World Nutrition Journal |eISSN 2580-7013

ORIGINAL PAPER

The preoperative prognostic nutritional index in patients undergoing major gynecologic oncology surgery and its association with postoperative outcomes

Helena Fabiani[1], Wiji Lestari[2], Gatot Purwoto[3]

1. *Department of Nutrition, Faculty of Medicine and Health Sciences, Krida Wacana Christian University, Jakarta, Indonesia*
2. *Department of Nutrition, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia*
3. *Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Indonesia, Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia*

Received 14 July 2025
Accepted 29 October 2025
Published 28 February 2026

Link to DOI:
10.25220/WNJ.V09.i2.0002

Citation: Fabiani H, Lestari W, Purwoto G. The preoperative prognostic nutritional index in patients undergoing major gynecologic oncology surgery and its association with postoperative outcomes. World Nutrition Journal.2026 February 28,9(i2): 13-24.

Abstract

Background: Patients undergoing major surgery for gynecologic cancer often experience postoperative complications. Postoperative complications are influenced by various factors, one of which is nutritional status. The preoperative prognostic nutritional index (PNI), calculated from serum albumin levels and lymphocyte count, is used as a preoperative nutritional parameter and has been associated with postoperative outcomes.

Objective: To investigate the association between preoperative PNI and postoperative outcomes in patients undergoing major gynecologic oncology surgery.

Methods: This prospective observational study was conducted at Dr. Cipto Mangunkusumo National General Hospital in August-December 2024. Subjects were gynecologic cancer patients aged 18-65 years who underwent major surgery. PNI was calculated based on preoperative serum albumin levels and lymphocyte count. Postoperative complications were assessed within 30 days following surgery using the Clavien-Dindo classification. Statistical analysis was performed using Chi-square or Fisher's exact test, followed by multivariable logistic regression.

Results: A total of 56 subjects were included, with a mean age of 47.8 ± 12.3 years and a median PNI of 50.2 (28.9-61.3). Postoperative complications occurred in 35.7% of subjects, with surgical site infections being the most common. The median PNI was lower in the complication group, although the difference was not statistically significant. In multivariable analysis, advanced tumor stage was the only independent predictor of postoperative complications (odd ratio [OR] 4.74, 95% CI 1.26–17.83, p = 0.021). Low PNI showed a nonsignificant trend toward higher odds of complications (OR 1.71, 95% CI 0.47–6.28, p=0.420).

Conclusion: PNI was not statistically significant but showed a trend toward association with postoperative complications, suggesting its potential importance of preoperative nutritional status. Advanced tumor stage was an independent predictor of complications. Further multicenter studies are needed to confirm the prognostic role of PNI in gynecologic oncology surgery.

Keywords: gynecologic cancer, major surgery, postoperative complications, preoperative malnutrition, prognostic nutritional index

Corresponding author:
Name : Helena Fabiani
Insitutions : Krida Wacana Christian University, Jakarta, Indonesia
Email : helena.fabiani@ukrida.ac.id

Introduction

Gynecologic cancers account for more than 1.3 million cases globally, with mortality rates reaching up to 47%.[1] In Indonesia, cervical and ovarian cancers are the most common gynecologic malignancies and are leading causes of cancer-related deaths among women.[2] Surgery remains the cornerstone of treatment for these cancers, particularly in the early stage. Due to their complexity and invasiveness, major gynecologic oncology surgeries are associated with a higher risk of adverse postoperative outcomes, which may increase the length of hospital stay, risk of readmission, and overall cost of care.[3,4]

Preoperative nutritional status is one of the key factors influencing postoperative outcomes. Malnutrition is common in gynecologic cancer and is driven by systemic inflammation, altered energy metabolism, inadequate nutrient intake, and adverse effects of cancer therapy.[5–7] Chronic malnutrition in cancer is associated with impaired immune function, particularly reduced lymphocyte levels and function, and may lead to hypoalbuminemia. These alterations are linked to increased postoperative morbidity and mortality.[6–8]

