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Original Article

Prognostic model for the prediction of cancer-specific survival in elderly patients with stage I-III gastric cancer

Ke-Xun Yu[1], Jing Li[1], Hui-Zhen Wang[1], Chao-Yang Zhang[1], Meng-Di Ma[1], Lei Xiao[2], Wei-Jie Yuan[2], Yong-Xiang Li[1]

[1]*Department of General Surgery, The First Affiliated Hospital of Anhui Medical University, Hefei, Anhui, China;*
[2]*Department of Gastrointestinal Surgery, Xiangya Hospital of Central South University, Changsha, Hunan, China*

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Abstract: Elderly patients with gastric cancer (GC) exhibit unique physiological conditions and population characteristics. However, no efficient predictive tools have been developed for this patient subgroup. We extracted data on elderly patients diagnosed with stage I-III GC between 2010 and 2015 from the Surveillance, Epidemiology, and End Results (SEER) database, and applied Cox regression analysis to examine factors associated with cancer-specific survival (CSS). A prognostic model was developed and validated to predict CSS. We assessed the performance of the prognostic model and stratified patients based on their prognostic scores. Notably, 11 independent prognostic factors, including age, race, grade, the tumor-node-metastasis (TNM) stage, T-stage, N-stage, operation, tumor size, regional nodes, radiation, and chemotherapy, associated with CSS were identified using multivariate Cox regression. A nomogram was constructed based on these predictors. The C-index score of the nomogram was 0.802 (95% (confidence interval) [CI]: 0.7939-0.8114), which is superior to the American Joint Commission on Cancer (AJCC) TNM staging prediction ability in the training cohort (C-index: 0.589; 95% CI: 0.5780-0.6017). Based on the receiver operating characteristic (ROC) and calibration curve, the predicted value of the nomogram demonstrated a satisfactory accuracy with the actual observation value. Additionally, decision curve analysis (DCA) showed that the nomogram had a more ideal clinical net benefit than TNM staging. Survival analysis of the different risk groups confirmed the noteworthy clinical and statistical utility of the nomogram in prognosis stratification. This retrospective study reports the successful creation and validation of a nomogram for predicting CSS at 1-, 3- and 5-years in elderly patients with stage I-III GC. This nomogram critically guides personalized prognostic assessments and may contribute to clinical decision-making and consultation for postoperative survival.

Keywords: Gastric cancer, nomogram, SEER, cause-specific survival, prognosis, AJCC, survival analysis

Introduction

GC is a predominant malignant tumor of the digestive system. It is characterized by complex pathogenesis and early lymph node metastasis during the progression of the malignant phenotype, ranking as the third leading cause of cancer-related deaths worldwide [1]. There were about 27,510 cases of new GC and 11,140 deaths that were reported in the United States in 2019 [2]. Most of the GCs occur in elderly patients (≥ 65 years of age) [3]. With the aging of the global population and popularization of carcinogenic factors, a high incidence rate of GC poses a significant health and safety threat to elderly patients.

Although diagnostic technology and therapeutic strategies have improved over the past ten years, the prognosis of elderly GC patients remains unsatisfactory, as these patients exhibit aggressive biological and clinical characteristics, including insidious onset and rapid drug resistance [4]. Furthermore, elderly patients often develop complications with multiple organ system diseases that linked to prolonged postoperative recovery time and short survival time [5]. According to the National Comprehensive Cancer Network (NCCN) clinical practice guidelines, patients without severe underlying diseases should undergo radical gastrectomy before or after adjuvant chemoradiotherapy. This disqualifies age as a limiting

factor in surgery [6]. Furthermore, studies have demonstrated that age may be an independent prognostic factor for GC, providing a reference for postoperative prognosis consultation for GC, supported by statistical data [7]. However, there are differences between different countries in the surgical methods and postoperative treatment regimens for elderly patients [8]. Consequently, discrepancies in CSS rates of elderly patients may arise.

Considering the high morbidity and mortality, identifying prognostic factors for elderly patients with stage I-III GC should be the priority. Through an extensive search of electronic databases, only a few studies have focused on the prognosis of elderly GC patients [9]. Additionally, the lack of prospective studies on elderly patients with GC implies insufficient strategies and guidelines for managing this population. Currently, TNM staging system of the AJCC is mainly used to evaluate the prognosis of elderly patients in clinical practice [10]. However, it cannot assess the effect of surgery and adjuvant chemotherapy on the prognosis of individual patients. Thus, developing a predictive tool to evaluate the prognosis at a personalized and comprehensive level is of great significance. With advantages over the TNM stage, nomograms have been widely applied in estimating the individual prognosis and quantification of all independent prognostic factors. This is achieved via scaled line segments and scoring of various forecast indicators [11], whose prediction performance might be more accurate than that of a traditional TNM staging system based on multiple tumor types [12]. However, no nomograms are available to report the prognosis of elderly patients with stage I-III GC. In this study, a nomogram was built based on a multivariate regression model to predict CSS in elderly patients with stage I-III GC. Additionally, it can evaluate the effects of different demographic and clinicopathological characteristics on individual patients.

Materials and methods

Data sources

For this retrospective cohort study, data of elderly patients with stage I-III GC were obtained from the SEER database of the National Cancer Institute, which is an effective source for updating annual records of cancer incidence and survival based on the United States' population. The SEER database covers approximately 34.6% of the United States' population. The registration data are open access after obtaining permission, which facilitates clinical relevance data statistics in retrospective studies [13]. To ensure integrated data and adequate follow-up time, we collected the clinicopathological information of elderly patients with primary GC stage I-III diagnosed between 2010 and 2015 using the SEER*Stat software, strictly adhering to the established screening standard. The SEER database was open to the public, and all personal privacy data were deleted. Therefore, informed consent and approval from the institutional ethics review board were not required.

Patient selection

Inclusion criteria of the current study were as follows: 1) patients aged ≥ 65 years at diagnosis; 2) GC as the first and only primary malignancy; 3) histopathologically confirmed diagnosis; and 4) AJCC clinical stages I-III. Exclusion criteria were as follows: 1) metastatic GC from other organ tissues; 2) unknown tumor stage or clinical stage IV; 3) unknown surgical treatment and gender; and 4) unknown survival data. Baseline information was extracted according to clinicopathological characteristics, including age, race, marital status, insurance, gender, histological type, tumor size, positive regional nodes, histological grade, T stage, N stage, chemotherapy, radiation, TNM stage, and surgical patterns of the primary tumor (gastrectomy or no operation was performed). Notably, elderly patients regularly develop complications and poor general conditions, thereby increasing the risk of non-cancerous death. To reduce the impact of comorbidities on overall survival, we focused on CSS, which was evaluated as the time from the date of diagnosis to death attributed to GC or follow-up deadline. Detailed patient selection process is shown in **Figure 1**.

