

Development and Validation of a Nomogram Based on Albumin-to-Neutrophil-to-Lymphocyte Ratio for Prognosis in Gastric Cancer

Nuo Xu

Guangxi Medical University

Hailun Xie

Guangxi Medical University

Shuyao Wang

Guangxi Medical University

Changhong Xu

Guangxi Medical University

Yibo Chen

Guangxi Medical University

Siyu Lin

Guangxi Medical University

Hanping Shi

shihp@ccmu.edu.cn

Guangxi Medical University

Article

Keywords: Gastric cancer, Albumin/Neutrophil-to-Lymphocyte Ratio, Prognosis, Overall survival, Progression-free survival, Nomogram

Posted Date: April 26th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8999159/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Background

The albumin-to-neutrophil-to-lymphocyte ratio (ANLR) is a novel inflammatory composite indicator with potential prognostic value in cancer. This study aimed to assess the association of ANLR with overall survival (OS) and progression-free survival (PFS) in patients with gastric cancer and evaluate its clinical relevance.

Methods

A retrospective analysis was performed on 2,051 patients undergoing radical gastrectomy for gastric cancer from 2012 to 2021 in the INSCOC database. The optimal ANLR cutoff was determined using receiver operating characteristic (ROC) analysis. Survival was estimated by Kaplan–Meier curves, and independent prognostic value was assessed with Cox proportional hazards models. A nomogram was constructed for OS and PFS prediction, with internal and external validations using ROC curves, calibration plots, and decision curve analysis (DCA) to evaluate model performance.

Results

A total of 1,766 patients were included (internal cohort, $n = 1,203$; external cohort, $n = 563$). The optimal ANLR cutoff was 20.39. Patients with high ANLR (≥ 20.39) had better OS and PFS than those with low ANLR (< 20.39). Multivariate Cox analysis confirmed ANLR as an independent prognostic factor for OS (HR = 0.623) and PFS (HR = 0.589, $P < 0.001$). The nomogram predicted OS and PFS with areas under the curve (AUCs) of 0.660 and 0.710. External validation demonstrated good calibration and discrimination (C-index: OS 0.664, PFS 0.883).

Conclusion

ANLR is an effective biomarker for prognostic assessment in gastric cancer. The nomogram provides individualized survival prediction and supports clinical decision-making.

Introduction

GC is a major global health challenge, ranking as the fourth most common cancer worldwide, following lung cancer, colorectal cancer and liver cancer[1]. According to the data from GLOBOCAN 2022, gastric cancer ranks fifth in terms of both mortality and incidence rates. Nearly 1 million new cases are diagnosed each year, resulting in over 650,000 deaths worldwide[2]. The systemic treatment for gastric cancer includes chemotherapy, immunotherapy and targeted therapy. The combination of immune checkpoint inhibitors and chemotherapy has become the standard treatment for patients with advanced gastric cancer[3]. The prognosis of gastric cancer depends on the stage of the cancer, the treatment, the biological characteristics, as well as patient-related factors such as nutrition and gender.

Systemic inflammation and nutritional status play a significant role in the occurrence, progression and prognosis of tumors[4–7].The NLR inflammatory state impairs the immune response, promotes tumor immune escape, and ultimately drives tumor progression and invasion[8, 9].The elevation of NLR and PLR is associated with poorer OS and DFS in GC patients, suggesting that they may have potential utility for risk stratification in clinical practice[10, 11].In the context of systemic inflammation, liver protein synthesis undergoes reprogramming, with the liver prioritizing the production of acute-phase proteins - thus, albumin has recently been proposed as a biomarker for systemic inflammation in cancer patients[12].It has been confirmed that peripheral blood inflammatory markers such as NLR, PLR and LMR have been shown to reflect the overall inflammatory status and are potential indicators that can assist in the clinical diagnosis and prognosis assessment of gastric cancer[13, 14].Shufa Tan et al. meta-analysis suggests that NLR, PLR, and LMR are significant independent risk predictors for GC patients receiving immune checkpoint inhibitors[15]. Ogata et al. [16] conducted a study which indicated that the high NLR before and after nab-paclitaxel treatment was significantly associated with a shortened OS for patients with unresectable or recurrent gastric cancer.

The ANLR, as a composite indicator that integrates nutritional status with inflammatory response, may provide a more comprehensive reflection of a patient's pathophysiological condition compared to single indicators. However, the prognostic value of ANLR in gastric cancer patients remains uncertain, and its associations with clinical pathological features and stability across different subgroups necessitate systematic verification. This study, based on a large retrospective cohort, aims to evaluate the association between ANLR and OS as well as PFS and to establish its value as an independent prognostic factor. Additionally, we intend to explore the prognostic stability of ANLR in various clinical pathological subgroups, construct and validate a nomogram prognostic model that includes ANLR, and provide a novel tool for the prognosis assessment of gastric cancer.

Materials and Methods

2.1. Research design and patients

This multicenter cohort study utilized data from the INSCOC database (registration number: ChiCTR1800020329). We employed the previously mentioned design and methods to prospectively collect cohort data from multiple medical centers across China. This investigation was a retrospective cohort study that included 1,766 patients with gastric cancer who underwent radical gastrectomy at various medical centers in China between January 2012 and December 2021. The patients were divided into an internal validation cohort (n = 1,203) and an external validation cohort (n = 563).Inclusion criteria: age ≥ 18 years; pathologically diagnosed with gastric cancer; underwent radical gastrectomy (R0 resection); complete clinical data. Exclusion criteria: received neoadjuvant radiotherapy and chemotherapy before surgery; had concurrent malignant tumors; had a history of autoimmune diseases; had possible acute or chronic inflammatory diseases that may affect neutrophil or albumin levels; had missing clinical or follow-up data. This study adhered to the principles outlined in the Helsinki Declaration and received approval from the ethics committees of each participating local center. All

participants provided written informed consent for the use of their clinical data, and their personal information was kept confidential.

2.2. Data collection

Clinical and pathological data were comprehensively collected from the hospital's electronic medical record system. This collection included baseline information of the patients, such as gender, age, height, weight, body mass index (BMI), history of hypertension, diabetes, heart disease, smoking, drinking, chronic hepatitis, tuberculosis, adjuvant therapy, and length of hospital stay. Tumor-related information encompassed the TNM stage (determined according to the 8th edition of the American Joint Committee on Cancer (AJCC) staging system), T stage, N stage, M stage, and differentiation grade.

Baseline fasting blood samples were obtained from all patients as recorded in the medical record system on the morning of the second day following admission. Laboratory parameters assessed included white blood cell count, neutrophil count, platelet count, lymphocyte count, hemoglobin, albumin, total bilirubin, direct bilirubin, total cholesterol, triglycerides, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine, urea nitrogen, C-reactive protein, ANLR, neutrophil/lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and prognostic nutritional index (PNI). The NLR was calculated as the neutrophil count ($\times 10^9/L$) divided by the lymphocyte count ($\times 10^9/L$), while the PLR was defined as the platelet count ($\times 10^9/L$) divided by the lymphocyte count ($\times 10^9/L$). The PNI was defined as albumin (g/L) + 5 $\times$ lymphocyte ($\times 10^9/L$). The ANLR was calculated as albumin (g/L) divided by NLR, or as albumin (g/dL) divided by (neutrophil count ($\times 10^9/L$) divided by lymphocyte count ($\times 10^9/L$)).

