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Construction and validation of a novel nomogram based on the log odds of positive lymph nodes to predict cancer-specific survival in elderly patients with gastric adenocarcinoma after radical surgery

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Abstract

Objective We aimed to evaluate the efficacy of the log odds of positive lymph nodes (LODDS) in survival prediction of elderly patients with gastric adenocarcinoma (GAC) after gastrectomy, and to construct a relevant survival prediction model.

Methods In this study, patient data was collected from both the Surveillance, Epidemiology, and End Results (SEER) database and a medical records database at a hospital in China. Least absolute shrinkage and selection operator (LASSO) regression and multivariate Cox analysis were used to identify independent risk factors for cancer-specific survival (CSS) and a nomogram was constructed based on the results of multivariate Cox regression. Using consistency index (C-index), calibration curve, time-dependent receiver operating characteristic curve (tdROC) and decision curve analysis (DCA) to evaluate the predictive performance of nomogram. Generating Kaplan-Meier survival curves to show the difference in CSS between different groups.

Results Multivariate Cox analysis indicated that race, site, T stage, size, and LODDS were independently associated with the CSS. The C-index and AUC of the nomogram both exceed 0.71, while the calibration curve suggests that the nomogram accurately predicts CSS. Additionally, DCA curve results demonstrate superior clinical net benefits of the nomogram over TNM staging. High-risk patients identified by the predictive model exhibit inferior survival outcomes compared to low-risk patients. In addition, group comparison showed that only high-risk patients or high-LODDS group could benefit from chemotherapy and radiotherapy.

Conclusions The LODDS is an independent prognostic factor for elderly GAC patients after gastrectomy. The nomogram based on LODDS has better predictive ability than the traditional TNM staging system, assisting clinical doctors in evaluating patient prognosis and guiding treatment.

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Keywords Gastric adenocarcinoma, Elderly patients, LODDS, Nomogram, SEER

Introduction

Gastric adenocarcinoma (GAC) is a prevalent malignant tumor in the digestive system, resulting in a considerable number of deaths globally each year [1, 2]. While radical gastrectomy is the cornerstone of curative treatment, prognosis remains poor due to frequent metastasis and recurrence [3]. Older patients often present with comorbidities, diminished physiological reserves, and reduced tolerance to aggressive therapies, leading to poor outcomes that challenge conventional prognostic frameworks [4–6]. Current staging systems, such as the American Joint Committee on Cancer (AJCC) TNM classification [7], rely heavily on the absolute number of metastatic lymph nodes (N stage) but fail to account for the total lymph nodes examined, introducing potential stage migration biases. This limitation underscores the need for more refined lymph node staging methods to improve risk stratification.

Recent studies have shown that the log odds of positive lymph nodes (LODDS), which integrates the counts of both positive and negative lymph nodes, is superior to the traditional N stage in evaluating the prognosis of cancer patients [8–11]. LODDS minimizes staging errors by incorporating the ratio of metastatic to non-metastatic nodes, enabling precise discrimination of survival outcomes even in node-negative patients. For instance, Che et al. demonstrated that LODDS-based nomograms outperformed AJCC N staging in differentiating risk subgroups and guiding radiotherapy decisions in a large population-based cohort [12]. However, existing prognostic models predominantly focus on general populations, with limited validation in elderly patients-a subgroup characterized by unique biological behaviors and therapeutic challenges. Furthermore, prior studies often lack external validation or fail to integrate LODDS with other clinicopathological variables critical for personalized prognosis [13–15].

The Surveillance, Epidemiology, and End Results (SEER) database encompasses more than 28% of the United States population and offers invaluable resources for cancer epidemiological research [16]. This study aims to fill this gap by developing and validating a nomogram based on LODDS for elderly patients with GAC. Utilizing data from the SEER database and an independent Chinese cohort, we evaluate the interplay between LODDS, tumor characteristics, and outcomes in elderly patients. By comparing our model with conventional TNM staging, we seek to provide clinicians with a robust tool for risk stratification and individualized treatment planning in this vulnerable population.

Methods

Study population

The data of elderly patients with GAC after radical surgery were obtained from the SEER database using SEER*Stat, version 8.4.3. The database selected for this study was "Incidence -SEER research plus data, 17 Registries Nov.2021 Sub (2000–2019)", with data information up to November 2021. Patients conforming to the criteria below were included: (a) histologically confirmed GAC, according to the histology and site codes, patients with GAC (including ICD-O-3 codes: 8140, 8144, 8145, 8211, 8255, 8260, 8480, 8481, and 8490) and the tumor site of stomach (site code: C16.0–16.6) were included; (b) age at diagnosis ≥ 65 years old; (c) patients undergoing curative gastrectomy, surgical code "30–80" refers to radical gastrectomy; (d) no distant metastasis; (e) complete clinicopathological data; (f) complete survival information. Additionally, cases conforming to the criteria below were excluded: (a) combining other malignant tumors; (b) GAC is not the first tumor; (c) patients with a survival time of 0. The extracted patients from SEER were randomly allocated to training and internal validation cohorts in a 7:3 ratio. Simultaneously, based on the same inclusion and exclusion criteria, retrospective data collection was conducted on GAC patients from the First Affiliated Hospital of Zhengzhou University between 2012 and 2018, which served as an external validation cohort. The training cohort was used for statistical analysis and model development, while the validation cohorts were used to evaluate the accuracy and performance of the model. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and has received approval from the Ethics Committee of the First Affiliated Hospital of Zhengzhou University. And the need for informed consent was waived by the ethics committee of the First Affiliated Hospital of Zhengzhou University due to the study's retrospective nature. Patient medical records are strictly anonymized and maintained confidentially, in accordance with ethical standards.

Variable collection

The variables consisted of demographic characteristics (gender, age at diagnosis, race and marital status) and clinicopathological characteristics (AJCC stage, T stage, N stage, tumor differentiation grade, tumor size, examined lymph nodes (ELN), positive lymph node (PLN), survival status and survival months). LODDS was calculated below, $LODDS = \log[(PLN + 0.5)/(ELN\text{-}PLN + 0.5)]$. Each variable was categorized as follows: gender, male or female; race, white, black or other; marital status, unmarried or married; T staging, T1, T2, T3 or T4; N staging,

N0, N1, N2 or N3. The X-tile software was used to determine the optimal cutoff values for continuous variables. Age was classified as ≤ 80 and > 80 years; tumor size was classified as < 2.7, 2.7–5.3, and > 5.3 cm; LODDS was classified as LODDS1 (< – 1.00), LODDS2 (– 1.00 to – 0.10), and LODDS3 (> – 0.10). The primary endpoint of this study is cancer-specific survival (CSS), which is defined as the time interval from pathological diagnosis to either death due to cancer or the end of follow-up for patients.