Statistical analysis

Eligible patients were randomly assigned to a training cohort (7,693) for model construction and to a validation cohort (5,127) for model validation at a ratio of 6:4. Hazard ratios (HRs) and their corresponding 95% CIs were calculated using univariate and multivariate Cox regression models, whereby we excavated

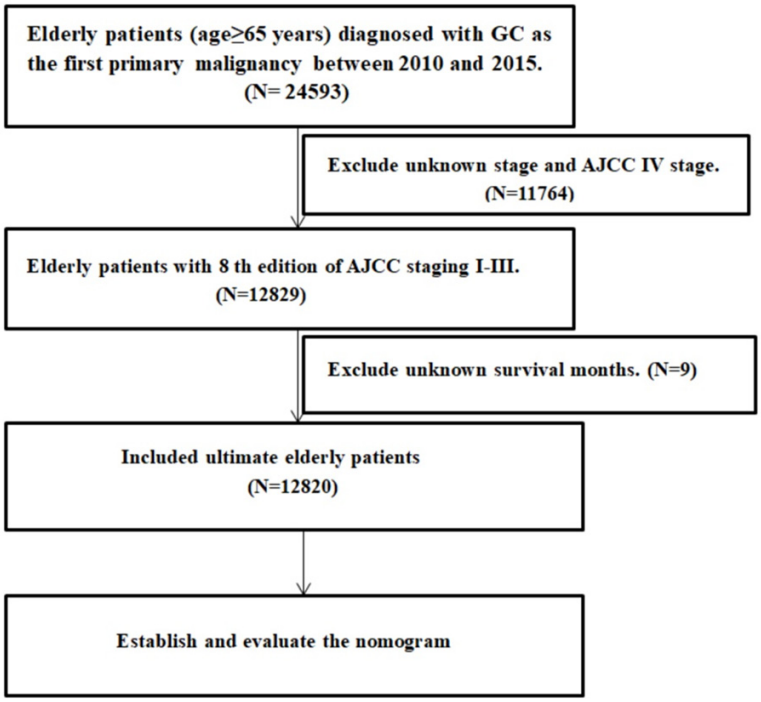

Figure 1. Flow diagram of the detailed patient selection process.

independent predictors closely associated with prognosis. Baseline characteristics were compared using the Mann-Whitney U-test (continuous variables) or chi-square test (categorical variables). All the independent predictors identified by the multivariate Cox regression analysis were used to construct the nomogram. We used the C-index and area under the time-dependent receiver operating characteristics curve (tAUC) to assess the predictive accuracy and discrimination of the prognostic nomogram. Calibration curves were plotted to visually reflect the difference and compare the nomogram-predicted probabilities with the actual observed values. DCA was applied to estimate the clinical validity of the nomogram compared with the AJCC staging system [14]. The Kaplan-Meier method was employed for survival analysis and compared using the log-rank test. Moreover, we used X-tile software (version 3.6.1, Yale University School of Medicine, New Haven, CT, USA) to determine the optimal cut-off of prognostic scores obtained from the nomogram [15]. Based on the cutoff values of the prognostic scores, we stratified the patients into subgroups with distinct prognoses.

Statistical analyses were performed using R package (version 4.1.0). All the tests were two-sided, and a *p*-value lower than 0.05 denoted statistical significance.

Results

Baseline patient characteristics

A total of 12,820 eligible elderly patients with stage I-III GC were included in this study, and divided into training (n = 7,693) and validation (n = 5,127) cohorts. The demographic characteristics and clinicopathological features of the patients are summarized in **Table 1**. In the entire population, most patients were male (7,869; 61.4%), white (9,120; 71.1%) and married (7,174; 56.0%). Insurance covered 86.4% of the elderly patients, aged 76.3 years on an average. The predominant histological type was adenocarcinomas (9,590; 74.8%). Most of the elderly patients underwent gastrectomy (8,659; 67.5%). More than half of the patients (7,105; 55.4%) had tumor diameters ≥ 2 cm. A large proportion of the patients had grade II (3,363; 26.2%) and grade III (5,823; 45.4%) tumors. Considering the poor nutritional status of elderly patients, decline in postoperative recovery ability and shortening of expected survival time, 5,078 (39.6%) patients received chemotherapy. The 1-, 3-, and 5-year CSS rates of the patients were 0.790, 0.642, and 0.596, respectively, with a median follow-up time of 45 months. Additionally, according to the AJCC staging system, TNM stages I, II, and III accounted for 44.6%, 25.2%, and 30.2% of the patients, respectively.

Independent prognostic factors for CSS

In total, 3,893 (30.4%) patients succumbed to CSS until the last follow-up. Patients with no endpoint events during the follow-up were included in the analysis. Univariate and multi-

Table 1. Baseline demographic and clinicopathological characteristics of the patients

