

INFLUENCE OF PREOPERATIVE ALBUMIN LEVELS ON POSTOPERATIVE RECOVERY AND COMPLICATIONS IN COLORECTAL CANCER SURGERIES

Abdullah Akef Abu Anzeh MD*, Ahmad Hussein Telfah MD, Ahmad Ibrahim Abdallah Alarman MD, Abdallah Hisham Khalid Khamash MD, Hemam Saleh Abdel Mahdi Al Sarayreh RN, Doaa Akef Mahmud Abu Anzeh RN, Nehaya Raji Helal RN, Ghada Ali Khalaf Ramadneh RN and Ahmad Uraiqat MD

Department of General Surgery Royal Medical Services Amman Amman Governorate Jordan 11121.



*Corresponding Author: Dr. Abdullah Akef Abu Anzeh MD
Department of General Surgery Royal Medical Services Amman Amman Governorate Jordan 11121.

Article Received on 23/09/2024

Article Revised on 13/10/2024

Article Accepted on 03/11/2024

ABSTRACT

Background: Linking hematologic, immunological, and nutritional measures with cancer prognosis is becoming increasingly common. Albumin is the most common blood protein and serve an important role in various diseases. Recent literature suggests an effect of albumin levels on cancer outcomes and mortality. **Purpose:** In this retrospective, single-center study, we aim to study the association between preoperative serum albumin levels and postoperative outcomes and complications in CRC patients who underwent surgical resection in Jordan. **Methods:** We will carry out a retrospective study including CRC patients from King Hussein Medical Center (KHMC), Amman, Jordan between the period 2016 to 2024. Patients' data will be collected through hospital records for the following demographic and clinical variables: age, gender, body-mass index (BM), smoking history, type of CRC surgery (Elective or emergency), mode of surgery (Laparoscopic, or open), preoperative albumin levels, and postoperative complications. **Results:** We included 573 colorectal cancer patients who underwent surgical resection. Laparoscopic surgery was performed in 65% of patients, and 24.6% experienced postoperative complications, with a 1% mortality rate. Patients were stratified based on their preoperative albumin levels as hypoalbuminemia (20.6%), hyperalbuminemia (0.7%), and normal (78.7%). Patients with hypoalbuminemia had significantly longer hospital stays and higher rates of postoperative complications and mortality. Logistic regression revealed that lower albumin levels were significantly associated with increased mortality, while higher albumin levels correlated with lower postoperative stoma incidence. **Conclusion:** This is the first study in Jordan to examine the prognostic value of preoperative serum albumin levels on CRC surgery. Our findings indicate that low serum albumin levels can be an independent predictor of poorer outcomes and higher mortality rates. These results suggest that serum albumin could be a cost-effective and accessible method for predicting colorectal cancer prognosis.

KEYWORDS: Colorectal cancer, Blood biomarkers, Albumin, complications, Jordan.

INTRODUCTION

Mortality rates for colorectal cancer (CRC) is rapidly increasing ranking it as the second most cause of mortality due to cancer worldwide.^[1] The Jordan Cancer Registry in 2018 showed that CRC is the second most common cancer in Jordan with an incidence rate of 10.6% in both sexes.^[2] The majority of diagnosed CRC patients present with stage II/III of the disease, with surgical resection being the treatment of choice. While giving adjuvant chemotherapy may benefit patients with stage III CRC, there is still a controversy for its benefit in patients with early-stage II CRC.^[3,4]

Albumin is the most abundant blood protein accounting for about 60% of blood proteins. It has several

physiological roles as a regulatory protein in addition to its anti-oxidant role.^[5] Historically, serum albumin has been utilized as an indicator and screening tool of nutrition, however, emergent studies are pointing to a potential indication for inflammation associated with several diseases including, cardiovascular, liver, kidney diseases, and cancers.^[6,7] Proinflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α) are released as response to an inflammatory response to cancer.^[8] This release of proinflammatory mediators exert a catabolic effect on patients' metabolism, which may cause reduction of serum albumin levels and interfere with albumin production in the liver.^[9]