Several parameters can be used to assess preoperative nutritional status; however, many of them still have some limitations. Subjectivity, lack of comprehensive data, and interference from tumor mass or fluid retention may lead to inaccurate assessment.[9,10] Therefore, a simple and objective nutritional parameter is needed. The prognostic nutritional index (PNI) is a parameter that reflects both nutritional and immune status, calculated based on serum albumin levels and total lymphocyte count.[11–13] Low PNI is associated with preoperative malnutrition and poor surgical outcomes in several malignancies.[6]

Although previous studies have investigated the prognostic role of PNI in gastrointestinal, hepatobiliary, and cardiac surgeries, evidence in gynecologic cancer surgery remains inconclusive.[14–19] Yet prospective data focusing specifically on gynecologic oncology surgery are scarce, particularly in Indonesia. Therefore, this study aimed to investigate preoperative nutritional status using PNI and its association with postoperative complications in patients undergoing major gynecologic oncology surgery.

Methods

This prospective observational study was conducted at Dr. Cipto Mangunkusumo National General Hospital (RSCM), Jakarta, Indonesia, from August to December 2024. A total of 60 consecutive patients met the eligibility criteria during the study period. The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia (KET-865/UN2.F1/ETIK/PPM.00.02/2024).

Study participants

Inclusion criteria were female patients aged 18-65 years with gynecologic cancer undergoing major surgery. Major gynecology oncology surgery was defined as laparotomy for resection of the genital organs (uterus, ovaries, fallopian tubes, vulva, or vagina) as well as adjacent structures that may serve as metastatic pathways, including pelvic and/or para-aortic lymph nodes, omentum, appendix, and peritoneal metastases.[4] Subjects with sepsis or severe infection, chronic liver disease, autoimmune disease,

concurrent malignancies, ongoing chemotherapy or radiotherapy, and taking immunosuppressive drugs (except low-dose corticosteroids <10 mg or non-steroidal anti-inflammatory drugs [NSAIDs]) were excluded.

Data collection

Demographic and clinical data, including age, cancer site, tumor stage, comorbidities, and history of perioperative blood or albumin transfusions, were obtained from medical records. Dietary intake was assessed using food recall and food records collected 3 days preoperatively and up to 30 days postoperatively. Energy intake was categorized using a cut-off of 25 kcal/kg body weight, and protein intake using 1.5 g/kg body weight.[20] Anthropometric measurements were obtained by estimating body weight using mid-upper arm circumference (MUAC) based on the formula by Cattermole et al.,[21] and estimating body height using the formula by Wong et al.[22] Nutritional status was assessed by using Global Leadership Initiative on Malnutrition (GLIM) criteria, and subjects were categorized as malnourished or not malnourished.[23]

Laboratory data

Laboratory data were collected preoperatively (within three weeks prior to surgery), including hemoglobin (Hb) levels, serum albumin, and total lymphocyte count. Subjects were categorized as having low or normal albumin using a cutoff of 3.5 g/dL. The PNI was calculated using the formula by Onodera et al.[24]: PNI = [10 × serum albumin (g/dL)] + [0.005 × total lymphocyte count (/μL)]. PNI with a cut-off value of 45 was used as a nutritional parameter; subjects were categorized as having low PNI (<45) or high PNI (≥45).[25]

Postoperative outcomes

Postoperative complications were assessed within 30 days after surgery, based on medical records and confirmed by the attending physicians. Postoperative complications were classified using the Clavien–Dindo system, which is widely used in major gynecologic oncology surgery.[26] For analysis, complications were grouped as minor (grades I–II) or major (grades III–V) (**Table 1**).

Table 1. Clavien-Dindo classification of surgical complications[26]

Grade	Definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiology interventions Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications Blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic or radiological intervention
IIIa	Intervention not under general anesthesia

Grade	Definition
IIIb	Intervention under general anesthesia
IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management
IVa	Single organ dysfunction (including dialysis)
IVb	Multiorgan dysfunction
V	Death of a patient

*Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.
CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.