Variable	Total (N = 12820)	Training cohort (N = 7693)	Validation cohort (N = 5127)	*P*-value
Age (year), mean ± SD	76.3 ± 7.5	76.2 ± 7.5	76.3 ± 7.5	0.767
Gender				0.177
Female	4951 (38.6)	2934 (38.1)	2017 (39.3)	
Male	7869 (61.4)	4759 (61.9)	3110 (60.7)	
Race				0.293
Black	1550 (12.1)	905 (11.8)	645 (12.6)	
White	9120 (71.1)	5495 (71.4)	3625 (70.7)	
Other	2101 (16.4)	1259 (16.4)	842 (16.4)	
Unknown	49 (0.4)	34 (0.4)	15 (0.3)	
Marital status				0.751
Married	7174 (56.0)	4310 (56.0)	2864 (55.9)	
Unmarried	4957 (38.7)	2979 (38.7)	1978 (38.6)	
Unknown	689 (5.4)	404 (5.3)	285 (5.6)	
Insurance				0.475
Insured	11081 (86.4)	6627 (86.1)	4454 (86.9)	
Any Medicaid	1645 (12.8)	1007 (13.1)	638 (12.4)	
Uninsured	94 (0.7)	59 (0.8)	35 (0.7)	
Histology				0.554
Adenocarcinomas	9590 (74.8)	5740 (74.6)	3850 (75.1)	
Others	3230 (25.2)	1953 (25.4)	1277 (24.9)	
Grade				0.720
I	1259 (9.82)	735 (9.55)	524 (10.2)	
II	3363 (26.2)	2039 (26.5)	1324 (25.8)	
III	5823 (45.4)	3492 (45.4)	2331 (45.5)	
IV	250 (2.0)	153 (2.0)	97 (1.9)	
Unknown	2125 (16.6)	1274 (16.6)	851 (16.6)	
Disease stage				0.150
I	5715 (44.6)	3410 (44.3)	2305 (45.0)	
II	3232 (25.2)	1911 (24.8)	1321 (25.8)	
III	3873 (30.2)	2372 (30.8)	1501 (29.3)	
Tumor stage				0.060
T1	4724 (36.8)	2807 (36.5)	1917 (37.4)	
T2	2048 (16.0)	1216 (15.8)	832 (16.2)	
T3	3946 (30.8)	2436 (31.7)	1510 (29.5)	
T4	2102 (16.4)	1234 (16.0)	868 (16.9)	
Node stage				0.256
N0	7885 (61.5)	4707 (61.2)	3178 (62.0)	
N1	2584 (20.2)	1541 (20.0)	1043 (20.3)	
N2	1203 (9.4)	754 (9.8)	449 (8.8)	
N3	1148 (9.0)	691 (9.0)	457 (8.9)	
Tumor size (cm)				0.252
≤ 2	2623 (20.5)	1573 (20.4)	1050 (20.5)	
2-5	4203 (32.8)	2505 (32.6)	1698 (33.1)	
≥ 5	2902 (22.6)	1786 (23.2)	1116 (21.8)	
Unknown	3092 (24.1)	1829 (23.8)	1263 (24.6)	
Regional nodes				0.671

Negative	3499 (27.3)	2120 (27.6)	1379 (26.9)	
Positive	3412 (26.6)	2048 (26.6)	1364 (26.6)	
Unknown	5909 (46.1)	3525 (45.8)	2384 (46.5)	
Surgery				0.527
No	4161 (32.5)	2480 (32.2)	1681 (32.8)	
Yes	8659 (67.5)	5213 (67.8)	3446 (67.2)	
Radiation				0.095
Yes	3437 (26.8)	2104 (27.3)	1333 (26.0)	
None/Unknown	9383 (73.2)	5589 (72.7)	3794 (74.0)	
Chemotherapy				0.874
Yes	5078 (39.6)	3052 (39.7)	2026 (39.5)	
No/Unknown	7742 (60.4)	4641 (60.3)	3101 (60.5)	

Data are mean ± SD or n (%). Percentages might not total 100% because of rounding.

variate analyses based on Cox regression were applied to evaluate the independent risk factors for CSS in the training cohort. According to univariate Cox regression analyses, age, gender, race, grade, TNM stage, T-stage, N-stage, operation, tumor size, regional nodes, radiation, and chemotherapy were significantly associated with CSS (**Table 2**). Further, the multivariate analysis validated that age, race, grade, TNM stage, T-stage, N-stage, operation, tumor size, regional nodes, radiation, and chemotherapy could be adopted to construct the predictive model ($P < 0.05$ for all), and were independent prognostic factors for the CSS (**Table 2**; **Figure 2**).

Construction and validation of prognostic nomograms

All significant risk factors were integrated to construct a nomogram for predicting the 1-, 3-, and 5-year CSS probabilities. To achieve this, we calculated the sum of point values corresponding to each patient's characteristics (**Figure 3**). The nomogram model demonstrated great discriminative ability in both cohorts, with C-indices of 0.802 (95% CI: 0.7939-0.8114) and 0.791 (95% CI: 0.7812-0.8024), respectively (**Table 3**). The area under the ROC curve (AUC) values of the nomogram at 1-year, 3-year, and 5-year were 0.850, 0.866, and 0.869, respectively, in the training cohort and 0.836, 0.867, and 0.881, respectively, in the validation cohort (**Figure 4A**, **4B**). Combined with C-indices, the nomogram showed reliable sensitivity and specificity in predicting CSS. Furthermore, calibration curves were applied in the two groups to test the prediction accuracy of CSS by the nomogram (**Figure 5A-F**), illustrating that the prediction results of the nomograms in 1-year, 3-year, and 5-year CSS were significantly correlated with the actual observation. The DCA analysis showed that the nomogram added more net benefits than the TNM staging system when predicting CSS among the patients in the training and validation cohorts, revealing that the nomograms had good clinical value (**Figure 6A-C**). Based on the optimal cutoff values of prognostic scores determined by the Xtile software, we categorized the patients into three groups (group 1, < 230.4; group 2, 230.4-307.5; and group 3, > 307.5). The Kaplan-Meier analysis demonstrated significant statistical diversity in survival rates among the three patient groups with discrepant risks (**Figure 7**).

Discussion

With the prolonged life expectancy and popularity of gastroscopy in recent years, the number of elderly patients diagnosed with GC is expected to rise in the future [16]. At present, radical gastrectomy remains the main treatment option for improving the prognosis of elderly GC patients. The choice to undergo chemotherapy depends on the pathological stage results. Unlike young patients, elderly patients have more comorbidities, discrepant degrees of organ function degradation, and reduced postoperative recovery ability. Thus, clinicians are expected to develop personalized treatment and follow-up strategies for patients based on their specific physiological conditions [17]. Herein, to prolong the survival time of elderly patients with GC, we established reli-

Table 2. Univariate and multivariate analysis of cancer-specific survival in the training cohort