2.3. Follow-up

Postoperative follow-up for the patients was conducted regularly within 5 years. In the first 2 years, it was done every 3 months, then every 6 months for the following 3 years, and annually thereafter. Each follow-up included a detailed inquiry about symptoms and signs to detect potential recurrence or metastasis, supplemented by basic examinations: routine blood tests, biochemical analysis, measurement of tumor markers, gastroscopy, and imaging studies (CT or MRI) for a comprehensive health assessment. All 1766 eligible patients (treated from 2012 to 2021) from the INSCOC database underwent long-term follow-up through telephone interviews and outpatient visits. The follow-up period was 65 (interquartile range: 40–84) months, and no deaths occurred. OS was measured as the time from surgery to any cause of death or the last follow-up date; PFS was measured as the time from surgery to tumor progression or any cause of death (whichever occurred first) or the last follow-up date.

2.4 Outcomes

The primary endpoint of this study was to evaluate the prognostic value of ANLR in predicting OS and PFS in gastric cancer, to differentiate the impact of high and low ANLR groups on survival prognosis, and to facilitate the early screening of patients. Secondary endpoints included the analysis of independent prognostic risk factors influencing OS and PFS in gastric cancer patients, as well as their correlation with ANLR. These factors were determined to be unaffected by gender, age, or BMI.

2.5 Model validation

We developed a risk prediction model and performed internal validation using data from 36 hospitals collected between December 2012 and December 2021 ($n = 1,203$). External validation was conducted using data from one independent hospital ($n = 553$). The internal validation assessed the stability of the predictive model against random variations in sample composition by performing 1,000 bootstrap resampling iterations. ROC curves were generated, followed by calibration curves, DCA, and clinical impact curves for the nomogram. External validation was conducted in a similar manner, generating the nomogram, ROC curve, and calibration curve, with predictive variables transformed consistently with those in the model derivation cohort. The results of both internal and external validations were statistically analyzed, and model performance was evaluated using the area under the receiver operating characteristic curve (AUROC), overall R^2 goodness-of-fit, D statistic, Harrell's C-index, and Brier score.

2.6 Statistical analysis

Statistical analysis was conducted using R version 4.0.2. Measurement data were presented as mean $\pm$ standard deviation (SD) or median (interquartile range, IQR), with comparisons between groups performed using t-tests or Kruskal-Wallis tests. Count data were expressed as frequencies (percentages), and group comparisons were conducted using χ^2 tests. Survival curves were generated using the Kaplan-Meier method, and differences between groups were assessed using the log-rank test. The Cox proportional hazards regression model was used to evaluate the association between ANLR and both OS and PFS, and to calculate HR and 95% CI. Three models were employed to adjust for confounding factors. Independent prognostic factors were included in the construction of nomogram models for OS and PFS. Model efficacy was evaluated using receiver ROC curves, calibration curves, and DCA, and was subsequently validated in an external cohort. A two-sided p-value of < 0.05 was considered statistically significant.

Results

3.1. Patient characteristics

This study included a total of 1,766 patients who underwent radical gastrectomy for gastric cancer between December 2012 and December 2021. Of these, 1,203 patients were included in the initial research cohort and subsequently entered the model development cohort, while 563 patients were allocated to the external validation cohort (Fig. 1). The baseline characteristics of patients in the main cohort, internal cohort, and external validation cohort. The median age was 65.72 years, with 67.6% of the patients being male ($p < 0.05$) (Table 1).

3.2 Comparison of ANLR cutoff values and grouping characteristics

The AUC was 0.594, with a 95% confidence interval of 0.564 to 0.624. The optimal cut-off value was established at 20.39, which yielded a sensitivity of 43.1% and a specificity of 72.8% (**Figure S1** and Fig. 2). We divided the cohort of 1,766 patients into two groups: low ANLR (< 20.39, n = 716) and high ANLR (≥ 20.39 , n = 482) (Table 2).

3.3 Kaplan-Meier and Survival Prognosis Analysis

Based on the ANLR cutoff, Kaplan–Meier analysis demonstrated that patients with low ANLR had significantly poorer survival than those with high ANLR, with lower OS (55.82% vs. 44.18%) and PFS (53.27% vs. 46.73%) (both Log-rank $p < 0.001$), as well as reduced 5-year survival (Fig. 3). Subgroup analysis by tumor differentiation showed consistently worse outcomes in the low ANLR group, including OS and PFS differences across high/moderate and low/undifferentiated grades (all $p < 0.001$; Fig. 4, **Figure S2**). Similarly, TNM stage stratification revealed inferior OS and PFS in the low ANLR group across all stages, particularly in stage III–IV disease ($p < 0.0001$; Fig. 5, **Figure S3**). These findings confirm the stable prognostic value of ANLR across differentiation grades and TNM stages.

3.4 The non-linear relationship between ANLR and the survival outcomes of GC patients

Multivariate restricted cubic spline (RCS) analyses were conducted using three progressively adjusted models to evaluate the association between ANLR and OS and PFS in GC patients. All models demonstrated a significant non-linear, L-shaped relationship ($p < 0.001$). A turning point was identified at an ANLR value of 20.39. When ANLR was below 20.39, $HR > 1$ indicated increased risk and poorer prognosis. Higher ANLR levels were associated with improved survival outcomes (Fig. 6).

3.5 Correlation Analysis of ANLR and GC Patients' Survival Outcomes

After full adjustment (Model c), the high ANLR group had significantly lower risks of mortality ($HR = 0.623$, 95% CI: 0.490–0.792, $p < 0.001$) and progression ($HR = 0.589$, 95% CI: 0.439–0.791, $p < 0.001$) compared with the low ANLR group. Consistent results were observed in cut-off and quartile analyses, showing a significant decreasing trend in OS and PFS risk with increasing ANLR ($p < 0.001$). Overall, higher ANLR remained a robust protective factor for OS and PFS after multivariable adjustment (**Table S8-S9**).

3.6 Subgroup analysis of survival outcomes in ANLR and GC patients

In the subgroup analysis of progression-free survival (PFS)-related factors, ANLR remained an independent risk factor for most subgroups ($P < 0.05$), except in the following cases: BMI (Normal), length of hospital stay (> 24 days), smoking, alcohol consumption, diabetes, hypertension, chronic hepatitis, tumor differentiation (Medium and Undifferentiated), TNM stage (III-IV), T stages (T1 and T4), N stages (N0, N2, N3), and M1 stage (**Figure S4**).

3.7 The prognostic performance of ANLR in comparison with established inflammatory nutrition indicators

In terms of OS prediction, ANLR demonstrated higher predictive efficacy, with AUC values exceeding those of the control indices (ANLR: 0.592 vs. NLR: 0.567 vs. PLR: 0.572 vs. PNI: 0.549)(**Figure S5**);In the 1-year, 3-year, and 5-year predictions, OS (1-year: 0.543 vs. 3-year: 0.531 vs. 5-year: 0.518) and PFS (1-year: 0.541 vs. 3-year: 0.533 vs. 5-year: 0.528) all demonstrated good predictive effects (**Figure S6**);During the 1-year, 3-year, and 5-year survival periods, for predicting the OS of patients, the area under the ROC curve of ANLR was the largest (ANLR: 0.519 vs. NLR: 0.471 vs. PLR: 0.517 vs. PNI: 0.498) (**Figure S7**).