Results

A total of 60 patients met the eligibility criteria. Four patients were dropped out because they did not complete the study or were lost to follow-up. Finally, 56 patients were included in the analysis. The study flow is shown in **Figure 1**. Based on the GLIM criteria, 50% of subjects were malnourished, including 23.3% with moderate malnutrition and 26.8% with severe malnutrition. Body mass index (BMI) was 23.7 ± 5.8 kg/m². Ovarian cancer was the most common diagnosis. Most patients had early-stage tumors (I–II), although stage III was the most frequently observed (33.9%), followed by stage I (32.1%), stage II (21.4%), and stage IV (12.5%). Advanced stage (III–IV) was significantly associated with a higher risk of postoperative complications. The most common comorbidities were cardiovascular diseases, followed by diabetes mellitus. Other comorbidities included respiratory diseases (9.4%), renal and urinary tract diseases (9.4%), and cholecystitis (3.1%).

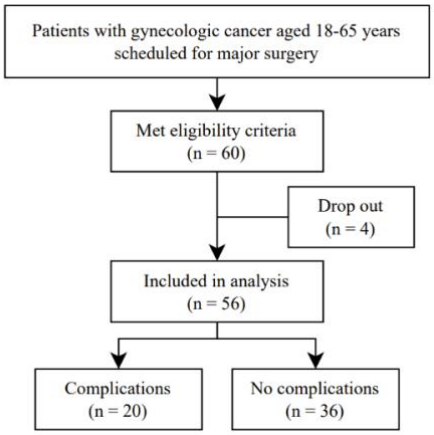

Figure 1. Study flow

Low preoperative albumin was significantly associated with postoperative complications. The median preoperative PNI was lower in patients who experienced postoperative complications compared to those without complications, although the difference did not reach statistical significance. Low PNI was observed in 33.9% of subjects. Postoperative complications occurred in 47.4% of subjects with low PNI compared to 29.7% of those with high PNI. However, this difference was not statistically significant.

Preoperatively, energy intake requirements were met by most subjects, with a median intake of 1,280 (600–1,700) kcal/day. However, protein intake was insufficient in most subject (48.1 ± 14.3 g/day). Postoperatively, 69.6% of subjects met their energy requirements, while only 33.9% met protein targets (52.5 ± 14.6 g/day). Perioperative blood transfusion was significantly associated with postoperative complications, with a higher proportion of complications observed among patients who received transfusions compared to those who did not.

Table 2. Subject characteristics (n=56)

Variable	Results	Complication		p-value
		Yes (n=20)	No (n=36)	
Age	47.8 ± 12.3*	49.3 ± 12.1*	47.2 ± 12.6*	0.762[a]
Nutritional status based on GLIM criteria (n, %)				
Malnourished	28 (50)	13 (46.4)	15 (53.6)	0.246[c]
Not malnourished	28 (50)	7 (25)	21 (75)	
Cancer site (n, %)				
Ovary	32 (57.1)	11 (34.4)	21 (65.6)	0.963[d]
Endometrium	19 (33.9)	7 (36.8)	12 (63.2)	
Cervix	5 (8.9)	2 (40)	3 (60)	
Vulva/vagina	0 (0)	0 (0)	0 (0)	
Tumor stage (n, %)				
I-II	30 (53.6)	5 (16.7)	25 (83.3)	0.002[c#]
III-IV	26 (46.4)	15 (57.7)	11 (42.3)	
Comorbidities (n, %)	26 (46.4)	11 (42.3)	15 (57.7)	
Diabetes mellitus	9 (28.1)	3 (33.3)	6 (66.7)	0.408[d]
Cardiovascular diseases	16 (50)	6 (37.5)	10 (62.5)	
Others	7 (21.8)	4 (57.1)	3 (42.9)	
Preoperative albumin (g/dL)	3.9 (2.3-4.8)†	3.7 (2.3-4.8)†	3.9 (2.5-4.8)†	0.173[b]
Low (n, %)	13 (23.2)	8 (61.5)	5 (38.5)	0.046[d#]
Normal (n, %)	43 (76.8)	12 (27.9)	31 (72.1)	
Preoperative total lymphocyte count (/µL)	1750 (645-3655)†	1751 (645-3160)†	2047 (878-3655)†	0.156[b]
Preoperative PNI	50.2 (28.9-61.3)†	45.1 (29-61)†	49.8 (31-61)†	0.067[b]
Low (≤45) (n, %)	19 (33.9)	9 (47.4)	10 (52.6)	0.224[c]
High (>45) (n, %)	37 (66.1)	11 (29.7)	26 (70.3)	
Preoperative Hb (g/dL)	11.2 ± 1.6*	10.4 ± 1.9*	11.7 ± 1.2*	0.002[a#]
Preoperative energy intake (kcal/kg body weight)	25.9 ± 6.0*	25.1 ± 6.6*	26.4 ± 5.7*	0.474[a]