Variable	Univariate analysis HR (95% CI)	*P*-value	Multivariate analysis HR (95% CI)	*P*-value
Age (year)	1.058 [1.052-1.063]	< 0.001	1.032 [1.026-1.038]	< 0.001
Sex				
Female	Ref.		Ref.	
Male	0.855 [0.787-0.929]	< 0.001	0.926 [0.851-1.008]	0.075
Race				
Black	Ref.		Ref.	
White	0.713 [0.634-0.801]	< 0.001	0.760 [0.675-0.855]	< 0.001
Other	0.754 [0.653-0.871]	< 0.001	0.763 [0.659-0.884]	< 0.001
Unknown	0.429 [0.191-0.962]	0.0399	0.471 [0.210-1.057]	0.068
Disease stage				
I	Ref.		Ref.	
II	1.350 [1.206-1.510]	< 0.001	0.890 [0.728-1.087]	0.253
III	2.516 [2.287-2.768]	< 0.001	0.690 [0.522-0.912]	0.009
Tumor category				
T1	Ref.		Ref.	
T2	0.798 [0.688-0.925]	0.0027	0.995 [0.838-1.181]	0.956
T3	1.358 [1.221-1.511]	< 0.001	1.560 [1.273-1.912]	< 0.001
T4	3.110 [2.791-3.466]	< 0.001	2.936 [2.323-3.710]	< 0.001
Node category				0.256
N0	Ref.		Ref.	
N1	1.718 [1.547-1.908]	< 0.001	1.351 [1.150-1.589]	< 0.001
N2	1.911 [1.680-2.173]	< 0.001	1.829 [1.468-2.279]	< 0.001
N3	3.421 [3.052-3.835]	< 0.001	2.844 [2.274-3.558]	< 0.001
Grade				
I-II	1		1	
III-IV	2.289 [2.077-2.524]	< 0.001	1.623 [1.463-1.799]	< 0.001
Unknown	1.260 [1.096-1.449]	0.0011	0.840 [0.728-0.969]	0.0165
Tumor size (cm)				
≤ 2	Ref.		Ref.	
2-5	2.608 [2.211-3.076]	< 0.001	1.666 [1.403-1.980]	< 0.001
≥ 5	4.027 [3.415-4.749]	< 0.001	1.915 [1.600-2.292]	< 0.001
Unknown	5.670 [4.818-6.674]	< 0.001	2.307 [1.942-2.742]	< 0.001
Surgery				
No	Ref.		Ref.	
Yes	0.291 [0.267-0.316]	< 0.001	0.171 [0.147-0.199]	< 0.001
Regional nodes				
Negative	Ref.		Ref.	
Positive	4.274 [3.729-4.899]	< 0.001	2.029 [1.679-2.452]	< 0.001
Unknown	3.597 [3.149-4.108]	< 0.001	1.070 [0.895-1.279]	0.457
Radiation				
None/Unknown	Ref.		Ref.	
Yes	0.882 [0.803-0.968]	0.0083	0.676 [0.606-0.754]	< 0.001
Chemotherapy				
No/Unknown	Ref.		Ref.	
Yes	0.933 [0.858-1.014]	0.102	0.620 [0.558-0.689]	< 0.001

HR denotes hazard ratio, CI confidence interval.

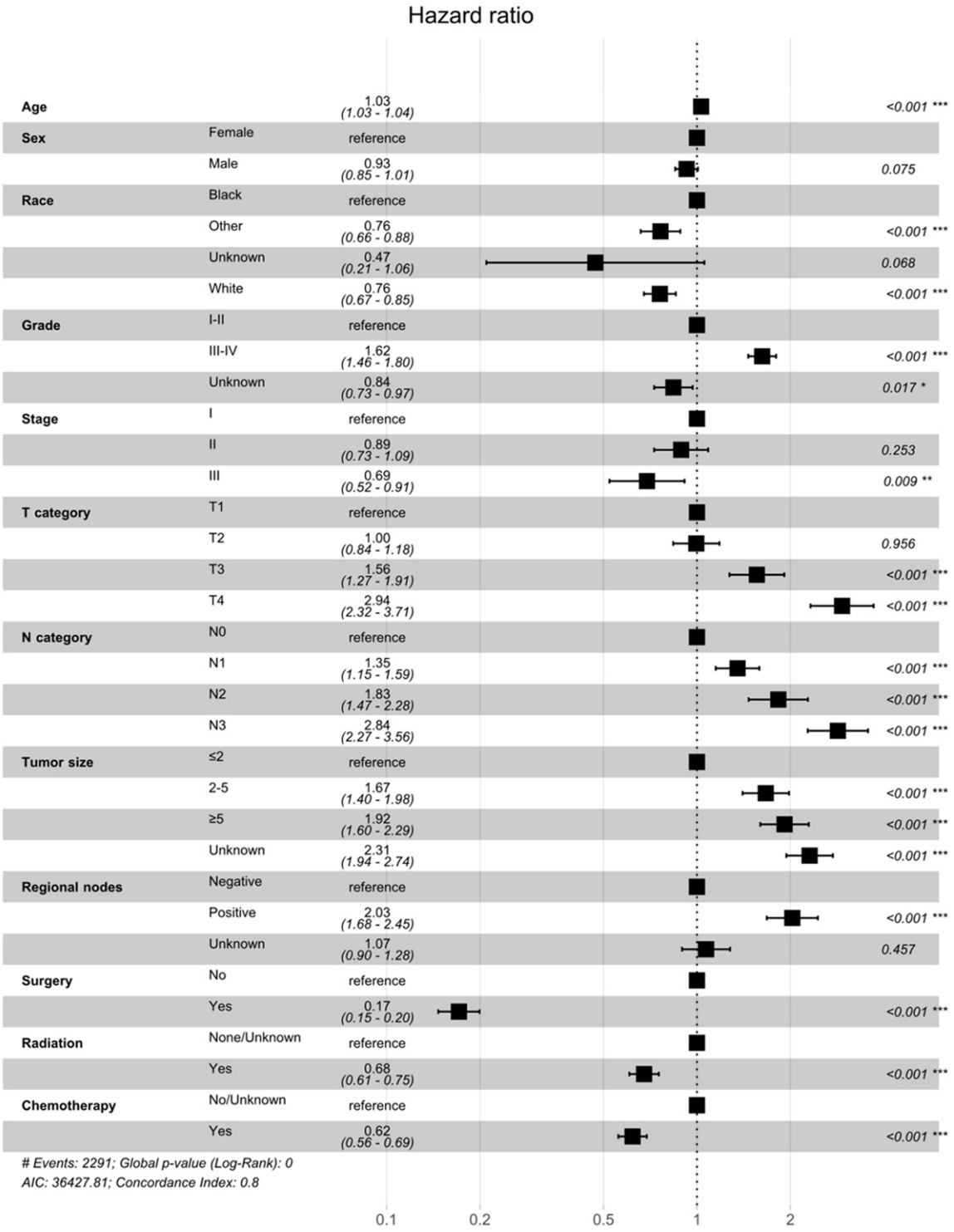

Figure 2. Forest plot model shows independent risk factors in the training cohort.

able and convenient assessment models that could effectively predict patient prognosis and provide a basis for clinicians to devise treatment strategies.

