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ORIGINAL RESEARCH

Preoperative Nutritional Status Screened by MNA-SF Predicts Major Complications in Elderly Patients Undergoing Lumbar Fusion Surgery

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Purpose: To investigate the role of Mini Nutritional Assessment-Short Form (MNA-SF) in predicting postoperative complications in older patients (≥75 years) undergoing lumbar fusion surgery.

Patients and Methods: Patients who had undergone posterior lumbar fusion surgery between June 2019 and September 2021 were enrolled. Those with an MNA-SF score of 12 or higher were categorized as the Nourished group, while those with a score less than 12 were placed in the Malnutrition-Risk group. Preoperative, intraoperative, and postoperative variables between groups were compared. Patients were then re-classified based on the presence of major complications, univariate analysis and multivariate logistic regression was used to identify risk factors for major complications.

Results: A total of 240 patients were enrolled, with 182 in the Nourished group and 58 in the Malnutrition-Risk group. The Malnutrition-Risk group exhibited a higher incidence of major complications (46.6% vs 23.1%, p = 0.001) and comprehensive complications index (18.42 ± 18.00 vs 12.65 ± 15.87, p = 0.021), Oswestry Disability Index (27.52 ± 23.44 vs 20.45 ± 20.42, p = 0.029) and longer recovery times (12.53 days vs 10.15 days, p =0.033). Length of stay (LOS) were also increased in the Malnutrition-Risk group (19.22 ± 10.67 vs 16.04 ± 7.69, p = 0.014). Multiple regression analysis identified nutritional risk and malnutrition, as assessed by MNA-SF, as independent factors associated with postoperative major complications (OR 2.81, 95% CI 1.42–5.53, p = 0.003).

Conclusion: Preoperative nutritional risk or malnutrition is an independent risk factor for major complications among older patients undergoing posterior lumbar fusion surgery. The MNS-SF emerges as a convenient and effective tool for promptly screening the nutritional status of older patients, prompting subsequent nutritional evaluation or intervention before surgery.

Keywords: mini nutritional assessment short form, lumbar degenerative disease, lumbar surgery, risk factors

Introduction

The global challenge of population aging is increasingly pressing, with projections indicating that the global elderly population will surpass 2 billion by 2050,[1] with a rise in the prevalence of lumbar degenerative diseases, and will accompany an increase in posterior lumbar fusion surgery for degenerative lumbar disease.[2] However, preoperative malnutrition among older patients contributed a heightened incidence of postoperative complications,[3] thereby potentially undermining the benefits of surgery for this demographic.[4] Malnutrition typifies the elderly population, and empirical evidence suggests that malnourished patients exhibit a significantly elevated risk of postoperative complications such as wound infections, delirium, and readmissions.[5–12]

Globally, malnutrition affects between 1% and 24.6% of the elderly population,[13] with hospital-based studies reporting rates as high as 40%.[14] Given that surgical treatment often forms the cornerstone of spinal surgery, the neglect of nutritional issues among spinal surgery patients may be even more pronounced. In order to effectively identify and address malnutrition, enabling timely interventions and reducing postoperative adverse events, various clinical methods

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for nutritional screening have been developed. Common laboratory indicators include albumin and the Prognostic Nutritional Index (PNI),[5,6,12,15] while practical tools such as the Mini Nutritional Assessment-Short Form (MNA-SF), Global Leadership Initiative on Malnutrition (GLIM), and Nutritional Risk Screening-2002 (NRS-2002) are also widely used. However, when the goal is to stratify nutrition based on immediate screening, laboratory tests lose their advantage. The MNA-SF is a widely used, concise nutritional screening tool. Although it cannot be used as a diagnostic standard for malnutrition, its effectiveness in elderly patients has been validated, with studies indicating its ability to predict the occurrence of postoperative adverse events.[10,16–19] In a study by Szymanowska et al[20] nutritional assessments of 273 community-dwelling elderly individuals using both MNA-SF and GLIM revealed that MNA-SF had better diagnostic capability for malnutrition. In another study focusing on patients with hip fractures, Helminen et al[21] found that MNA-SF demonstrated superior predictive ability for adverse events compared to NRS-2002. Therefore, the MNA-SF, as a simple and effective nutritional screening tool, is well-suited for broader clinical application. However, there remains a relative dearth of relevant studies concerning the application of MNA-SF in the context of spine surgery.[19]

Therefore, the objective of this study was to investigate the correlation between malnutrition or risk as assessed by the MNA-SF and major complications after lumbar fusion surgery.