Variable	Results	Complication		p-value
		Yes (n=20)	No (n=36)	
Insufficient (n, %)	23 (41.1)	10 (43.5)	13 (56.5)	0.311[c]
Sufficient (n, %)	33 (58.9)	10 (30.3)	23 (69.7)	
Preoperative protein intake (g/kg body weight)	0.99 ± 0.30*	0.98 ± 0.33*	0.99 ± 0.29*	0.358[a]
Insufficient (n, %)	39 (69.6)	13 (33.3)	26 (66.7)	0.573[c]
Sufficient (n, %)	17 (30.4)	7 (41.2)	10 (58.8)	
Postoperative energy intake (kcal/kg body weight)	26.9 ± 6.7*	25.0 ± 9.1*	27.9 ± 4.6*	0.112[a]
Insufficient (n, %)	17 (30.4)	9 (52.9)	8 (47.1)	0.076[c]
Sufficient (n, %)	39 (69.6)	11 (28.2)	28 (71.8)	
Postoperative protein intake (g/kg body weight)	1.07 ± 0.28*	1.02 ± 0.35*	1.10 ± 0.23*	0.272[a]
Insufficient (n, %)	37 (66.1)	13 (35.1)	24 (64.9)	0.900[c]
Sufficient (n, %)	19 (33.9)	7 (36.8)	12 (63.2)	
Perioperative blood transfusion (n, %)				
Yes	11 (19.6)	7 (63.6)	4 (36.4)	0.041[d#]
No	45 (80.4)	13 (28.9)	36 (71.1)	
Perioperative albumin transfusion (n, %)				
Yes	10 (17.9)	2 (20)	8 (80)	0.304[d]
No	46 (82.1)	18 (16.4)	28 (60.9)	

*mean ± standard deviation; †median (minimum-maximum); [a]independent t test; [b]Mann-Whitney U test; [c]chi-square test; [d]Fisher test; #p<0.05.
GLIM, Global Leadership Initiative on Malnutrition; Hb, hemoglobin; PNI, prognostic nutritional index.

The proportion of postoperative complications in this study was 35.7%, with minor complications being the most common. The most common type of complication was surgical site infections (SSIs). Among SSIs, 16.9% were superficial wound infections and 3.6% were sepsis. Other complications are pneumonia (3.6%), and pulmonary embolism (1.8%). The 30-day mortality rate was 3.6%, primarily caused by sepsis due to complicated intra-abdominal infections.

Table 3. Postoperative complications

Variable	Results (n=56)
Complication (n, %)	
No	36 (64.3)
Yes	20 (35.7)
Clavien-Dindo classification (n, %)	
Minor	12 (21.4)
Grade I	2 (3.5)
Grade II	10 (17.9)
Major	8 (14.2)
Grade III	3 (5.3)
Grade IV	3 (5.3)
Grade V	2 (3.6)

Variable	Results (n=56)
Type of complication (n, %)	
Surgical site infections	11 (19.6)
Hemorrhage	5 (8.9)
Ileus	5 (8.9)
Others	3 (5.4)

In the multivariable logistic regression model including PNI, preoperative Hb, tumor stage, and perioperative blood transfusion, only advanced tumor stage (III-IV) was independently associated with postoperative complications (OR 4.74, 95% CI 1.26–17.83, p=0.021). Subjects with low PNI tended to have higher odds of complications, although the association was not statistically significant (OR 1.71, 95% CI 0.47–6.28, p=0.420). Preoperative Hb <12 g/dL and perioperative blood transfusion were also not significant predictors. Serum albumin was not included in the regression model since it is a direct component of the PNI and would introduce collinearity.