The AJCC TNM staging system is a crucial tool for predicting the prognosis of patients with GC. It can comprehensively evaluate tumor extension, lymph node metastasis, and distant

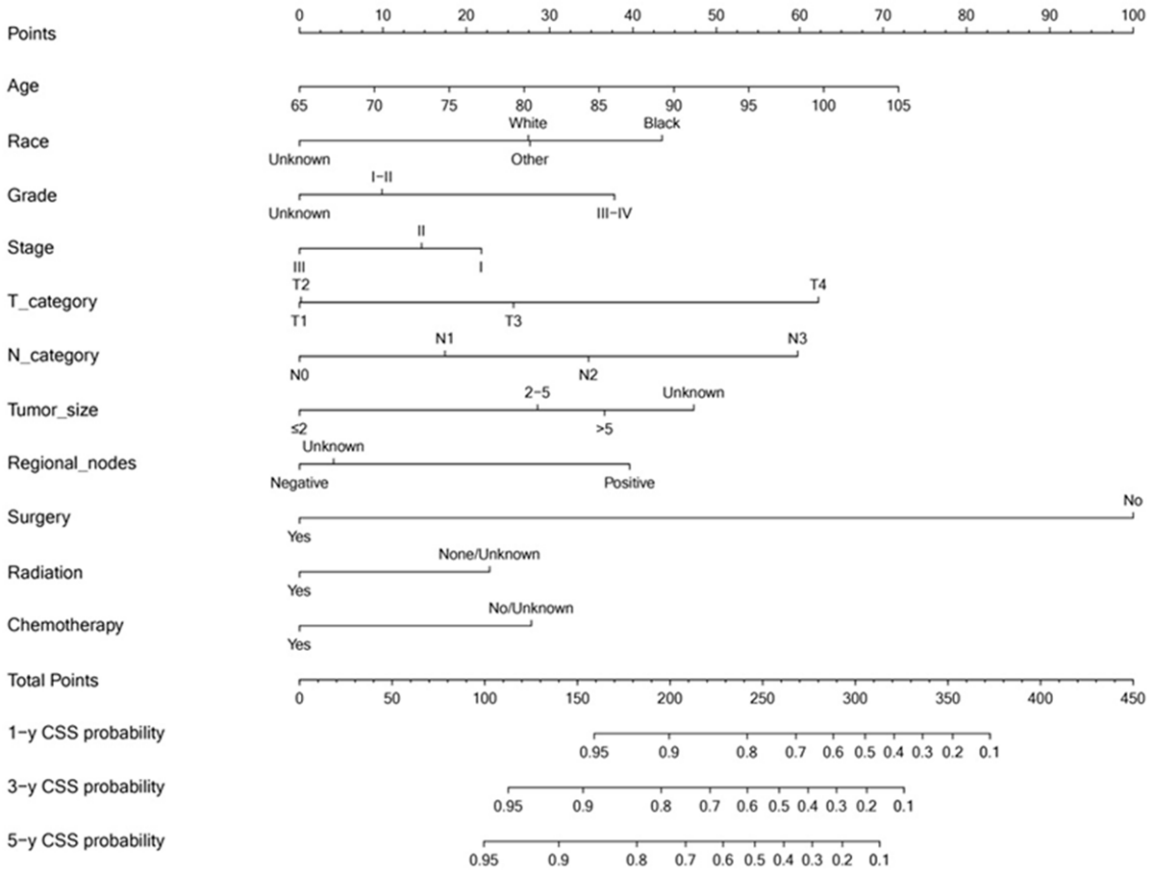

Figure 3. Nomogram of predicting 1-, 3-, and 5-year cancer-specific survival for elderly patients with GC.

Table 3. C-indexes for the nomograms and other stage systems in patients with GC

Model	Training cohort		Validation cohort	
	C-index	95% CI	C-index	95% CI
Nomogram	0.802	(0.794-0.811)	0.791	(0.794-0.811)
Disease stage	0.598	(0.578-0.602)	0.590	(0.576-0.605)
Tumor category	0.609	(0.598-0.622)	0.604	(0.590-0.619)
Node category	0.588	(0.577-0.599)	0.576	(0.794-0.811)

HR denotes hazard ratio, CI confidence interval.

metastasis, and guide clinical work in consultation with the expected survival time [18]. However, the TNM staging system excludes independent risk factors, such as age, tumor size, and operation mode in the analysis range; thus, it cannot achieve a comprehensive prognosis evaluation of individual patients. In most cases, we found that GC patients with similar TNM stage exhibited significant differences in clinical survival time. Additionally, the prognosis of invalids in stage I-III elderly patients is heterogeneous because the populations are commonly associated with various chronic diseases, including cardiac dysfunction, pulmonary failure, cerebrovascular diseases, and diabetes mellitus. Additionally, instances of death attributed to other causes may appear before cancer-specific etiological events, which influences the follow-up survival results. Collectively, the prediction of prognosis based on TNM staging may show different degrees of deviation. Compared with TNM staging, a nomogram integrates both clinicopathological and demographic characteristics into a comprehensive model to predict CSS in patients. A nomogram adopts quantitative and intuitive lines to convey the predictive value of various independent risk factors and is more significant in terms of sensitivity, accuracy, and specificity [19]. Furthermore, it predicts the individual prognosis risk of different patients by calculating the

