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CLINICAL STUDY

# Hyponutrition among newly diagnosed gastric cancer

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**ABSTRACT**

OBJECTIVES: This study aims to determine the malnutrition status among Vietnamese patients newly diagnosed with gastric cancer (GC).

BACKGROUND: GC remains the top rank of common and deadly diseases. With limited clinical manifestation, most GC patients were diagnosed at late stages when tumor is not radically resected. Malnutrition was associated with poor prognosis of GC, such as prolonged hospitalization, limited treatment efficacy and low survival rate.

METHODS: The cross-sectional descriptive study recruited 77 patients newly diagnosed with GC and 90 healthy individuals (HC). The data used for this study were approved by the local Ethical Committee. The data were analysed on STATA 14.0 and GraphPad Prism 8.0.

RESULTS: We observed the male dominant distribution in GC cohort and over 65% of GC were firstly diagnosed at advanced stages (III and IV). Anemia was detected in about 50% of GC patients. Hyponutrition was prevalent in newly diagnosed GC. We found the decreased tendency of anemia related indexes from HC to early stages (I and II) and advanced stages (III and IV) of GC patients.

CONCLUSION: Anemia and hypoproteinemia occurred frequently among Vietnamese newly diagnosed GC. The nutrition therapy would benefit GC patients *(Tab. 4, Fig. 4, Ref. 20)*. Text in PDF www.elis.sk

KEY WORDS: hyponutrition, gastric cancer, anemia, hypoproteinea.

**Abbreviations:** Area under ROC curve (AUR), Gastric cancer (GC), Healthy individuals (HC), White Blood Cell count (WBC), Red blood cells (RBC), Hemoglobin (HBG), Hematocrit (HCT), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC)

## Introduction

Gastric cancer (GC) remains the common and deadly cancer, ranking at the 5th of incidence and the 3rd of mortality worldwide (1). Over one million new GC cases were diagnosed and 768,793 cases were died in 2020 worldwide (2). Despite of the steadily declined incidence and mortality over the last 50 years, GC remains the leading health burden and is estimated to reach 1.3 million deaths and 1.8 million new cases by 2040 (1, 3, 4). Among several risk factors reported, the most attributable influences of GC are *Helicobacter pylori* infection, *Human gammaherpesvirus 4* infection, genetic susceptibility, high-salt foods and salt-preserved foods (5). The strong association between GC and its common modifiable risk factors hints it a significantly preventable disease (6). With limited clinical manifestation, most GC patients are diagnosed at late stages when tumor is not radically resected (5). Disregarding stages, the five-year survival rates of GC are 31% in the United States, 19% in the United Kingdom and 26% in Europe (3). Localized, regional and distant GC showed 72%, 33% and 6% of five-year survival rate, respectively (7). The most countries showed about 20−30% of the five-year survival rate of GC, excluding Japan and Korea (8).

Besides stage-dependence, GC prognosis depends on nutritional status, as well. About 31−87% newly diagnosed cancer presents weight loss, whereas 80% of advanced GC experienced malnutrition (9). The stomach stores, crushes and mechanically disrupts the intake foods, directly impact digestion and absorption (10). In addition, acid and pepsin secreted in stomach digests food, especially peptide food and absorption of vitamin B12. Given the most important role in the digestive system, undernutrition occurs commonly among GC patients. Malnutrition was detected in up to 85% GC patients and associated with poor prognosis, such as: increased morbidity and mortality, prolonged hospitalization, limited treatment efficacy and low survival rate (11). GC surgery