3.8 The establishment of the nomogram

Multivariate Cox proportional hazards regression analysis demonstrated that age, BMI, diabetes, TNM stage, N stage, and ANLR were independent risk factors for OS in patients with GC ($P < 0.05$). For PFS, age, adjuvant chemotherapy, TNM stage, N stage, and ANLR were identified as independent risk factors ($P < 0.05$) (**Table S6-S7**). Based on these key variables, a nomogram was constructed to predict 1-, 3-, and 5-year OS and PFS in GC patients (**Figure S8**). The predicted probabilities of OS and PFS at these time points were calculated by summing the scores assigned to each variable.

3.9 Internal validation of the nomogram

The predictive performance of the nomogram was assessed using ROC analysis with bootstrap internal validation. The AUCs for predicting OS and PFS were 0.660 and 0.710, respectively (**Figure S9**). Calibration curves for 1-, 3-, and 5-year survival showed good agreement between predicted and observed outcomes, particularly in the high-probability range, with slight deviation in the mid-low range (**Figure S10**). Decision curve analysis demonstrated that the nomogram provided greater net clinical benefit within the key risk threshold range of 1.5%–4% and reduced unnecessary interventions for patients with a risk below 1.5% (**Figure S11**).

3.10 Verification of the external cohort

External validation using an independent hospital cohort confirmed the internal findings, with Cox regression identifying the same independent risk factors and a nomogram constructed (**Figure S12**). Bootstrap internal validation yielded AUCs of 0.690 for OS and 0.920 for PFS (**Figure S13**). Calibration curves for 1-, 3-, and 5-year survival demonstrated high accuracy, with predicted 5-year OS and PFS closely matching observed outcomes (**Figure S14**). Decision curve analysis showed that in the external cohort, the nomogram substantially improved net clinical benefit within the key risk threshold of 0.05–0.15, outperforming standard thresholds across different risk levels (**Figure S15**).

3.11 Comparison of verification efficiency between internal queue and external queue

We further validated the models of the internal and external queues. In the OS model, we compared the performance of each algorithm for the internal queue and the external queue. The Brier score was (0.189 vs. 0.218), the overall R^2 fitting effect was (0.087 vs. 0.167), Harrell's C index was (0.655 vs. 0.664), and the calibration slope was all 1.000 (0.920–1.080), indicating that the model has good discrimination and calibration. Similarly, in the model PFS, we compared the performance of each algorithm for the two queues. The Brier score was (0.150 vs. 0.099), the overall R^2 fitting effect was (0.133 vs. 0.578), Harrell's C index was (0.667 vs. 0.510), and the calibration slope was all 1.000 (0.920–1.080), all indicating that the model has good discrimination and calibration (**Table S10-S12**).

Discussion

GC remains a significant global health issue, characterized by high incidence and mortality rates, especially in certain parts of the world. Although the incidence of gastric cancer has generally decreased in many countries, it remains the leading cause of cancer-related deaths, with over 1 million new cases diagnosed each year[17]. In terms of treatment, surgery remains the cornerstone for achieving a cure, but the role of systemic treatments, including neoadjuvant chemotherapy (NAC), chemotherapy, targeted therapy and immunotherapy, is becoming increasingly important[18, 19].

Inflammation plays a crucial role in the development and progression of cancer[20]. Inflammatory markers, such as the PLR, the monocyte-to-lymphocyte ratio (MLR), the systemic inflammatory response index (SIRI), and the Glasgow Prognostic Score (GPS), have demonstrated the potential to provide valuable prognostic information in GC[21–25]. In patients with gastric cancer, higher levels of NLR and PLR are associated with poorer OS and PFS, while a higher lymphocyte-to-monocyte ratio (LMR) is associated with a better prognosis [26]. Studies have shown that a high NLR is associated with a poorer clinical outcome and can serve as a prognostic biomarker for patients with colorectal cancer[27]. Furthermore, the level of serum albumin reflects the inflammation and malnutrition of the cancer host[28]. A retrospective study involving 1023 GC patients showed that the pre-treatment serum albumin level was an important prognostic factor[29]. A prospective study involving 500 GC patients showed that preoperative NLR/Alb was a prognostic factor for survival after radical surgery [30]. The ratio of neutrophils to lymphocytes / serum albumin. Multiple studies have reported that preoperative NLR and PNI are prognostic factors for patients after GC surgery[31–35]. Furthermore, a retrospective study demonstrated that the OS of ESCC patients with high NLR/pre-Alb was worse than that of patients with low NLR/pre-Alb ($p = 0.043$) [36]. Additionally, a retrospective study indicated that in advanced RCC cases, patients with high NLR/Alb and CRP/Alb ratios had significantly poorer PFS and OS compared to those with low NLR/Alb and CRP/Alb ratios[37].

The results of this study suggest that ANLR is an effective biomarker for prognosis assessment in patients with gastric cancer. Patients with $ANLR \geq 20.39$ had better 5-year OS and PFS compared to those with $ANLR < 20.39$ ($P < 0.001$). The multivariate Cox regression analysis showed that a high ANLR was an independent protective factor for OS and PFS. Subgroup analysis indicated that ANLR had stable prognostic value in different TNM stages, differentiation degrees, and clinical characteristic subgroups.

The Nomogram model constructed based on ANLR showed good calibration and discrimination efficacy (C-index: OS 0.664, PFS 0.883). This result has been previously validated in studies regarding the prognostic ability of ANLR under different conditions: an elevated peripheral ANLR can effectively predict adverse outcomes of coronary artery disease and diabetic foot ulcers[38–40]. This predictive ability extends to gastrointestinal cancers, as demonstrated by Onuma et al. (in a small sample from a single center), where preoperative ANLR was identified as an important prognostic indicator for gastric cancer patients after radical gastrectomy[41].

Compared to existing inflammation-nutrition indicators (NLR, PLR, PNI), ANLR demonstrates superior performance in prognosis assessment. For OS prediction, the AUC for ANLR (0.592) is higher than that for NLR (0.567), PLR (0.572), and PNI (0.549). In PFS prediction, the AUC for ANLR (0.616) is also significantly superior to that of the other indicators. Subgroup analysis shows that ANLR can effectively differentiate prognosis risk in patients with various clinical characteristics. Notably, for patients with advanced and poorly differentiated tumors, the risk stratification value is particularly significant.

The nomogram constructed in this study incorporated key factors, including ANLR, age, BMI, and TNM stage. It was validated through both internal (C-index OS = 0.727, PFS = 0.719) and external validation (AUC OS = 0.690, PFS = 0.920), demonstrating good discrimination and calibration. DCA indicated that within the risk threshold range of 1.5% to 4% for OS and 0.05 to 0.15 for PFS, the net benefit of the nomogram was significantly higher than that of traditional staging tools, effectively reducing excessive interventions for low-risk patients. For high-risk patients (e.g., ANLR $\geq$ 20.39 and stage III), a more intensive postoperative follow-up (e.g., imaging examinations every 3 months) should be emphasized, and intensified adjuvant therapy may be considered. Conversely, for low-risk patients, interventions can be appropriately reduced to prevent unnecessary treatment.