The literature suggest a link between high prevalence of low serum albumin levels and poor nutrition in cancer patients. However, there is still no consensus on the implications of preoperative serum albumin levels as prognostic indicator of postoperative outcomes in CRC surgery.^[10,11] In this retrospective, single-center observational study, we aim to assess the effect of preoperative serum albumin levels on the postoperative outcomes and mortality rate in CRC surgery. By utilizing serum albumin levels as a continuous measure, in addition to stratifying patients based on a cutoff of <3.5 g/dL as hypoalbuminemia, ≥ 5.5 g/dL as hyperalbuminemia, and normal albumin levels between 3.5-5.5 g/dL.

Methods

Study design

A single-centered, retrospective observational study was carried out at King Hussien Medical Center (KHMC) in Amman, Jordan between the period of May 2014 to April 2024. Patients diagnosed with non-metastatic colorectal cancer and undergone surgical resection were included in this study. Surgical biopsy was performed to determine the tumor stage, after which a team of expert oncologists assesses the tumor's resectability to decide the treatment plan. Patients with resectable cancer received neoadjuvant chemotherapy and were followed by care under the Enhanced Recovery After Surgery (ERAS) protocol.

Study Outcomes and Data collection

The primary outcome of this study was postoperative outcomes including duration of hospital stay and postoperative complications, and preoperative albumin levels in resected CRC patients. Mortality rate defined as the number of deaths after surgery was also investigated. Postoperative complications included ileus, anastomosis, wound infection, stoma, pain, and renal complications. We retrieved the data retrospectively through accessing hospital's medical records between the period May 2014 to April 2024. Demographic variables included patient's hospital ID, national ID, age, and sex. Clinical variables included the following information: preoperative albumin levels (g/L), mortality rate, postoperative complications, and length of hospital stay in days. Records with missing information were removed, and a total of 573 patients with CRC who underwent either open or laparoscopic surgical resection were included.

Ethical approval

Ethical approval for this study was obtained from the Institutional Review Board at King Hussien Medical Center. Given that this was a retrospective study utilizing de-identified data from existing medical records, the requirement for informed consent was waived in accordance with the Declaration of Helsinki. All procedures were conducted in compliance with relevant ethical standards and institutional guidelines.

Statistical analysis

Continuous data will be summarized using mean (Standard deviation) and analyzed with the student's t-test for normally distributed data, and median (Range) with the Wilcoxon rank-sum test for non-normally distributed data. Categorical variables will be described using frequencies and percentages and analyzed with the Chi-square test. Logistic and linear regression models will be constructed to examine the association between the preoperative albumin levels and post-operative outcomes. All analyses will be performed using R statistical software.

RESULTS

A total of 573 patients with CRC who underwent surgical resection were included in the study. The mean age was 58.0 (14.0) years, and 338 (59%) were males (**Table 1**). Surgical resection was performed laparoscopically in 357 (65%) of patients, open surgery in 152 (27%) of patients, and 46 (8%) of patients had laparoscopy but converted to open surgery. The mean duration of hospital stay was 4.15 (3.36) days, and 141 (24.6%) patients developed postoperative complications, including wound infection in 30 (5.2%) of patients, ileus in 19 (3.3%) of patients, stoma in 15 (2.6%) of patients, and 10 (1.7%) of patients had anastomosis. Six patients died with a mortality rate of 1%.