Statistical analysis

Statistical analysis and data visualization were performed using IBM SPSS Statistics (version 26.0) and R software (version 4.3.1). Chi-square test or Fisher's exact test was employed for between-group comparisons of categorical variables. The least absolute shrinkage and selection operator (LASSO) regression was used to screen variables, and the screened variables were included in the multivariate Cox analysis to screen independent predictive factors. In this study, a two-sided $P < 0.05$ was considered statistically significant for detecting differences.

The nomogram for predicting patient CSS was constructed using the "survival", "foreign", "rms" and "regplot" packages in R language, based on the results of a multivariable Cox regression analysis. Meanwhile, the "DynNom" package is utilized to build a convenient online prediction tool. The consistency index (C-index), time-dependent receiver operating characteristic curve (tdROC) and calibration curve were used to evaluate the accuracy and discriminative ability of the nomogram. And construct decision curve analysis (DCA) to show clinical benefit of nomogram. We divided patients into high- and low-risk groups according to their median risk score based on the nomogram by using R software. The Kaplan–Meier method was used to draw the CSS survival curve, and the log-rank test was used for statistical analysis.

Results

Patient characteristics

According to the inclusion and exclusion criteria, a total of 2,698 elderly GAC patients who underwent gastrectomy were extracted from the SEER database, which were divided into a training cohort ($n = 1,888$) and an internal validation cohort ($n = 810$). In the training set, the median follow-up time was 40 months (range, 1–119 months). Females accounted for 37.9% while males accounted for 62.1%. In the internal validation set, the median follow-up time was 42 months (range, 1–118 months). Females accounted for 36.4% while males accounted for 63.6%. Overall, the baseline characteristics were balanced between the training and internal validation groups. And, a total of 234 elderly GAC patients were selected from Chinese hospitals as an external validation cohort. The median follow-up time in the external validation set was 28 months (range, 1–79 months). Females accounted for 23.4% while males accounted for 75.6%. Table 1 summarizes the clinicopathological characteristics of the included patients.

Prognostic analyses for CSS

To prevent overfitting, variables were included in the LASSO regression, and ultimately, six variables were selected for the multivariable Cox analysis, including race, tumor site, T staging, N staging, tumor size, and LODDS (Fig. 1A/B/C). As shown in Table 2, results of the multivariable analysis confirmed that race, tumor site, T staging, tumor size, and LODDS were independent prognostic factors ($P < 0.05$).

Development and validation of the prognostic nomogram

Based on the results of the multivariable Cox analysis, we constructed a nomogram that includes five meaningful factors ($P < 0.05$): race, tumor site, T staging, tumor size, and LODDS (Fig. 1D). To make the predictive model more conveniently applied in clinical practice, we have developed a web-based prediction tool (https://vici.shinyapps.io/DynNomappforGAC/). By simply entering the patient's information on the webpage, the survival curve of the patient can be plotted, and the prognosis of the patient can be evaluated (Fig. 1E).

The nomogram demonstrated a C-index of 0.739 (95%CI, 0.723–0.755) in the training cohort, 0.733 (95%CI, 0.708–0.758) in the internal validation cohort and 0.731 (95%CI, 0.700-0.762) in the external validation cohort, which are higher than 0.71. As shown in Fig. 2, the calibration curves plotted are very close to the diagonal line, indicating that the nomogram predictions are close to the actual results and have good calibration. The tdROC curves showed that the AUC values of nomogram in 3- and 5-years were 0.806 (95%CI, 0.785–0.827) and 0.817 (95%CI, 0.795–0.839) in the training cohort, were 0.804 (95%CI, 0.772–0.835) and 0.832 (95%CI, 0.800-0.863) in the internal validation cohort, and were 0.808 (95%CI, 0.735–0.881) and 0.873 (95%CI, 0.776–0.969) in the external validation cohort. the AUC values of TNM stage in 3- and 5-years were 0.754 (95%CI, 0.732–0.775) and 0.765 (95%CI, 0.742–0.789) in the training cohort, were 0.746 (95%CI, 0.714–0.779) and 0.761 (95%CI, 0.725–0.796) in the internal validation cohort, and were 0.672 (95%CI, 0.598–0.746) and 0.783 (95%CI, 0.654–0.913) in the external validation cohort. The AUC values of nomogram were higher than those of pure TNM stage which indicated that our model has better predictive ability than TNM stage. Furthermore, we performed an analysis of the clinical utility of the model. The DCA curves demonstrated that the net benefit rates of the nomogram were higher than those of the TNM staging system in

Table 1 Clinicopathological characteristics in elderly patients following surgical removal of gastric adenocarcinoma

Variable	NO. (%)			*P* value
	Training cohort	Internal validation cohort	External validation cohort	
Sex				< 0.001
Female	715(37.9)	295(36.4)	58(24.5)	
Male	1173(62.1)	515(63.6)	179(75.5)	
Race				< 0.001
White	1210(64.1)	506(62.5)	0	
Black	191(10.1)	96(11.8)	0	
Other	487(25.8)	208(25.7)	237(100)	
Age, years				< 0.001
≤ 80	1472(78.0)	635(78.4)	231(97.5)	
>80	416(22.0)	175(21.6)	6(2.5)	
Marital status				< 0.001
Unmarried	704(37.3)	304(37.5)	8(3.4)	
Married	1184(62.7)	506(62.5)	229(96.6)	
Site				< 0.001
Cardia	503(26.6)	195(24.1)	144(60.8)	
Non-cardia	1385(73.4)	615(75.9)	93(39.2)	
Tumor grade				< 0.001
Well	717(38.0)	306(37.8)	58(24.5)	
Poor	1171(62.0)	504(62.2)	179(75.5)	
Stage				< 0.001
I	561(29.7)	230(28.4)	16(6.8)	
II	539(28.6)	238(29.4)	66(27.8)	
III	788(41.7)	342(42.2)	155(65.4)	
T stage				< 0.001
T1	491(26.0)	193(23.8)	15(6.3)	
T2	258(13.7)	141(17.4)	25(10.6)	
T3	760(40.3)	301(37.2)	33(13.9)	
T4	379(20.0)	175(21.6)	164(69.2)	
N stage				< 0.001
N0	825(43.7)	337(41.6)	54(22.8)	
N1	414(21.9)	192(23.7)	55(23.2)	
N2	305(16.2)	138(17.0)	59(24.9)	
N3	344(18.2)	143(17.7)	69(29.1)	
Size, cm				< 0.001
< 2.7	570(30.2)	241(29.8)	40(16.9)	
2.7–5.3	763(40.4)	303(37.4)	113(47.7)	
> 5.3	555(29.4)	266(32.8)	84(35.4)	
LODDS				< 0.001
LODDS1	933(49.4)	383(47.3)	67(28.3)	
LODDS2	626(33.2)	274(33.8)	107(45.1)	
LODDS3	329(17.4)	153(18.9)	63(26.6)	
Chemotherapy				< 0.001
No	1028(54.4)	444(54.8)	93(39.2)	
Yes	860(45.6)	366(45.2)	144(60.8)	
Radiotherapy				< 0.001
No	1316(69.7)	575(71.0)	235(99.2)	
Yes	572(30.3)	235(29.0)	2(0.8)	

the training, internal validation, and external validation cohorts (Fig. 3). This indicates that the nomogram provides greater clinical benefit.

