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ORIGINAL ARTICLE

Clinical significance of pre-operative prognostic nutritional index in predicting survival in patients with renal cell carcinoma

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ABSTRACT

BACKGROUND
Renal cell carcinoma (RCC) is a prevalent urologic malignancy with heterogeneous outcomes even after surgery. Conventional prognostic factors are insufficient to capture host-related influences on survival. The prognostic nutritional index (PNI), derived from serum albumin and lymphocyte count, reflects nutritional and immunological status and has emerged as a potential prognostic biomarker. The objective of this study was to determine preoperative PNI in predicting survival outcomes of RCC patients.

METHODS
This was a retrospective cohort study involving 107 RCC patients who underwent radical or partial nephrectomy. Patients were categorized into normal and low PNI. Associations between PNI and clinicopathological features were assessed, while survival outcomes were evaluated using Kaplan–Meier analysis and Cox proportional hazards regression.

RESULTS
Patients' mean age was 53.1 ± 13.5 years, and 58.9% of the patients were male. Clear cell carcinoma was the most common histological type (69.2%). Low PNI was significantly associated with older age ($p=0.04$), metastatic disease ($p<0.001$), and advanced tumor stage ($p=0.014$). Kaplan–Meier analysis demonstrated significantly poorer survival in the low-PNI group ($p<0.001$). In the multivariate Cox model, PNI remained the strongest independent predictor of overall survival (HR = 0.29, 95% CI: 0.13–0.67, $p=0.003$), while metastasis also retained independent significance (HR = 2.04, 95% CI: 1.06–3.93, $p=0.031$).

CONCLUSION
The PNI is an independent, simple, and cost-effective prognostic factor for overall survival in RCC. Incorporating PNI into preoperative risk stratification may enhance clinical decision-making. Therefore, PNI could be used as an effective prognostic indicator in RCC.

Keywords: Renal cell carcinoma, prognostic nutritional index, overall survival, cancer prognosis, immunological status

INTRODUCTION

Renal cell carcinoma (RCC) is one of the most prevalent urogenital malignancies worldwide. In 2020, an estimated 431,288 new cases of kidney cancer (KC) were reported globally.[1] In China, approximately 66,000 new RCC cases were documented annually between 2000 and 2011.[2] Clinically, 20–30% of patients with localized RCC who undergo surgical resection subsequently experience local recurrence or develop metastatic disease.[3] Therefore, accurate prognostic assessment of RCC is critically important for both clinicians and patients in guiding postoperative management. Among patients undergoing nephrectomy, conventional prognostic parameters—such as tumor stage, nuclear grade, and tumor size—remain insufficient to fully account for host-related factors that substantially influence oncological outcomes.[3] Consequently, the identification of reliable host-related prognostic markers remains an unmet clinical need to improve risk stratification and inform treatment decision-making.[2]

The concentration of serum albumin is an important biomarker that reflects both the nutritional and immunological status of cancer patients.[4] Decreased serum albumin levels have been associated with unfavorable prognosis in cancer patients.[5] By combining serum albumin levels with peripheral lymphocyte counts, the prognostic nutritional index (PNI) has been proposed as a prognostic indicator. Several subsequent studies have reported associations between PNI and short-term outcomes, including postoperative infections and wound healing.[2,6,7] Furthermore, Takushima et al.[8] demonstrated a significant correlation between PNI and cancer outcomes and formally introduced a formula for its calculation.

Subsequent investigations from diverse geographic regions have similarly demonstrated the potential prognostic value of PNI in RCC. However, substantial heterogeneity among studies—including variation in PNI cutoff thresholds and differences in study populations, such as the inclusion of metastatic cases and patients receiving targeted therapies—has contributed to inconsistent findings and underscores the need for further validation.[9] Hofbauer et al.[10] reported that a low preoperative PNI was an independent predictor of poor long-term survival in patients with localized RCC. In contrast, in a cohort of 660 patients with RCC who underwent nephrectomy, no statistically significant association was reported between preoperative PNI and cancer-specific survival (CSS) (HR=0.66; 95% CI: 0.41–1.07; p=0.092).[11] In addition, several meta-analyses have evaluated the prognostic significance of PNI in RCC. Kim et al. [12] and Mao et al. [13] consistently demonstrated that a reduced PNI is associated with greater tumor aggressiveness and inferior survival outcomes across multiple cohorts. However, it should be noted that, when the PNI is treated as a continuous variable, its prognostic significance may diminish. In their multivariate Cox regression analysis of patients with metastatic RCC receiving targeted therapy, Kwon et al.[14] did not observe a statistically significant association between pretreatment PNI and overall survival (HR=0.96, 95% CI: 0.91-1.00, p=0.076) or progression-free survival (HR = 0.94, 95% CI: 0.85-1.03, p=0.164).

