

IMPACT OF NUTRITIONAL STATUS ON POSTOPERATIVE RECOVERY OUTCOMES IN ORTHOPEDIC SURGERY PATIENTS

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Abstract:

Orthopedic surgeries such as total hip arthroplasty, total knee arthroplasty, and fracture fixation are associated with substantial physiological stress, inflammatory responses, and metabolic demands that directly influence recovery outcomes. Nutritional status is increasingly recognized as a modifiable risk factor affecting postoperative complications, wound healing, infection rates, functional recovery, and length of hospital stay. This thesis investigates the impact of nutritional status on postoperative recovery outcomes among orthopedic surgery patients using a structural equation modeling approach through Smart PLS. A quantitative cross-sectional design was employed with data collected from 250 orthopedic patients admitted to tertiary care hospitals. Nutritional status was assessed using body mass index, serum albumin levels, and the Mini Nutritional Assessment tool. Postoperative recovery outcomes were measured through infection incidence, wound healing rate, length of hospital stay, pain score reduction, and early mobilization indicators. was utilized to examine the direct and indirect relationships between nutritional status and recovery outcomes while controlling for age and comorbidities. Results demonstrated a significant positive relationship between adequate nutritional status and improved postoperative recovery outcomes. Patients with better preoperative nutritional profiles experienced shorter hospital stays, reduced complication rates, and faster functional recovery. The findings highlight the importance of early nutritional screening and targeted nutritional interventions in orthopedic settings. The study concludes that optimizing nutritional status before and after surgery can significantly enhance patient recovery trajectories and reduce healthcare burden.

Keywords: Nutritional Status, Orthopedic Surgery, Postoperative Recovery, Wound Healing, Hospital Stay, Infection Rate

Introduction

Orthopedic surgery represents a major component of global surgical care, addressing conditions such as degenerative joint diseases, traumatic fractures, spinal disorders, and congenital deformities. Advances in surgical techniques and implant technology have significantly improved survival and functional outcomes. However, postoperative recovery remains variable among patients, with complications such as surgical site infections, delayed wound healing, prolonged hospital stay, and reduced mobility continuing to present challenges. Among the numerous determinants influencing recovery outcomes, nutritional status has emerged as a critical yet often underrecognized factor.

Surgery induces a hypermetabolic and catabolic response characterized by increased energy expenditure, protein breakdown, and inflammatory activation. In orthopedic patients,

especially elderly individuals and those with chronic diseases, preexisting malnutrition or suboptimal nutrient reserves can exacerbate this stress response. Inadequate nutritional status may impair immune function, reduce collagen synthesis, compromise muscle strength, and delay tissue repair, thereby prolonging recovery. Conversely, adequate protein and micronutrient availability supports immune competence, enhances wound healing, and facilitates early mobilization.

The prevalence of malnutrition among hospitalized surgical patients ranges from 20 percent to 50 percent depending on assessment criteria and population characteristics. Orthopedic patients are particularly vulnerable due to advanced age, trauma related blood loss, limited mobility, and chronic inflammatory conditions such as osteoarthritis and rheumatoid arthritis. Studies have demonstrated associations between hypoalbuminemia and increased postoperative infections, as well as between low body mass index and delayed fracture healing.

Despite growing recognition of its importance, nutritional assessment is not consistently integrated into routine orthopedic preoperative protocols. Many institutions focus primarily on surgical technique and pharmacological management while overlooking modifiable nutritional risk factors. Implementing structured nutritional screening tools such as the Mini Nutritional Assessment or Nutritional Risk Screening 2002 can help identify high risk patients.

The theoretical rationale for exploring the relationship between nutritional status and postoperative outcomes is grounded in the stress response theory and the immunonutrition framework. The stress response theory posits that surgical trauma triggers hormonal and metabolic changes that increase nutrient requirements. The immunonutrition framework suggests that adequate macro and micronutrients modulate inflammatory pathways and immune cell function, thereby influencing healing processes.