Materials and Methods

Patients and Study Cohort

This study was conducted retrospectively, using a prospectively collected database. Prior approval from the Ethics Committee for Human Subjects of Capital Medical University Xuanwu hospital (permit data 2018.4.3; no. 2018086) and fully complies with the ethical principles of the Declaration of Helsinki. All participants provided informed consent prior to the start of the study, potential risks and benefits, and data privacy protection measures were thoroughly explained to ensure participants fully understood and voluntarily agreed to take part. Our recruitment focused on patients who underwent lumbar fusion for lumbar degenerative disease between June 2019 and September 2021. To be included in the study, patients had to meet the following criteria: (1) be 75 years of age or older; (2) have undergone elective posterior lumbar fusion as a result of lumbar spondylolisthesis, lumbar spinal stenosis, or severe degenerative disc disease, and (3) have no cognitive impairment. Exclusion criteria included (1) incomplete data, (2) loss of follow-up, (3) previous lumbar spine surgery, (4) those who combined the lumbar fusion surgery with cervical or thoracic surgery, (5) lesions at or above the lumbar spine that would impact the evaluation of the surgery outcome, (6) patients with lumbar spine infections or tumors, and (7) preoperative evaluation by the nursing department requiring systematic nutritional intervention. Nutritional status of patients was screened by trained specialist nurses using the MNA-SF within 24 hours of admission. It comprises six sections: appetite or eating problems, recent weight loss, mobility impairment, acute illness or stress, dementia or depression, and body mass index. The scoring is as follows: 0–7 points indicate malnutrition, 8–11 points indicate malnutrition risk, and 12–14 points indicate normal nutritional status. Since only 5 patients were classified as malnourished according to the MNA-SF, grouping them separately would result in insufficient statistical power. Therefore, patients identified as either malnourished or at nutritional risk were combined into the Malnutrition-Risk group (58 patients), while the remaining patients were categorized into the Nourished group (182 patients).

Data Collection and Outcome Assessment

Preoperative variables were collected or assessed and recorded within 24 hours prior to surgery, including age, gender, body mass index (BMI), smoking and drinking status, initial diagnosis, American Society of Anesthesiologists (ASA) grade, comorbidities, Age-adjusted Charlson comorbidity index (ACCI), low back and leg pain (measured by VAS) and the Oswestry Disability Index (ODI) reflecting functional status, frailty index (measured by Fried score), laboratory data, and prognostic nutritional index (PNI). The PNI was calculated using the formula of $10 \times$ serum albumin (g/dL) + $0.005 \times$ total lymphocyte count (/µL). Surgical data were collected in the surgical record system. The primary outcome of the study was major complications. Throughout the hospital stay, clinicians evaluated and recorded any complications that arose. Complications of grade 2 (which required treatment beyond analgesics, antiemetics, antipyretics, diuretics, and electrolytes) or higher, were classified as major complications according to the Clavien-Dindo classification system. To avoid detection bias, evaluators are unaware of the patients' group assignments when recording complications. Other outcomes were also measured, including the VAS and ODI one-year post-surgery, LOS, readmission and reoperation within 30 days, and postoperative laboratory data and nutritional therapy. We also evaluated the Comprehensive Complication Index (scores range from 0 to 100, with a score of 100 being death as a result of complications) which integrates all complications with their respective severities. Comprehensive Complication Index is based on the complication grading by the Clavien-Dindo Classification and captures every complication that occurred after surgery.[22,23] Laboratory data included albumin and hemoglobin levels on the first postoperative day, the third postoperative day, and the day before discharge. The postoperative nutritional treatments included in the statistics encompassed blood transfusion, albumin infusion, and the administration of oral nutritional powder. We also recorded the time of the patient's first ambulation, bowel movement, and void after surgery. The sum of these three times was used as an indicator to reflect the recovery of physiological function.[24] The collection of perioperative data for patients was completed by the 30th postoperative day.

Postoperative Nutritional Treatment

There are three primary types of nutritional treatment after surgery. If a patient's hemoglobin drops below 70g/L, they will be given blood transfusions in doses of 2IU per treatment. In this study, none of the patients required a blood transfusion due to acute postoperative blood loss. Intraoperative blood transfusions were not considered in the post-operative blood transfusion treatment statistics. If a patient's albumin levels fall below 25g/L, they will receive albumin infusion therapy in 20g doses. All patients receiving albumin or blood transfusion therapy must meet the above laboratory parameters and have their condition assessed by a clinician to determine the need for such treatments. Additionally, approval from the pharmacy or transfusion department is required before they can receive the relevant therapy. In cases where a patient's nutritional status is deemed poor, with decreased hemoglobin or albumin, but not severe enough for intravenous therapy, nutritional powder will be used as an intervention. This option may also be considered if the patient is unable to meet 50% of the recommended energy requirements through a self-directed diet within a week. The nutritional powder used in our center is a compound formulation that contains 450 kcal of energy and 15.9g of protein per 100g. Patients are instructed to take 55.8g of this powder twice daily between meals, dissolved in warm water to make a 250mL oral solution. If the patient is severely malnourished or has specific conditions such as diabetes or renal insufficiency, a personalized nutritional intervention plan will be developed through a consultation with the nutrition department.