These inconclusive results require further investigation. This study aims to determine whether pre-operative PNI constitutes an independent prognostic factor in predicting survival outcomes of RCC patients.

METHODS

Research design

A retrospective cohort study was conducted at Dr. Sardjito General Hospital, Yogyakarta, Indonesia, from January 2018 to August 2024.

Research subjects

A total of 107 patients diagnosed with RCC and treated with radical or partial nephrectomy with curative intent were included. Inclusion criteria: (1) histopathologically confirmed RCC; (2) availability of complete preoperative laboratory and clinical records; (3) follow-up data accessible. Exclusion criteria: (1) incomplete clinical or laboratory data; (2) prior systemic therapy; (3) concurrent inflammatory or autoimmune disease affecting PNI; (4) bilateral RCC or hereditary syndromes. RCC diagnosis followed WHO classification criteria.[15]

Data collection

Demographic, clinical, and pathological data were obtained from hospital medical records and pathology reports. Variables collected included age, sex, histological RCC subtype, tumor grade, and metastatic status. Preoperative laboratory

values, including serum albumin concentration (g/dL) and lymphocyte counts (cells /mm^3), were used to calculate the PNI using the standard formula: PNI = (10 × serum albumin [g/dL]) + (0.005 × total lymphocyte count [cells/mm^3]).[10]

Patients were followed every three months during the first postoperative year, and survival status was determined from hospital records. Overall survival (OS) was defined as the interval from surgery to death from any cause.

For analytical purposes, patients were categorized into low-PNI and normal-PNI groups. Given the absence of a universally accepted cutoff value, the median PNI of the cohort was used to define these categories.[13] Age was classified into two groups (<60 and ≥60 years). Histological RCC subtype was categorized into clear cell and non–clear cell. Tumor grade was assessed according to the WHO/ISUP grading system and categorized as low grade (grades 1–2) or high grade (grades 3–4). Metastatic status was classified as either present or absent.

Statistical analysis

Associations between PNI and clinicopathological features were examined using non-parametric tests. Survival curves were estimated using the Kaplan–Meier method and compared with the log-rank test. Multivariate Cox proportional hazards regression was performed to evaluate the independent prognostic value of PNI after adjusting for age, sex, tumor stage, metastasis, and histological subtype. Results were expressed as hazard ratios (HRs) with 95% confidence intervals (CIs). All analyses were performed using SPSS version 29.0 (IBM, Armonk, NY, USA), with a two-sided p value <0.05 considered statistically significant.

Ethics approval and consent to participate

This study received approval from the Ethics Committee of Gadjah Mada University prior to initiation (Validation No. 68e31b9db9fe0; approved on October 6, 2025).

RESULTS

A total of 107 patients with renal cell carcinoma (RCC) were included in this study. The majority were younger than 60 years (68%), with a mean age of 53.1 ± 13.5 years. Males were more common than females (58.9% vs. 41.1%). Early-stage disease (pT1/2) accounted for 57.9% of cases. Regarding histopathological subtypes, clear cell carcinoma was the most prevalent (69.2%), while 30.8% consisted of non–clear cell variants. At diagnosis, 28.9% of patients presented with metastatic disease, whereas 71.1% had localized tumors. Patients were subsequently categorized into two groups based on their PNI values: a low-PNI group (<43) and a normal-PNI group (≥43). (Table 1).

