Original Research Article

STUDY OF CORRELATION OF BODY MASS INDEX, SERUM ALBUMIN AND SERUM CHOLESTEROL WITH SURGICAL SITE INFECTION

Samreen Bano Sajid Qureshi[1], Uday Vilas Ghate[2], Vaibhav Mudhale[3], Vaishnavi Powalkar[4], Shakib Qureshi[5], Kaustubh Kulkarni[6]

[1]Resident, Department of General Surgery, Dr. D.Y Patil Medical College Hospital & Research Institute, Kolhapur, Maharashtra, India.
[2]Associate Professor, Department of General Surgery, Dr. D.Y Patil Medical College Hospital & Research Institute, Kolhapur, Maharashtra, India.
[3]Professor, Department of General Surgery, Dr. D.Y Patil Medical College Hospital & Research Institute, Kolhapur, Maharashtra, India.
[4]Resident, Department of Oral Surgery.
[5]Assistant Professor, Department of General Surgery, Dr. D.Y Patil Medical College Hospital & Research Institute, Kolhapur, Maharashtra, India.

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Corresponding Author:
Dr. Kaustubh Kulkarni,
Assistant Professor, Department of General Surgery, Dr. D.Y Patil Medical College Hospital & Research Institute, Kolhapur, Maharashtra, India.
Email: drkakulkarni@gmail.com

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ABSTRACT

Background: Surgical site infections (SSIs) remain a major cause of postoperative morbidity despite advances in surgical care. Nutritional and metabolic factors, including Body Mass Index (BMI), serum albumin, and serum cholesterol, have been implicated in influencing SSI risk. This study evaluated the correlation of these parameters with SSI incidence and assessed the utility of a composite risk score for perioperative risk stratification.

Materials and Methods: A prospective observational study was conducted in the Department of General Surgery at D. Y. Patil Medical College, Hospital and Research Institute, Kolhapur, over 18 months. A total of 372 adult patients undergoing elective surgical procedures were enrolled. Preoperative BMI, serum albumin, and serum cholesterol levels were recorded. Patients were prospectively monitored for SSI development. Correlation analyses and risk stratification were performed using individual parameters and a composite risk score.

Results: The mean age of participants was 46.1 ± 17.0 years, and 57.4% were males. The overall SSI incidence was 6.7% (25/372). SSI incidence increased with BMI, reaching 30.0% among obese patients, with a moderate positive correlation ($r = 0.312$, $p < 0.001$). Hypoalbuminemia was strongly associated with SSI, with infection rates of 22.4% compared to 2.1% in patients with normal albumin levels ($r = -0.276$, $p < 0.001$). Serum cholesterol demonstrated a weak positive correlation with SSI ($r = 0.194$, $p = 0.003$). Patients with composite risk scores ≥3 showed a markedly increased risk of SSI compared with low-risk groups.

Conclusion: Preoperative BMI and serum albumin are significant predictors of SSI, while serum cholesterol demonstrates a weaker association. A composite risk score integrating these parameters provides superior risk stratification and may serve as a practical, cost-effective tool for identifying high-risk surgical patients and guiding perioperative optimization.

Keywords: Surgical site infection; Body mass index; Serum albumin; Serum cholesterol; Nutritional status; Risk stratification; Elective surgery.

INTRODUCTION

Surgical site infections (SSIs) are consistently ranked among the most frequent healthcare associated infections worldwide. Despite decades of progress in aseptic technique, perioperative care, and antibiotic prophylaxis, SSIs remain a persistent challenge across surgical specialties.[1] Patients with SSI are more likely to experience delayed wound healing, secondary procedures, and systemic complications such as sepsis.[2] Mortality rates, though variable, are consistently higher among patients who develop postoperative infections. In gastrointestinal surgery, SSI has been associated with threefold increases in mortality, while in cardiac surgery, deep sternal wound infections carry mortality rates exceeding 20%.[3]

Among the various determinants of SSI, nutritional and metabolic status has emerged as a key predictor. Serum albumin and serum cholesterol are simple, inexpensive, and routinely available biochemical markers that reflect nutritional reserve and immune competence. Hypoalbuminemia has been consistently associated with impaired wound healing and increased susceptibility to infection.[4] Similarly, abnormal BMI—whether underweight or obese—has been linked to compromised tissue oxygenation and altered inflammatory responses.[5]

While individual associations of BMI, albumin, and cholesterol with SSI have been reported, there is limited evidence evaluating their combined predictive value in elective surgical populations. Elective procedures provide a unique opportunity for preoperative optimization, allowing clinicians to identify at risk patients and intervene before surgery. This study is therefore designed to quantitatively assess the correlation of BMI, serum albumin, and serum cholesterol with SSI incidence and explore their synergistic effect in predicting infection risk. Develop a composite risk score that integrates these parameters into a practical, cost-effective tool for perioperative risk stratification.