The mean preoperative albumin levels was 38.3 (5.5) g/L, 118 (20.6%) patients had hypoalbuminemia, 4 (0.70%) patients had hyperalbuminemia, while 451 (78.7%) patients had normal albumin levels. There was no significant difference in age and sex between the study groups (p -value >0.05). The length of hospital stay was significantly different between the groups (p -value <0.05), in which patients with hypoalbuminemia had a significantly longer duration of hospital stay compared to patients with normal and hyperalbuminemia (mean: 4.88 vs. 3.97 vs. 2.67, respectively). Postoperative complications also differed significantly between the study group, in which 5 (4.2%) patients with hypoalbuminemia had stoma, and 1 (25%) of patients with hyperalbuminemia developed stoma (p -value=0.026). Mortality rate was significantly higher in the hypoalbuminemia group compared to normal and hyperalbuminemia groups (rate: 3.4% vs. 0.4%, vs. 0%, respectively) (p -value=0.043).

The logistic regression model showed a significant association between length of hospital stay and postoperative complications (OR: 1.5, 95% CI: 1.37-1.72, p -value <0.001) as shown in **Table 2**. Albumin levels did not reveal significant association in the logistic regression model (p -value >0.05). Linear regression model showed a significant association between gender and duration of hospital stay, in which males had a significantly lower estimates with hospital duration (SE: 0.20, 95% CI: 0.03-0.36, p -value=0.023) as shown in **Table 3**. Additionally, the logistic regression model showed a significantly lower likelihood of developing

postoperative stoma in patients with normal albumin levels compared to patients with hyperalbuminemia (OR: 0.07, 95% CI: 0.01-0.81, p-value=0.033) as shown in **Table 4**. The logistic regression model for mortality rate showed a significant association with albumin levels, in which higher albumin levels were associated with lower mortality rate (OR: 0.83, 95% CI: 0.71-0.98, p-value=0.026) as shown in **Table 5**. There was no significant correlation between length of hospital stay and age with preoperative albumin levels ($|R| < 0.6$, p-value < 0.05) as shown in **Figure 1**.

DISCUSSION

Colorectal cancer (CRC) shows the highest cancer incidence after lung cancers, making it an alarming concern globally and in Jordan.^[12] Screening for CRC resulted in a significant decrease in the incidence rate and showed better prognostic outcomes.^[13] However, there's still a need for biological prognostic markers for CRC surgery. In this study we investigate the association of preoperative serum albumin levels on the postoperative outcomes including mortality rate, duration of hospital stay, and postoperative complications of CRC surgery in Jordan.

In addition to its anti-inflammatory effects, albumin is the most common blood protein and have an essential role in regulating the osmotic and oncotic blood pressure and transportation of substances.^[14] Several studies revealed a significant importance of serum albumin levels on the prognosis and mortality rates of several cancers.^[15,16] In this study, our results showed that low serum albumin levels were linked to a significantly longer hospitalization period and longer hospitalization period was associated with higher likelihood of postoperative complications. In addition, hypoalbuminemia was associated with higher likelihood of postoperative stoma, and higher mortality rate. This is similar to the findings from Al-Amry et al. study in which 60% of patients with hypoalbuminemia had postoperative complications.^[17] These findings suggest that low serum albumin level can be an independent predictor of postoperative complications in CRC surgery.

Previous literature suggested that albumin levels are mainly driven by patients' nutritional status, however, this theory has been questioned with the role of inflammation in driving albumin levels.^[18,19] Several studies showed evidence of the role of albumin as an inflammatory marker in several diseases rather than a nutritional marker, including patients with end-stage kidney disease, cardiovascular diseases, and many cancers.^[20-22] However, there is still no consensus and standardization on the cut-off value for which albumin can be utilized as an inflammatory marker in practice.^[23] In CRC, the prognostic value of preoperative albumin levels have been studied since 1998 by Heys et al. and shown to significantly affect the postoperative surgical outcomes.^[24] The early investigation showed that mortality risk was increased by 25% with a reduction of

0.5 g/dL in serum albumin levels with an independent prediction of survival.^[24] Interestingly, our results showed that patients with hyperalbuminemia were associated with a significantly lower mortality rate and better prognosis. This finding is consistent with the results of Gupta et al. study, showing that in gastrointestinal malignancies, high serum albumin levels was associated with better survival in 26 studies. However, there was a variation in the cut-off value of serum albumin and no meta-analysis was performed to evaluate the pooled evidence.^[25]