The limitations of this study include its retrospective design, which may introduce selection bias; the absence of data on postoperative dynamic changes in ANLR; the lack of exploration into the association between ANLR and the efficacy of immunotherapy; and the failure to fully address potential confounding factors (such as *Helicobacter pylori* infection and dietary structure). Future prospective cohort studies, combined with multi-omics data, are needed to further validate the prognostic value and underlying mechanisms of ANLR.

Conclusion

ANLR serves as an independent prognostic factor for OS and PFS in patients with gastric cancer. A high ANLR score indicates a poor prognosis. The nomogram model constructed based on ANLR demonstrates strong prognostic prediction efficacy and can serve as a straightforward and reliable tool in clinical practice

Declarations

Ethical approval and consent to participate

This study adhered to the Helsinki Declaration. All participants signed the informed consent form, and the study was approved by the hospital's institutional review board (registration number: ChiCTR1800020329).

Consent to publish

All authors have agreed to publish.

Availability of data and materials

The datasets used and/or analyzed during the study can be obtained from the corresponding authors upon reasonable request.

Declaration of competing interests

There are no competing interests.

Funding

This study was supported by the Youth Science Foundation of Guangxi Medical University (GXMUYSF 202548), the 18th batch of Special Funding from the China Postdoctoral Science Foundation (2025T180639), the National Key Research and Development Program (2022YFC2009600, 2022YFC2009601), Laboratory for Clinical Medicine, Capital Medical University (2023-SYJCLC01).

Author contributions

XN: Draft writing, data collection, data analysis. HL: Review and editing, visualization, supervision, methodology, conceptualization. SW: Data investigation, supervision, methodology. CX: Software, methodology, supervision. YC: Data organization. SL: Data collection. HS: Review and editing, supervision, conceptualization.

Acknowledgments

The authors would like to thank the INSCOC project members for their substantial work on data collection and patient follow-up.

References

1. Siegel, R. L., Giaquinto, A. N., Jemal, A. & Cancer statistics Ca Cancer J Clin. 2024 2024 Jan-Feb;74(1):12–49. (2024). <https://doi.org/10.3322/caac.21820>
2. Siegel, R. L., Miller, K. D., Wagle, N. S., Jemal, A. & Cancer statistics Ca Cancer J Clin. 2023 2023;73(1):17–48. (2023). <https://doi.org/10.3322/caac.21763>
3. Olson, D. J. et al. Pembrolizumab plus ipilimumab following anti-pd-1/l1 failure in melanoma. *J. Clin. Oncol.* 2021. **39** (24), 2647–2655. <https://doi.org/10.1200/JCO.21.00079> (2021).

4. Zhang, H. Y. et al. Lymphocyte to c-reactive protein ratio could better predict the prognosis of patients with stage iv cancer. *Bmc Cancer* 2022. **22** (1), 1080. <https://doi.org/10.1186/s12885-022-10145-x> (2022).
5. Xie, H. et al. Inflammatory burden as a prognostic biomarker for cancer. *Clin Nutr.* (2022). 2022;41(6):1236-43 <https://doi.org/10.1016/j.clnu.2022.04.019>
6. Liu, C. A. et al. Nutrition impact symptoms: noteworthy prognostic indicators for lung cancer. *Clin Nutr.* (2023). 2023;42(4):550 – 58 <https://doi.org/10.1016/j.clnu.2023.02.021>
7. Liu, T. et al. C-reactive protein trajectories and the risk of all cancer types: a prospective cohort study. *Int J Cancer.* (2022). 2022;151(2):297–307 <https://doi.org/10.1002/ijc.34012>
8. Lv, B. et al. Immunotherapy: reshape the tumor immune microenvironment. *Front Immunol.* (2022). 2022;13:844142 <https://doi.org/10.3389/fimmu.2022.844142>
9. Sharma, B. R. & Kanneganti, T. D. Nlrp3 inflammasome in cancer and metabolic diseases. *Nat Immunol.* (2021). 2021;22(5):550 – 59 <https://doi.org/10.1038/s41590-021-00886-5>
10. Zhang, L. X., Wei, Z. J., Xu, A. M. & Zang, J. H. Can the neutrophil-lymphocyte ratio and platelet-lymphocyte ratio be beneficial in predicting lymph node metastasis and promising prognostic markers of gastric cancer patients? Tumor marker retrospective study. *Int J Surg.* (2018). 2018;56:320 – 27 <https://doi.org/10.1016/j.ijsu.2018.06.037>
11. Tan, S. et al. Prognostic value of inflammatory markers nlr, plr, and lmr in gastric cancer patients treated with immune checkpoint inhibitors: a meta-analysis and systematic review. *Front. Immunol.* 2024. **15**, 1408700. <https://doi.org/10.3389/fimmu.2024.1408700> (2024).
12. Evans, D. C. et al. The use of visceral proteins as nutrition markers: an aspen position paper. *Nutr. Clin. Pract.* 2021. **36** (1), 22–28. <https://doi.org/10.1002/ncp.10588> (2021).
13. Hirahara, T. et al. Combined neutrophil-lymphocyte ratio and platelet-lymphocyte ratio predicts chemotherapy response and prognosis in patients with advanced gastric cancer. *Bmc Cancer* 2019. **19** (1), 672. <https://doi.org/10.1186/s12885-019-5903-y> (2019).
14. Ou, W., Zhou, C., Zhu, X., Lin, L. & Xu, Q. Prognostic significance of preoperative lymphocyte-to-c-reactive protein ratio in patients with non-metastatic colorectal cancer. *Onco Targets Ther.* 2021. **14**, 337–346. <https://doi.org/10.2147/OTT.S290234> (2021).
15. Tan, S. et al. Prognostic value of inflammatory markers nlr, plr, and lmr in gastric cancer patients treated with immune checkpoint inhibitors: a meta-analysis and systematic review. *Front. Immunol.* 2024. **15**, 1408700. <https://doi.org/10.3389/fimmu.2024.1408700> (2024).
16. Ogata, T. et al. Neutrophil-to-lymphocyte ratio as a predictive or prognostic factor for gastric cancer treated with nivolumab: a multicenter retrospective study. *Oncotarget.* (2018). 2018;9(77):34520-27 <https://doi.org/10.18632/oncotarget.26145>
17. Thrift, A. P. & El-Serag, H. B. Burden of gastric cancer. *Clin Gastroenterol Hepatol.* (2020). 2020;18(3):534 – 42 <https://doi.org/10.1016/j.cgh.2019.07.045>
18. Chen, J., Bu, Z. & Ji, J. Surgical treatment of gastric cancer: current status and future directions. *Chin. J. Cancer Res.* 2021. **33** (2), 159–167. <https://doi.org/10.21147/j.issn.1000-9604.2021.02.04>

(2021).