Risk stratification based on the nomogram

Calculating the risk score according to the nomogram and divided the patients into low-risk group and high-risk group with the median as the cut-off value. We could observe that the prognosis of patients in the low-risk group was significantly better than that of the patients in the high-risk group ($P < 0.001$). The subsequent analysis revealed that chemoradiotherapy demonstrated significant benefits exclusively in the high-risk group, as identified by our model (Fig. 4).

Risk stratification based on LODDS

From the Fig. 5, the Kaplan-Meier method demonstrated a significant association between high LODDS scores and poor prognosis ($P < 0.001$). Meanwhile, through multiple subgroup analyses, it was found that in different tumor stages, T stages, and age stratifications, higher LODDS were all associated with poorer prognosis in elderly GAC patients. Based on the LODDS stratification of patients in T2-T3, we found that radiotherapy and chemotherapy only showed beneficial effects in the LODDS2 and LODDS3 subgroups. In the LODDS1 subgroup, radiotherapy and chemotherapy were either meaningless or had the opposite effect to what was expected (Fig. 6).

Discussion

With the aging of the population, there has been a significant increase in the incidence of GAC among elderly patients. Despite the continuous development of comprehensive treatment methods such as surgery, chemotherapy, and radiotherapy, the prognosis of GAC patients remains unsatisfactory, especially for elderly patients [17]. Due to the frequent presence of multiple comorbidities, decreased physiological reserve function, and poor tolerance to treatment, the prognosis for elderly GAC patients is even more challenging. Therefore, accurately assessing the prognosis of elderly GAC patients and formulating personalized treatment plans are of crucial importance [18, 19].

In this study, we constructed a novel nomogram (https://vici.shinyapps.io/DynNomappforGAC/) incorporating LODDS and other clinicopathological variables to predict CSS in elderly GAC patients after radical surgery. Our findings demonstrate that LODDS, race, tumor site, T stage, and tumor size, serve as independent prognostic factors, with the nomogram outperforming traditional TNM staging in predictive accuracy. The calibration curve showed that the predictions of the nomogram model were in good agreement with the actual outcomes. Additionally, the C-index and tdROC analysis indicated

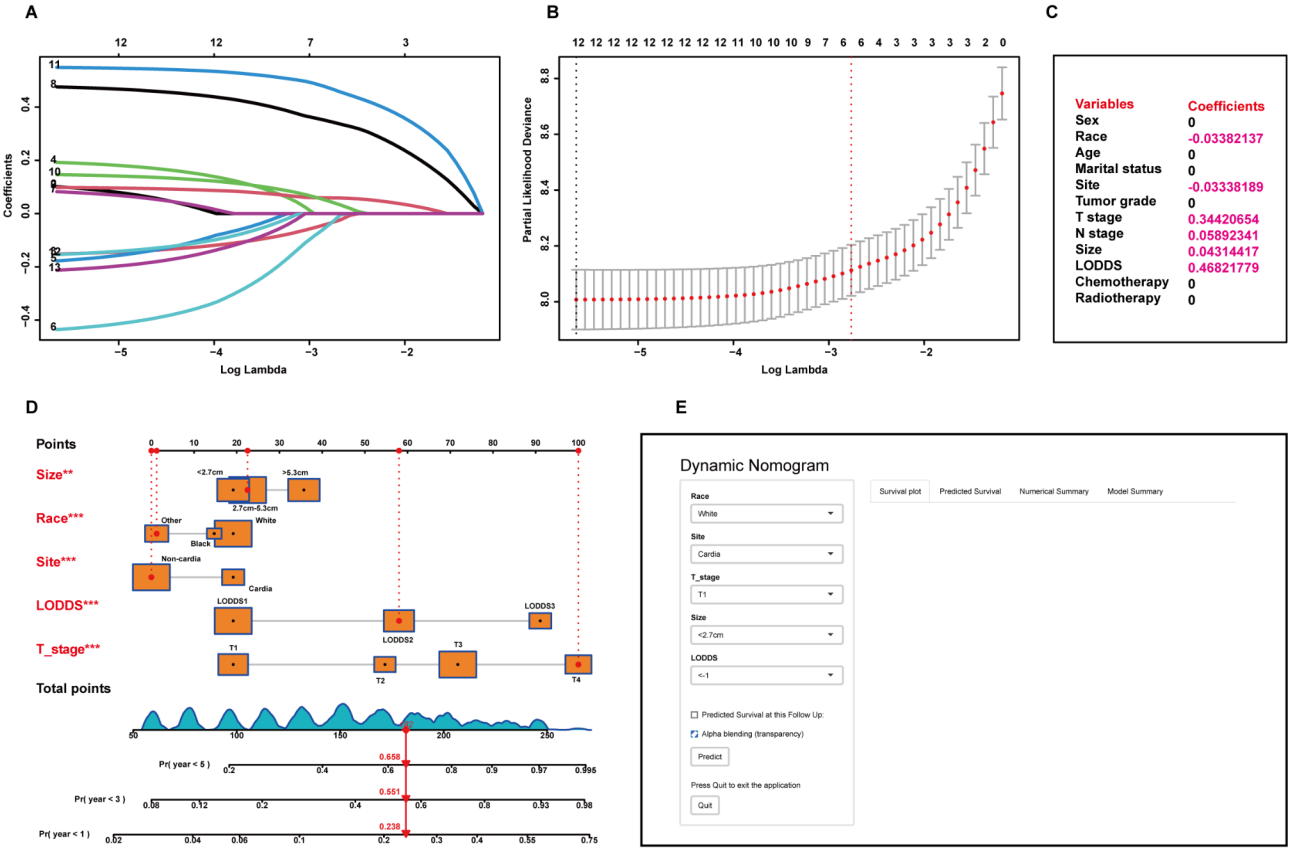

Fig. 1 (**A**) Lasso regression coefcients. (**B**) Lasso tenfold cross-validation. (**C**) The coefficients of the individual variables. (**D**) Nomogram predicting CSS of elderly patients with GAC after radical resection. (**E**) Online prediction tool (https://vici.shinyapps.io/DynNomappforGAC/)

a significant improvement in the discriminative ability of the nomogram model compared to TNM staging, making it more accurate for prognostic evaluation. Furthermore, the DCA curve demonstrated that the nomogram model had a better clinical net benefit. Through risk stratification using the nomogram, it was found that the survival rate of patients in the high-risk group was significantly lower than that in the low-risk group, and only patients in the high-risk group could benefit from radiotherapy and chemotherapy. This provides an important reference for clinicians to identify high-risk patients and formulate reasonable treatment plans.