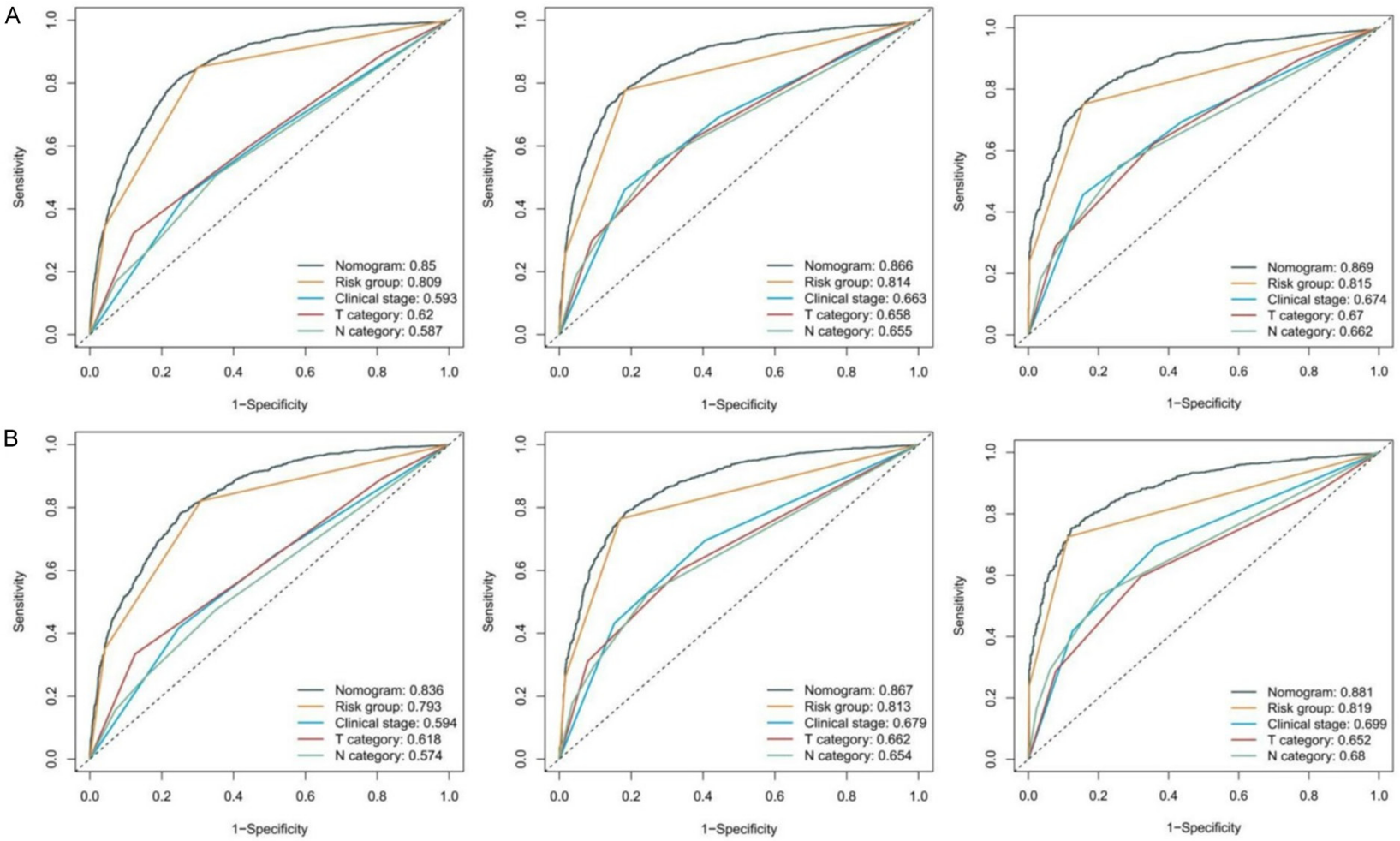

Figure 4. The time-dependent ROC curves of nomograms compared with the AJCC staging system. A. The AUC values of ROC were 85.0%, 86.6% and 86.9% regarding nomograms predicting 1-, 3- and 5-year CSS in training cohort. B. The 1-, 3-, and 5-year AUC values of the nomogram for CSS were 83.6%, 86.7% and 88.1% in validation cohort.

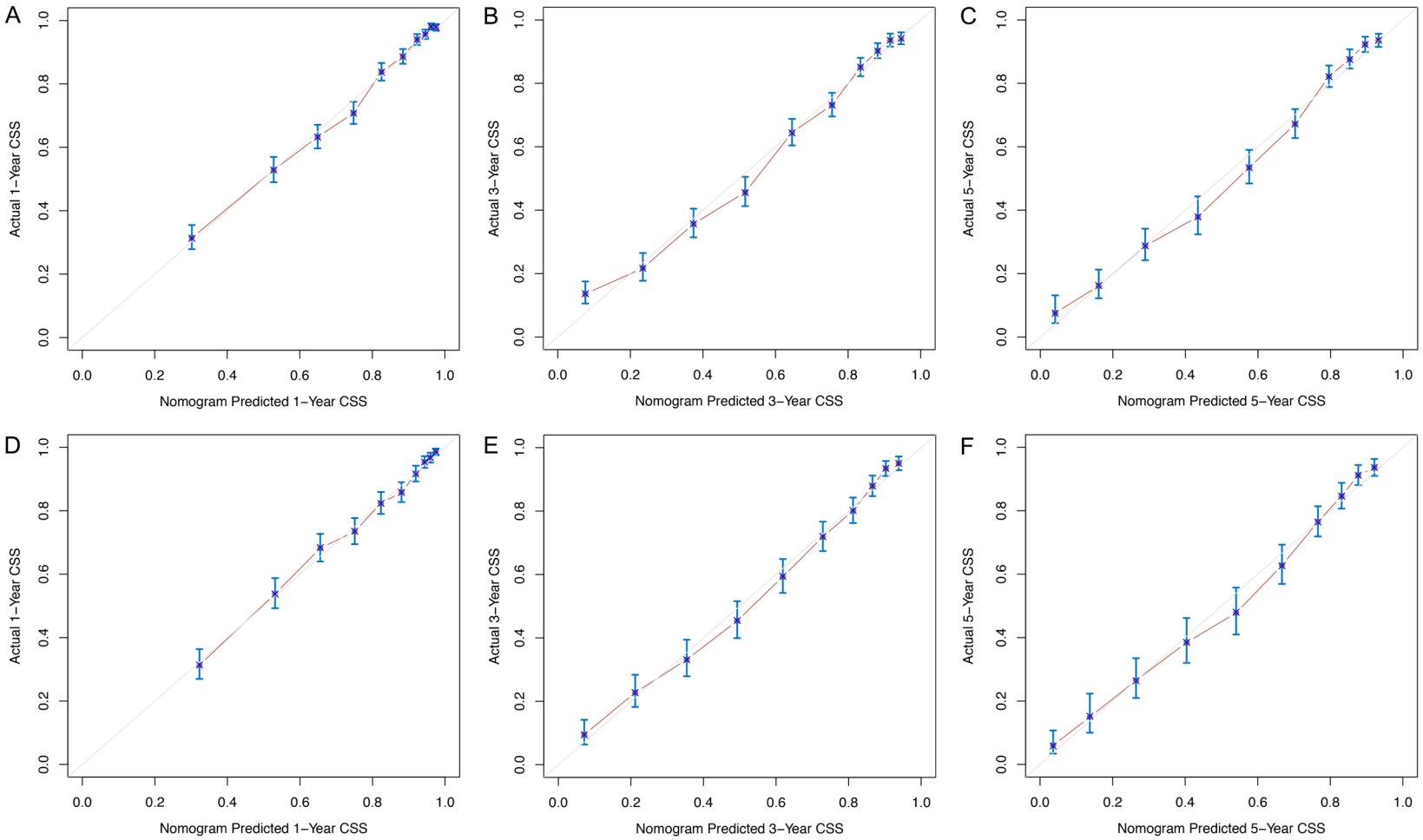

Figure 5. The calibration curve for predicting patients' cause-specific survival. A. The calibration plots for 1-year CSS in training cohort. B. The calibration plots for 3-year CSS in training cohort. C. The calibration plots for 5-year CSS in training cohort. D. The calibration plots for 1-year CSS in validation cohort. E. The calibration plots for 3-year CSS in validation cohort. F. The calibration plots for 5-year CSS in validation cohort.