19. De Vita, F. et al. Current status of targeted therapies in advanced gastric cancer. *Expert Opin. Ther. Targets* 2012. **16** (Suppl 2), S29–34. <https://doi.org/10.1517/14728222.2011.652616> (2012).
20. Yang, S. et al. Correlation between neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio with prognosis in gastric cancer patients undergoing neoadjuvant chemotherapy: a meta-analysis. *Bmc Gastroenterol.* (2025). 2025;25(1):445 <https://doi.org/10.1186/s12876-025-04056-x>
21. Zhang, X. et al. Clinicopathological and prognostic significance of platelet-lymphocyte ratio (plr) in gastric cancer: an updated meta-analysis. *World J. Surg. Oncol.* 2020. **18** (1), 191. <https://doi.org/10.1186/s12957-020-01952-2> (2020).
22. Zhou, D. et al. The prognostic value of neutrophil-to-lymphocyte ratio and monocyte-to-lymphocyte ratio in metastatic gastric cancer treated with systemic chemotherapy. *J. Cancer* 2020. **11** (14), 4205–4212. <https://doi.org/10.7150/jca.39575> (2020).
23. Zhang, C. X. et al. Association between pretreatment glasgow prognostic score and gastric cancer survival and clinicopathological features: a meta-analysis. *Onco Targets Ther.* 2016. **9**, 3883–3891. <https://doi.org/10.2147/OTT.S103996> (2016).
24. Chen, L. et al. In gastric cancer patients receiving neoadjuvant chemotherapy systemic inflammation response index is a useful prognostic indicator. *Pathol. Oncol. Res.* 2021. **27**, 1609811. <https://doi.org/10.3389/pore.2021.1609811> (2021).
25. Sundararaju, U. & Rajakumar, H. K. Prognostic value of neutrophil-to-lymphocyte ratio in gastric cancer: enhancing clinical relevance. *World J. Gastrointest. Oncol.* 2025. **17** (4), 103128. <https://doi.org/10.4251/wjgo.v17.i4.103128> (2025).
26. Tan, S. et al. Prognostic value of inflammatory markers nlr, plr, and lmr in gastric cancer patients treated with immune checkpoint inhibitors: a meta-analysis and systematic review. *Front. Immunol.* 2024. **15**, 1408700. <https://doi.org/10.3389/fimmu.2024.1408700> (2024).
27. Naszai, M., Kurjan, A. & Maughan, T. S. The prognostic utility of pre-treatment neutrophil-to-lymphocyte-ratio (nlr) in colorectal cancer: a systematic review and meta-analysis. *Cancer Med.* (2021). 2021;10(17):5983-97 <https://doi.org/10.1002/cam4.4143>
28. Yeun, J. Y. & Kaysen, G. A. Factors influencing serum albumin in dialysis patients. *Am J Kidney Dis.* 1998;32(6 Suppl 4):S118-25. (1998). [https://doi.org/10.1016/s0272-6386\(98\)70174-x](https://doi.org/10.1016/s0272-6386(98)70174-x)
29. Onate-Ocana, L. F. et al. Serum albumin as a significant prognostic factor for patients with gastric carcinoma. *Ann Surg Oncol.* (2007). 2007;14(2):381 – 89 <https://doi.org/10.1245/s10434-006-9093-x>
30. Onuma, S. et al. Clinical effects of the neutrophil-to-lymphocyte ratio/serum albumin ratio in patients with gastric cancer after gastrectomy. *J Pers Med.* (2023). 2023;13(3) <https://doi.org/10.3390/jpm13030432>
31. Zhang, L. X., Wei, Z. J., Xu, A. M. & Zang, J. H. Can the neutrophil-lymphocyte ratio and platelet-lymphocyte ratio be beneficial in predicting lymph node metastasis and promising prognostic

- markers of gastric cancer patients? Tumor marker retrospective study. *Int J Surg.* (2018). 2018;56:320 – 27 <https://doi.org/10.1016/j.ijsu.2018.06.037>
32. Li, Z. et al. The clinical value and usage of inflammatory and nutritional markers in survival prediction for gastric cancer patients with neoadjuvant chemotherapy and d2 lymphadenectomy. *Gastric Cancer* 2020. **23** (3), 540–549. <https://doi.org/10.1007/s10120-019-01027-6> (2020).
 33. Hirahara, N. et al. Comparison of the prognostic value of immunoinflammation-based biomarkers in patients with gastric cancer. *Oncotarget* 2020. **11** (27), 2625–2635. <https://doi.org/10.18632/oncotarget.27653> (2020).
 34. Takechi, H. et al. Using the preoperative prognostic nutritional index as a predictive factor for non-cancer-related death in post-curative resection gastric cancer patients: a retrospective cohort study. *Bmc Gastroenterol.* (2020). 2020;20(1):256 <https://doi.org/10.1186/s12876-020-01402-z>
 35. Xishan, Z., Ye, Z., Feiyan, M., Liang, X. & Shikai, W. The role of prognostic nutritional index for clinical outcomes of gastric cancer after total gastrectomy. *Sci. Rep.* 2020. **10** (1), 17373. <https://doi.org/10.1038/s41598-020-74525-8> (2020).
 36. Lv, Y., Zhang, J., Liu, Z., Tian, Y. & Liu, F. A novel inflammation-based prognostic index for patients with esophageal squamous cell carcinoma: neutrophil lymphocyte ratio/prealbumin ratio. *Med. (Baltimore)* 2019. **98** (7), e14562. <https://doi.org/10.1097/MD.00000000000014562> (2019).
 37. Ueda, K. et al. The prognostic value of systemic inflammatory markers in advanced renal cell carcinoma patients treated with molecular targeted therapies. *Anticancer Res.* 2020. **40** (3), 1739–1745. <https://doi.org/10.21873/anticancer.14127> (2020).
 38. Lin, Z., Zhuang, W., Wang, L. & Lan, W. Association between nutritional inflammation index and diabetic foot ulcers: a population-based study. *Front Nutr.* (2025). 2025;12:1532131 <https://doi.org/10.3389/fnut.2025.1532131>
 39. Yang, S. B. & Zhao, H. W. Associations between albumin/neutrophil-to-lymphocyte ratio score and new-onset atrial fibrillation in patients with acute myocardial infarction undergoing pci. *J. Inflamm. Res.* 2025. **18**, 61–71. <https://doi.org/10.2147/JIR.S500743> (2025).
 40. Wei, C. et al. Nomograms based on the albumin/neutrophil-to-lymphocyte ratio score for predicting coronary artery disease or subclinical coronary artery disease. *J. Inflamm. Res.* 2023. **16**, 169–182. <https://doi.org/doi:10.2147/JIR.S392482> (2023).
 41. Onuma, S. et al. Clinical effects of the neutrophil-to-lymphocyte ratio/serum albumin ratio in patients with gastric cancer after gastrectomy. *J Pers Med.* (2023). 2023;13(3) <https://doi.org/10.3390/jpm13030432>

Tables

Tables are available in the Supplementary Files section.