The clinical implications of utilizing preoperative serum albumin levels as prognostic marker for CRC surgery has several advantages. While several molecular biomarkers are approved for CRC, including RAS mutations, microsatellite instability (MSI), and mismatch repair (MMR) status, these markers are only used to guide CRC treatment, but do not provide an indication of treatment prognosis.^[26,27] Apart from that, several genomic biomarkers have been studied to predict CRC postoperative prognosis, however, the cost of utilizing such biomarkers is high. Therefore, more cost-effective methods to stratify high-risk CRC patients and guide the treatment approach are needed.^[28] Preoperative serum albumin shows a cost-effective method as prognostic indication of CRC surgery.^[29] Additionally, serum albumin is widely accessible and is routinely tested in healthcare settings. Serial monitoring of serum albumin levels can also help in patients' recovery and provide a practical, inexpensive and informative marker.^[30,31]

Our study provides a robust dataset with powerful evidence due to the inclusion of a large sample of Jordanian CRC patients. We also analyzed the long-term outcomes of CRC surgery of a period of 10 years to capture variations in postoperative outcomes and improve the validity of our conclusions. Finally, we investigated the prognostic and cost-effective implications of preoperative serum albumin on the postoperative outcomes of CRC surgery. However, being conducted at a single-center may limit the generalizability of our study to other healthcare settings. In addition, the nutritional status of included patients was not assessed, therefore preoperative albumin levels may have been confounded by the nutritional status and may not reflect a sole indication as an inflammatory marker.

In conclusion, this is the first study in Jordan to investigate the prognostic indication of preoperative serum albumin levels for CRC surgery. Our results showed that low serum albumin levels (below 3.5 g/dL) can be used as an independent predictor of poorer outcomes and higher mortality rates after CRC surgery. These findings can be implicated in clinical practice with an advantage as a cost-effective, and accessible method of predicting CRC prognosis. Future prospective trials are needed to investigate the effects of nutritional status and longitudinal follow-up on serum albumin levels and the postoperative outcomes.

Table 1: Patients Demographics and Clinical characteristics based on albumin levels.

Characteristic	Hyperalbuminemia N ¹ = 4	Hypoalbuminemia N ¹ = 118	Normal N ¹ = 451	p-value ²	Overall N ¹ = 573
Gender				0.2	
Male	3 (75%)	62 (53%)	273 (61%)		338 (59%)
Female	1 (25%)	56 (47%)	178 (39%)		235 (41%)
Age	59 (14)	60 (14)	58 (14)	0.3	58 (14)
Albumin levels (g/L)	60.3 (11.8)	30.8 (3.0)	40.1 (3.6)	<0.001	38.3 (5.5)
Mode of surgery				<0.001	
Laparoscopy	2 (50%)	52 (44%)	321 (71%)		375 (65%)
Open	1 (25%)	50 (42%)	101 (22%)		152 (27%)
Laparoscopy converted to open	1 (25%)	16 (14%)	29 (6.4%)		46 (8.0%)
Length of hospital stay (Days)	2.67 (1.15)	4.88 (3.49)	3.97 (3.31)	<0.001	4.15 (3.36)
Postoperative complications					
Ileus	0 (0%)	7 (5.9%)	12 (2.7%)	0.2	19 (3.3%)
Anastomosis	0 (0%)	1 (0.8%)	9 (2.0%)	0.7	10 (1.7%)
Stoma	1 (25%)	5 (4.2%)	9 (2.0%)	0.026	15 (2.6%)
Renal	0 (0%)	1 (0.8%)	8 (1.8%)	0.7	9 (1.6%)
Dead	0 (0%)	4 (3.4%)	2 (0.4%)	0.043	6 (1.0%)
Pain	0 (0%)	3 (2.5%)	3 (0.7%)	0.14	6 (1.0%)
Wound infection	0 (0%)	3 (2.5%)	27 (6.0%)	0.3	30 (5.2%)
None	3 (75%)	81 (69%)	348 (77%)	0.13	432 (75%)

¹ n (%); Mean (SD)
² Fisher's exact test; Kruskal-Wallis rank sum test

Table 2: Logistic regression model.