Given the burden of orthopedic conditions globally and the rising number of joint replacement surgeries, understanding modifiable predictors of recovery is essential. Prolonged hospitalization not only increases healthcare costs but also exposes patients to nosocomial infections and functional decline. Identifying nutritional status as a predictive factor may enable clinicians to implement targeted interventions such as protein supplementation, vitamin D optimization, and individualized diet plans.

This study aims to examine the impact of nutritional status on postoperative recovery outcomes among orthopedic surgery patients using a structural equation modeling approach. By applying Smart PLS, the research evaluates the strength and direction of relationships between nutritional indicators and recovery metrics. The findings are expected to contribute to evidence based clinical practice and policy development in orthopedic perioperative care.

Literature Review

Malnutrition in hospitalized patients has been widely documented as a predictor of adverse

clinical outcomes. In surgical populations, preoperative malnutrition has been associated with higher rates of postoperative complications, increased mortality, and extended hospital stays. Barker et al. found that malnourished patients experienced significantly longer hospitalization and higher healthcare costs compared to well-nourished individuals.

In orthopedic surgery specifically, hypoalbuminemia has been identified as a strong independent predictor of postoperative infection and wound complications. Bohl et al. reported that serum albumin levels below 3.5 g per dL were significantly associated with increased surgical site infections following total joint arthroplasty. Similarly, Fu et al. observed that low preoperative albumin predicted prolonged length of stay and readmission after hip fracture surgery.

Body mass index has also been examined in relation to recovery outcomes. Underweight patients demonstrate higher complication rates due to limited physiological reserves, whereas severe obesity may increase operative time and wound complications. However, moderate overweight status has sometimes shown neutral or protective associations, suggesting a complex relationship between body composition and recovery.

Protein energy malnutrition affects collagen synthesis and immune function, thereby impairing wound healing. Protein supplementation studies have demonstrated improved nitrogen balance and reduced complication rates in orthopedic trauma patients. Schuetz et al. showed that individualized nutritional support reduced complications and improved functional outcomes in hospitalized patients at nutritional risk.

Micronutrients such as vitamin D, zinc, and vitamin C play essential roles in bone metabolism and tissue repair. Vitamin D deficiency has been linked to delayed fracture healing and reduced muscle strength. Supplementation trials have suggested improved functional recovery in deficient patients undergoing orthopedic procedures.

The Mini Nutritional Assessment tool has been validated for identifying malnutrition risk in elderly orthopedic patients. Koren Hakim et al. found that patients classified as malnourished or at risk had significantly higher rates of postoperative complications compared to well-nourished individuals.

Inflammation and immune modulation provide a biological explanation for these associations. Malnutrition compromises lymphocyte proliferation, cytokine regulation, and antibody production, increasing susceptibility to infection. In orthopedic surgery, where implants are used, infection risk carries serious consequences including revision surgery.

Structural equation modeling studies in healthcare have demonstrated the utility of Smart PLS in examining complex relationships among latent constructs such as nutritional status and recovery outcomes. PLS SEM allows simultaneous assessment of measurement and structural models, making it suitable for healthcare research with multiple indicators.

Despite substantial evidence linking malnutrition to adverse outcomes, gaps remain

regarding comprehensive modeling of nutritional status as a multidimensional construct influencing recovery trajectories in orthopedic settings. Few studies have used advanced statistical modeling to quantify direct and indirect effects while controlling for demographic variables. This study addresses this gap by applying Smart PLS to evaluate the predictive relationship between nutritional status and postoperative recovery outcomes.

Conceptual Model and Theoretical Framework

The conceptual model posits Nutritional Status as an exogenous latent construct measured by body mass index, serum albumin, and Mini Nutritional Assessment score. Postoperative Recovery Outcomes is an endogenous latent construct measured by infection rate, wound healing time, length of hospital stays, pain reduction, and early mobilization. Age and comorbidities serve as control variables.

The framework integrates stress response theory and immunonutrition theory. Adequate nutrition enhances immune competence and tissue repair capacity, thereby improving recovery indicators.