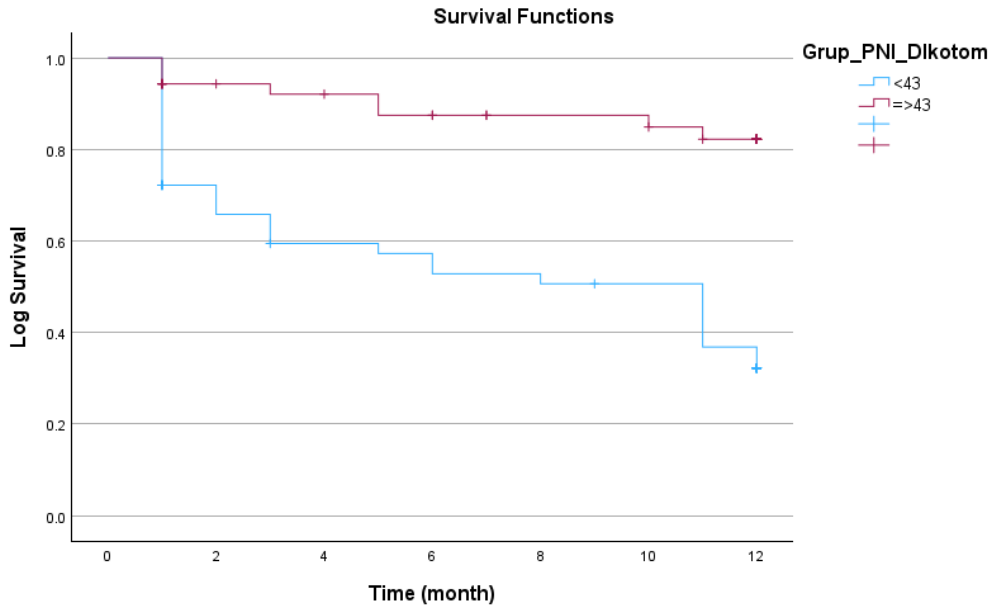
Kaplan–Meier survival analysis revealed significant differences in overall survival according to PNI categories (Log Rank = 23.33; p<0.001). Patients with low PNI had a mean survival of 7.0 months (95% CI: 5.7–8.4). Patients with normal PNI had a mean survival of 10.7 months (95% CI: 9.9–11.6) (Figure 1).

Univariate Cox regression analysis identified PNI, T stage, and metastasis as significant predictors of survival. Low PNI was associated with increased risk of mortality (HR=0.94, 95% CI: 0.92–0.97, p<0.001). Advanced T stage was significantly associated with higher mortality risk (HR=3.04, 95% CI: 1.60–5.76, p=0.001). The presence of metastasis increased the risk of death by 3.45-fold (HR=3.454, 95% CI: 1.85–6.44, p<0.001). Age, gender, and histopathology were not significant predictors (p>0.05) (Table 2). In the multivariate model that included PNI, T stage, and metastatic status, PNI remained an independent prognostic factor (HR=0.29, 95% CI: 0.13–0.67, p<0.001). Metastasis was also identified as a significant prognostic factor (HR= 2.04, 95% CI: 1.06–3.93, p=0.031), whereas T stage did not retain statistical significance (p=0.067) (Table 2).

Table 1. Demographic and clinico-pathological characteristics of patients with RCC (n=107)

Variables	n (%)
Age (years)	
≤ 60	73 (68.2)
> 60	34 (31.8)
Sex	
Male	63 (58.9)
Female	44 (41.1)
Stage (T)	
I-II	62 (57.9)
III-IV	45 (42.1)
Metastasis	
Yes	31 (29.0)
No	76 (71.0)
Histopathology	
Clear cell	74 (69.2)
Non clear cell	33 (30.8)
PNI	
Normal (≥ 43)	54 (50.5)
Low (< 43)	53 (49.5)

Note : data presented as n (%)



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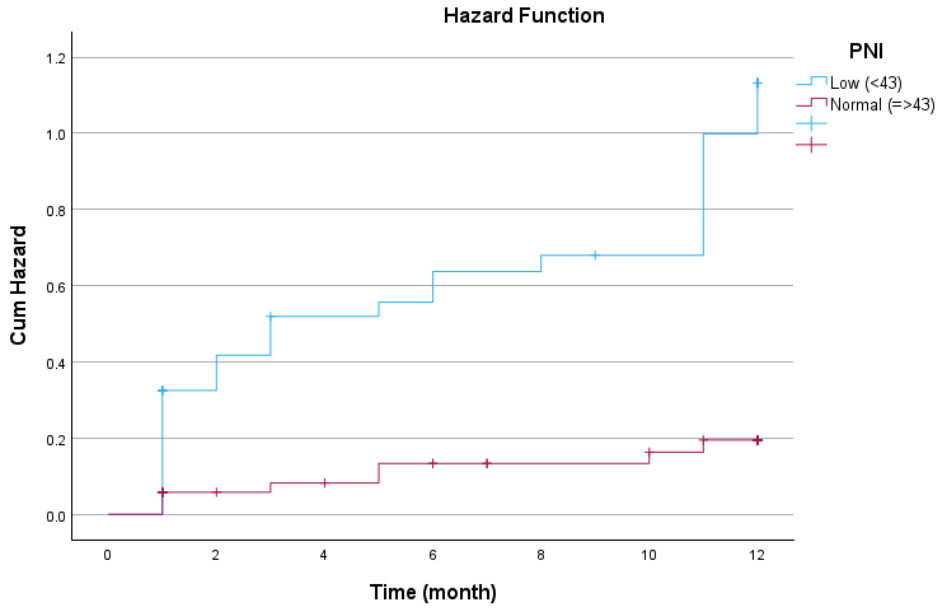

