Inflammatory status predicts prognosis in patients with gastric cancer with early pyloric stenosis who underwent radical resection: A propensity score-matching analysis

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Abstract. The inflammatory status of patients is closely related to their nutritional status, and the impact of inflammatory status on patients with pyloric stenosis remains unclear. The present study aimed to investigate the impact of inflammatory status on the prognosis of patients with gastric cancer with early pyloric stenosis who underwent radical resection. A retrospective analysis included 242 patients with gastric cancer who underwent radical resection at the Affiliated Hospital of Southwest Medical University between July 2016 and December 2020. All patients were diagnosed with early pyloric stenosis. Correlation analysis was used to assess variations among different factors, and survival analysis was conducted to evaluate differences in overall survival (OS). To identify independent prognostic indicators, both univariate and multivariate Cox regression analyses were performed, addressing potential multicollinearity using Lasso analysis. Propensity score matching (PSM) was employed to eliminate potential confounding factors. Additionally, a prognostic risk model and nomogram based on inflammatory indicators were developed to comprehensively explore their impact on prognosis. Initial survival analysis revealed significant associations between neutrophil-to-lymphocyte ratio (NLR; χ^2=10.522, P<0.001), systemic immune-inflammation index (SII; χ^2=6.733, P=0.025), systemic inflammation response index (SIRI; χ^2=15.490, P<0.001) and OS of the patients, while there was no significant survival difference among patients with different platelet-to-lymphocyte ratio (PLR; χ^2=2.561, P=0.050). SIRI not only had the highest area under the curve but was also found to be an independent prognostic indicator (hazard ratio=1.851, P=0.046) in the present study. Following PSM on SIRI, a total of 174 patients were included in the subsequent analysis. Time-receiver operating characteristic and survival curves for SIRI after PSM consistently demonstrated its robust prognostic predictive capability. Furthermore, the prognostic risk model based on SIRI and the nomogram incorporating SIRI both exhibited high prognostic value. Inflammatory status was significantly associated with the prognosis of patients with gastric cancer with early pyloric stenosis who underwent radical resection. The NLR, SII and SIRI could all predict patient outcomes. Moreover, SIRI exhibited the highest prognostic value among the inflammatory indices and has been identified as an independent prognostic factor in the present study.

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Introduction

Gastric cancer, a widespread malignancy on a global scale, imposes a significant burden in terms of both incidence and mortality in numerous countries (1). The prognosis of patients with gastric cancer is influenced by a myriad of factors, including tumor staging, histological type and the overall health status of the individuals (2-4). Due to its high malignancy, investigating the factors influencing the clinical outcomes of gastric cancer remains of significant importance (5,6).

Pyloric stenosis, a relatively common complication, is known to significantly impact the nutritional status of the patients (7,8). It not only disrupts dietary intake and reduces the quality of life but also has a substantial influence on the treatment and prognosis of gastric cancer (9-11). Since pyloric stenosis can lead to decreased treatment tolerance and rapid disease progression, nutritional status has always been a focal point of concern (12-14). While previous studies have primarily examined the nutritional status of pyloric stenosis patients, few have delved into their systemic inflammatory status (15,16). Inflammatory status can impact the disease progression of

patients with gastric cancer through various pathways, and a substantial body of previous research has also identified the close relationship and interaction between inflammation and nutritional status (17-19). Therefore, it is still necessary to explore the inflammatory status of patients with gastric cancer with pyloric stenosis and its impact on prognosis.

Hence, the primary objective of the present study was to probe the intricate relationship between systemic inflammatory status and prognosis in patients with gastric cancer who were concurrently afflicted by pyloric stenosis and underwent radical resection, employing a retrospective approach. To mitigate potential biases, propensity score-matching analysis was employed, which enabled the authors to more accurately assess this association. The present study is the first, to the best of the authors' knowledge, to examine the inflammatory status of patients with early pyloric stenosis using multiple classic inflammatory indices and to analyze their impact on patient prognosis. Additionally, the predictive abilities of different inflammatory indices were compared to identify the one with the highest prognostic value.

Patients and methods

Patients. The present retrospective study enrolled 242 patients with gastric cancer at the Affiliated Hospital of Southwest Medical University (Luzhou, China) between July 2016 and December 2020. Inclusion criteria were as follows: i) Patients were confirmed to have early pyloric stenosis. The diagnosis of early pyloric stenosis in patients was established through a comprehensive assessment, including: a) Clinical symptoms: Presentation of upper abdominal pain, bloating, weight loss, acid reflux and fatigue; b) gastroscopic examination: Direct visualization of the stenosis in the pyloric region via gastroscopy, with a biopsy conducted to rule out or confirm malignancy; c) imaging studies: Utilization of upper gastrointestinal barium meal X-ray, CT scan, or MRI to ascertain the location and extent of the stenosis; d) clinical manifestations: Evaluation of the nutritional status of the patient to assess the impact of the stenosis on digestion and absorption. ii) Patients with tumor-node-metastasis (TNM) stage II or III who had received radical resection. iii) Patients who had received complete treatment and follow-up, with comprehensive clinical and medical record data. Exclusion criteria were as follows: i) Patients suffering from chronic inflammatory conditions. A chronic inflammatory condition refers to a prolonged and persistent inflammatory response in the body, which is closely associated with the development, progression and exacerbation of diseases. This state can be induced by various factors, including persistent infections, autoimmune reactions, long-term exposure to harmful substances, chronic stress, or the presence of chronic diseases. It is typically characterized by elevated white blood cell counts, increased levels of inflammatory markers in the blood (such as C-reactive protein, tumor necrosis factor-α and interleukin-6), and infiltration of inflammatory cells in the affected tissues. This condition can lead to tissue damage, fibrosis, impaired organ function, and the onset and progression of chronic diseases. ii) Patients who received preoperative chemotherapy, radiation therapy, or immunotherapy. iii) Patients who were lost to follow-up or had incomplete clinical and pathological information. Since all patients were in TNM stage II and III, they all underwent standard curative resection surgery, and received adjuvant chemotherapy with either the standard SOX (oxaliplatin + S1) or XELOX (oxaliplatin + capecitabine) regimen based on pathological staging 3 weeks postoperatively. This study received approval and support from the Ethics Committee of The Affiliated Hospital of Southwest Medical University (approval no. KY2023224; Luzhou, China).