Statistical Analysis

Continuous variables were expressed as means ± SD and compared using the 2-tailed Student's *t*-test or Mann–Whitney *U*-test depending on the type of variable. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test. Multivariate Logistic Regression was used to analyze the relationship between multiple factors and the occurrence of major complications. Variables that were associated with major complications ($p < 0.2$) in univariate analyses were entered into the multivariate logistic analysis. Despite preoperative albumin, hemoglobin, and PNI did not reach the predetermined p-value in univariate correlation analysis, clinical experience and previous similar studies suggest that these factors may still be associated with postoperative complications. Therefore, they were included in the multivariate logistic regression. The total lymphocyte count was considered a redundant variable and therefore was not included. All statistical analyses were performed using SPSS Statistics 25 (SPSS, Version 22.0, Inc., Chicago, IL, USA). In all analyses, P values were two-tailed and were considered statistically significant at < 0.05.

Results

From June 2019 to September 2021, a total of 252 patients who underwent elective lumbar fusion completed the preoperative nutritional assessments using the MNA-SF. After removing four patients with missing inpatient data and eight patients who were lost to follow-up, 240 patients took part in the final assessment of pain and functional status

(ODI) at the one-year follow-up and were included in the analysis. Of these patients, 182 were classified as Nourished group, and 58 as part of the Malnutrition-Risk group according to the MNA-SF scale (Figure 1).

Table 1 presents the preoperative data for both groups. Table 2 shows that there were no statistically significant differences in intraoperative variables such as operative segment, operative time, estimated blood loss, and blood transfusion between the two groups. Table 3 outlines the postoperative variables. The Malnutrition-Risk group had a higher incidence of major complications, as defined by the Clavien-Dindo system, compared to the Nourished group (46.6% vs 23.1%, p = 0.001). The Malnutrition-Risk group also had a higher comprehensive complications index (18.42 ± 18.00 vs 12.65 ± 15.87, p = 0.021) than the Nourished group. Furthermore, the Malnutrition-Risk group had higher ODI at the 1-year follow-up (27.52 ± 23.44 vs 20.45 ± 20.42, p = 0.029). The length of hospital stay, postoperative hospital stay, and prolongation of hospital stay were all higher in the Malnutrition-Risk group than in the Nourished group (19.22 ± 10.67 vs 16.04 ± 7.69, p = 0.014; 12.07 ± 10.33 vs 8.70 ± 4.57, p = 0.019; 51.7% vs 29.1%, p = 0.002). Finally, the Malnutrition-Risk group had a significantly longer total time to recover physical function (12.53 days vs 10.15 days, p =0.033) (Figure 2).

The data for postoperative nutrition-related variables can be found in Table 4. Upon reexamination of laboratory indicators, it was discovered that the Malnutrition-Risk group had lower levels of albumin on POD1 and Pre-discharge (30.64 ± 3.01 vs 31.72 ± 2.80, p = 0.013; 31.52 ± 3.28 vs 32.52 ± 2.22, p = 0.033), and lower level of hemoglobin pre-discharge (109.35 ± 11.78 vs 113.68 ± 11.01, p = 0.011) (Figures 3 and 4). Additionally, a greater number of patients in the Malnutrition-Risk group received postoperative nutritional treatment in the form of albumin or nutritional powder (34.5% vs 17%, p = 0.005; 29.3% vs 14.8%, p = 0.013), and the average cost of postoperative nutrition therapy for this group was $ 44.28 higher compared to the Nourished group (62.14 ± 10.58 vs 106.42 ± 18.43, p = 0.001).

Table 5 displays the data grouped by the presence or absence of major complications. Univariate correlation analysis revealed that MNA, osteoporosis, ODI, operation time, and allogeneic blood transfusion volume had a P-value of less than 0.2, making them eligible for entry into the multivariate Logistic regression analysis. Multivariate logistic regression analysis indicated that malnutrition or risk was an independent risk factor for major postoperative complications (OR 2.81, 95% CI 1.42–5.53, p = 0.003) (Table 6).