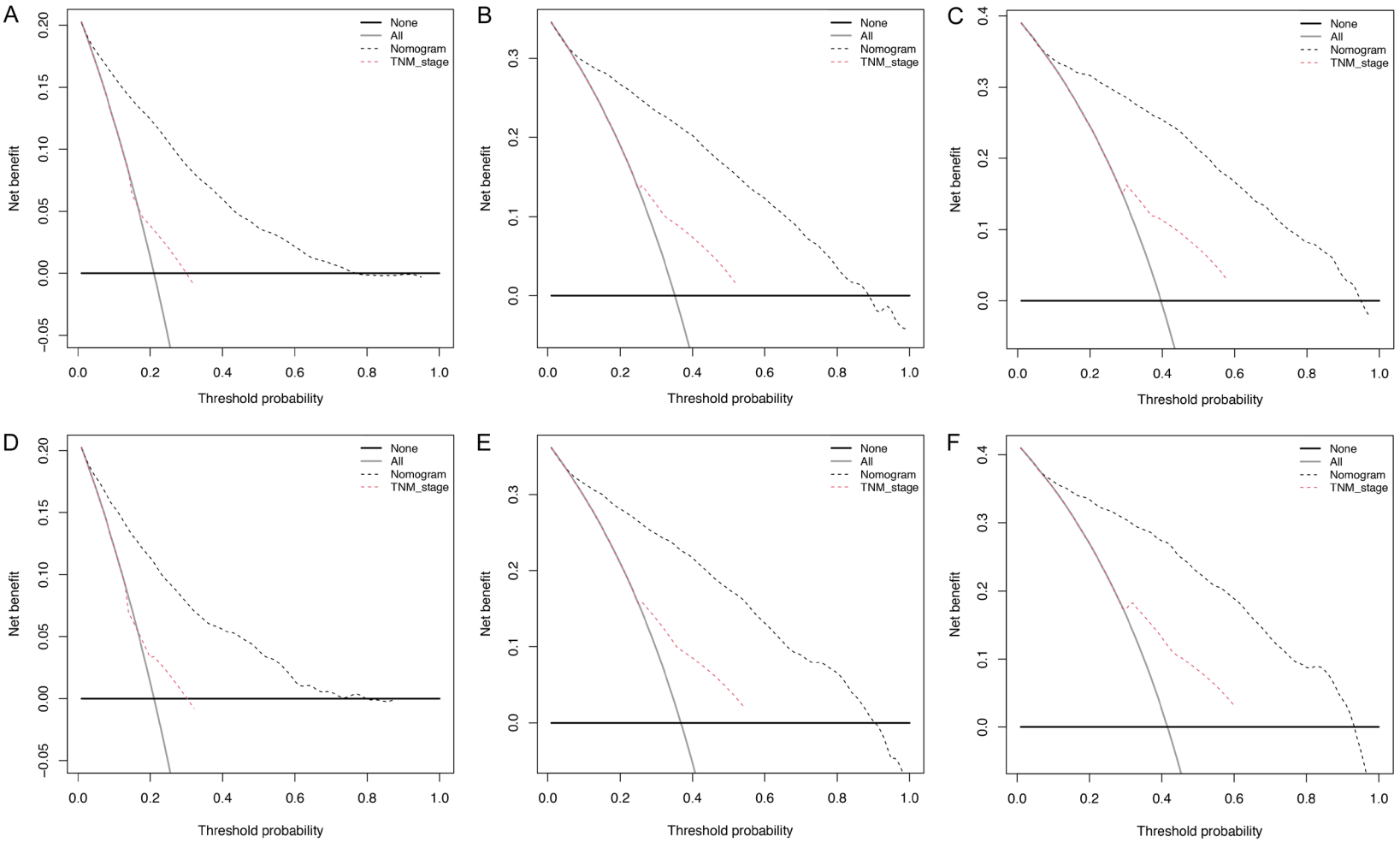

Figure 6. Decision curve analysis (DCA) of CSS nomograms. A. The DCA of the nomogram for 1-CSS in the training cohort. B. The DCA of the nomogram for 3-CSS in the training cohort. C The DCA of the nomogram for 5-CSS in the training cohort. D. The DCA of the nomogram for 1-CSS in the validation cohort. E. The DCA of the nomogram for 3-CSS in the validation cohort. F. The DCA of the nomogram for 5-CSS in the validation cohort.