The lymph node metastasis status of GAC is an important indicator that affects long-term survival in postoperative patients [20]. LODDS, a newly emerged indicator for evaluating lymph node metastasis, has demonstrated exceptional predictive value across various tumor types [21, 22]. In contrast to traditional N staging, LODDS effectively reduces staging errors by comprehensively considering the number of positive and negative lymph nodes, and can more precisely predict the survival outcome of patients. Even in patients with negative lymph nodes, LODDS can avoid the error caused by zero observations through its unique calculation method. In this study, we employed X-tile software to categorize LODDS into three groups and observed that higher LODDS values corresponded to poorer local lymph node metastasis status and worse prognosis for elderly patients with GAC after gastrectomy. Our research findings are consistent with previous studies [12, 23, 24]. Meanwhile, unlike those studies that focused on the general GAC population, our analysis specifically targeted elderly patients, a subgroup with distinct clinicopathological characteristics and treatment challenges, providing evidence for the application of LODDS in the elderly population. Further subgroup analysis results indicated that only at higher LODDS scores did the use of chemotherapy and radiotherapy have a positive therapeutic effect on the elderly GAC patients, which provided more evidence for the clinical application of LODDS.

Notably, our model identified race and tumor site (particularly cardia location) as significant predictors, factors less prominently discussed in prior LODDS-based nomograms. This may be related to the fact that our study population consisted of elderly GAC patients. It is important to note that cardia cancer exhibits significant differences from gastric cancer in other locations, including etiology, histology, and treatment modalities. Consequently, it

Table 2 Multivariate Cox regression analyses of prognostic factors for CSS

Variables	Multivariate Analysis		
	HR	95% CI	*P*-value
Race			
White	1		
Black	0.919	0.733–1.153	0.464
Other	0.722	0.608–0.857	**< 0.001**
Site			
Cardia	1		
Non-cardia	0.716	0.611–0.839	**< 0.001**
T stage			
T1	1		
T2	1.884	1.401–2.532	**< 0.001**
T3	2.522	1.947–3.267	**< 0.001**
T4	4.147	3.128–5.499	**< 0.001**
N stage			
N0	1		
N1	1.191	0.951–1.491	0.129
N2	1.142	0.874–1.493	0.331
N3	1.288	0.962–1.725	0.090
Size, cm			
<2.7	1		
2.7–5.3	1.045	0.859–1.273	0.659
>5.3	1.324	1.078–1.828	**0.008**
LODDS			
LODDS1	1		
LODDS2	1.850	1.501–2.281	**< 0.001**
LODDS3	3.169	2.423–4.145	**< 0.001**

has been classified as an independent type of cancer by mainstream research [25]. The findings of our study validate the inferior prognosis associated with cardia cancer and emphasize the need for further investigation into its underlying factors. In this study, we observed a higher survival risk among patients of Caucasian ethnicity, which aligns with recent population survey findings. The poorer prognosis observed in Caucasian patients in our study echoes findings by Wu et al., suggesting that racial disparities in lifestyle, treatment adherence, or biological tumor behavior warrant further exploration [26].

In conclusion, while LODDS has been established as a robust prognostic tool in general GAC cohorts, our study extends its utility to elderly patients, integrating demographic and anatomic variables overlooked in prior frameworks. By addressing the unique prognostic needs of this population, our nomogram provides a practical tool for personalized survival prediction and therapeutic decision-making. However, we acknowledge that this study still has several limitations. Firstly, this study is retrospective in nature, and more evidence from prospective studies is still needed to validate the reliability of the predictive model. Additionally, several prognostic-related variables, such as Eastern Cooperative Oncology Group (ECOG) performance status, family history and smoking history, were not included in this study. There is also a lack of specific chemotherapy and radiation therapy protocols and surgical procedures. The main reason for this is the lack of availability of these variables in the SEER database. Furthermore, the SEER database also lacks detailed information on targeted therapy and immunotherapy. These aspects will be important focus areas for future research.

Conclusions

In this study, we developed and validated a novel nomogram incorporating LODDS to predict CSS in elderly patients with GAC following radical gastrectomy. The model integrated LODDS with demographic and clinicopathological variables—race, tumor site, T stage, and tumor size—and demonstrated superior predictive accuracy over the traditional TNM staging system. This was supported by higher C-index and time-dependent AUC values across training, internal validation, and external validation cohorts. Crucially, risk stratification using the nomogram identified high-risk patients and those with elevated LODDS scores, both of whom exhibited significantly poorer survival outcomes. Subgroup analyses further revealed that chemotherapy and radiotherapy conferred survival benefits exclusively in these high-risk or high-LODDS subgroups. These findings highlight the clinical utility of LODDS as a robust prognostic tool for elderly GAC patients, enabling personalized risk assessment and tailored therapeutic strategies.