Figures

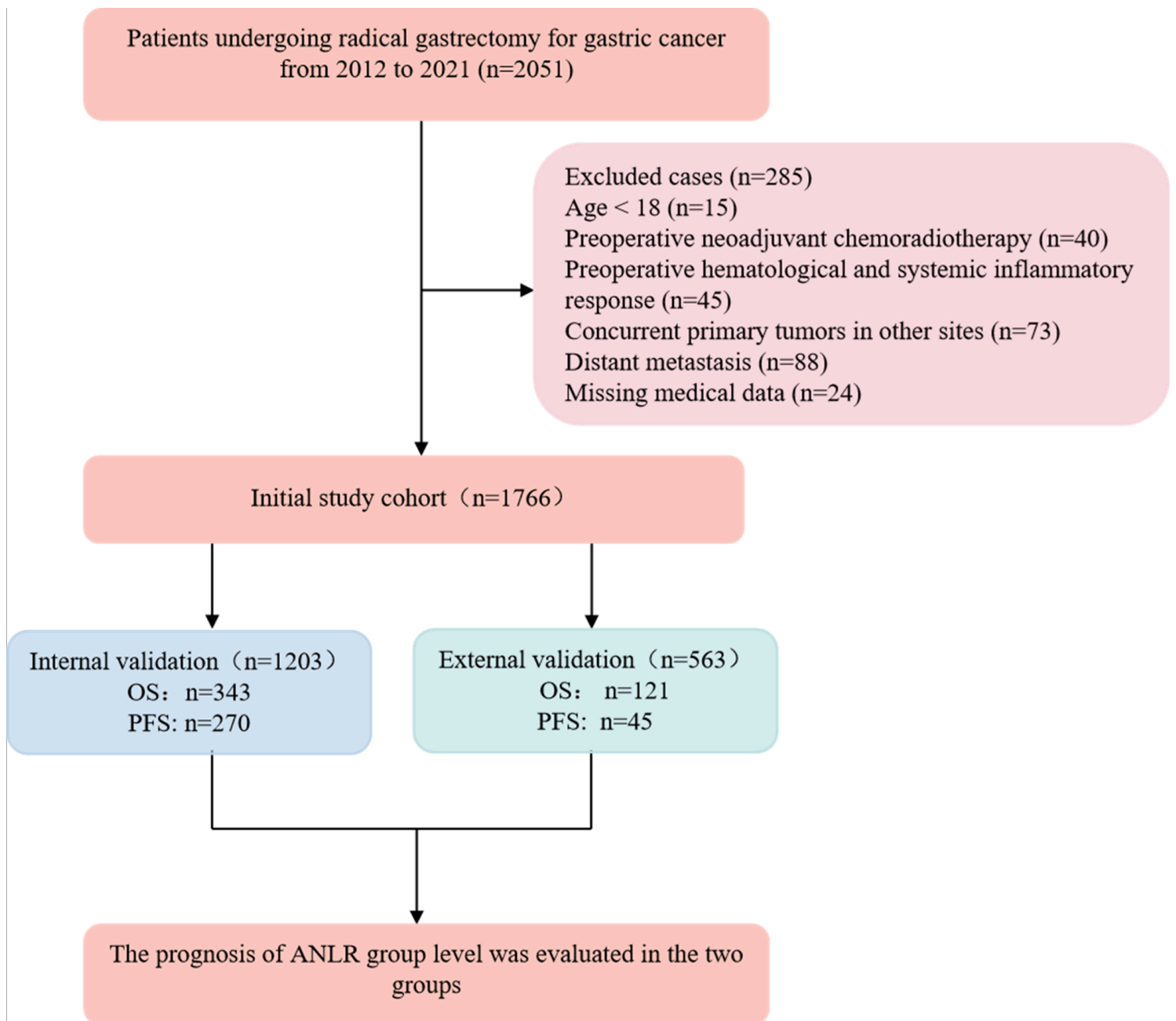


Figure 1

Study design and flow chart.

B

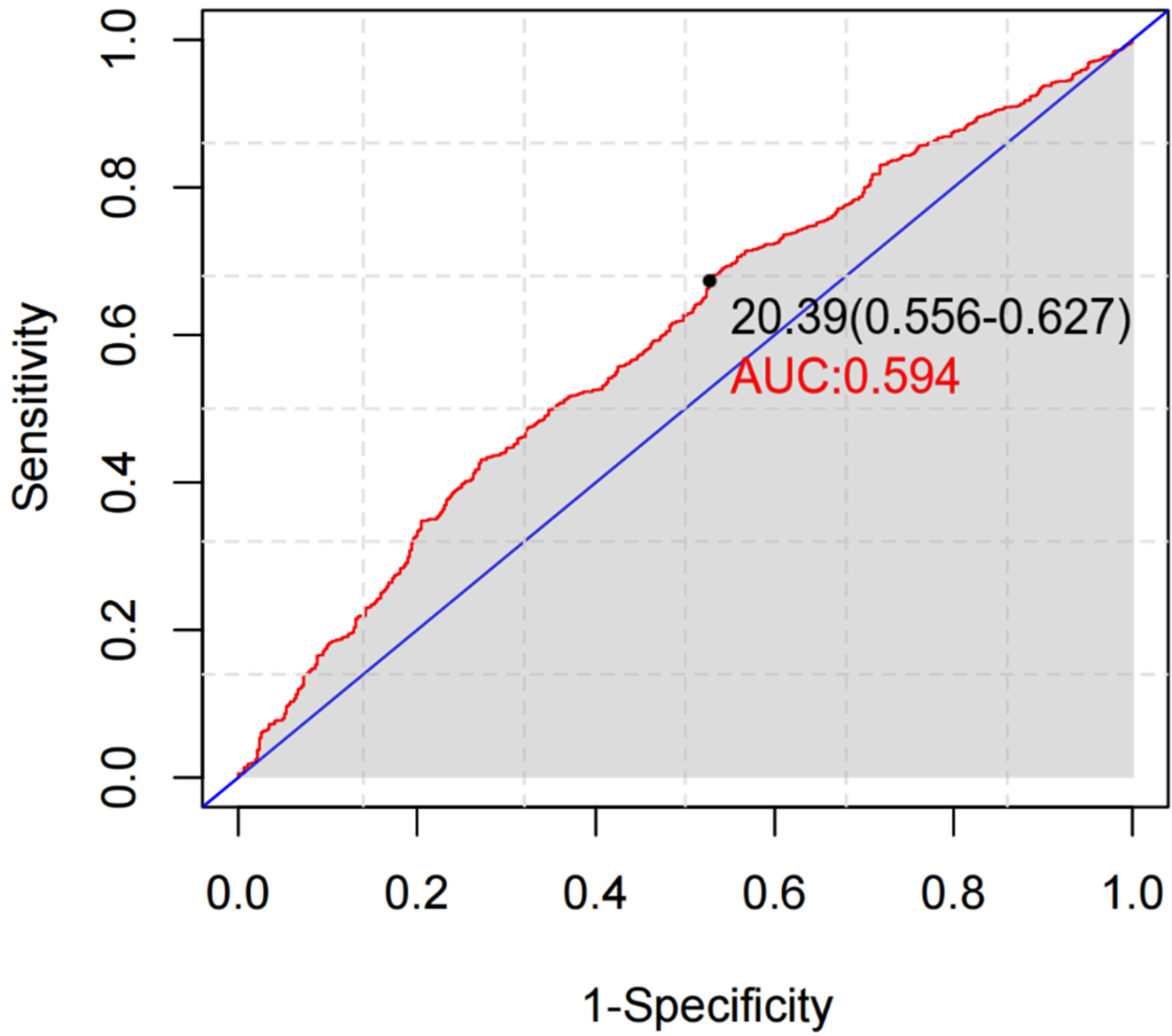


Figure 2

The optimal threshold cutoff of ANLR by ROC curve.