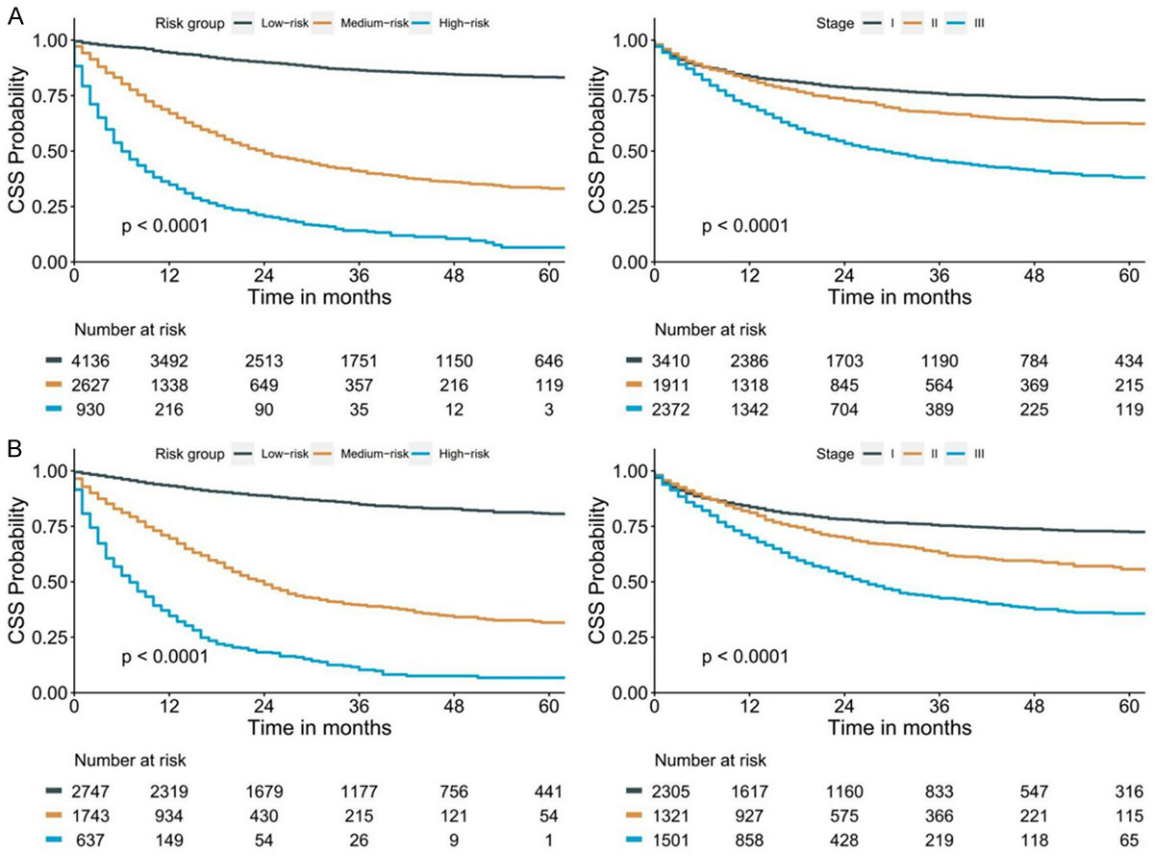

Figure 7. A. Kaplan-Meier survival curves for cancer-specific survival in training cohort. B. Kaplan-Meier survival curves for cancer-specific survival in validation cohort.

total score of individuals for different predictors. Thus, an oncologist can formulate personalized postoperative clinical decision-making and follow-up plans [20]. To the best of our knowledge, many studies in the past decade have explored the prognosis of patients with stage I-III GC [21]. However, a smaller proportion of these studies focused on elderly patients, and most were limited by the small sample size of a single center [22]. Moreover, elderly patients often succumb to comorbidities. Aggravation of comorbidity arises from an enhancement of the tumor's metabolic status and toxic effect of cancer treatment [23], making CSS prediction more critical in survival counseling and treatment planning. However, we did not identify any model tools for individualized prognosis and survival assessment of CSS in elderly patients with stage I-III GC.

Furthermore, we extracted the clinical registration data of elderly GC patients subjected to relevant treatment in the United States between 2010 and 2015 and constructed a nomogram for personalized prediction of CSS. The ability of these nomograms to predict the prognosis of elderly patients with stage I-III GC was compared with the TNM staging. The results showed that the C-index of the nomogram and TNM staging in the training and validation groups, were 0.802 (95% CI: 0.7939-0.8114) versus 0.589 (95% CI: 0.5780-0.6017) and 0.791 (95% CI: 0.7812-0.8024) versus 0.590 (95% CI: 0.5764-0.6049), respectively, indicating that the nomogram could provide a more accurate prognosis prediction. The calibration curves demonstrated no apparent deviation between the predicted and actual observation values in the two groups of included patients. Multivariate regression analysis revealed that clinical factors, such as age, race, grade, TNM stage, T-stage, N-stage, operation, tumor size, regional nodes, radiation, and chemotherapy were significantly associated with CSS in the elderly patients with stage I-III GC. Notably, our nomogram integrated various

independent predictors, indicating the complexity of elderly patients with stage I-III GC disease. By integrating the scores of each independent risk predictor, the ultimate nomogram represented an individualized prognosis prediction scheme, and the results were reproducible, thereby providing a generalized conclusion. Additionally, the DCA curve revealed that the predictive nomogram model had higher clinical practicability and more benefits to patients in the treatment process than the TNM stages. The AUC results further verified the C-index value, making the nomogram more representative. Finally, based on the stratification survival analysis results, the prognoses of the three groups were significantly different. This affirmed that the nomograms could predict the independent survival of individual patients and provide a reliable basis for prognosis consultation.

As a public resource database, the SEER database provides crucial clinical and baseline information for elderly patients with GC. Although it cannot integrate all integral prognostic factors, it remains a significant data source for constructing effective prediction models [24]. Our nomogram is based on the development of SEER data with a large sample size. Moreover, the establishment of the model follows a rigorous programmable decision [25], that guarantees the reliability and accuracy of the results. Remarkably, we present the first predictive model to evaluate CSS among elderly patients with stage I-III GC, diminishing the risk of death induced by comorbidities for prognostic survival analysis. This finding offers an essential basis for devising clinical treatment strategies and prognosis consultations. Despite the merits of our study, some limitations cannot be ignored. First, although independent predictors were comprehensively integrated, the nomogram could not include nonnumerical information and potentially key indicators, such as advanced technologies, mental health, and family social support to evaluate the characteristics of elderly patients. This may have influenced its predictive effectiveness [26]. Second, the SEER database contains incomplete and ambiguous patient information, including regimens and cycles of adjuvant chemotherapy. These factors are thought to reduce the recurrence rate and slow GC progression [27]. Consequently, the elimination of patients without specific data may introduce selection bias. Third, this was a single data-set and retrospective analysis with associated fixed limitations that should be examined in other centers or databases. Additionally, before the clinical application and prognostic stratification analysis, future prospective experiments are warranted to verify the present results.

In conclusion, the present study developed and validated a simple and accurate prognostic model for predicting CSS probability in elderly patients with stage I-III GC. This model has been validated and is promising for the evaluation of CSS prognosis. It could be a convenient tool for devising individualized clinical treatment strategies and postoperative consultation for the expected survival time of elderly patients with stage I-III GC.

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Disclosure of conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Address correspondence to: Dr. Yong-Xiang Li, Department of General Surgery, The First Affiliated Hospital of Anhui Medical University, Hefei 230022, Anhui, China. E-mail: liyongxiang@ahmu.edu.cn

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