Discussion

This study highlights the importance of perioperative nutritional status, particularly as assessed by the Mini Nutritional Assessment Short Form (MNA-SF), in predicting major complications in older patients undergoing lumbar fusion

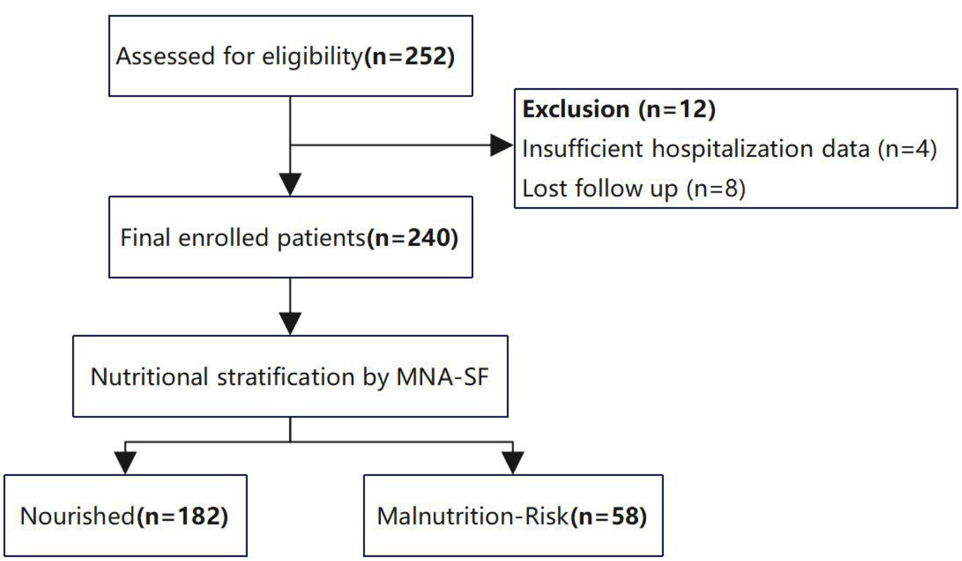

Figure 1 Displays the participant flow in the study, starting with 252 individuals assessed for eligibility, leading to 4 exclusions due to insufficient hospitalization data and 8 lost to follow-up, resulting in a final study population of 240 participants, categorized into Nourished (182) and Malnutrition-Risk (58) groups.

Table 1 Preoperative Variables

Preoperative Variables	Nourished (n=182)	Malnutrition-Risk (n=58)	*P* Value
Age (y)	79.50 ± 3.17	80.38 ± 3.79	0.081
Female n/ (%)	115 (63.2)	35 (60.3)	0.697
BMI (kg/m^2)	25.37 ± 3.39	23.22 ± 3.59	<0.001*
Smoking n/ (%)	15 (8.2)	5 (8.6)	0.928
Drinking n/ (%)	8 (4.4)	5 (8.6)	0.239
Main Diagnosis n/ (%)			0.121
DDD	48 (26.4)	20 (34.5)	
LSS	120 (65.9)	30 (51.7)	
Spondylolisthesis	14 (7.7)	8 (13.8)	
ASA	2.71 ± 0.49	2.71 ± 0.53	0.980
ACCI	4.91 ± 1.04	5.10 ± 1.05	0.226
Comorbidities n/ (%)			
Hypertension	120 (65.9)	41 (70.7)	0.502
Diabetes	56 (30.8)	18 (31)	0.970
Osteoporosis	59 (32.4)	28 (48.3)	0.029*
Heart disease	54 (29.7)	20 (34.5)	0.498
Gastrointestinal	10 (5.5)	8 (13.8)	0.047*
Chronic lung disease	3 (1.6)	1 (1.7)	0.99
Cerebrovascular	10 (5.5)	7 (12.1)	0.136
Chronic kidney disease	5 (2.7)	2 (3.4)	0.677
VAS (lower back)	6.24 ± 0.85	6.23 ± 0.86	0.925
VAS (leg)	6.58 ± 1.22	6.66 ± 1.21	0.692
ODI	51.99 ± 12.44	55.99 ± 11.94	0.033*
Fried	2.33 ± 0.66	3.16 ± 0.94	0.001*
MNA-SF	13.19 ± 0.88	8.77±1.88	0.001*
Laboratory data			
Serum albumin (g/L)	37.84 ± 3.20	36.65 ± 3.83	0.019*
Lymphocyte count (10^9/L)	1.86 ± 0.69	1.68 ± 0.54	0.038*
Hemoglobin (g/L)	127.73 ± 14.99	124.22 ± 17.41	0.138
PNI	47.14 ± 5.36	45.03 ± 4.76	0.008*

Notes: **P* value <0.05 between the Nourished and Malnutrition Risk groups.
Abbreviations: BMI, Body mass index; DDD, Degenerative disc disease; LSS, Lumbar spinal stenosis; ASA, American Society of Anesthesiologists; ACCI, Age-adjusted Charlson Comorbidity Index; VAS, Visual Analogue Scale; ODI, Oswestry disability index; MNA-SF, Mini nutritional assessment-Short form; PNI, Prognostic nutritional index.