Table 4. Multivariate analysis of factors associated with postoperative complications

Variable	B	Wald	p-value	OR	CI 95%
Low PNI (<45)	0.536	0.652	0.420	1.709	0.465–6.283
Preoperative Hb <12 g/dL	0.430	0.330	0.566	1.537	0.355-6.660
Tumor stage III-IV	1.555	5.291	0.021#	4.737	1.259-17.826
Perioperative blood transfusion	0.936	1.391	0.238	2.549	0.538-12.066

#p<0.05
CI, confidence interval; Hb, hemoglobin; OR, odd ratio; PNI, prognostic nutritional index.

Discussion

In this prospective study, we investigated the PNI and postoperative outcomes in patients undergoing major gynecologic oncology surgery. According to GLIM criteria, the prevalence of malnutrition in this study was 50%, which was higher than that observed when using BMI alone (19,7%).[23] This highlights the importance of considering etiological and functional aspects in the nutritional assessment of gynecologic cancer patients. Although not statistically significant, postoperative complications were more frequent among malnourished patients. Loss of muscle mass can lead to a blunted inflammatory response, impaired wound healing and has been associated with poor surgical outcomes.[27]

Most subjects were diagnosed with ovarian cancers, in alignment with previous studies.[4,28] Complications were most commonly observed in subjects with cervical cancer. Cervical cancer is often asymptomatic and frequently diagnosed at advanced stage, which is associated with a higher surgical risk.[4] Postoperative complications tended to be more frequent in subjects with comorbidities, although not statistically significant. Comorbidities may contribute to increased oxidative stress and immune dysregulation, increasing susceptibility to postoperative complications.[4,29]

Subjects with complications had significantly lower preoperative Hb compared to those without complications. Preoperative anemia may reduce tissue oxygenation, increase oxidative stress, and suppress immune response and activity.[30,31] In addition, both preoperative and postoperative protein intake were generally insufficient in subjects with and without complications. Low protein intake during both preoperative and postoperative period is associated with prolonged hospital stay and a higher risk of complications.[20,32–34] Perioperative blood transfusion was significantly associated with postoperative complications, consistent with prior studies suggesting that patients who received transfusions often had more severe clinical conditions and may also experience adverse immunomodulatory effects of transfusion products.[35,36]

The proportion of postoperative complications in this study was 35.7%, slightly higher than previous studies. This difference may be explained by our inclusion of only major gynecologic oncology procedures, which are more extensive than laparoscopy or transvaginal approaches reported in other studies.[4,37] Surgical site infections (SSIs) were the most common complication. Hypoalbuminemia, perioperative anemia, and perioperative blood transfusions are an independent predictor of SSIs. Low albumin and anemia impair immune function and wound healing process, potentially increasing the risk of SSIs.[30,38,39]

In multivariate analysis, advanced tumor stage (III-IV) was identified as the only independent predictor of postoperative complications. This is consistent with the notion that advanced disease requires more complex surgical procedures, thereby contributing to the risk of postoperative complications.[29,40] Previous studies have also suggested that malnutrition is more prevalent in advanced-stage cancer, which triggers a more severe inflammatory and surgical stress response, thereby increase the risk of complications.[41,42]

Although PNI was not statistically significant, it showed a trend toward higher odds of complications, suggesting that nutritional and immune status remain important contributors to postoperative outcomes. This finding is in line with the significant association observed between low preoperative albumin and complications, as albumin is a major component of the PNI. Preoperative Hb and perioperative blood transfusion were not independent predictors in the adjusted model, indicating that their effects may be mediated through other clinical factors.