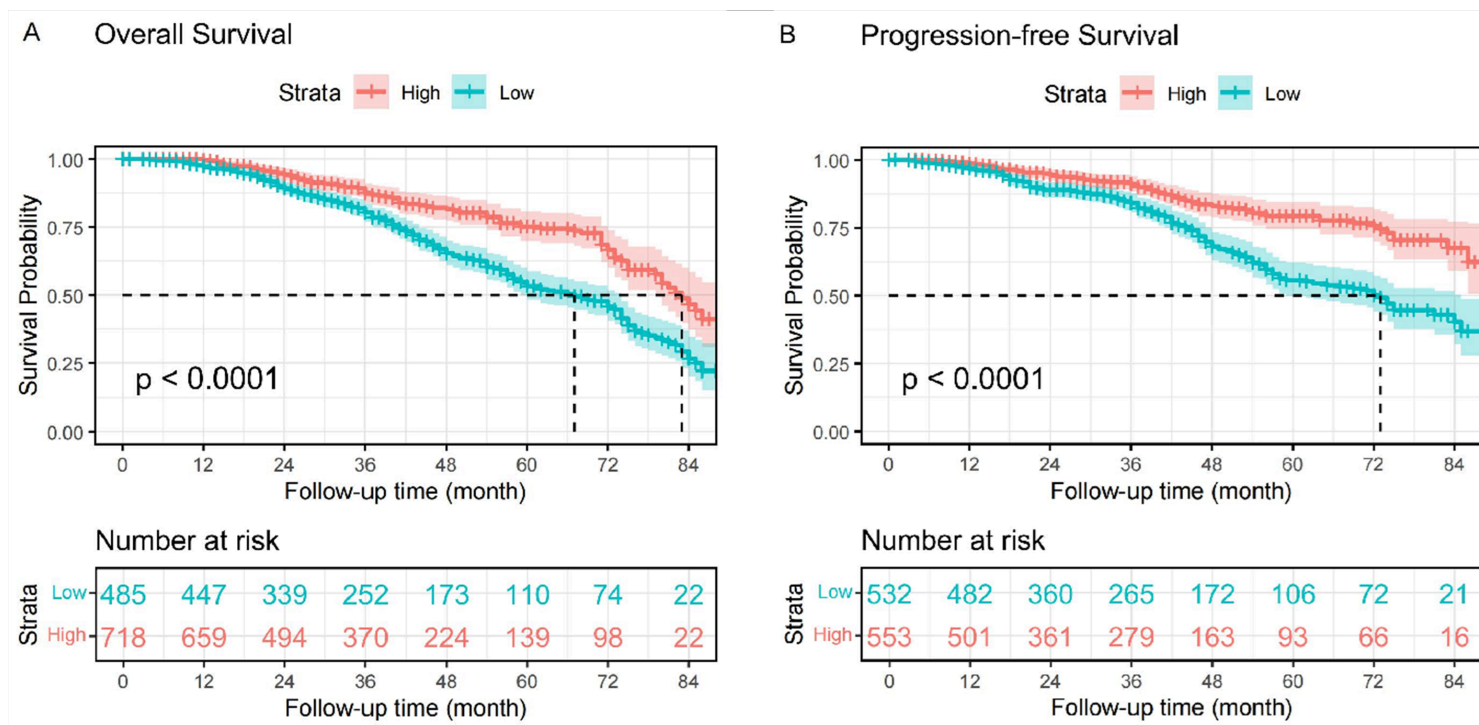


Figure 3

Kaplan-Meier curve of ANLR in GC patients.

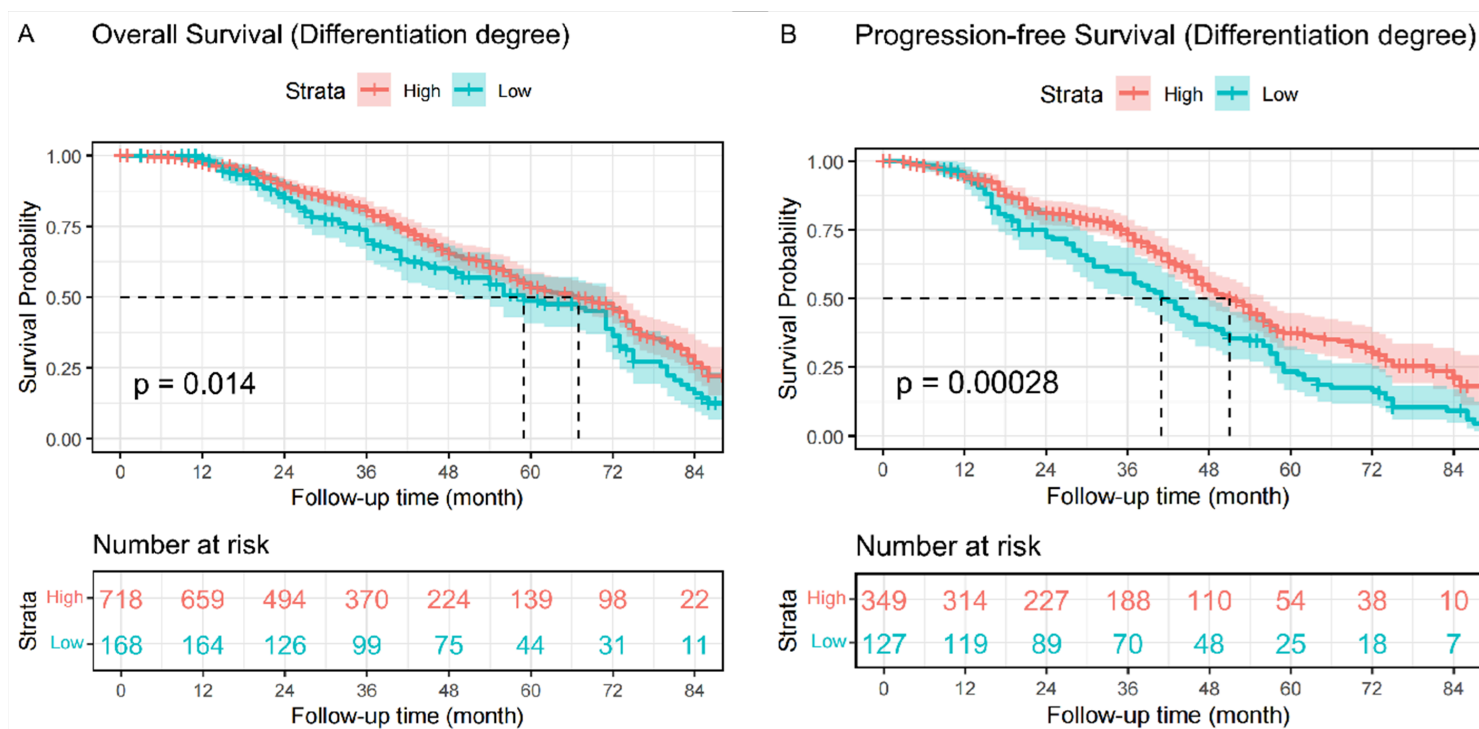


Figure 4

Kaplan-Meier curve of ANLR based on differentiation degree subgroup in GC patients.