Methodology

A quantitative cross-sectional design was adopted. The study sample consisted of 250 adult patients undergoing elective or trauma related orthopedic surgery in tertiary hospitals. Inclusion criteria were age above 18 years and consent to participate. Exclusion criteria included malignancy and chronic renal failure.

Data were collected using structured questionnaires and medical record review. Nutritional status was assessed preoperatively using body mass index, serum albumin levels, and the Mini Nutritional Assessment. Postoperative recovery data were collected within 30 days following surgery.

Smart PLS version 4 was used for structural equation modeling. Reliability was assessed using Cronbach alpha and composite reliability. Convergent validity was evaluated using average variance extracted. Path coefficients and significance levels were determined using bootstrapping with 5000 resamples.

Analysis and Results

Table 1 Measurement Model Results

Construct	Indicator	Loading	Cronbach Alpha	Composite Reliability	AVE
Nutritional Status	BMI	0.81	0.88	0.91	0.71
	Serum Albumin	0.87			
	MNA Score	0.85			
Postoperative Recovery	Infection Rate	0.83	0.90	0.93	0.73
	Wound Healing	0.88			
	Hospital Stay	0.84			
	Pain Reduction	0.86			

Early
Mobilization 0.89

Interpretation of Table 1

The measurement model results demonstrate strong reliability and validity of the constructs used in this study. Indicator loadings for Nutritional Status range from 0.81 to 0.87, exceeding the recommended threshold of 0.70, indicating that body mass index, serum albumin, and Mini Nutritional Assessment score adequately represent the latent construct. High factor loadings suggest that these indicators share substantial variance and reliably capture the underlying nutritional dimension.

Cronbach alpha value of 0.88 for Nutritional Status indicates high internal consistency among its indicators. Composite reliability of 0.91 further confirms the robustness of the construct. The average variance extracted value of 0.71 exceeds the minimum criterion of 0.50, demonstrating convergent validity. This implies that more than 71 percent of the variance in the indicators is explained by the latent construct.

Similarly, the Postoperative Recovery construct exhibits strong psychometric properties. Indicator loadings range from 0.83 to 0.89, suggesting that infection rate, wound healing, hospital stay duration, pain reduction, and early mobilization are valid measures of recovery outcomes. Cronbach alpha of 0.90 and composite reliability of 0.93 indicate excellent internal consistency. The average variance extracted value of 0.73 confirms strong convergent validity.

Overall, the measurement model satisfies reliability and validity criteria, supporting the suitability of the constructs for structural analysis.

Table 2 Structural Model Results

Path	Beta	T Value	P Value	R Square
Nutritional Status to Postoperative Recovery	0.62	9.45	0.000	0.48
Age to Recovery	-0.21	3.12	0.002	
Comorbidities to Recovery	-0.29	4.87	0.000	

Interpretation of Table 2

The structural model reveals a significant positive relationship between Nutritional Status and Postoperative Recovery Outcomes. The standardized path coefficient of 0.62 indicates a strong effect size, suggesting that improvements in nutritional status are associated with substantial enhancements in recovery indicators. The T value of 9.45 and P value less than 0.001 confirm statistical significance.

The R square value of 0.48 indicates that approximately 48 percent of the variance in postoperative recovery outcomes is explained by nutritional status, age, and comorbidities. This represents moderate to substantial explanatory power in behavioral and health sciences research.

Age demonstrates a negative relationship with recovery outcomes, with a beta coefficient of negative 0.21. This finding aligns with existing literature indicating slower healing and increased complications among older patients. Comorbidities also show a significant negative effect, with a beta coefficient of negative 0.29, highlighting the compounded impact of chronic diseases on recovery.

Importantly, even after controlling for age and comorbidities, nutritional status remains the strongest predictor of recovery outcomes. This underscores its clinical relevance as a modifiable risk factor. The magnitude of the path coefficient suggests that targeted nutritional interventions may yield meaningful improvements in patient outcomes, including reduced infection rates, shorter hospital stays, and enhanced functional recovery.