Predictor	Odds ratio	95% CI		p-value
		Lower	Upper	
Gender:				
Male – Female	1.42	0.89227	2.26	0.139
Age	0.9933	0.97701	1.01	0.422
Mode of surgery:				
Laparoscopy – Laparoscopy converted to open	0.5893	0.27905	1.244	0.166
Open – Laparoscopy converted to open	0.6801	0.30498	1.517	0.346
Length of hospital stay (Days)	1.5352	1.37242	1.717	<.001
Albumin Levels (g/L)	1.0018	0.96061	1.045	0.932

Note. Estimates represent the log odds of "Postoperative complications = Yes vs. No"

Table 3: Logistic regression model.

Predictor	Stand. Estimate	95% CI		p-value
		Lower	Upper	
Gender:				
Male – Female	0.19516	0.0268	0.3635	0.023
Age	0.00144	-0.0834	0.0863	0.973
Mode of surgery:				
Laparoscopy – Laparoscopy converted to open	-0.23511	-0.5443	0.0741	0.136
Open – Laparoscopy converted to open	0.12435	-0.2098	0.4585	0.465
Albumin Level (g/L)	-0.0643	-0.1508	0.0222	0.145

Table 4: Logistic regression model.

Predictor	Odds ratio	95% CI		p-value
		Lower	Upper	
Gender:				
Male – Female	1.4652	0.48395	4.436	0.499
Age	0.9762	0.9415	1.012	0.193
Mode of surgery:				
Laparoscopy – Laparoscopy converted to open	0.3108	0.07313	1.321	0.113
Open – Laparoscopy converted to open	0.4722	0.10434	2.137	0.33

Albumin:				
Hypoalbuminemia – Hyperalbuminemia	0.1429	0.01187	1.72	0.125
Normal – Hyperalbuminemia	0.0725	0.0065	0.809	0.033
Odds of "Stoma = Yes vs. No"				

Table 5: Logistic regression model.

Predictor	Odds ratio	95% CI		p-value
		Lower	Upper	
Gender:				
Male – Female	2.221	0.3467	14.227	0.4
Age	1.012	0.95107	1.078	0.7
Mode of surgery:				
Laparoscopy – Laparoscopy converted to open	0.17	0.01015	2.842	0.217
Open – Laparoscopy converted to open	1.093	0.11495	10.389	0.938
Albumin levels (g/L)	0.836	0.71448	0.979	0.026
Odds of "Dead = Yes vs. No"				

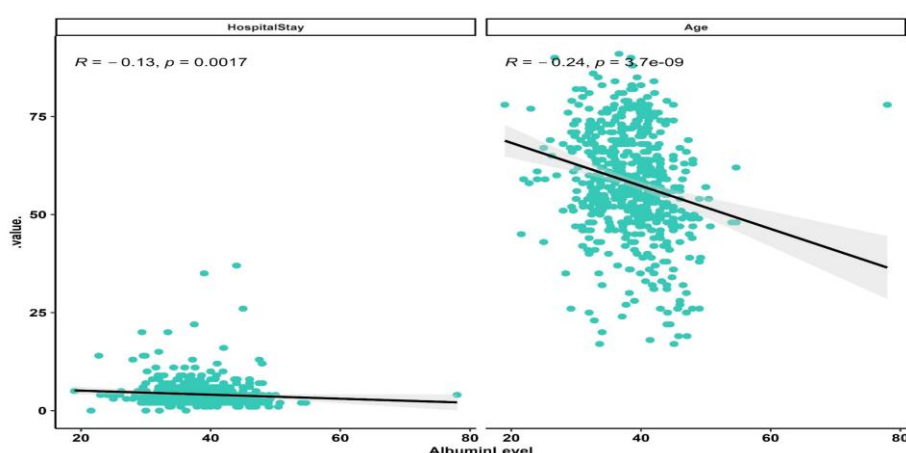


Figure 1: Scatter plot showing the correlation between albumin levels (g/L) with hospital stay (days) and age (years).