Data collection and follow-up. Information regarding the general health status and disease progression of patients through the medical record system was screened and collected. To investigate the inflammatory and nutritional status of the patients, pertinent blood parameters, which included total protein, albumin, globulin, prealbumin, neutrophil (NEU), lymphocyte (LYM), monocyte (MON) and platelet counts were concurrently gathered. For preoperative blood collection, 5 ml of fasting venous blood from the elbow was drawn. In total, 2 ml of the blood was transferred into an ethylenediaminetetraacetic acid anticoagulant tube and mixed well, then automatically analyzed for routine hematological parameters using a BC-6000 Automated Hematology Analyzer (Shenzhen Mindray Bio-Medical Electronics Co., Ltd.). Additionally, 3 ml of the blood was transferred into a dry tube and left to stand at room temperature to obtain the upper layer fluid, which was then centrifuged (Sorvall ST8 Benchtop Room Temperature Centrifuge, 20-25 degrees Celsius; Thermo Fisher Scientific, Inc.) at a relative centrifugal force of 3,260 x g for 5 min to separate the serum. The serum biochemical parameters were automatically measured using a cobas® c 311 analyzer (Roche Diagnostics). To investigate systemic inflammation status, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII) and systemic inflammation response index (SIRI) based on the blood parameters of patients were calculated (Table I). The ranges for NLR, PLR, SII and SIRI were 0.77-38.82, 66.27-741.18, 178.89-1,891.76 and 0.24-19.41, respectively. Overall survival (OS) was obtained through routine telephone follow-up and was defined as the period from the first day of surgery to either the date of death or the last follow-up.

Statistical analysis. Categorical variables were described using n (%) and differences were assessed through chi-square test and Fisher's exact test. Continuous variables were presented as mean [standard deviations (SD)] and differences were analyzed using an unpaired Student's t-test. Kaplan-Meier survival curves and log-rank tests were employed to evaluate survival disparities. Cox regression analysis and Lasso regression analysis were utilized to identify independent prognostic factors in the present study and address issues related to multicollinearity. The proportional hazards assumption test was performed using the Cox model and Schoenfeld residual plots. Additionally, to mitigate potential selection bias, propensity score matching (PSM) was employed. Finally, a risk prognosis model and nomogram were constructed to further validate the prognostic value of the inflammatory markers. Two-sided $P<0.05$ was considered to indicate a statistically significant difference. All statistical analyses were conducted using SPSS 25 (IBM, Corp.) and R 4.1.3 (The R Foundation for Statistical Computing; https://www.r-project.org/).

Table I. Calculation formulas.

Parameters	Calculation formula
Neutrophil-to-lymphocyte ratio	Neutrophil (10^9/l)/lymphocyte (10^9/l)
Platelet-to-lymphocyte ratio	Platelet (10^9/l)/lymphocyte (10^9/l)
Systemic immune-inflammation index	Platelet (10^9/l) x neutrophil (10^9/l)/lymphocyte (10^9/l)
Systemic inflammation response index	Monocyte (10^9/l) x neutrophil (10^9/l)/lymphocyte (10^9/l)

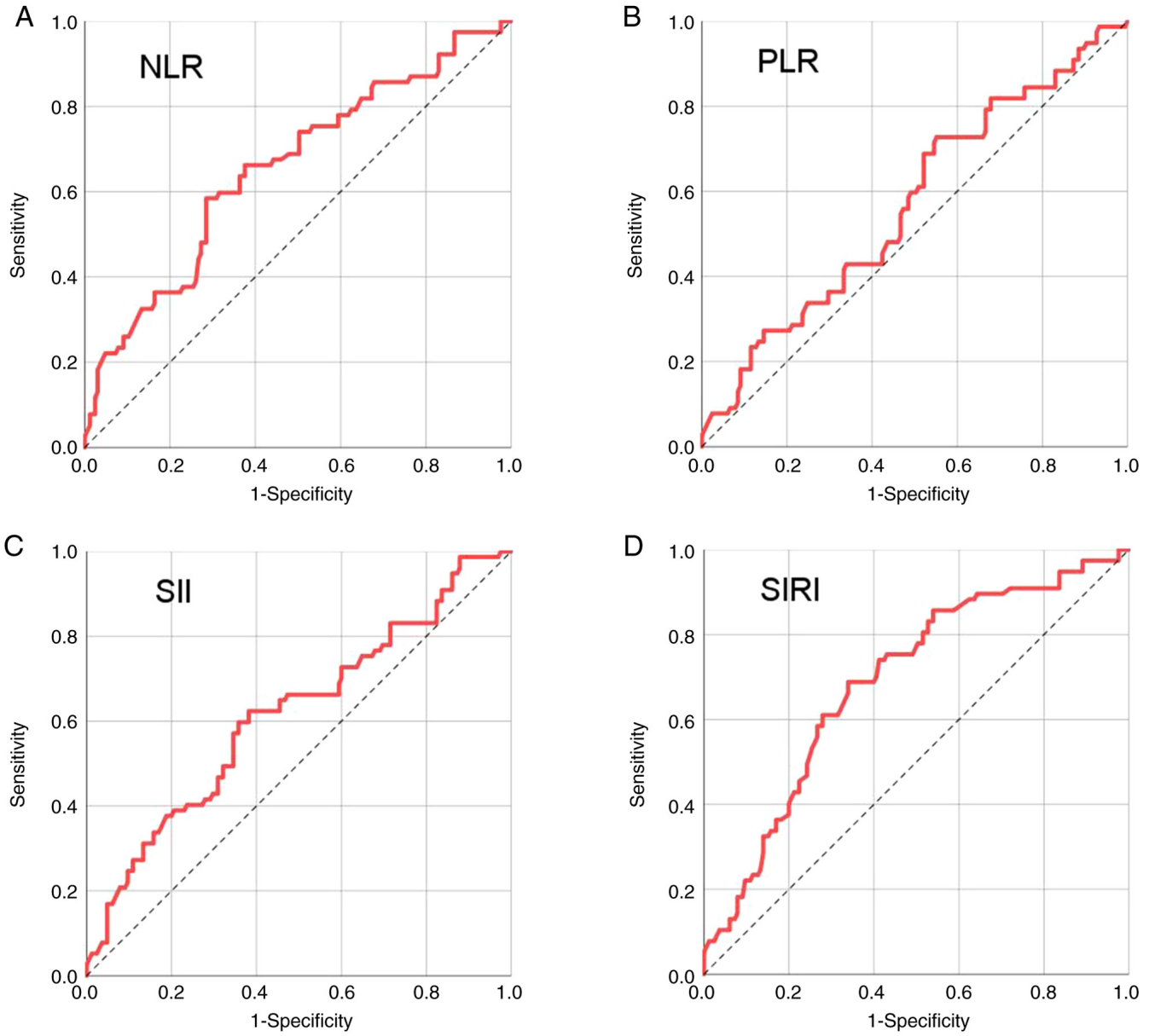

Figure 1. Receiver operating characteristic curves of (A) NLR, (B) PLR, (C) SII and (D) SIRI. NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index; SIRI, systemic inflammation response index.