Our findings differed from previous studies, which reported significant associations between low PNI and postoperative complications.[18,19] This discrepancy could be explained by differences in PNI cut-off values; the inclusion of only major laparotomy procedures in our study, whereas other studies included less complex procedures such as laparoscopy or transvaginal surgery, which may affect complication risk. In addition, the relatively small sample size in our study may have limited statistical power, although a trend toward increased complications in the low-PNI group was observed.

The molecular mechanisms underlying the relationship between PNI and postoperative complications are complex and multifactorial. Malnutrition and systemic inflammation lead to lymphocyte suppression and hypoalbuminemia.[7,8] Lymphocytes are involved in

modulating inflammation and promoting wound healing, while albumin plays a critical role in immune response, collagen synthesis, and granuloma formation. Low lymphocytes count and hypoalbuminemia may compromise immune function and impair wound healing, therefore increasing the risk of postoperative complications.[5,38,43]
This study has several strengths, including its prospective design and the use of the Clavien-Dindo classification, which allows standardized reporting of both minor and major complications. The use of the GLIM criteria as an indicator of nutritional status also reduces potential bias caused by tumor mass or fluid retention. Nonetheless, some limitations should be acknowledged. Dietary intake was collected only during hospitalization and may not reflect habitual intake. The sample size was relatively small, and the single-center design may limit the generalizability of the findings.

Conclusion

In conclusion, although PNI did not reach statistical significance, it showed a trend toward association with postoperative complications, highlighting the potential importance of preoperative nutritional status. Advanced tumor stage, however, was identified as an independent predictor of complications. Larger multicenter studies are warranted to further establish the prognostic role of PNI in gynecologic oncology surgery.

Conflict of interest

The authors declared no conflict of interest regarding this article.

Open Access

Author Contributions

All authors contributed equally to the conception and design of the study, data acquisition, analysis and interpretation of data, drafting and critical revision of the manuscript, and final approval of the version to be published. All authors have read and approved the final manuscript.

References

1. S Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71:209–49.
2. Gondhowiardjo S, Christina N, Ganapati NPD, Hawariy S, Radityamurti F, Jayalie VF, et al. Five-year cancer epidemiology at the national referral hospital: Hospital-based cancer registry data in Indonesia. JCO Glob Oncol. 2021;7:190–203.
3. Gaba F, Ash K, Blyuss O, Bizzarri N, Kamfwa P, Saiz A, et al. International variations in surgical morbidity and mortality post gynaecological oncology surgery: A Global Gynaecological Oncology Surgical Outcomes Collaborative Led Study (GO SOAR1).