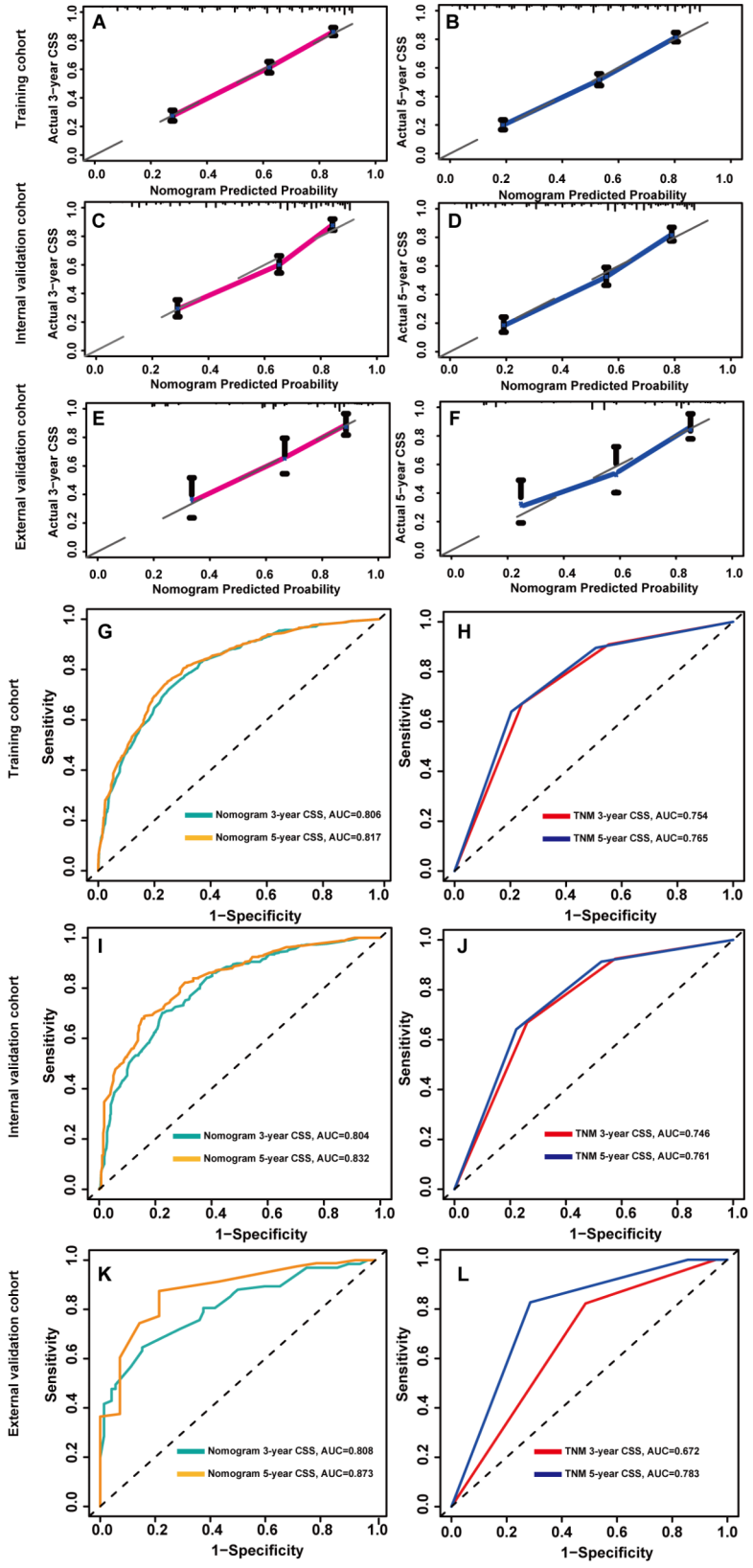

Fig. 2 Calibration curves of nomogram for predicting 3-year CSS (**A**) and 5-year CSS (**B**) in the training set. Calibration curves of nomogram for predicting 3-year CSS (**C**) and 5-year CSS (**D**) in the internal validation set. Calibration curves of nomogram for predicting 3-year CSS (**E**) and 5-year CSS (**F**) in the external validation set. Time-dependent ROC curves were used to test the predictive power of the 3-year OS and 5-year OS in the training set (**G** and **H**), the internal validation set (**I** and **J**) and the external validation set (**K** and **L**), respectively

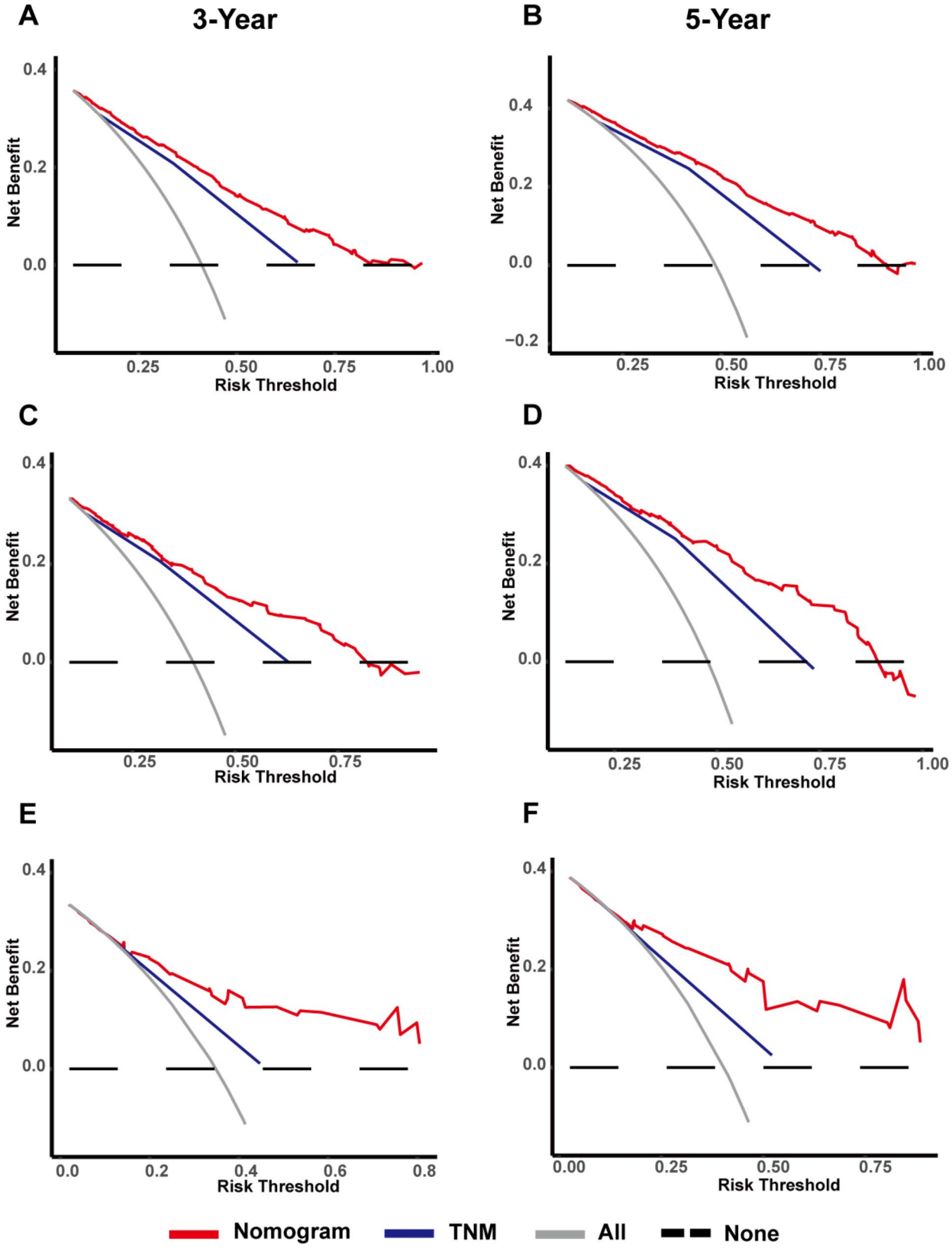

Fig. 3 DCA of the nomogram and TNM stage 3-year OS and 5-year OS of the training set (**A** and **B**), the internal validation set (**C** and **D**) and the external validation set (**E** and **F**), respectively