Results

Patient characteristics. The present study included a total of 242 participants, consisting of 193 male and 49 female patients. The average age of the study cohort was 63.18 (SD, 9.91) years. The age range was 40-81 years. Due to the concurrent presence of pyloric stenosis, most patients exhibited distinct clinical symptoms. Among these patients, 110 (45.5%) experienced stomachache, 128 (52.9%) reported abdominal distention, 105 (43.4%) had weight loss, 94 (38.8%) suffered from sour regurgitation and 61 (25.2%) presented with fatigue. Furthermore, the patients also demonstrated rapid tumor progression, with

Table II. Characteristics of patients with gastric cancer.

Parameters	Number of patients with pyloric stenosis (total n=242)
Mean age, years (SD)	63.18 (9.91)
Mean BMI, kg/m^2 (SD)	20.84 (3.36)
Mean total protein, g/l (SD)	61.45 (7.70)
Mean albumin levels, g/l (SD)	35.65 (4.49)
Mean globulin levels, g/l (SD)	26.02 (5.30)
Mean prealbumin levels, g/l (SD)	177.59 (53.75)
Median neutrophil levels, 10^9/l (IR)	3.68 (2.94, 4.88)
Median lymphocyte levels, 10^9/l (IR)	1.34 (1.00, 1.90)
Median monocyte levels, 10^9/l (IR)	0.41 (0.34, 0.52)
Median platelet levels, 10^9/l (IR)	244.00 (200.00, 288.00)
Median neutrophil-to-lymphocyte ratio, (IR)	2.74 (2.02, 3.94)
Median platelet-to-lymphocyte ratio, (IR)	185.47 (128.24, 246.67)
Median systemic immune-inflammation index, (IR)	671.22 (447.55, 1015.01)
Median systemic inflammation response index, (IR)	1.15 (0.84, 1.76)
Sex, n (%)	
Male	193 (78.9)
Female	49 (20.2)
Stomach ache, n (%)	
Yes	110 (45.5)
No	132 (54.5)
Abdominal distension, n (%)	
Yes	128 (52.9)
No	114 (47.1)
Weight loss, n (%)	
Yes	105 (43.4)
No	137 (56.6)
Fatigue, n (%)	
Yes	61 (25.2)
No	181 (74.8)
Acid reflux, n (%)	
Yes	94 (38.8)
No	148 (61.2)
Primary tumor site, n (%)	
Upper 1/3	8 (3.3)
Middle 1/3	26 (10.7)
Lower 1/3	204 (84.3)
Whole	4 (1.7)
Borrmann type, n (%)	
I	44 (18.2)
II	170 (70.2)
III	22 (9.1)
IV	6 (2.5)
Peripheral lymph node, n (%)	
Positive	192 (79.3)
Negative	50 (20.7)
Tumor size, n (%)	
<50 mm	108 (44.6)
≥50 mm	134 (55.4)
Tumor-node-metastasis stage, n (%)	
II	82 (33.9)
III	160 (66.1)

Table II. Continued.

Parameters	Number of patients with pyloric stenosis (total n=242)
Human epidermal growth factor receptor 2, n (%)	
Positive	114 (47.1)
Negative	128 (52.9)

SD, standard deviation; IR, interquartile range.

Table III. AUC and cutoff values of inflammatory markers.

Parameters	AUC	95% CI	Youden index	Cut-off
Neutrophil-to-lymphocyte ratio	0.655	0.580-0.730	0.300	3.150
Platelet-to-lymphocyte ratio	0.569	0.492-0.647	0.176	150.200
Systemic immune-inflammation index	0.616	0.539-0.694	0.242	718.025
Systemic inflammation response index	0.690	0.619-0.760	0.349	1.215

AUC, area under the curve.

over half of them having a tumor size of ≥50 mm (55.4%) and being in TNM stage III (66.1%), as shown in Table II.

Inflammatory markers. Receiver operating characteristic (ROC) curves were generated using patient survival status to compare the predictive capabilities of various inflammatory markers and identify their optimal cutoff values (Fig. 1). The optimal cut-off values, determined using the maximum Youden index, were 3.150 for NLR (150 vs. 92 patients), 150.200 for PLR (95 vs. 147 patients), 718.025 for SII (131 vs. 111 patients) and 1.215 for SIRI (133 vs. 109 patients). Their corresponding AUC values were 0.655, 0.569, 0.616 and 0.690, respectively. Notably, SIRI exhibited the highest AUC, demonstrating its strong predictive efficacy (Table III). Furthermore, to further compare their predictive abilities, time-dependent ROC curves were created for the inflammatory markers (Fig. 2). The results revealed that SIRI consistently exhibited the highest AUC at all time points, providing additional confirmation of its excellent predictive performance.

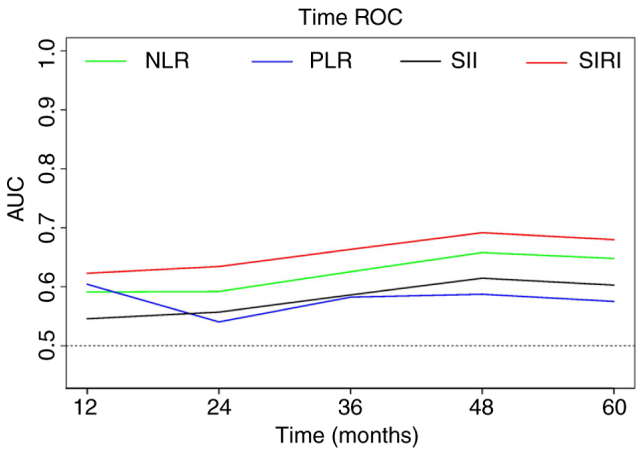

Figure 2. Time-ROC curves of inflammatory markers. ROC, receiver operating characteristic; AUC, are under the curve.