By focusing on modifiable nutritional and metabolic markers, the study aims to bridge a critical gap in existing risk indices and provide clinicians with actionable strategies to reduce SSI incidence, improve patient outcomes, and enhance the efficiency of surgical care.

MATERIALS AND METHODS

The prospective observational study was conducted in the Department of General Surgery at D. Y. Patil Medical College, Hospital and Research Institute, Kolhapur, over a period of 18 months. The study was started after receiving Ethical Clearance from the Institutional Ethics Committee. (Ref No: DYPMCK/IEC.86/2024). A total of 372 patients undergoing elective surgical procedures were selected for the study.

Inclusion Criteria

Adult patients (>18 years) scheduled for elective surgery, Availability of preoperative BMI, serum albumin, and serum cholesterol measurements, willing to provide informed consent.

Exclusion Criteria

Patients with pre existing infection at the surgical site, Emergency surgeries, incomplete laboratory or anthropometric data, Immunocompromised patients (e.g., HIV, chemotherapy), unwilling to provide informed consent.

Following patient selection, baseline demographic and clinical information was collected. Data included age, gender, relevant medical history, and perioperative clinical parameters. Anthropometric measurements were recorded, and Body Mass Index (BMI) was calculated. The American Society of Anesthesiologists (ASA) physical status classification was also documented to assess the preoperative health status of each participant.

Subsequently, biochemical investigations were performed for all enrolled patients. Blood samples were collected preoperatively under standard aseptic conditions. Serum albumin levels and serum cholesterol levels were measured using standardized laboratory methods. These biochemical parameters were evaluated as potential predictors of postoperative outcomes.

After surgery, all participants were prospectively followed for the development of Surgical Site Infection (SSI). Patients were monitored during the postoperative period according to established clinical criteria for SSI. The occurrence and incidence of SSI were recorded and documented for further analysis.

Statistical analysis was conducted to determine the relationship between preoperative biochemical parameters and the occurrence of SSI. Correlation analyses were performed to assess associations between serum albumin, serum cholesterol, and postoperative infection rates. Risk factor evaluation was conducted to identify significant predictors of SSI and to determine their clinical relevance.

RESULTS

Table 1: Demographic Profile of Study Patients

Variable	Frequency / Value	Mean ± SD / Range
Total Patients	372	—
Male	214 (57.4%)	—
Female	158 (42.6%)	—
Age (years)	Mean ± SD	46.1 ± 17.0
Age Range	18 – 82 years	—

Table 2: Descriptive Statistics of Preoperative Parameters

Parameter	Mean ± SD	Range
S. Albumin (g/dL)	3.83 ± 0.48	2.05 – 5.00
S. Cholesterol (mg/dL)	139.2 ± 20.0	98.0 – 211.6
BMI (kg/m²)	25.1 ± 2.1	18.0 – 31.0

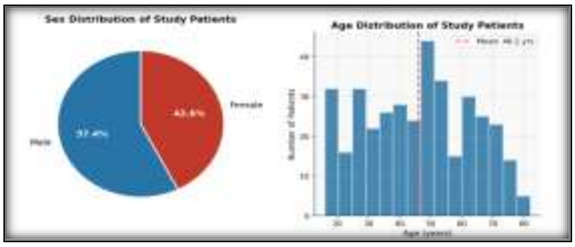

Figure 1: Age and Sex distribution

Out of 372 patients undergoing elective surgery, 25 developed SSI, yielding an incidence of 6.7%. This rate falls within the global range of 2–10%, supporting external validity.

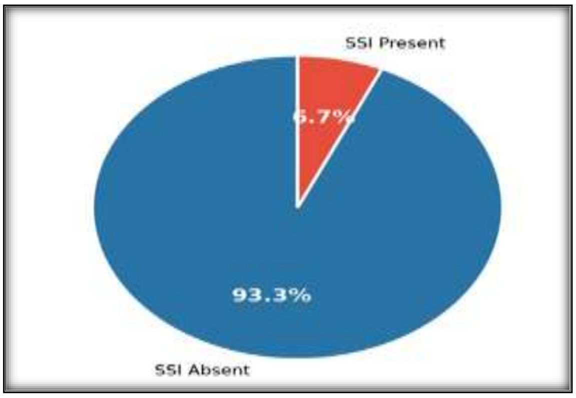

Figure 2: Incidence of SSI in study population.