REFERENCES

- Jiang Y, Yuan H, Li Z, Ji X, Shen Q, Tuo J, et al. Global pattern and trends of colorectal cancer survival: a systematic review of population-based registration data. *Cancer Biol Med*, 2021; 18: 0–0.
- Ministry of Health Non-Communicable Diseases Directorate. Jordan Cancer Registry (JCR). 2018. Jordan Cancer Registry Cancer Incidence in Jordan, 2018.
- Punt CJA, Koopman M, Vermeulen L. From tumour heterogeneity to advances in precision treatment of colorectal cancer. *Nat Rev Clin Oncol*, 2017; 6, 14(4): 235–46.
- Auclin E, Zaanan A, Vernerey D, Douard R, Gallois C, Laurent-Puig P, et al. Subgroups and prognostication in stage III colon cancer: future perspectives for adjuvant therapy. *Annals of Oncology*, 2017; 28(5): 958–68.
- van de Wouw J, Joles JA. Albumin is an interface between blood plasma and cell membrane, and not just a sponge. *Clin Kidney J*, 2022; 31, 15(4): 624–34.
- Sheinenzon A, Shehadeh M, Michelis R, Shaoul E, Ronen O. Serum albumin levels and inflammation. *Int J Biol Macromol*, 2021; 184: 857–62.
- Evans DC, Corkins MR, Malone A, Miller S, Mogensen KM, Guenter P, et al. The Use of Visceral Proteins as Nutrition Markers: An ASPEN Position Paper. *Nutrition in Clinical Practice*, 2021; 30, 36(1): 22–8.
- Hirano T. IL-6 in inflammation, autoimmunity and cancer. *Int Immunol*, 2021; 1, 33(3): 127–48.
- Soeters PB, Wolfe RR, Shenkin A. Hypoalbuminemia: Pathogenesis and Clinical Significance. *Journal of Parenteral and Enteral Nutrition*, 2019; 4, 43(2): 181–93.
- Alajmi A, Almehari A, Alzahrani AR, Aljurays Y, Alzahrani N, Aladel AM, et al. Impact of Preoperative Serum Albumin Level on the Outcome of Colorectal Cancer Surgery. *Cureus*, 2024; 5.
- Mao Y, Lan J. Prognostic value of the geriatric nutritional index in colorectal cancer patients undergoing surgical intervention: A systematic review and meta-analysis. *Front Oncol*, 2022; 23: 12.
- Menon G, Recio-Boiles A, Lotfollahzadeh S, Cagir B. *Colon Cancer*, 2024.
- Smith RA, Andrews KS, Brooks D, Fedewa SA, Manassaram-Baptiste D, Saslow D, et al. Cancer screening in the United States, 2019: A review of