Table 2 Operative Variables

Operative Variables	Nourished (n=182)	Malnutrition-Risk (n=158)	*P* Value
Surgical level	2.15 ± 1.00	2.09 ± 0.90	0.674
Operation time (min)	217.10 ± 70.21	213.34 ± 66.56	0.720
Estimated blood (mL)	300 (100, 500)	200 (145,400)	0.098
Autologous transfusion (mL)	144 (40, 260)	100 (0, 177.5)	0.113
Allogeneic transfusion (mL)	0 (0, 0)	0 (0, 0)	0.261

Notes: Normally distributed continuous variables are presented as means ± standard deviation and no-normally distributed variables as median (25th percentile, 75th percentile).

surgery. Our findings align with existing literature, which underscores the significant impact of malnutrition on surgical outcomes, particularly among older adults.[9,10,16,18]

Li et al[19] utilized the MNA-SF to evaluate patients aged 70 years and older who underwent lumbar surgery and identified a significant relationship between malnutrition and postoperative infections. Building upon these findings, our

Table 3 Postoperative Variables

Postoperative Variables	Nourished (n=182)	Malnutrition-Risk (n=58)	*P* Value
Complications n/ (%)			
Major complications n/ (%)	42 (23.1)	27 (46.6)	0.001*
SSI	14 (7.7)	10 (17.2)	0.035*
UTI	3 (1.6)	7 (12.1)	0.002*
DVT	11 (6)	8 (13.8)	0.089
Heart failure	4 (2.2)	1 (1.7)	>0.99
Atrial fibrillation	3 (1.6)	1 (1.7)	>0.99
Pneumonia	6 (3.3)	1 (1.7)	0.864
Delirium	1 (0.5)	3 (5.2)	0.045*
Cerebral infarction	1 (0.5)	0 (0)	>0.99
Minor complications n/ (%)	55 (30.2)	22 (37.9)	0.273
Urinary retention	11 (6)	7 (12.1)	0.153
Constipation	23 (12.6)	10 (17.2)	0.375
Diarrhea	6 (3.3)	2 (3.4)	>0.99
Nausea and Vomiting	22 (12.1)	10 (17.2)	0.315
Comprehensive complications index	12.65 ± 15.87	18.42 ± 18.00	0.021*
Post-VAS (lower back)	2.70 ± 1.14	2.93 ± 1.59	0.222
Post-VAS (leg)	2.26 ± 1.51	2.36 ± 1.93	0.688
Post-ODI	20.45 ± 20.42	27.52 ± 23.44	0.029*
LOS	16.04 ± 7.69	19.22 ± 10.67	0.014*
Post-LOS	8.70 ± 4.57	12.07 ± 10.33	0.019*
Prolonged post-LOS n/ (%)	53 (29.1)	30 (51.7)	0.002*
30d-readmission n/ (%)	16 (8.8)	9 (15.5)	0.144
Re-operation	1 (0.5)	1 (1.7)	0.426
Return of physiological function (day)			
1st ambulation POD	3.28 ± 2.14	4.41 ± 3.78	0.033*
1st bowel movement POD	3.5 ± 1.41	3.93 ± 2.03	0.141
1st void POD	3.37 ± 2.15	4.26 ± 3.82	0.095

Notes: **P* value <0.05 between the Nourished and Malnutrition-Risk groups.
Abbreviations: SSI, Surgical site infection; UTI, Urinary tract infection; DVT, Deep vein thrombosis; VAS, Visual analogue scale; ODI, Oswestry disability index; LOS, Length of hospital stay; POD, Postoperative day.

study not only focused on patients aged 75 and above but also examined a broader range of complications. Unlike previous studies, which often concentrated on specific types of complications, our research integrates a comprehensive analysis of major complications, including surgical site infection (SSI), urinary tract infection (UTI), and delirium. This approach offers a more holistic view of how nutritional status influences postoperative health, particularly in older

Figure 2 Compares the physiological recovery between the Malnutrition-Risk group and the Nourished group, which is composed of the number of days for the first time getting out of bed after surgery, the first bowel movement after surgery, and the first urination postoperative. The Malnutrition-Risk group has the value of 12.6, and the Nourished group has the value of 10.15.