Conclusion

This study confirms that nutritional status significantly influences postoperative recovery outcomes in orthopedic surgery patients. Using Smart PLS modeling, the findings demonstrate that adequate nutritional reserves positively affect wound healing, infection prevention, pain reduction, and early mobilization while reducing hospital stay duration. Nutritional status emerged as a stronger predictor of recovery than age and comorbidities.

Discussion and Future Recommendations

The findings align with prior research emphasizing the role of protein energy balance and micronutrient sufficiency in immune competence and tissue repair. Integrating routine nutritional screening into preoperative orthopedic protocols can identify at risk patients early. Hospitals should implement standardized assessment tools and provide individualized nutritional support programs.

Future research should adopt longitudinal designs to examine long term functional outcomes and explore intervention-based trials assessing specific nutritional supplementation strategies. Policymakers should recognize nutritional optimization as a cost-effective strategy to enhance surgical outcomes and reduce healthcare burden.

References

- Abd Aziz, N., et al. 2021. Serum albumin and surgical site infection. *Medicine*, 100, e24620.
- Barker, L. A., Gout, B. S., and Crowe, T. C. 2011. Hospital malnutrition. *International Journal of Environmental Research and Public Health*, 8, 514-527.
- Bohl, D. D., et al. 2016. Hypoalbuminemia predicts complications. *Journal of Arthroplasty*, 31, 15-21.
- Cederholm, T., et al. 2019. GLIM criteria for malnutrition. *Clinical Nutrition*, 38, 1-9.
- Correia, M. I., and Waitzberg, D. L. 2003. The impact of malnutrition. *Clinical Nutrition*, 22, 235-239.
- Delmi, M., et al. 1990. Protein supplementation and hip fracture. *Lancet*, 335, 1013-1016.
- Fu, M. C., et al. 2017. Albumin and length of stay. *Journal of Orthopaedic Trauma*, 31, 128-134.
- Gao, Y., et al. 2022. Malnutrition and surgical outcomes. *BMC Surgery*, 22, 112.
- Gherini, S., et al. 2020. Nutritional risk in hip fracture. *Clinical Interventions in Aging*, 15,



- 645 654.
- Huang, R., et al. 2013. Malnutrition and joint replacement. *Journal of Arthroplasty*, 28, 21 24.
- Jensen, G. L., et al. 2010. Adult starvation and disease related malnutrition. *JPEN*, 34, 156 159.
- Klek, S., et al. 2020. Perioperative nutrition. *Nutrients*, 12, 1466.
- Koren Hakim, T., et al. 2012. Nutritional risk and complications. *Clinical Nutrition*, 31, 373 377.
- Lee, J. S., et al. 2021. Nutritional status and arthroplasty outcomes. *Journal of Bone and Joint Surgery*, 103, 1120 1128.
- Ljungqvist, O., et al. 2017. Enhanced recovery after surgery. *JAMA Surgery*, 152, 292 298.
- Norman, K., et al. 2008. Prognostic impact of disease related malnutrition. *Clinical Nutrition*, 27, 5 15.
- Ottesen, T. D., et al. 2018. Readmission and nutrition. *Journal of Arthroplasty*, 33, 3375 3380.
- Schuetz, P., et al. 2019. Individualized nutritional support. *Lancet*, 393, 2312 2321.
- Smith, R. K., et al. 2020. Nutritional biomarkers. *Nutrients*, 12, 3456.
- Thompson, J., et al. 2022. Orthopedic recovery predictors. *International Orthopaedics*, 46, 2345 2353.
- Volkert, D., et al. 2019. ESPEN guidelines on nutrition. *Clinical Nutrition*, 38, 10 47.
- Weimann, A., et al. 2017. ESPEN guideline clinical nutrition in surgery. *Clinical Nutrition*, 36, 623 650.
- Wischmeyer, P. E. 2017. Nutrition therapy in surgery. *Anesthesiology*, 126, 173 181.
- Zhang, X., et al. 2021. Vitamin D and fracture healing. *Journal of Orthopaedic Research*, 39, 1234 1242.