Survival analysis of inflammatory markers. Survival analysis was performed on all inflammatory markers and survival curves were plotted. The results indicated that higher NLR (χ^2=10.522, P<0.001), SII (χ^2=6.733, P=0.025) and SIRI (χ^2=15.490, P<0.001) were all associated with shorter OS, while there was no significant survival difference among patients with different PLR (χ^2=2.561, P=0.050) (Fig. 3A-D). In addition, to further explore their prognostic value, univariate and multivariate survival analyses were conducted (Table IV). It was found that neutrophil (P=0.002), monocyte (P=0.023), NLR (P=0.002), SII (P=0.011), SIRI (P<0.001), positive peripheral lymph node (P=0.001) and TNM stage (P<0.001) were associated with the OS of the patients. Given the high correlations among inflammation-related blood parameters and inflammatory markers, Lasso regression analysis was performed on these variables before conducting multivariate analysis to mitigate multicollinearity. After 285 rounds of cross-validation, the optimal λ value was identified as 0.009. Based on the optimal λ value, monocyte and SII were found to be collinear and were excluded from the multivariate analysis (Fig. 4A and B). Finally, SIRI (HR=1.851, P=0.046) and TNM stage (HR=2.906, P=0.033) were identified as independent prognostic factors in this study (Table IV).

Propensity score matching analysis for SIRI. In the present study, SIRI not only exhibited the highest AUC but also proved to be an independent prognostic indicator. To minimize interference factors as much as possible, PSM analysis was conducted on SIRI. Before PSM, there were 133 patients with low SIRI and 109 patients with high SIRI. The chi-square test and Fisher's exact test showed that SIRI was associated with ALB, sex,

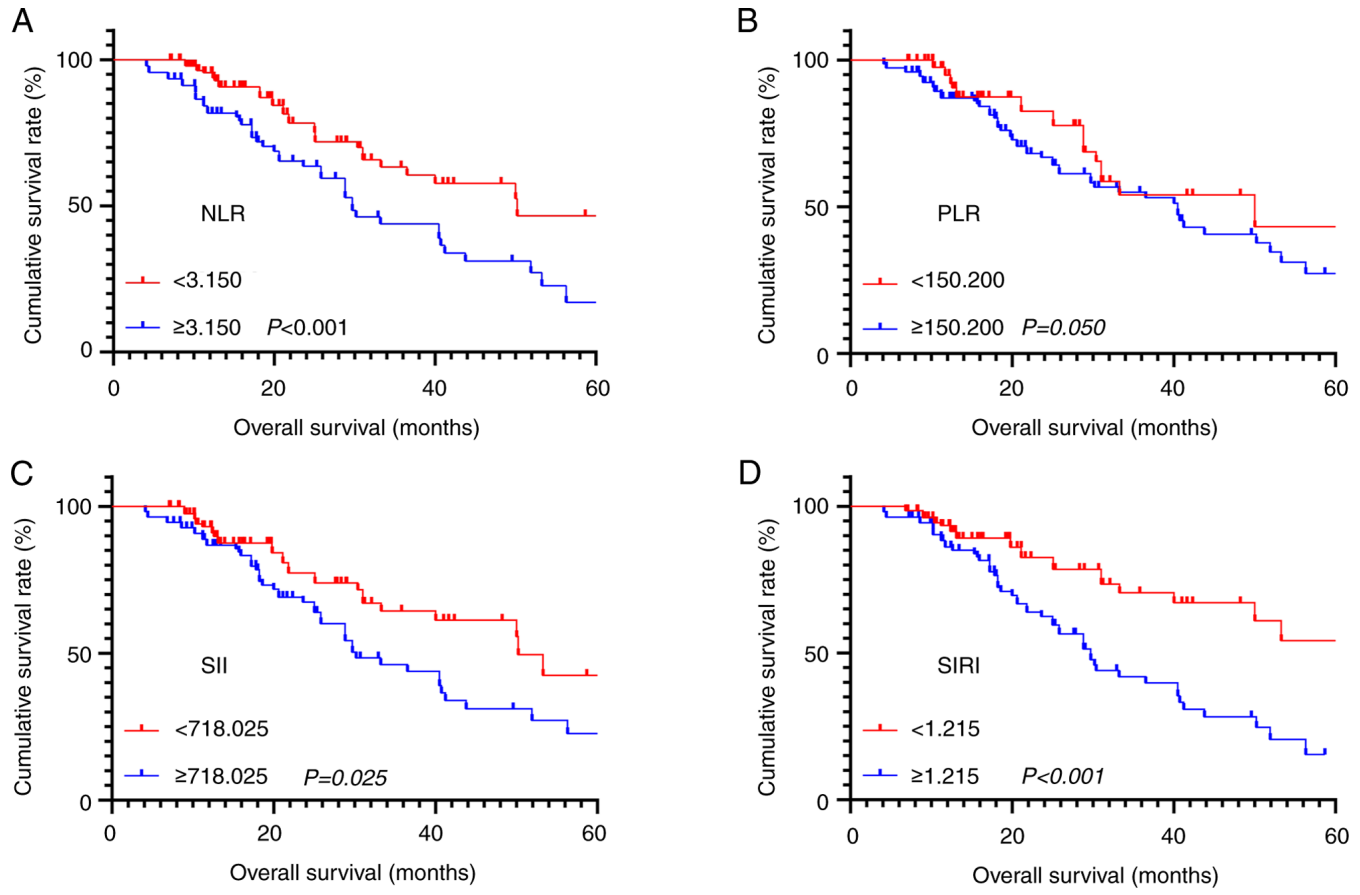

Figure 3. Survival curves of (A) NLR, (B) PLR, (C) SII and (D) SIRI. NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index; SIRI, systemic inflammation response index.