Table 4 Postoperative Nutritional Variables

Postoperative Nutritional Variable	Nourished (n=182)	Malnutrition-Risk (n=58)	*P* Value
POD1 Serum albumin (g/L)	31.72 ± 2.80	30.64 ± 3.01	0.013*
POD3 Serum albumin (g/L)	30.48 ± 3.38	30.68 ± 2.10	0.668
Pre-discharge albumin (g/L)	32.52 ± 2.22	31.52 ± 3.28	0.033*
POD1 hemoglobin (g/L)	112.26 ± 13.63	108.67 ± 15.30	0.091
POD3 hemoglobin (g/L)	110.27 ± 12.25	107.77 ± 12.71	0.183
Pre-discharge hemoglobin (g/L)	113.68 ± 11.01	109.35 ± 11.78	0.011*
Nutritional treatment n/ (%)			
Blood transfusion	27 (14.8)	12 (20.7)	0.292
Albumin injection	31 (17)	20 (34.5)	0.005*
Oral protein powder	27 (14.8)	17 (29.3)	0.013*
Nutritional treatment cost ($)	62.14 ± 10.58	106.42 ± 18.43	0.001*

Notes: **P* value <0.05 between the Nourished and Malnutrition-Risk groups.
Abbreviation: POD, Postoperative day.

patients, and establishes malnutrition as an independent predictor of major complication. Additionally, we explored the long-term effects of malnutrition on functional recovery, which contrasts with previous studies that primarily emphasized short-term complications. Our findings demonstrate the lasting impact of malnutrition on long-term postoperative health.

From a short-term perspective, patients with preoperative malnutrition or risk were found to have a higher incidence of major postoperative complications. Multivariate logistic regression identified malnutrition or risk, as defined by MNA-SF, as an independent risk factor for major complications. Traditionally, serum albumin, hemoglobin, and the prognostic nutritional index (PNI) have been considered essential tools for assessing postoperative risk, especially in elderly populations. Declining serum albumin levels are often viewed as indicators of inflammation and poor nutritional reserves. A study by Sim et al[25] demonstrated that low serum albumin is closely linked to slower physiological recovery and poorer postoperative quality of life. PNI, which combines serum albumin and lymphocyte count, is widely used to predict surgical outcomes. Oe et al[25] found that low PNI was an independent risk factor for postoperative delirium in patients undergoing spinal deformity surgery. Similarly, Grosso et al[26] identified preoperative anemia as a predictor of mortality, medical complications, and unplanned readmissions following total hip arthroplasty. However, in our study, these laboratory markers did not show statistical significance in multivariate analysis. This discrepancy may be attributed to the specific characteristics of the older spinal surgery population, whose perioperative physiological burden and recovery

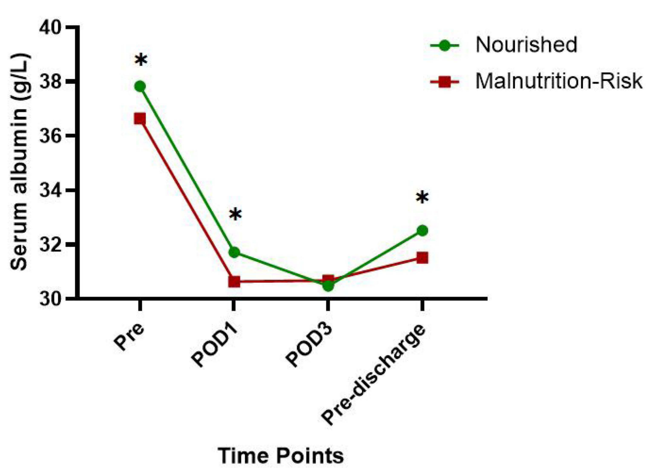

Figure 3 Displays the serum albumin levels at various time points for two groups: Nourished and Malnutrition-Risk. Both groups showed a continuous decline in serum albumin levels from preoperative to the third postoperative day, with a rebound before discharge. However, the Nourished group consistently had higher serum albumin levels than the Malnutrition-Risk group, with significant differences observed preoperative day, the first postoperative day, and before discharge. POD represents postoperative day; * represents significant difference.

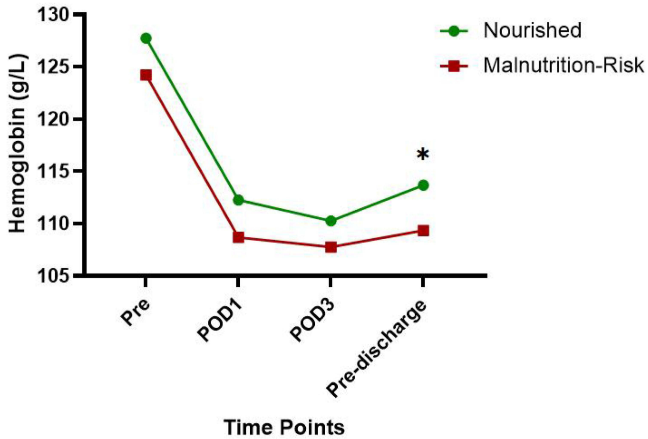

Figure 4 Presents the hemoglobin levels at different time points for the Nourished and Malnutrition-Risk groups. Both groups experienced a continuous decrease in hemoglobin levels from preoperative to the third postoperative day, followed by an increase before discharge. The Nourished group exhibited consistently higher hemoglobin levels compared to the Malnutrition-Risk group, with significant disparities prior to discharge. POD represents postoperative day; * represents significant difference.

processes cannot be fully captured by individual preoperative laboratory markers.[27] In contrast, the MNA-SF offers a more comprehensive evaluation of nutritional status, taking into account dietary habits, weight changes, physical activity, and mental health, which allows it to better capture the overall health status of older patients. Comprehensive screening tools like the MNA-SF are particularly valuable for older patients, as they encompass multiple aging-related health factors, providing a broader understanding of health status than isolated laboratory measurements.[28] This, in turn, supports clinicians in making more accurate preoperative assessments and developing tailored interventions.

