times, and more intraoperative blood loss, their pain levels and functional outcomes are comparable to those of non-obese patients. However, these findings suggest that obesity does not preclude lumbar spinal fusion [21, 22].
Our results also found that as pain and general recovery, do not appear to be affected by obesity. Operative times, hospital stays, and complication rates were found to be comparable between obese and non-obese patients. Despite this, the amount of blood lost and the length of hospital stay did not vary significantly between the two groups [16, 17, 18]. Back and leg pain and increases on the physical component scale following lumbar fusion were comparable in the two groups, but there was no statistically significant difference, according to **Djurasovic *et al.'s*** study [23], which was included of the metaanalysis. **Erkan *et al.*** [24], on the other hand, discovered that obese individuals who had posterolateral lumbar fusion fared worse statistically than normal patients in terms of their back and leg pain. Because obese patients have trouble seeing and accessing the operating field, it is possible that their operation will take longer.

The clinical implications of this review are significant, particularly in the context of managing obese patients undergoing spinal fusion surgery. Surgeons and healthcare teams should be prepared for increased intraoperative challenges, such as blood loss and longer surgery times, particularly in patients with morbid obesity. Preoperative optimization, including weight management and careful planning for postoperative care, may help mitigate some of these risks. Additionally, hospitals should allocate resources for potentially longer hospital stays and postoperative monitoring in this patient population. Tailored rehabilitation programs may also support more effective recovery in obese patients following spinal fusion surgery.

Strengths and limitations

This review synthesizes data from multiple studies, providing a comprehensive understanding of the impact of obesity on spinal fusion outcomes. The inclusion of both retrospective and prospective studies strengthens the findings by incorporating diverse methodologies. Moreover, the review highlights critical aspects of perioperative care that may otherwise be overlooked, offering actionable insights for clinicians.

One of the primary limitations is the heterogeneity of the included studies, which vary in terms of sample size and surgical techniques. Additionally, all studies are retrospective, which may introduce bias and limit the ability to establish causality. Furthermore, many studies do not differentiate between obese and morbidly obese patients, which may obscure the specific challenges faced by patients with higher BMIs. Finally, the lack of international studies limits the generalizability of the findings, as most data were drawn from the U.S. healthcare system.

Conclusion

Obesity significantly impacts perioperative outcomes in spinal fusion surgery, particularly in terms of blood loss, hospital stay, and postoperative complications. While long-term outcomes such as reoperation and readmission rates are not heavily influenced by BMI, the immediate perioperative period presents notable challenges.

Addressing these through preoperative planning, enhanced perioperative management, and postoperative care tailored to obese patients can improve surgical outcomes and recovery. Given the rising prevalence of obesity, these findings are critical for optimizing care for this growing patient population.

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