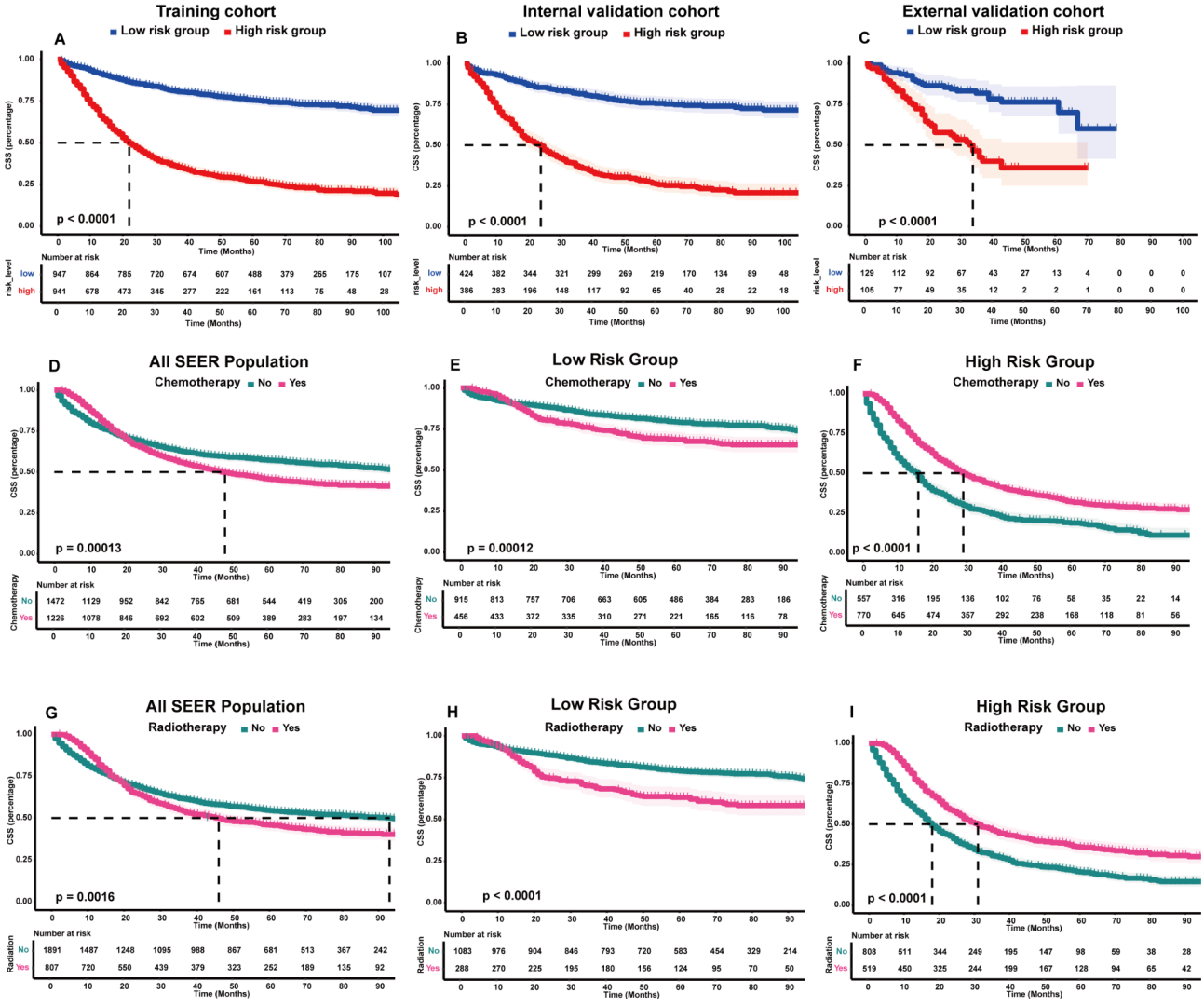

Fig. 4 Kaplan–Meier survival curves for the patients in the low- and high-risk groups based on the risk scores. ((**A**) Training set, (**B**) Internal validation set, (**C**) External validation set). Effect of chemotherapy in different risk groups ((**D**) total population, (**E**) low-risk group, (**F**) high-risk group). Effect of radiotherapy in different risk groups ((**G**) total population, (**H**) low-risk group, (**I**) high-risk group)