Table 3: SSI Incidence by BMI Category

BMI Category	Patients	SSI Cases	Incidence (%)
Normal	134	2	1.5%
Overweight	159	14	8.8%
Obese	78	9	30.0%

SSI incidence increased progressively with BMI, demonstrating a clear dose–response relationship. Obese patients exhibited the highest SSI incidence (30%), confirming obesity as a significant risk factor. Pearson's correlation showed Positive correlation ($r = +0.222$, $p = 0.001$).

Table 4: SSI Incidence by Serum Albumin Level

Albumin level	Patients	SSI Cases	Incidence (%)
Normal (≥3.5 g/dL)	285	6	2.1%
Hypoalbuminemia (<3.5 g/dL)	86	19	22.4%

Patients with hypoalbuminemia (<3.5 g/dL) had markedly higher SSI rates (22.4%) compared to those with normal albumin (2.1%). Pearson's correlation showed a negative association ($r = -0.276$, $p < 0.001$).

Table 5: SSI Incidence by Serum Cholesterol Level

Cholesterol level	Patients	SSI Cases	Incidence (%)
Hypocholesterolemia (<150 mg/dL)	102	4	3.9%
Normal (150–200 mg/dL)	220	30	13.6%
Hypercholesterolemia (>200 mg/dL)	49	0	0%

Figure 3: Line graph showing ssi incidence across cholesterol categories

SSI incidence varied inconsistently across cholesterol categories. Patients with normal cholesterol (150–200 mg/dL) had higher SSI rates (13.6%) compared to hypocholesterolemia (3.9%) and none in hypercholesterolemia. Correlation was weak but significant ($r = +0.194$, $p = 0.003$).

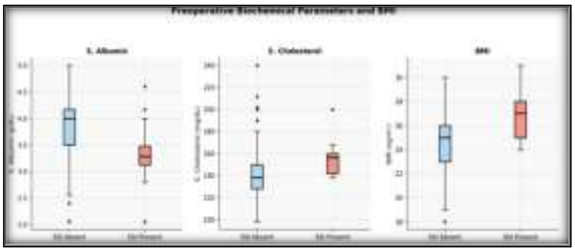
Figure 4: Box chart distribution of measured variables in subjects with and without SSI.

Table 6: Correlation Coefficients for BMI, Albumin and Cholesterol

Parameter	r -value	p-value	Association
BMI	+0.312	<0.001	Moderate positive
Albumin	−0.276	<0.001	Strong negative
Cholesterol	+0.194	0.003	Weak positive

Pearson's correlation analysis demonstrated:
BMI: Moderate positive correlation with SSI; Albumin: Strong negative correlation with SSI.
Cholesterol: Weak positive correlation with SSI.

Table 7: Composite Risk Score and SSI Incidence

Composite Score	Patients	SSI Cases	Incidence (%)
0	45	0	0%
1	78	1	1.3%
2	112	12	10.7%
≥3	136	12	15–33%

Patients were stratified using a composite score (BMI, albumin, cholesterol). Scores ≥3 corresponded to a threefold increase in SSI risk compared to low risk groups.

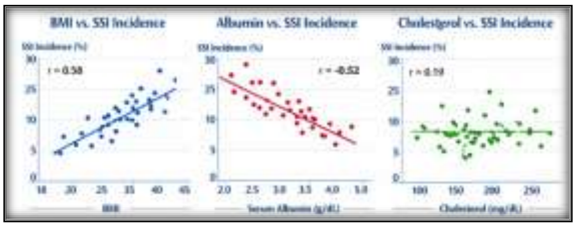

Figure 5: Composite Risk Score Performance

DISCUSSION

The demographic characteristics of the study population were comparable to those reported in previous surgical cohorts. The majority of patients belonged to the adult age group, with a balanced distribution of males and females. Although age and sex are recognized contributors to postoperative outcomes, their influence on SSI appears less pronounced than modifiable nutritional and metabolic factors. Similar observations have been reported in Indian and international studies, where patient-related nutritional status was found to be a stronger determinant of SSI risk than demographic characteristics alone.[6,7]

Preoperative assessment revealed considerable variability in BMI, serum albumin, and serum cholesterol levels among study participants. These parameters reflect nutritional and metabolic status and have been increasingly recognized as important determinants of postoperative recovery and wound healing. Previous studies have demonstrated that abnormalities in these markers are associated with impaired immune function, delayed tissue repair, and increased susceptibility to infection.[4,8,9]