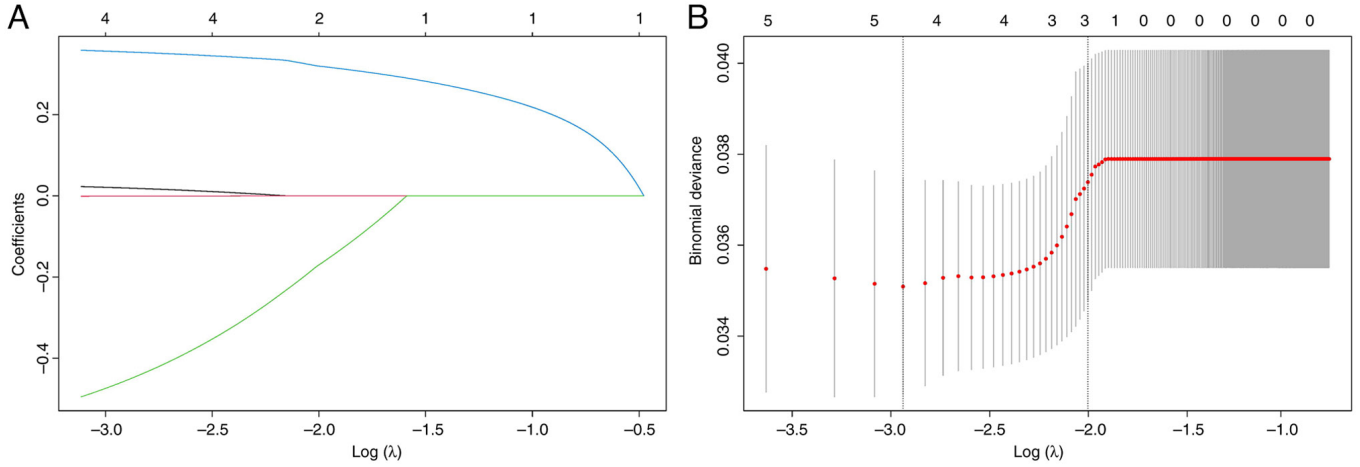

Figure 4. Lasso regression analysis. (A) The variation characteristics of the coefficient of variables. (B) The optimum value of the parameter λ in the Lasso regression model was selected by cross-validation method.

fatigue, primary tumor site and HER2 expression (all P<0.05). After incorporating all interference factors and setting the matching tolerance to 0.02, a total of 174 patients were successfully matched. After PSM, there were 87 patients in both the low and high SIRI groups, and SIRI was not associated with any clinical or pathological parameter (all P>0.05) (Table V).

The ROC curve and survival curve for SIRI were plotted based on the new dataset. The 1 and 3-year AUC for SIRI were 0.648 and 0.652, respectively, which remained relatively high (Fig. 5A). Additionally, survival analysis indicated that SIRI was still significantly associated with the clinical outcome of the patients, with higher SIRI values associated with lower OS (χ^2=14.547, P<0.001, Fig. 5B).

In addition, a prognostic risk model based on SIRI using the β coefficient from the Cox analysis was established. The risk score was calculated as SIRI value x0.392. The risk

Table IV. The univariate and multivariate survival analysis.

	Univariate analysis		Multivariate analysis	
Parameters	Hazard ratio (95% CI)	P-value	Hazard ratio (95% CI)	P-value
Age, years	1.022 (0.998-1.047)	0.075		
BMI, kg/m^2	0.964 (0.898-1.034)	0.306		
Total protein, g/l	1.034 (0.999-1.069)	0.057		
Albumin, g/l	1.025 (0.969-1.085)	0.383		
Globulin, g/l	1.035 (0.991-1.082)	0.123		
Prealbumin, g/l	0.997 (0.993-1.002)	0.292		
Neutrophil, g/l	1.190 (1.064-1.331)	0.002	1.068 (0.933-1.223)	0.341
Lymphocyte, g/l	0.793 (0.516-1.218)	0.290		
Monocyte, g/l	3.343 (1.184-9.441)	0.023		
Platelet, g/l	0.999 (0.993-1.001)	0.325		
Neutrophil-to-lymphocyte ratio (<3.150 vs. ≥3.150)	2.080 (1.321-3.277)	0.002	1.217 (0.667-2.219)	0.523
Platelet-to-lymphocyte ratio (<150.200 vs. ≥150.200)	1.502 (0.908-2.486)	0.113		
Systemic immune-inflammation index (<718.025 vs. ≥718.025)	1.822 (1.148-2.891)	0.011		
Systemic inflammation response index (<1.215 vs. ≥1.215)	2.542 (1.568-4.122)	<0.001	1.851 (1.010-3.394)	0.046
Sex (male vs. female)	0.597 (0.318-1.120)	0.108		
Stomach ache (yes vs. no)	1.201 (0.763-1.889)	0.429		
Abdominal distention (yes vs. no)	0.900 (0.569-1.422)	0.651		
Weight loss (yes vs. no)	1.375 (0.869-2.176)	0.174		
Fatigue (yes vs. no)	0.987 (0.613-1.588)	0.957		
Acid reflux (yes vs. no)	1.406 (0.886-2.230)	0.148		
Primary tumor site (low 1/3 vs. others)	1.204 (0.763-1.898)	0.425		
Borrmann type (I+II vs. III+IV).	0.991 (0.646-1.520)	0.967		
Peripheral lymph node (positive vs. negative)	3.867 (1.770-8.446)	0.001	1.493 (0.475-4.696)	0.493
Tumor size (<50 mm vs. >50 mm)	1.004 (0.641-1.573)	0.985		
Tumor-note-metastasis stage (II vs. III)	4.082 (2.098-7.941)	<0.001	2.906 (1.087-7.768)	0.033
Human epidermal growth factor receptor 2 (positive vs. negative)	1.337 (0.851-2.099)	0.208		

factor correlation plot demonstrated a significant association between higher risk scores and lower survival rates (Fig. 5C). This further validated the predictive capacity of SIRI for patient prognosis.

Nomogram for SIRI. A nomogram was constructed to predict patient survival probabilities based on TNM stage and SIRI. Schoenfeld residual plots for TNM stage (P=0.5978) and SIRI (P=0.7675) indicated that neither of them violated the proportional hazards assumption (Fig. 6A). The C-index of the nomogram was 0.671 (Fig. 6B). Furthermore, calibration curves based on bootstrapping also demonstrated a high level of consistency between predicted probabilities and actual probabilities (Fig. 6C). These findings collectively highlighted the high accuracy of the SIRI nomogram.