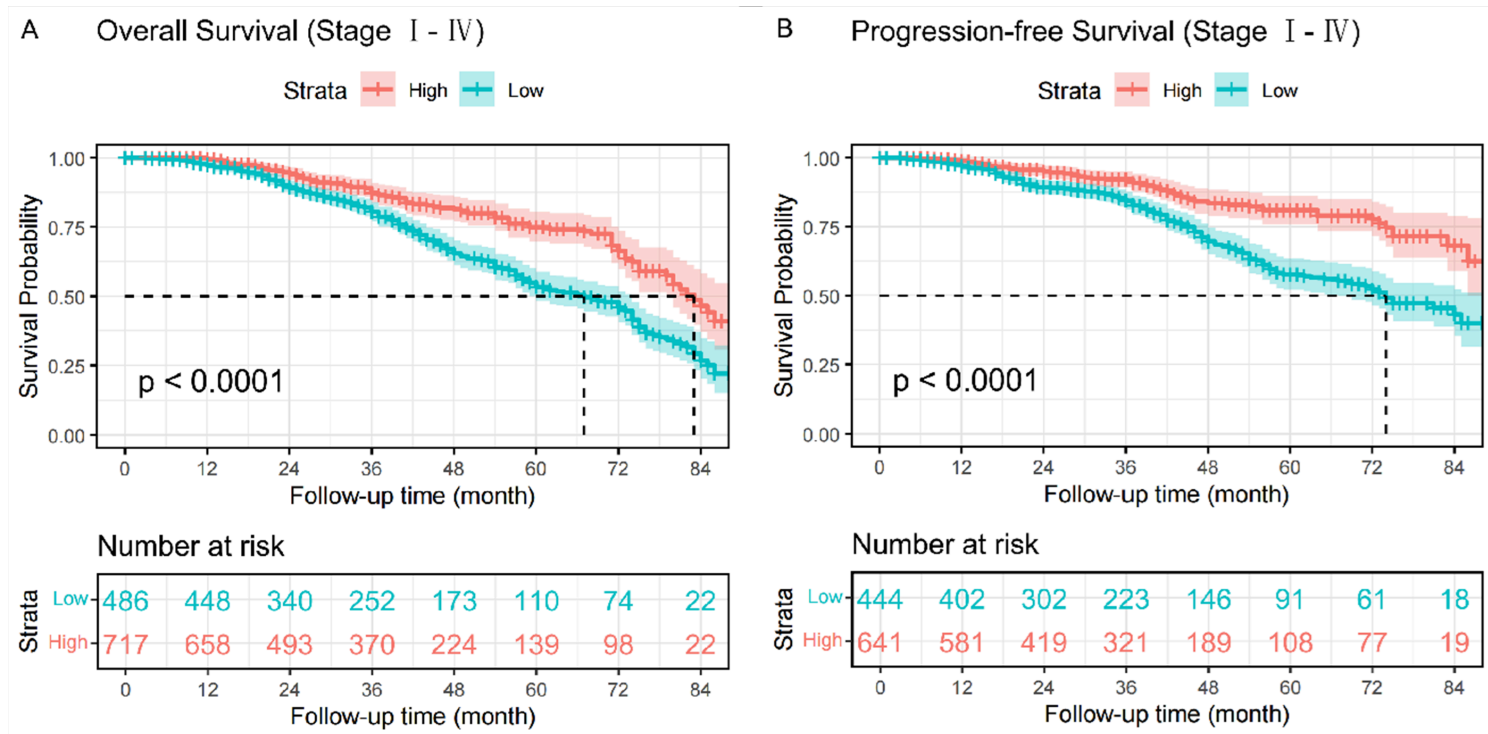


Figure 5

Kaplan-Meier curve of ANLR based on degree TNM subgroup in GC patients.

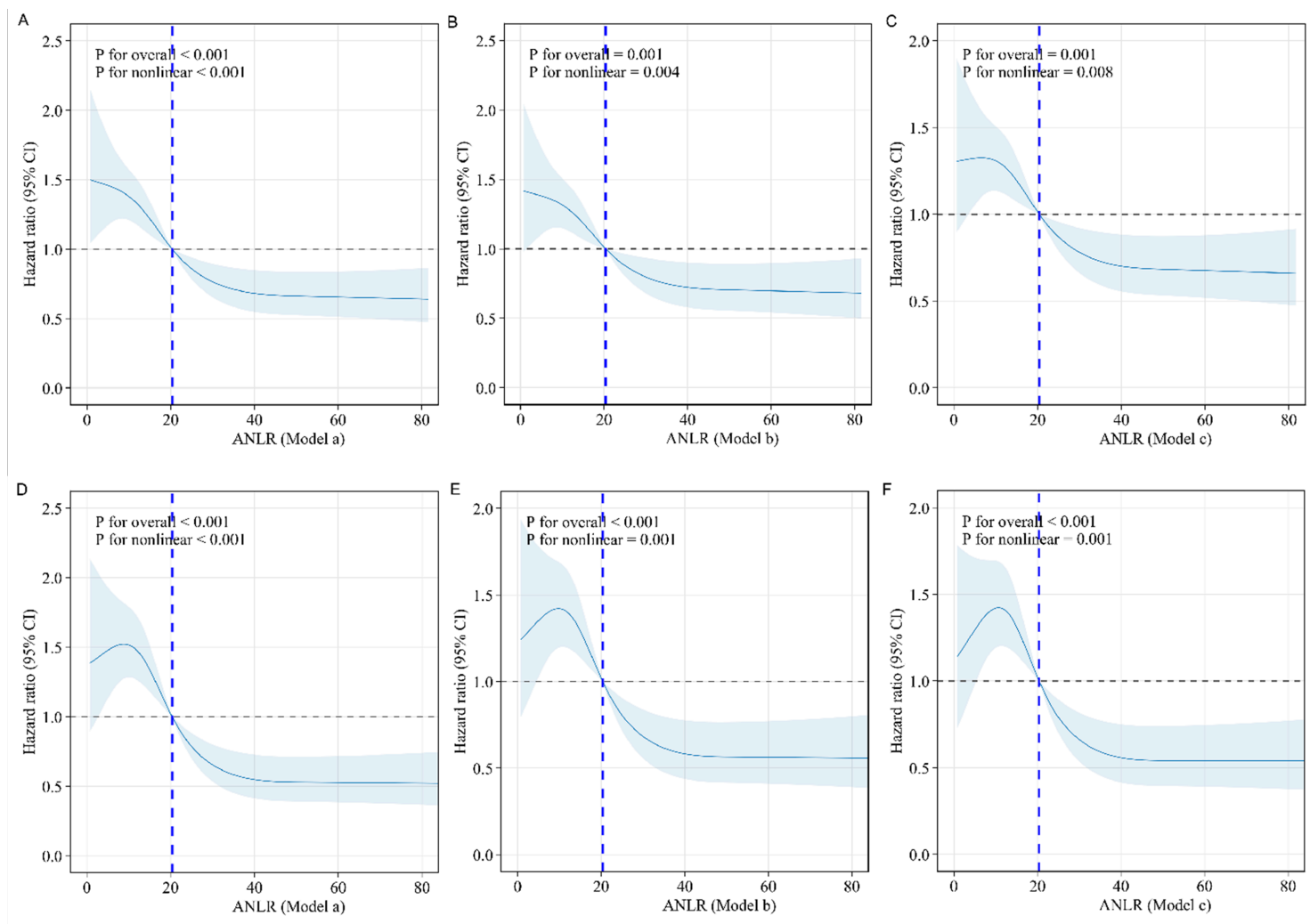


Figure 6

The association between ANLR and survival in GC patients.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1.doc](#)
- [Table2.doc](#)
- [SupplementaryMaterial.docx](#)