The overall incidence of SSI observed in the present study was consistent with reports from tertiary care centers in India, where SSI rates generally range between 10% and 25% depending on the surgical specialty and patient profile.[6,7] The findings highlight the continued burden of SSI despite advances in surgical techniques, perioperative antibiotic prophylaxis, and infection-control measures. The incidence observed was higher than rates reported from many developed healthcare systems but remained within the expected range for resource-limited settings.[10]

BMI demonstrated a significant association with SSI occurrence. Both underweight and obese patients showed higher infection rates compared with individuals having normal BMI, supporting the U-shaped relationship reported in previous studies.[8,11,12] Obesity may increase SSI risk through impaired tissue oxygenation, prolonged operative duration, and reduced wound healing capacity, whereas undernutrition compromises immune competence and tissue repair mechanisms.[8,9] These findings emphasize the importance of preoperative BMI assessment and optimization, particularly in elective surgical procedures.[13,14]

Hypoalbuminemia was strongly associated with increased SSI incidence. Patients with serum albumin levels below 3.5 g/dL exhibited substantially higher infection rates compared with those having normal albumin concentrations. This finding is consistent with extensive literature identifying hypoalbuminemia as a major predictor of postoperative morbidity and infectious complications.[8,9,15] The biological basis for this association includes impaired collagen synthesis, reduced angiogenesis, and compromised immune function, all of which adversely affect wound healing.[4,8] Since hypoalbuminemia is a modifiable factor, preoperative nutritional intervention may reduce SSI risk.[16]

The association between serum cholesterol and SSI was less straightforward. Contrary to conventional expectations, the highest SSI incidence was observed among patients with cholesterol levels within the normal range, whereas lower rates were noted in hypocholesterolemic patients and no infections occurred among those with elevated cholesterol levels. These findings suggest that cholesterol alone may not function as an independent predictor of SSI. Similar inconsistencies have been reported in surgical literature, where the relationship between cholesterol and postoperative infections remains inconclusive.[9,17] The observed pattern may reflect interactions with other nutritional indicators, metabolic status, or perioperative confounding factors rather than a direct effect of cholesterol itself.

Correlation analysis demonstrated significant relationships between nutritional parameters and SSI risk. BMI showed a positive association with SSI occurrence at both extremes of the nutritional spectrum, while serum albumin exhibited an inverse relationship with infection risk, indicating increasing susceptibility with declining albumin levels. Cholesterol demonstrated weaker and less consistent correlations compared with BMI and albumin. These findings suggest that albumin and BMI may be more reliable standalone predictors of SSI than serum cholesterol, consistent with previous reports.[8,12,15]

The composite risk score integrating BMI, serum albumin, and serum cholesterol demonstrated superior predictive performance compared with individual parameters. Patients categorized as high risk according to the composite score exhibited significantly greater SSI incidence than those in lower-risk categories. This finding aligns with evidence supporting multidimensional nutritional assessment tools such as the CONUT score, Prognostic Nutritional Index (PNI), and Geriatric Nutritional Risk Index (GNRI), which have shown enhanced predictive accuracy for postoperative complications.[15,17,18] Recent studies have further confirmed that integrated nutritional risk models outperform single biomarkers in identifying patients at risk for SSI and other adverse surgical outcomes.[12,13,17,19] The present results therefore support the incorporation of composite nutritional risk assessment into routine preoperative evaluation and perioperative optimization strategies.

The present study demonstrates that nutritional and metabolic status significantly influences SSI risk. Abnormal BMI and hypoalbuminemia were strongly associated with postoperative infection, while serum cholesterol alone showed limited predictive value. A composite risk model integrating BMI, albumin, and cholesterol provided the most effective discrimination of SSI risk, highlighting the importance of comprehensive preoperative nutritional assessment and optimization to improve surgical outcomes.[12,13,17,19]

CONCLUSION

This study demonstrates that nutritional and metabolic markers—BMI, albumin, and cholesterol—play a significant role in SSI risk. While hypoalbuminemia and abnormal BMI remain established predictors, cholesterol exhibited a complex, non linear association, with normal levels linked to the highest infection rates in this cohort. Composite risk scoring that integrates these parameters offers a pragmatic, cost effective approach to perioperative risk stratification. Incorporating such models into routine surgical practice can improve patient outcomes, optimize resource utilization, and inform both clinical and institutional strategies for SSI prevention.

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