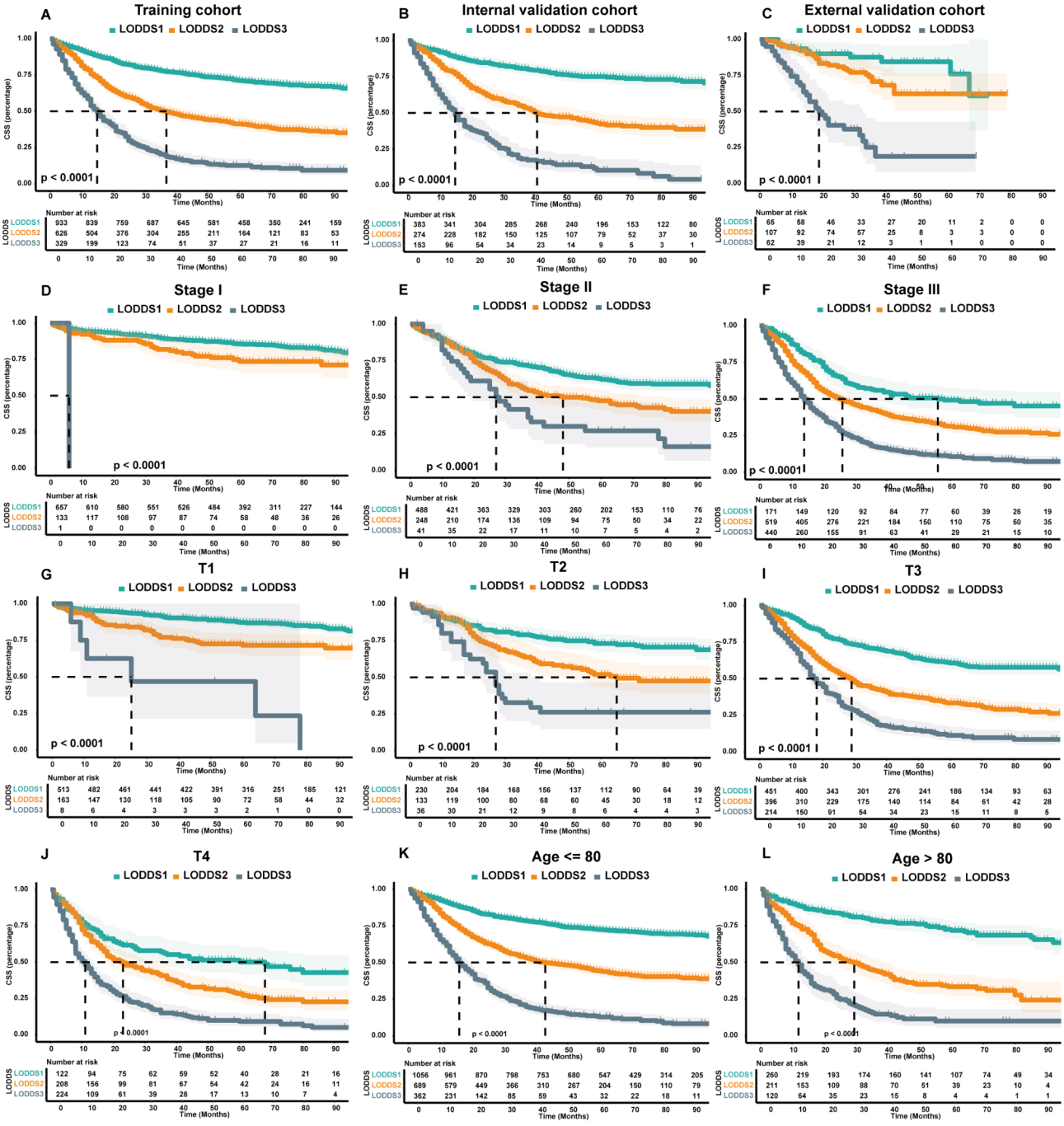

Fig. 5 Kaplan–Meier survival curves of CSS according to LODDS ((**A**) Training set, (**B**) Internal validation set, (**C**) External validation set). Kaplan–Meier survival curves of CSS according to LODDS in different tumor stages ((**D**) Stage I, (**E**) Stage II, (**F**) Stage III). Kaplan–Meier survival curves of CSS according to LODDS in different T stages ((**G**) T1, (**H**) T2, (**I**) T3, (**J**) T4). Kaplan–Meier survival curves of CSS according to LODDS in different age groups ((**K**) Age < = 80, (**L**) Age > 80)

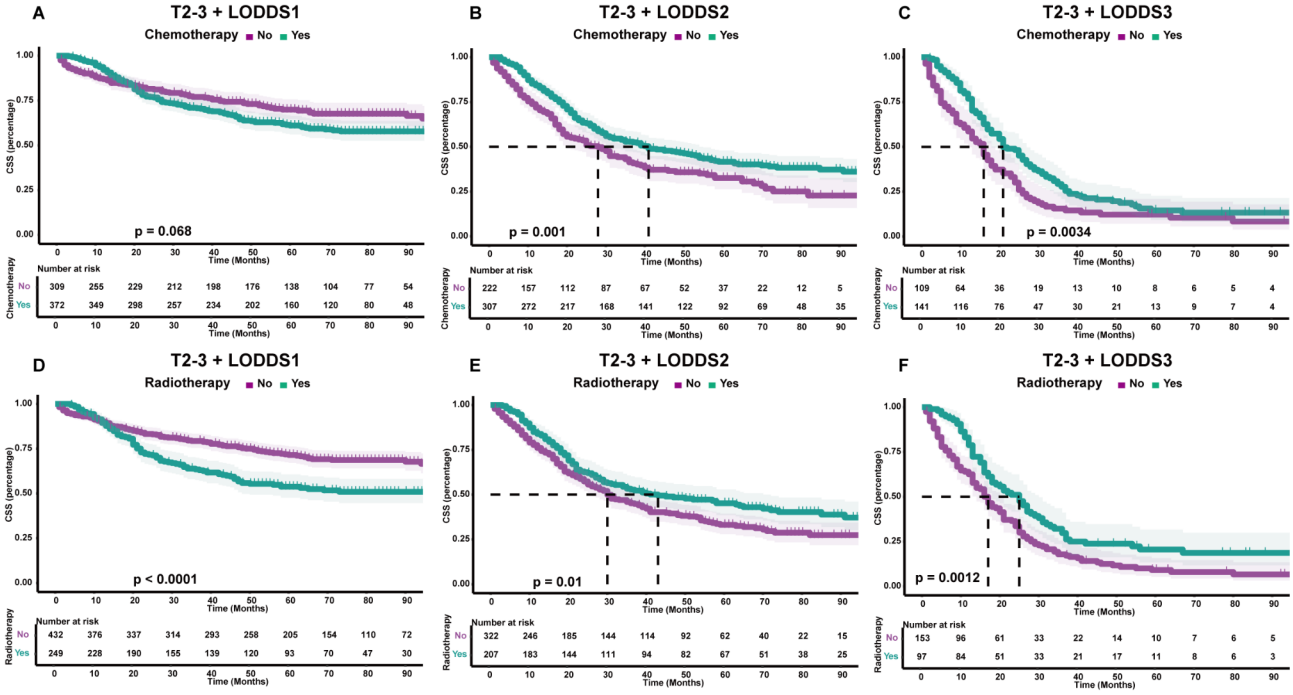

Fig. 6 The chemotherapy efficacy in patients with T2-T3 stage based on LODDS stratification. ((**A**) LODDS1, (**B**) LODDS2, (**C**) LODDS3). The radiotherapy efficacy in patients with T2-T3 stage based on LODDS stratification. ((**C**) LODDS1, (**D**) LODDS2, (**E**) LODDS3)

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Author contributions
All authors contributed to the study conception and design. Conceptualization, methodology, and writing the original draft: Lei Wang, Jingjing Ge. Data curation and visualization: Yihua Fang. Conceptualization and reviewing the manuscript: Huiqiong Han and Yanru Qin. All authors reviewed and approved the final manuscript.