Cancers. 2023;15:5001.
4. Iyer R, Gentry-Maharaj A, Nordin A, Burnell M, Liston R, Manchanda R, et al. Predictors of complications in gynaecological oncological surgery: A prospective multicentre study (UKGOSOC—UK gynaecological oncology surgical outcomes and complications). Br J Cancer. 2015;112:475–84.
5. Goins EC, Weber JM, Truong T, Moss HA, Previs RA, Davidson BA, et al. Malnutrition as a risk factor for post-operative morbidity in gynecologic cancer: Analysis using a national surgical outcomes database. Gynecol Oncol. 2022;165:309–16.
6. Hertlein L, Kirschenhofer A, Fürst S, Beer D, Göß C, Lenhard M, et al. Malnutrition and clinical outcome in gynecologic patients. Eur J Obstet Gynecol Reprod Biol. 2014;174:137–40.
7. Conci S, Campagnaro T, Danese E, Lombardo E, Isa G, Vitali A, et al. Role of inflammatory and immune-nutritional prognostic markers in patients undergoing surgical resection for biliary tract cancers. Cancers. 2021;13:3594.
8. Kim J, Shim SH, Oh IK, Yoon SH, Lee SJ, Kim SN, et al. Preoperative hypoalbuminemia is a risk factor for 30-day morbidity after gynecological malignancy surgery. Obstet Gynecol Sci. 2015;58:359-67.
9. Xu YC, Vincent JI. Clinical measurement properties of malnutrition assessment tools for use with patients in hospitals: A systematic review. Nutr J. 2020;19:106.
10. Di Sebastiano KM, Mourtzakis M. A critical evaluation of body composition modalities used to assess adipose and skeletal muscle tissue in cancer. Appl Physiol Nutr Metab. 2012;37:811–21.
11. Schroth J, Weber V, Jones TF, Del Arroyo AG, Henson SM, Ackland GL. Preoperative lymphopaenia, mortality, and morbidity after elective surgery: Systematic review and meta-analysis. Br J Anaesth. 2021;127:32–40.
12. Zhang W, Ye B, Liang W, Ren Y. Preoperative prognostic nutritional index is a powerful predictor of prognosis in patients with stage III ovarian cancer. Sci Rep. 2017;7:9548.
13. Ida N, Nakamura K, Saijo M, Kusumoto T, Masuyama H. Prognostic nutritional index as a predictor of survival in patients with recurrent cervical cancer. Mol Clin Oncol. 2018;8:257-263.
14. Yang Y, Gao P, Song Y, Sun J, Chen X, Zhao J, et al. The prognostic nutritional index is a predictive indicator of prognosis and postoperative complications in gastric cancer: A meta-analysis. Eur J Surg Oncol. 2016;42:1176–82.
15. Lee SI, Ko KP, Choi CH, Park CH, Park KY, Son KH. Does the prognostic nutritional index have a predictive role in the outcomes of adult cardiac surgery? J Thorac Cardiovasc Surg. 2020;160:145-153.e3.
16. Bolat İ, Biteker M. Prognostic nutritional index predicts perioperative adverse events in patients undergoing noncardiac surgery. Indian J Surg. 2020;82:780–5.
17. Pandey G, Patel B, Dave PS, Patel S, Arora R, Parekh C. Prognostic nutrition index and its significance in advanced ovarian cancer. Indian J Gynecol Oncol. 2020;18:85.
18. Pergialiotis V, Thomakos N, Papalios T, Lygizos V, Vlachos DE, Rodolakis A, et al. Prognostic nutritional index as a predictive biomarker of post-operative infectious morbidity in gynecological cancer patients: A prospective cohort study. Nutr Cancer. 2024;76:364–71.
19. Miralpeix E, Gayete S, Solé-Sedeño JM, Rodriguez-Cosmen C, Payà A, Mancebo G. Prognostic nutritional index predicts postoperative outcome in ovarian cancer. Clin Nutr. 2018;25:180.
20. Muscaritoli M, Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H, et al. ESPEN practical guideline: Clinical nutrition in cancer. Clin Nutr. 2021;40:2898–913.
21. Cattermole GN, Graham CA, Rainer TH. Mid-arm circumference can be used to estimate weight of adult and adolescent patients. Emerg Med J. 2017;34:231–6.
22. Wong WY, Lim SL, Chan YH. Simple method for assessing standing height using recumbent length in bedridden patients using soft and firm mattresses. Malays J Nutr. 2019;25:37–45.
23. Jensen GL, Cederholm T, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et al.