- current American Cancer Society guidelines and current issues in cancer screening. *CA Cancer J Clin*, 2019; 69(3): 184–210.
14. Bihari S, Bannard-Smith J, Bellomo R. Albumin as a drug: its biological effects beyond volume expansion. *Critical Care and Resuscitation*, 2020; 22(3): 257–65.
 15. Tang Q, Li X, Sun CR. Predictive value of serum albumin levels on cancer survival: a prospective cohort study. *Front Oncol*, 2024; 4: 14.
 16. Suzuki S, Taguchi Y, Kitabayashi T, Sato N, Kaya H, Abe T, et al. Serum Albumin as an Independent Predictor of Long-Term Survival in Patients with Recurrent and Metastatic Head and Neck Squamous Cell Carcinoma Treated with Nivolumab. *J Clin Med*, 2024; 23, 13(9): 2456.
 17. Al-Amry A, Obadiel Y, Al-Shehari M, Gailan W, Bajubair M, Jowah H. Early Postoperative Complications in Colorectal Cancer Patients Following Colorectal Surgery Among Yemeni Patients: A Prospective Study. *Open Access Surgery*, 2024; 17: 81–90.
 18. Ishida S, Hashimoto I, Seike T, Abe Y, Nakaya Y, Nakanishi H. Serum albumin levels correlate with inflammation rather than nutrition supply in burns patients: a retrospective study. *The Journal of Medical Investigation*, 2014; 61(3.4): 361–8.
 19. Anderson CF, Wochos DN. The utility of serum albumin values in the nutritional assessment of hospitalized patients. *Mayo Clin Proc*, 1982; 57(3): 181–4.
 20. Gremese E, Bruno D, Varriano V, Perniola S, Petricca L, Ferraccioli G. Serum Albumin Levels: A Biomarker to Be Repurposed in Different Disease Settings in Clinical Practice. *J Clin Med*, 2023; 17, 12(18): 6017.
 21. Yoshioka G, Tanaka A, Goriki Y, Node K. The role of albumin level in cardiovascular disease: a review of recent research advances. *J Lab Precis Med*, 2023; 8: 7–7.
 22. Alves FC, Sun J, Qureshi AR, Dai L, Snaedal S, Bárány P, et al. The higher mortality associated with low serum albumin is dependent on systemic inflammation in end-stage kidney disease. *PLoS One*, 2018; 3, 13(1): e0190410.
 23. Zhang C long, Gao M qi, Jiang X chen, Pan X, Zhang X yuan, Li Y, et al. Research progress and value of albumin-related inflammatory markers in the prognosis of non-small cell lung cancer: a review of clinical evidence. *Ann Med*, 2023; 12, 55(1): 1294–307.
 24. Heys SD, Walker LG, Deehan DJ, Eremin OE. Serum albumin: a prognostic indicator in patients with colorectal cancer. *J R Coll Surg Edinb*, 1998; 43(3): 163–8.
 25. Gupta D, Lis CG. Pretreatment serum albumin as a predictor of cancer survival: A systematic review of the epidemiological literature. *Nutr J*, 2010; 22, 9(1): 69.
 26. Koncina E, Haan S, Rauh S, Letellier E. Prognostic and Predictive Molecular Biomarkers for Colorectal Cancer: Updates and Challenges. *Cancers (Basel)*, 2020; 30, 12(2): 319.
 27. Sepulveda AR, Hamilton SR, Allegra CJ, Grody W, Cushman-Vokoun AM, Funkhouser WK, et al. Molecular Biomarkers for the Evaluation of Colorectal Cancer. *The Journal of Molecular Diagnostics*, 2017; 19(2): 187–225.
 28. Puccini A, Seeber A, Berger MD. Biomarkers in Metastatic Colorectal Cancer: Status Quo and Future Perspective. *Cancers (Basel)*, 2022; 3, 14(19): 4828.
 29. Tamai K, Hirose H, Okamura S, Akazawa Y, Koh M, Hayashi K, et al. Prognostic Value of C-reactive Protein-to-albumin Ratio after Curative Resection in Patients with Colorectal Cancer. *J Anus Rectum Colon*, 2023; 25, 7(4): 2023–016.
 30. Ghimire B, Shah S, Paudyal MB, Bhattarai M, Pangen PM, Kharel A, et al. Serial estimations of serum albumin levels as a prognostic marker in critically ill patients admitted in ICU in tertiary center: An observational study. *Medicine*, 2023; 10, 102(45): e35979.
 31. Riviati N, Legiran, Indrajaya T, Saleh I, Ali Z, Irfannuddin, et al. Serum Albumin as Prognostic Marker for Older Adults in Hospital and Community Settings. *Gerontol Geriatr Med*, 2024; 7: 10.