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Data availability
The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Human ethics and consent to participate declarations
This study involving human participants was conducted in strict compliance with the Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki/). The study was reviewed and approved by the medical ethics committee of the First Affiliated Hospital of Zhengzhou University (2023-KY-0019). And the need for informed consent was waived by the ethics committee of the First Affiliated Hospital of Zhengzhou University due to the study's retrospective nature.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. Cancer J Clin. 2021;71(3):209–49.
2. Siegel RL, Giaquinto AN, Jemal A. Cancer statistics, 2024. Cancer J Clin. 2024;74(1):12–49.
3. Li GZ, Doherty GM, Wang J. Surgical management of gastric cancer: A review. JAMA Surg. 2022;157(5):446–54.
4. Akinoso-Imran AQ, O'Rorke M, Kee F, Jordao H, Walls G, Bannon FJ. Surgical under-treatment of older adult patients with cancer: A systematic review and meta-analysis. J Geriatric Oncol. 2022;13(4):398–409.
5. Xu Y, Wang Y, Xi C, Ye N, Xu X. Is it safe to perform gastrectomy in gastric cancer patients aged 80 or older? A meta-analysis and systematic review. Medicine. 2019;98(24):e16092.
6. Matthaiou C, Papamichael D. Management of gastric cancer in older adults. J Geriatric Oncol. 2017;8(6):403–6.
7. Amin MB, Greene FL, Edge SB, Compton CC, Gershenwald JE, Brookland RK, Meyer L, Gress DM, Byrd DR, Winchester DP. The eighth edition AJCC cancer staging manual: continuing to build a Bridge from a population-based to a more personalized approach to cancer staging. Cancer J Clin. 2017;67(2):93–9.
8. Wang L, Ge J, Feng L, Wang Z, Wang W, Han H, Qin Y. Establishment and validation of a prognostic nomogram for postoperative patients with gastric cardia adenocarcinoma: A study based on the surveillance, epidemiology, and end results database and a Chinese cohort. Cancer Med. 2023;12(12):13111–22.
9. Zhang X, Zhang K, Li S, Xu A. A nomogram based on the log odds of positive lymph nodes predicts the prognosis of patients with colon neuroendocrine tumors after surgery: A surveillance, epidemiology,

and end results Population-Based study. Technol Cancer Res Treat. 2023;22:15330338231180776.
10. Zheng W, Jiang W, Wu Q, Chen J, Zhang Z, Yu S, Guo C. Comparisons of different lymph node staging systems for predicting overall survival of node-positive patients with renal cell carcinoma: a retrospective cohort study using the surveillance, epidemiology and end results database. BMJ Open. 2023;13(4):e068044.
11. Cao ZX, Weng X, Huang JS, Long X. Prognostic value of LODDS in medullary thyroid carcinoma based on competing risk model and propensity score matching analysis. Updates Surg. 2022;74(5):1551–62.
12. Che K, Wang Y, Wu N, Liu Q, Yang J, Liu B, Wei J. Prognostic nomograms based on three lymph node classification systems for resected gastric adenocarcinoma: A large Population-Based cohort study and external validation. Ann Surg Oncol. 2021;28(13):8937–49.
13. Roberto M, Botticelli A, Strigari L, Ghidini M, Onesti CE, Ratti M, Benzoni I, Pizzo C, Falcone R, Lomiento D, et al. Prognosis of elderly gastric cancer patients after surgery: a nomogram to predict survival. Med Oncol (Northwood Lond Engl). 2018;35(7):111.
14. Chen J, Ji X, Xing H. Risk factors and a nomogram model for postoperative delirium in elderly gastric cancer patients after laparoscopic gastrectomy. World J Surg Oncol. 2022;20(1):319.
15. Yong R, Jiang L. Predicative factors and development of a nomogram for postoperative delayed neurocognitive recovery in elderly patients with gastric cancer. Aging Clin Exp Res. 2023;35(7):1497–504.
16. Che WQ, Li YJ, Tsang CK, Wang YJ, Chen Z, Wang XY, Xu AD, Lyu J. How to use the surveillance, epidemiology, and end results (SEER) data: research design and methodology. Military Med Res. 2023;10(1):50.
17. Endo S, Dousei T, Yoshikawa Y, Hatanaka N, Kamiike W, Nishijima J. Prognosis of gastric carcinoma patients aged 85 years or older who underwent surgery or who received best supportive care only. Int J Clin Oncol. 2013;18(6):1014–9.
18. Lee DU, Fan GH, Chang K, Lee KJ, Han J, Jung D, Kwon J, Karagozian R. The clinical impact of advanced age on the postoperative outcomes of patients undergoing gastrectomy for gastric cancer: analysis across US hospitals between 2011–2017. J Gastric Cancer. 2022;22(3):197–209.
19. Brown LR, Kamarajah SK, Madhavan A, Wahed S, Navidi M, Immanuel A, Hayes N, Phillips AW. The impact of age on long-term survival following gastrectomy for gastric cancer. Ann R Coll Surg Engl. 2023;105(3):269–77.
20. Yamasaki M, Miyata H, Miyazaki Y, Takahashi T, Kurokawa Y, Nakajima K, Takiguchi S, Mori M, Doki Y. Evaluation of the nodal status in the 7th edition of the UICC-TNM classification for esophageal squamous cell carcinoma: proposed modifications for improved survival stratification: impact of lymph node metastases on overall survival after esophagectomy. Ann Surg Oncol. 2014;21(9):2850–6.
21. Wang F, Gao SG, Xue Q, Tan FW, Gao YS, Mao YS, Wang DL, Zhao J, Li Y, Yu XY, et al. Log odds of positive lymph nodes is a better prognostic factor for oesophageal signet ring cell carcinoma than N stage. World J Clin Cases. 2021;9(1):24–35.
22. Resende V, Endo Y, Munir MM, Khalil M, Rashid Z, Lima HA, Rawicz-Pruszyński K, Khan MMM, Katayama E, Tsilimigras DI, et al. Prognostic value of nodal staging classification and number of examined lymph nodes among patients with ampullary cancer. J Gastrointest Surgery: Official J Soc Surg Aliment Tract. 2024;28(1):33–9.
23. Zhou R, Zhang J, Sun H, Liao Y, Liao W. Comparison of three lymph node classifications for survival prediction in distant metastatic gastric cancer. Int J Surg (London England). 2016;35:165–71.
24. Jian-Hui C, Shi-Rong C, Hui W, Si-le C, Jian-Bo X, Er-Tao Z, Chuang-Qi C, Yu-Long H. Prognostic value of three different lymph node staging systems in the survival of patients with gastric cancer following D2 lymphadenectomy. Tumour Biology: J Int Soc Oncodevelopmental Biology Med. 2016;37(8):11105–13.
25. Ichihara S, Uedo N, Gotoda T. Considering the esophagogastric junction as a 'zone'. Dig Endoscopy: Official J Japan Gastroenterological Endoscopy Soc. 2017;29(Suppl 2):3–10.
26. Wu SP, Keshavjee SH, Yoon SS, Kwon S. Survival outcomes and patterns of care for stage II or III resected gastric cancer by race and ethnicity. JAMA Netw Open. 2023;6(12):e2349026.

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