Figure 2. Kaplan-Meier survival analysis (A) overall survival and (B) Hazard function in normal/Low PNI group. Time: time after surgery (months)

Table 2. Univariate and multivariate Cox analyses of overall survival

Variable	Univariate analysis			Multivariate Analysis		
	HR	95% CI	p value	HR	95% CI	p value
Age	1.02	0.52–1.96	0.953	-	-	-
Sex	1.43	0.76–2.70	1.244	-	-	-
Stage	3.04	1.60–5.76	<0.001	1.86	0.95–3.63	0.067
Metastasis	3.45	1.85–6.44	<0.001	2.04	1.06–3.93	0.031
Histopathology	1.76	0.945–3.27	0.081	-	-	-
PNI	0.94	0.92–0.97	<0.001	0.29	0.13–0.67	0.003

Note : PNI : prognostic nutritional index; HR : hazard ratio; C.I. : confidence interval

DISCUSSION

Our findings demonstrated that PNI was a significant and independent predictor of overall survival. Patients with low PNI had substantially shorter survival times compared to those with normal PNI, as confirmed by Kaplan–Meier and multivariate Cox regression analyses. Importantly, PNI retained its prognostic significance even after adjusting for tumor stage and metastasis, underscoring its robustness as a prognostic biomarker in RCC. This finding reinforces the clinical relevance of nutritional and immunological status in cancer progression and outcomes.

The PNI, which combines serum albumin concentration and peripheral lymphocyte count, reflects both nutritional reserves and systemic immune response.[14] Hypoalbuminemia often indicates chronic inflammation and poor nutritional status, while lymphopenia reflects impaired cell-mediated immunity, both of which may contribute to tumor progression and decreased survival.[14,15] Our results are consistent with a previous study, which showed that a low PNI is associated with an adverse prognosis in RCC patients across various stages of disease, including metastatic cases. Hu et al.[11] analyzed 660 patients with RCC who underwent nephrectomy and reported that those with a low preoperative PNI were more likely to be older, have a higher pathological stage, and present with distant metastases.

In the univariate analysis, tumor stage and metastatic status were significantly associated with survival, aligning with the well-established understanding that tumor burden and disease dissemination are key determinants of prognosis.[13] However, in the multivariate model, the prognostic significance of T stage diminished, whereas metastasis remained a significant predictor. Kermani et al.,[16] in a cohort of 230 RCCpatients, also reported that advanced tumor stage and the presence of metastasis were significantly associated with poorer overall survival. In our multivariate analysis, the prognostic contribution of tumor stage was no longer observable after metastatic status and PNI were incorporated into the model, suggesting substantial overlap among these variables. Importantly, PNI exhibited the strongest independent association with overall survival, as reflected by a markedly protective hazard ratio, indicating that systemic host-related factors captured by this index exert significant influence on patient outcomes. The persistent statistical significance of PNI reinforces its robustness as a prognostic biomarker and highlights its capacity to provide prognostic information that extends beyond conventional anatomic parameters.

Other clinicopathological variables, including age, sex, and histopathological subtype, were not significantly associated with survival in this cohort. This is in line with some earlier reports that histological subtype, particularly in clear cell carcinoma, though common, may not independently predict prognosis when adjusted for other factors.[2] The predominance of clear cell RCC in our sample may have further limited the ability to detect differences between histological subtypes.