Table 5 Univariate Analysis for Major Complications

Variables	No-Major (n=178)	Major (n=62)	*P* Value
Preoperative Variables			
Malnutrition-Risk n/ (%)	33 (18.5)	25 (40.3)	0.001**
Age (y)	79.66 ± 3.30	79.85 ± 3.48	0.698
Female n/ (%)	109 (61.2)	41 (66.1)	0.493
BMI (kg/m^2)	24.87	24.81	0.910
ASA	2.72 ± 0.50	2.70 ± 0.50	0.593
ACCI	4.94±1.04	5.00±1.07	0.717
Smoking n/ (%)	14 (7.9)	6 (9.7)	0.790
Drinking n/ (%)	9 (5.1)	4 (6.5)	0.926
Main Diagnosis n/ (%)			0.439
DDD	53 (29.8)	15 (24.2)	
LSS	113 (63.5)	40 (64.5)	
Spondylolisthesis	12 (6.7)	7 (11.3)	
Comorbidities n/ (%)			
Hypertension	119 (66.9)	42 (67.7)	0.898
Diabetes	58 (32.6)	16 (25.8)	0.320
Osteoporosis	60 (33.7)	27 (43.5)	0.165**
Heart disease	57 (32)	17 (27.4)	0.499
Gastrointestinal	13 (7.3)	5 (8.1)	0.846
Chronic lung disease	2 (1.1)	2 (3.2)	0.298
Cerebrovascular	11 (6.2)	6 (9.7)	0.370
Chronic kidney disease	4 (2.2)	3 (4.8)	0.321

(*Continued*)

Table 5 (Continued).

Variables	No-Major (n=178)	Major (n=62)	*P* Value
VAS (lower back)	6.21 ± 0.82	6.31 ± 0.93	0.433
VAS (leg)	6.54 ± 1.19	6.76 ± 1.28	0.236
ODI	52.15 ± 12.22	55.27 ± 12.47	0.089**
Fried	2.39 ± 0.64	2.45 ± 0.74	0.553
Laboratory data			
Serum albumin (g/L)	37.69 ± 3.38	37.17 ± 3.42	0.302
Lymphocyte count (10^9/L)	1.83 ± 0.69	1.78 ± 0.57	0.625
Hemoglobin (g/L)	126.53 ± 16.11	127.89 ± 14.32	0.557
PNI	46.82 ± 5.39	46.07 ± 4.99	0.333
Operative Variables			
Surgical level	2.12 ± 0.96	2.18 ± 1.03	0.681
Operation time (min)	212.76 ± 68.65	226.05 ± 70.48	0.194**
Estimated blood (mL)	290 (115, 500)	220 (115, 500)	0.940
Autologous transfusion (mL)	168.18 ± 178.88	183.44 ± 214.92	0.584
Allogeneic transfusion (mL)	126.40 ± 278.47	196.77 ± 344.97	0.151**

Notes: ***P* value <0.2 between the No-Major and Major groups.
Abbreviations: BMI, Body mass index; ASA, American Society of Anesthesiologists; ACCI, Age-adjusted Charlson comorbidity index; DDD, Degenerative disc disease; LSS, Lumbar spinal stenosis; VAS, Visual analogue scale; ODI, Oswestry disability index; PNI, Prognostic nutritional index. No-normally distributed variables are presented as median (25th percentile, 75th percentile).

Table 6 Multivariate Analysis for Major Complications

Variables	Univariate Analysis *P*	Multivariate Analysis *P*		
		OR	95% CI	*P* Value
Baseline variables				
Malnutrition-Risk	0.001	2.81	1.42–5.53	0.003 *
Osteoporosis	0.165	1.50	0.79–2.83	0.215
ODI	0.089	1.02	0.99–1.04	0.236
Serum albumin	0.302	0.97	0.83–1.13	0.672
Hemoglobin	0.557	1.001	1.000–1.002	0.223
PNI	0.333	0.98	0.89–1.08	0.675
Operative variables				
Operation time	0.194	1.003	0.998–1.007	0.221
Allogeneic transfusion	0.151	1.001	1.000–1.002	0.053

Notes: **P* value <0.05.
Abbreviations: ODI, Oswestry disability index; PNI, Prognostic nutritional index; OR, Odds ratio; CI, Confidence interval.