Discussion

Nutritional status has been demonstrated to be related to the prognosis of various cancers (20-23). A study conducted by Sun *et al* (24) on the Prognostic Nutritional Index (PNI) in gastric cancer confirmed the association between poor nutritional status and poor survival outcomes. In 2022, they collected data from 146 patients who received postoperative immunotherapy or chemotherapy and found a correlation between low PNI and poor OS. A meta-analysis conducted by Zhang *et al* (25) in 2023 also reached the same conclusion. Early pyloric stenosis often leads to a poor nutritional status, which significantly impacts the prognosis of patients with gastric cancer. Notably, two retrospective studies conducted between 2021 and 2023 investigated the clinical characteristics and survival outcomes of patients with early pyloric stenosis. Jiao *et al* (26) and Li *et al* (27) collected data from 73 and 221 patients, respectively, and found that individuals with early pyloric stenosis not only exhibited poorer nutritional status and tumor burden but also experienced significantly worse survival outcomes compared with patients without early pyloric stenosis. The impact of systemic inflammation on gastric cancer had been a topic of interest for numerous researchers. Hashimoto *et al* (28) explored the

Table V. Patient characteristics related to SIRI before and after PSM.

	Before PSM			After PSM		
Parameters	Low SIRI (total n=133)	High SIRI (total n=109)	P-value	Low SIRI (total n=87)	High SIRI (total n=87)	P-value
Mean age, years (SD)	63.39 (10.30)	62.93 (9.47)	0.718	63.23 (9.81)	62.45 (9.60)	0.596
Mean BMI, kg/m^2 (SD)	21.04 (2.95)	20.59 (3.80)	0.309	20.94 (2.93)	20.26 (3.72)	0.379
Mean total protein, g/l (SD)	61.82 (7.87)	60.11 (7.43)	0.087	61.96 (7.90)	61.79 (7.30)	0.862
Mean albumin, g/l (SD)	36.66 (4.10)	34.42 (4.64)	<0.001	35.75 (4.23)	35.46 (4.47)	0.911
Mean globulin, g/l (SD)	25.44 (4.78)	26.73 (5.81)	0.060	25.47 (4.96)	26.55 (5.97)	0.195
Mean prealbumin, g/l (SD)	183.03 (51.39)	170.96 (56.01)	0.082	187.00 (52.96)	175.38 (56.90)	0.165
Sex (%)			0.009			0.839
Male	98 (73.7)	95 (87.2)		72 (82.8)	73 (83.9)	
Female	35 (26.3)	14 (12.8)		15 (17.2)	14 (16.1)	
Stomach ache (%)			0.524			0.442
Yes	58 (43.6)	52 (47.7)		34 (39.1)	39 (44.8)	
No	75 (56.4)	57 (52.3)		53 (60.9)	48 (55.2)	
Abdominal distention (%)			0.866			0.649
Yes	71 (53.4)	57 (52.3)		46 (52.9)	43 (49.4)	
No	62 (46.6)	52 (47.7)		41 (47.1)	44 (50.6)	
Weight loss (%)			0.854			0.649
Yes	57 (42.9)	48 (44.0)		43 (49.4)	40 (46.0)	
No	76 (57.1)	61 (56.0)		44 (50.6)	47 (54.0)	
Fatigue (%)			0.001			0.159
Yes	22 (16.5)	39 (35.8)		16 (18.4)	22 (25.3)	
No	111 (83.5)	70 (64.2)		71 (81.6)	65 (74.7)	
Acid reflux (%)			0.861			0.878
Yes	51 (38.3)	43 (39.4)		37 (42.5)	38 (43.7)	
No	82 (61.7)	66 (60.6)		50 (57.5)	49 (56.3)	
Primary tumor site (%)			0.009			0.065
Upper 1/3	2 (1.5)	6 (5.5)		2 (2.3)	6 (6.9)	
Middle 1/3	20 (15.0)	6 (5.5)		13 (14.9)	5 (5.7)	
Low 1/3	111 (83.5)	93 (85.3)		72 (82.8)	72 (82.8)	
Whole	0 (0.0)	4 (3.7)		0 (0.0)	4 (4.6)	
Borrmann type (%)			0.913			0.447
I	22 (16.5)	22 (20.2)		14 (16.1)	17 (19.5)	
II	95 (71.4)	75 (68.8)		66 (75.9)	60 (69.0)	
III	12 (9.0)	10 (9.2)		5 (5.7)	9 (10.3)	
IV	4 (3.0)	2 (1.8)		2 (2.3)	1 (1.1)	
Peripheral lymph node (%)			0.637			0.999
Positive	107 (80.5)	85 (78.0)		71 (81.6)	71 (81.6)	
Negative	26 (19.5)	24 (22.0)		16 (18.4)	16 (18.4)	
Tumor size (%)			0.142			0.167
<50 mm	65 (48.9)	43 (39.4)		45 (51.7)	33 (37.9)	
≥50 mm	68 (51.1)	66 (60.6)		42 (48.3)	54 (62.1)	
Tumor-node-metastasis stage (%)			0.799			0.873
II	46 (34.6)	36 (33.0)		30 (34.5)	29 (33.3)	
III	87 (65.4)	73 (67.0)		57 (65.5)	58 (66.7)	
Human epidermal growth factor receptor 2 (%)			0.049			0.095
Positive	69 (51.9)	45 (41.3)		47 (54.0)	36 (41.4)	
Negative	64 (48.1)	64 (58.7)		40 (46.0)	51 (58.6)	

PSM, propensity score matching; SIRI, systemic inflammation response index; SD, standard deviation.