GLIM criteria for the diagnosis of malnutrition: A consensus report from the Global Clinical Nutrition Community. J Parenter Enteral Nutr. 2019;43:32–40.
24. Onodera T, Goseki N, Kosaki G. Prognostic nutritional index in gastrointestinal surgery of malnourished cancer patients. Nihon Geka Gakkai Zasshi. 1984;85:1001–5.
25. Fumagalli D, Sonik R, De Vitis L, Rossi V, Bazzurini L. Evaluating nutrition in advanced ovarian cancer: which biomarker works best? Gynecol Oncol. 2024;188:97–102.
26. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205–13.
27. Skeie E, Tangvik RJ, Nymo LS, Harthug S, Lassen K, Viste A. Weight loss and BMI criteria in GLIM's definition of malnutrition is associated with postoperative complications following abdominal resections – Results from a National Quality Registry. Clin Nutr. 2020;39:1593–9.
28. Tjokroprawiro BA, Novitasari K, Saraswati W, Yuliati I, Ulhaq RA, Sulistya HA. The challenging journey of cervical cancer diagnosis and treatment at the second largest hospital in Indonesia. Gynecol Oncol Rep. 2024;51:101325.
29. Inci MG, Richter R, Woopen H, Rasch J, Heise K, Anders L, et al. Role of predictive markers for severe postoperative complications in gynecological cancer surgery: A prospective study (RISC-Gyn Trial). Int J Gynecol Cancer. 2020;30:1975–82.
30. Richards T, Musallam KM, Nassif J, Ghazeeri G, Seoud M, Gurusamy KS, et al. Impact of preoperative anaemia and blood transfusion on postoperative outcomes in gynaecological surgery. PLoS One. 2015;10:e0130861.
31. Foley OW, Vega B, Roque D, Hinchcliff E, Marcus J, Tanner EJ, et al. Characterization of pre-operative anemia in patients undergoing surgery by a gynecologic oncologist and association with post-operative complications. Int J Gynecol Cancer. 2023;33:1778–85.
32. Muhamad D, Manikam NRM, Syaiful RA. Association preoperative protein adequacy and post elective laparotomy surgical site infection. Korean J Gastroenterol. 2023;82:282–7.
33. Constansia RDN, Hentzen JEKR, Hogenbirk RNM, van der Plas WY, Campmans-Kuijpers MJE, Buis CI, et al. Actual postoperative protein and calorie intake in patients undergoing major open abdominal cancer surgery: A prospective, observational cohort study. Nutr Clin Pract. 2022;37:183–91.
34. Hubert M, Gabriel D, El Khouda S, Coster M, Routiaux C, Hans G, et al. Energy and protein intake after return home in colorectal surgery patients with an enhanced recovery program: A prospective observational study. Nutr Clin Pract. 2021;36:639–47.
35. Prescott LS, Aloia TA, Brown AJ, Taylor JS, Munsell MF, Sun CC, et al. Perioperative blood transfusion in gynecologic oncology surgery: Analysis of the National Surgical Quality Improvement Program database. Gynecol Oncol. 2015;136:65–70.
36. Zhang H, Wu X, Xu Z, Sun Z, Zhu M, Chen W, et al. Impact of perioperative red blood cell transfusion on postoperative recovery and long-term outcome in patients undergoing surgery for ovarian cancer: A propensity score-matched analysis. Gynecol Oncol. 2020;156:439–4.
37. Mou T, Das D, Brown O, Mueller MG, Kenton K, Bretschneider C. 21 Postoperative complications after abdominal, laparoscopic, and vaginal hysterectomy for uteri weighing ≤250 g. Am J Obstet Gynecol. 2021;224:S758–9.
38. Uppal S, Al-Niaimi A, Rice LW, Rose SL, Kushner DM, Spencer RJ, et al. Preoperative hypoalbuminemia is an independent predictor of poor perioperative outcomes in women undergoing open surgery for gynecologic malignancies. Gynecol Oncol. 2013;131:416–22.
39. Mahdi H, Gojayev A, Buechel M, Knight J, SanMarco J, Lockhart D, et al. Surgical site infection in women undergoing surgery for gynecologic cancer. Int J Gynecol Cancer. 2014;24:779–86.
40. Son J, Kong T, Paek J, Chang S, Ryu H. Perioperative outcomes of extensive bowel resection during cytoreductive surgery in patients with advanced ovarian cancer. J Surg Oncol. 2019;119:1011–5.
41. Finnerty CC, Mabvuure NT, Kozar RA, Herndon DN. The surgically induced stress response. J Parenter Enter Nutr. 2013;37:21S-29S.

42. Ho CY, Ibrahim Z, Abu Zaid Z, Mat Daud Z 'Azuan, Md Yusop NB. Clinical malnutrition predictive model among gynecologic cancer patients prior to elective operation: A cross-sectional study. Clin Nutr. 2021;40:4373–9.
43. Zhao J, Huang W, Wu Y, Luo Y, Wu B, Cheng J, et al. Prognostic role of pretreatment blood lymphocyte count in patients with solid tumors: A systematic review and meta-analysis. Cancer Cell Int. 2020;20:15.