Our study also identified a significant association between specific postoperative complications and nutritional status. We observed that UTI incidence was higher in the nutritional risk group, suggesting that malnutrition may impair immune function, contributing to the development of UTI.[28] Additionally, prolonged catheterization and delayed spontaneous urination were likely contributing factors to the increased UTI risk among malnourished patients. The correlation between preoperative nutritional status and surgical site infections (SSI) and delirium was also confirmed, although we were unable to establish their independent predictive role for major complications due to limited sample size. Previous larger studies, however, have substantiated these associations.[5,29] These findings underscore the need for heightened vigilance among clinicians when managing malnourished patients and suggest that specific preventive measures should be employed.

Nutritional status also significantly affected key indicators of postoperative recovery. Patients in the Nourished group demonstrated faster physiological recovery, leading to a shorter length of hospital stay. Furthermore, the faster recovery allowed these patients to regain mobility earlier, reducing the risk of bedrest-associated complications, such as deep vein thrombosis.[30] In contrast, patients in the Malnutrition-Risk group had a higher incidence of complications, a longer hospital stay, and required more postoperative nutritional support, such as albumin infusion and oral nutritional supplements. This highlights not only the importance of preoperative nutritional screening but also the potential economic benefits of nutritional interventions.[31]

Beyond short-term outcomes, our study demonstrates that nutritional status has long-term implications for functional recovery. At the one-year follow-up, patients in the nutritional risk group had significantly higher ODI scores than those in the Nourished group, indicating that malnutrition not only delays postoperative recovery but also impairs long-term functional outcomes. This may be closely linked to frailty and sarcopenia, conditions commonly associated with malnutrition.[32] Previous studies have shown that malnutrition contributes to frailty in elderly patients, and frailty itself is a critical factor in postoperative recovery.[27,33] Functional impairment can also negatively affect patients' daily living abilities, independence, and life satisfaction.[34,35] These findings suggest that clinicians should pay close attention to the long-term prognosis of patients, particularly those who are malnourished or at nutritional risk, as early intervention may be crucial for improving long-term outcomes.

The MNA-SF not only provides a more accurate evaluation of patients' nutritional status but also effectively captures the complex relationship between malnutrition and postoperative risks through rapid screening. Future prospective studies should further investigate whether nutritional interventions can effectively reduce postoperative complications. Although numerous studies have demonstrated the effectiveness of preoperative nutritional interventions in reducing adverse events, such as the large randomized controlled trial by Schuetz et al[36] involving 2088 patients, which found that personalized nutritional support significantly improved the nutritional status of hospitalized malnourished patients and reduced adverse events and 30-day mortality, the application of such strategies in older spinal surgery patients remains limited.[37] Additionally, more research is needed to explore the mechanisms by which nutritional interventions improve outcomes, including how personalized nutritional support before and after surgery can enhance patient recovery and whether these interventions can be broadly applied in clinical practice.

Limitation

Our study has some limitations that are worth noting. Firstly, it was a single-center study with a limited sample size, which hindered our ability to determine the association between preoperative malnutrition and major complications such as SSI, UTI, and delirium. And due to the limitation of sample size, patients screened as malnutrition had to be combined with those at risk of malnutrition, which may to some extent reduce the statistical power and affect the reliability of the conclusions. Secondly, MNA-SF was not employed in the long-term follow-up of patients, and only laboratory indicators were used to reflect the changes in short-term nutritional status after surgery, which would lead to a lack of longitudinal comparison of nutritional status before and after surgery, and it would not fully reflect the nutritional status and changes of patients. Thirdly, despite our use of consecutive enrollment of patients and multivariate regression to rule out possible confounding, there are numerous other factors (eg, polypharmacy, preoperative anxiety, or depression) that could impact postoperative outcomes. Finally, since this study is not a prospective study, we administered nutrition-related treatments to patients who developed malnutrition after surgery based on clinical principles. This is likely to have an impact on the postoperative outcomes of both groups. Thus, we aim to further design a multicenter prospective large-sample randomized controlled trial to determine the effect of nutritional supplementation on postoperative complications in malnourished patients, and consequently, reduce the incidence of major postoperative complications in older patients.

Conclusion

MNA-SF can serve as an effective tool for predicting major complications in elderly patients undergoing lumbar fusion surgery and can provide decision-making guidance or directing nutritional interventions for malnutrition or risk populations. Further studies should investigate a preoperative nutritional intervention program for older patients undergoing lumbar surgery and evaluate its effectiveness in mitigating the negative impact of malnutrition on postoperative results.

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Disclosure

The author(s) report no conflicts of interest in this work.

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