Our results are supported by several meta-analyses that have demonstrated the prognostic value of PNI in RCC and other malignancies. Mao et al.[13] reported that low PNI was associated with poorer overall survival (HR=2.10, 95% CI: 1.67–2.64) and progression-free survival (HR=1.99, 95% CI: 1.67–2.36) in RCC patients. Beyond RCC, the prognostic role of PNI has also been validated across multiple cancer types. Liao et al.[17] reported that lower PNI correlated with unfavorable prognostic factors and poor prognosis in patients with esophageal cancer, based on a meta-analysis of 3,118 patients. Various types of cancers were shown to be associated with low PNI, such as in the studies of Li et al.[18] and Shao et al.[19] for colorectal and lung cancer, respectively. In addition, Li et al.[20] showed that a low PNI was associated with shorter OS in patients with pancreatic cancer. Another meta-analysis demonstrated that a low PNI could predict short- and long-term survival outcomes in patients with nasopharyngeal carcinoma.[21] These results reaffirm PNI as a robust and clinically meaningful prognostic biomarker, and further establish its role as an independent predictor of survival in patients with RCC.[22]

This study has several limitations. First, its retrospective single-center design may limit the generalizability of the findings. Second, the relatively small number of patients with non–clear cell histology restricted further analysis of subtype-specific outcomes. Third, PNI was assessed only at baseline, and dynamic changes over the disease course were not evaluated. Future prospective multicenter studies with larger sample

sizes and serial monitoring of PNI are warranted to validate these findings.

The PNI is simple, inexpensive, and readily available from routine laboratory tests, making it feasible for integration into preoperative risk stratification. Patients with low PNI may benefit from closer surveillance, prehabilitation, or nutritional-immune optimization prior to surgery.

CONCLUSIONS

Pre-operative PNI demonstrates a significant and independent prognostic factor for overall survival in patients with renal cell carcinoma. Patients with low PNI exhibited markedly worse survival outcomes, and PNI remained an independent predictor even after adjusting for tumor stage and metastasis. Given its simplicity, accessibility, and cost-effectiveness, PNI may serve as a valuable adjunct to conventional prognostic tools in clinical practice. Future multicenter prospective studies are warranted to validate these findings and to evaluate whether nutritional and immunological interventions can improve outcomes in patients with poor PNI.

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Conflict of Interest

All authors declare that there are no conflicts of interest

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Author Contributions

ETPU: conceptualization, validation, writing—original draft preparation, review and editing, and funding acquisition; RD: validation, supervision, and writing—review and editing; ES: surgical management, review, and validation. All authors have read and approved the final manuscript.

Data Availability Statement

Derived data supporting the findings of this case report are available from the corresponding author on request.

Declaration the Use of AI in Scientific Writing

This study utilized artificial intelligence (AI) tools and methodologies, including the AI-based language model ChatGPT, for language refinement (improving grammar, structure, and readability of the manuscript). All AI-assisted processes were thoroughly reviewed by the authors to ensure the integrity and reliability of the work. The final decisions, interpretations, and conclusions presented in this article were made solely by the authors.

REFERENCES

1. Bukavina L, Bensalah K, Bray F, et al. Epidemiology of renal cell carcinoma: 2022 update. Eur Urol 2022;82:529–42. doi: 10.1016/j.eururo.2022.08.019.
2. Tang Y, Liang J, Liu Z, et al. Clinical significance of prognostic nutritional index in renal cell carcinomas. Medicine (Baltimore) 2021;100:10(e25127). doi: 10.1097/MD.0000000000025127.
3. Sonpavde G, Escudier B. Prognosis of renal-cell carcinoma: recognising host genetics. Lancet Oncol 2013;14:9–10. doi: 10.1016/S1470-2045(12)70531-4.
4. Nazha B, Moussaly E, Zaarour M, Weerasinghe C, Azab B. Hypoalbuminemia in colorectal cancer prognosis: nutritional marker or inflammatory surrogate? World J Gastrointest Surg 2015;7:370. doi: 10.4240/wjgs.v7.i12.370.
5. Liu J, Wang F, Li S, Huang W, Jia Y, Wei C. The prognostic significance of preoperative serum albumin in urothelial carcinoma: a systematic review and meta-analysis. Biosci Rep 2018;38:BSR20180214. doi: 10.1042/bsr20180214.
6. Hazer S, Gülhan SŞE, Solak N, et al. the effect of prognostic nutritional index in postoperative infection following lobectomy in non-small cell lung cancer patients. Cureus 2023;15:e37611. doi: 10.7759/cureus.37611.
7. Xiong T, Qin W, Zhang Y, Chen Y, Ou Y. Prognostic nutritional index and naples prognostic score as biomarkers for the prognosis of incisional wound healing after thoracolumbar tuberculosis surgery. PLoS One 2024;19:e0309267. doi: 10.1371/journal.pone.0309267.
8. Takushima Y, Abe H, Yamashita S. [Evaluation of prognostic nutritional index (PNI) as a prognostic indicator in multimodal treatment for gynecological cancer patients]. Gan To Kagaku Ryoho 1994;21:679–82. Japanese.
9. Shim SR, Kim SI, Kim SJ, Cho DS. Prognostic nutritional index as a prognostic factor for renal cell carcinoma: a systematic review and meta-