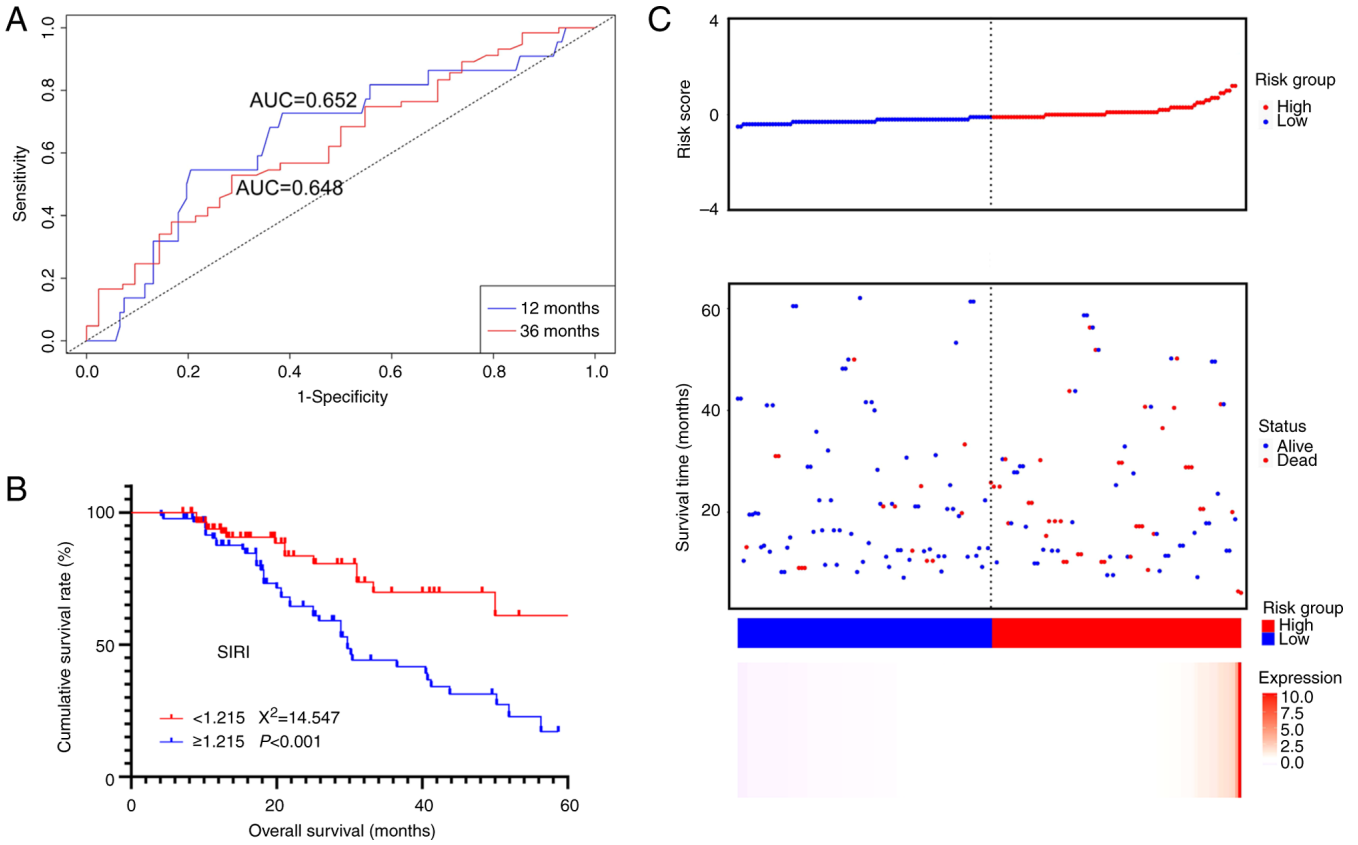

Figure 5. Survival analysis of SIRI after propensity score matching. (A) The 1- and 3-year time-receiver operating characteristic curve of SIRI. (B) Survival curve of SIRI. (C) The risk factor correlation plot of the prognostic risk model. SIRI, systemic inflammation response index.

impact of hematologic inflammatory markers on the prognosis of soft tissue sarcomas (STSs). The study included a total of 22 patients with STS treated at their institution and analyzed the correlation between pretreatment blood markers and tumor characteristics. The findings suggested that C-reactive protein levels, white blood cell and neutrophil counts, and NLR may be poor prognostic factors for highly aggressive STSs. Zurlo *et al* (29) conducted a retrospective analysis of the application of NLR, tumor infiltrating lymphocytes ($CD4^+/CD8^+$) and programmed death-ligand 1 expression in patients with gastric cancer who underwent neoadjuvant treatment. Through their analysis of data collected from 65 patients in 2022, they found significant associations between these factors and patient prognosis, indicating that the pre-treatment systemic inflammatory and immune status could influence clinical outcomes. In addition, Wu *et al* (30) and Qiu *et al* (31) conducted two meta-analyses that confirmed the significant impact of SII on the prognosis of patients with gastric cancer. These findings indirectly validated the importance of exploring the inflammatory status in patients with pyloric stenosis.

In the present study, the inflammatory status was determined by calculating the NLR, PLR, SII and SIRI of the patient. In the survival analysis of all patients, all inflammatory markers except PLR were significantly associated with OS. In addition, after excluding multicollinearity through Lasso regression analysis, SIRI was also found to be an independent prognostic factor. In addition, SIRI had the highest AUC, indicating its high prognostic value. In further analysis of SIRI, the SIRI after PSM still demonstrated a high AUC and was significantly correlated with OS. The risk prognosis model and nomogram established based on SIRI also revealed high accuracy. This further confirms the significant correlation between inflammatory status and the prognosis of patients with early pyloric stenosis.

The inflammatory status of the patients was reflected through various classic inflammatory indices, including NLR, PLR, SII and SIRI. In the preliminary analysis, it was found that NLR, SII and SIRI were all associated with patient prognosis. Moreover, it was also discovered that SIRI had the highest prognostic value among the inflammatory indices. Therefore, the predictive ability of SIRI for prognosis in detail through PSM was further analyzed and ultimately confirmed its strong predictive power. The specific mechanisms through which inflammatory status affects the clinical outcomes of patients with gastric cancer with early pyloric stenosis remain unclear. Systemic inflammatory status may lead to immune function suppression in patients with gastric cancer (32). This not only weakens the ability of the immune system to inhibit and destroy tumors but also renders patients more susceptible to complications such as infections, thereby accelerating disease progression and reducing treatment effectiveness (33-35). Additionally, some inflammatory mediators can stimulate tumor cell proliferation and promote new blood vessel formation, thus directly contributing to tumor progression (36,37). SIRI consists of NEU, MON and LYM, all of which have been found to be significantly associated with the prognosis of patients with gastric cancer in previous studies (38-41).