analysis. PLoS ONE 2022;17:e0271821. doi: 10.1371/journal.pone.0271821.
10. Hofbauer SL, Pantuck AJ, de Martino M, et al. The preoperative prognostic nutritional index is an independent predictor of survival in patients with renal cell carcinoma. Urol Oncol 2015;33:68.e61–7. doi: 10.1016/j.urolonc.2014.08.005.
11. Hu X, Wang YH, Lia T, et al. Prognostic value of preoperative prognostic nutritional index in patients with renal cell carcinoma after nephrectomy. Clinica Chimica Acta 2020;509:210–6. doi: 10.1016/j.cca.2020.06.025.
12. Kim SI, Kim SJ, Kim SL, Cho DS. Prognostic nutritional index and prognosis in renal cell carcinoma: a systematic review and meta-analysis, Urol Oncol 2021;39: 623-30. doi: 10.1016/j.urolonc.2021.05.028.
13. Mao C, Xu W, Ma W, Wang C, Guo Z, Yan J. Prognostic value of pretreatment prognostic nutritional index in patients with renal cell carcinoma: a meta-analysis. Front Oncol 2021;11:719941. doi: 10.3389/fonc.2021.719941.
14. Kwon WA, Kim S, Kim SH, et al. Pretreatment prognostic nutritional index is an independent predictor of survival in patients with metastatic renal cell carcinoma treated with targeted therapy. Clin Genito Canc 2017;15:100–11. doi: 10.1016/j.clgc.2016.07.025.
15. Goswami PR, Singh G, Patel T, Dave R. The WHO 2022 classification of renal neoplasms (5th edition): salient updates. Cureus 2024;16:e58470. doi: 10.7759/cureus.5847014.
16. Kermani AT, Torghabeh AE, Moghadam MC, et al. Evaluation of clinicopathologic characteristics and survival rates of patients with renal cell carcinoma in Northeast of Iran. Int J Cancer Manag 2024;17:e147065. doi: 10.5812/ijcm-147065.
17. Liao G, Zhao Z, Yang H, Chen M, Li X. Can prognostic nutritional index be a prediction factor in esophageal cancer?: a meta-analysis. Nutr Cancer 2020;72:187–93. doi: 10.1080/01635581.2019.1631859.
18. Li H, Sun W, Fu S, et al. Prognostic value of the preoperative prognostic nutritional and systemic immunoinflammatory indexes in patients with colorectal cancer. BMC Cancer 2025;25:403. doi: 10.1186/s12885-025-13828-3.
19. Shao Y, Cao W, Gao X, Tang M, Zhu D, Liu W. Pretreatment "prognostic nutritional index" as an indicator of outcome in lung cancer patients receiving ICI-based treatment: systematic review and meta-analysis. Medicine (Baltimore) 2022;101:e31113. doi: 10.1097/MD.0000000000031113.
20. Li S, Tian G, Chen Z, Zhuang Y, Li G. Prognostic role of the prognostic nutritional index in pancreatic cancer: a meta-analysis. Nutr Cancer 2019;71:207–13. doi: 10.1080/01635581.2018.1559930..
21. Tu X, Ren J, Zhao Y. Prognostic value of prognostic nutritional index in nasopharyngeal carcinoma: a meta-analysis containing 4511 patients. Oral Oncol 2020;110:104991. doi: 10.1016/j.oraloncology.2020.104991.
22. Tang Y, Liang J, Liu Z, et al. Clinical significance of prognostic nutritional index in renal cell carcinomas. Medicine (Baltimore) 2021;100:e25127. doi: 10.1097/MD.0000000000025127.