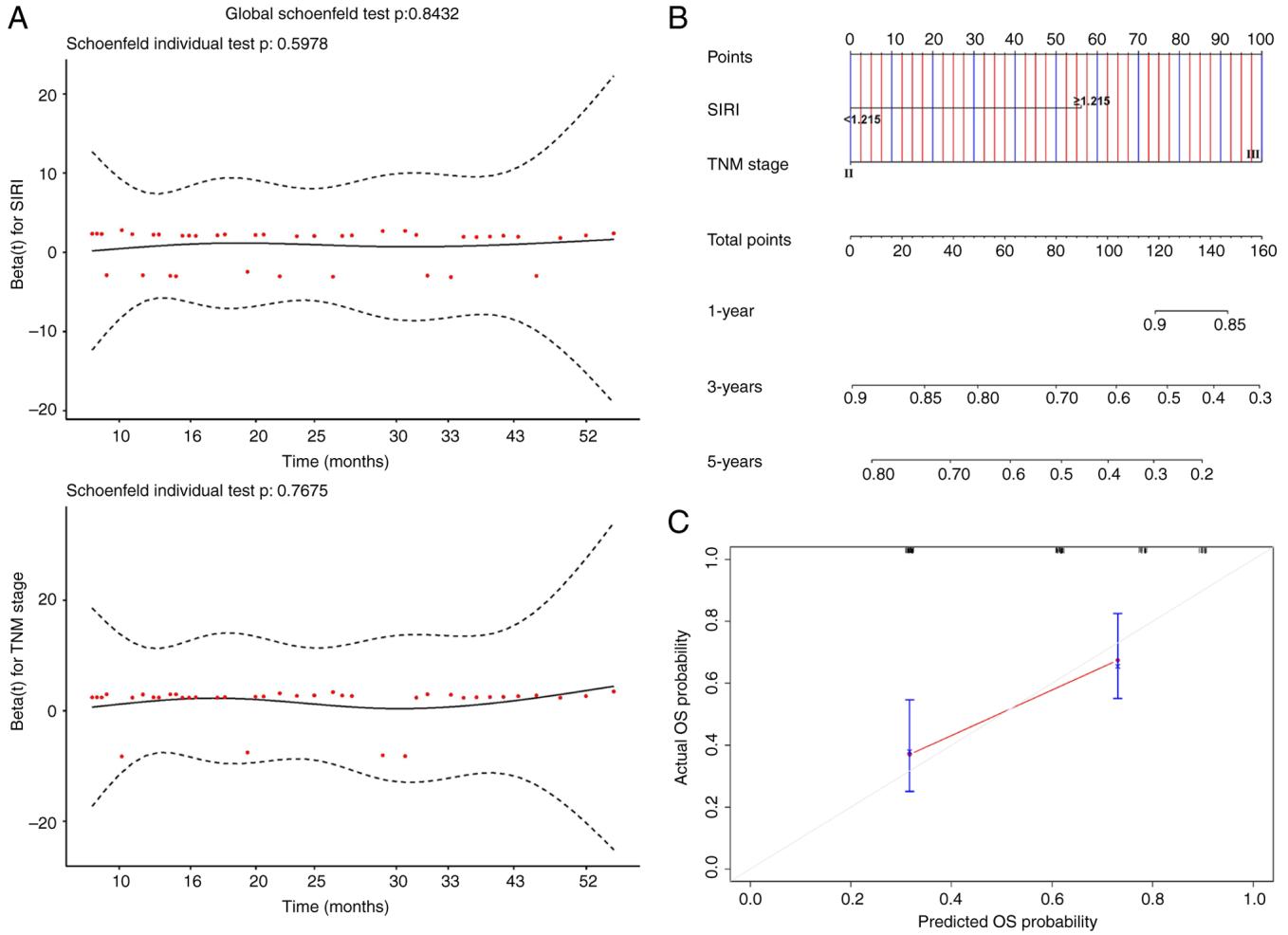

Figure 6. Nomogram after propensity score matching. (A) Schoenfeld residual plots for TNM stage and SIRI. (B) Nomogram of TNM stage and SIRI. (C) Calibration curve of the nomogram. SIRI, systemic inflammation response index; TNM, tumor-node-metastasis; OS, overall survival.

NEU and MON were demonstrated to play pivotal roles in immune-inflammatory responses, often correlating with the degree of inflammation (42). In certain situations, elevated counts of NEU and MON indicated an overactive immune system or an inflammatory state, which could signal a high tumor burden and potentially exacerbate tumor progression (43,44). Conversely, LYM was revealed as a major component of the antitumor immune response, playing a critical role in resistance against both tumors and infections (45,46). Low counts of LYM indicated immune suppression, which could have led to tumor evasion and dissemination (47). Inflammation status and pyloric stenosis exhibit a close interplay (48). On the one hand, pyloric stenosis directly reduces the energy intake of the patients, leading to malnutrition (49,50). On the other hand, certain inflammatory mediators not only affect the energy intake and absorption of the patients but also induce protein breakdown, decrease muscle mass, result in weight loss, thereby further exacerbating the malnutrition status of the patients (51,52). These factors could all potentially explain why the inflammatory status, particularly SIRI, was closely associated with the clinical outcomes of the patients.

However, the present study was a retrospective study, and despite efforts to minimize selection bias through PSM analysis, there may have been unaccounted-for confounding factors that could have impacted the research results. In addition, the data of this study was only retrieved from one hospital, which might have regional and population specificity, limiting the applicability of the research results. Finally, the optimal cut-off value for inflammatory indicators was calculated through the ROC curve, and there was still no recognized standard. The conclusions of this study require further validation in larger and broader studies. Additionally, while past research on inflammatory indices in other cancers has yielded numerous positive results, the pathogenesis of different cancers varies, as do the factors inducing malnutrition and their impact on tumors. Therefore, the applicability of the findings of the present study to other cancers still requires confirmation through further research involving larger sample sizes and multiple types of cancer.

In conclusion, inflammatory status was significantly associated with the prognosis of patients with gastric cancer with early pyloric stenosis who underwent radical resection. The NLR, SII and SIRI could all predict patient outcomes. Moreover, SIRI exhibited the highest prognostic value among the inflammatory indices and has been identified as an independent prognostic factor in the present study.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

The design and writing of the original manuscript draft was conducted by LH. Data acquisition was performed by JL. XL and XW conducted the analysis and interpretation of data. QY contributed to the allocation of resources, conception, design and project administration. All authors read and approved the final version of the manuscript. LH and QY confirm the authenticity of all the raw data.

Ethics approval and consent to participate

The present study was approved by the Ethics Committee of the Affiliated Hospital of Southwest Medical University (approval no. KY2023224; Luzhou, China). The Ethics Committee of the Affiliated Hospital of Southwest Medical University has waived the need for patient informed consent due to the retrospective nature of the study.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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