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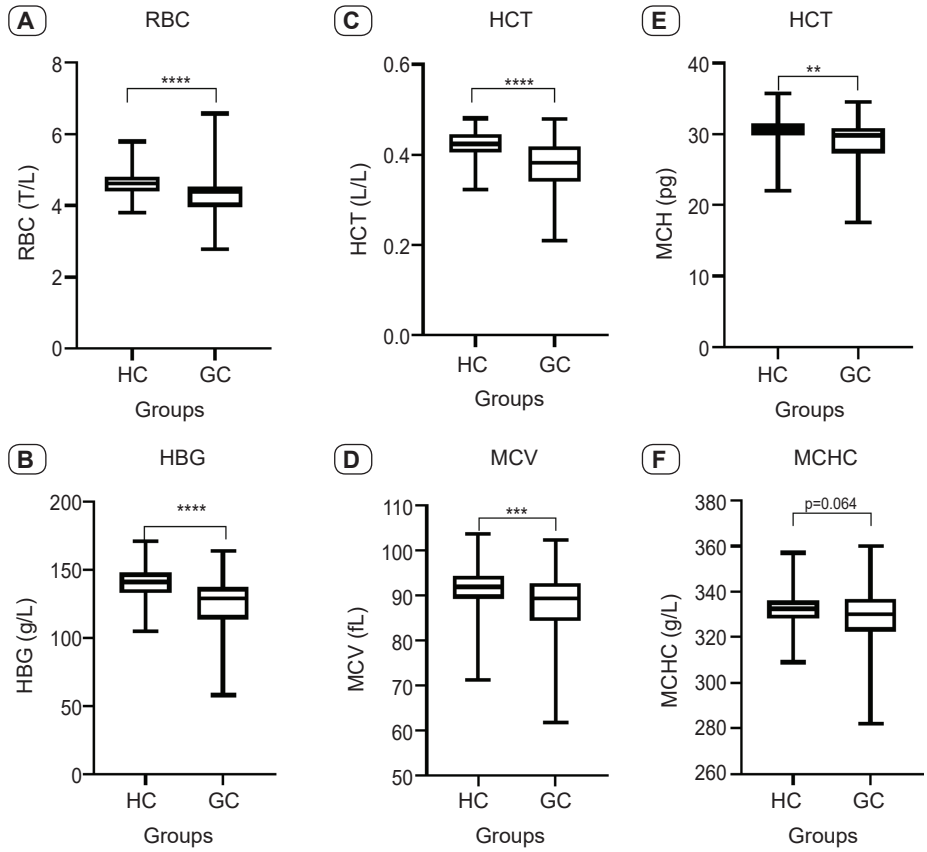


**Fig. 1. The relationship between anemia-related indexes and gastric cancer patients (GC). Anemia-related indexes significant decreased in GC, compared to healthy control (HC). (A) Red blood cell (RBC); (B) Hemoglobin (HBG); (C) Hematocrit (HCT); (D) The mean corpuscular volume (MCV); (E) The mean corpuscular hemoglobin (MCH); (F) The mean corpuscular hemoglobin concentration (MCHC).**

removes partly or totally gastric, directly reduces digestive activity, leading to the deficient intake and uptake. Nutrition supplement not only replenishes deficient intake but also imposes the recovery after the operation (12). Early detection and appropriate nutrition supplement improve the postoperative outcome (11). The superior life quality is an additional concern of malnutrition among patients with GC (11). Thus, the determination of undernutrition of newly diagnosed GC patients to supply nutrition appropriately is needed to improve their prognosis. Thus, this study aims to determine the malnutrition status among Vietnamese patients newly diagnosed with GC for further nutrition strategy.

## Materials and methods

*Patient consent and ethical approval*

All participants were informed and agreed with the collection and reporting their clinical data in this study. The recruitment and execution of this study were approved by the Ethical Committee,

**Tab. 1. Referent range to categorize the level of anemia-related index.**

| Index | Decrease | Normal range | Increase |
|---|---|---|---|
| Red blood cell (RBC) | Male: <4.2<br>Female: <4.0 | Male: 4.2–5.4<br>Female: 4–4.9 | Male: >5.4<br>Female: >4.9 |
| Hemoglobin (HBG) | Male: <130<br>Female: <120 | Male: 130–160<br>Female: 120–150 | Male: >160<br>Female: >150 |
| Hematocrit (HCT) | Male: <0.4<br>Female: <0.37 | Male: 0.4–0.47<br>Female: 0.37–0.42 | Male: >0.47<br>Female: >0.42 |
| Mean corpuscular volume (MCV) | <85 | 85–95 | >95 |
| Mean corpuscular hemoglobin (MCH) | <28 | 28–32 | >32 |
| Mean corpuscular hemoglobin concentration (MCHC) | <320 | 320–360 | >360 |
| Protein (Pro) | <66 | 66–83 | >83 |
| Albumin (Alb) | <35 | 35–52 | >52 |

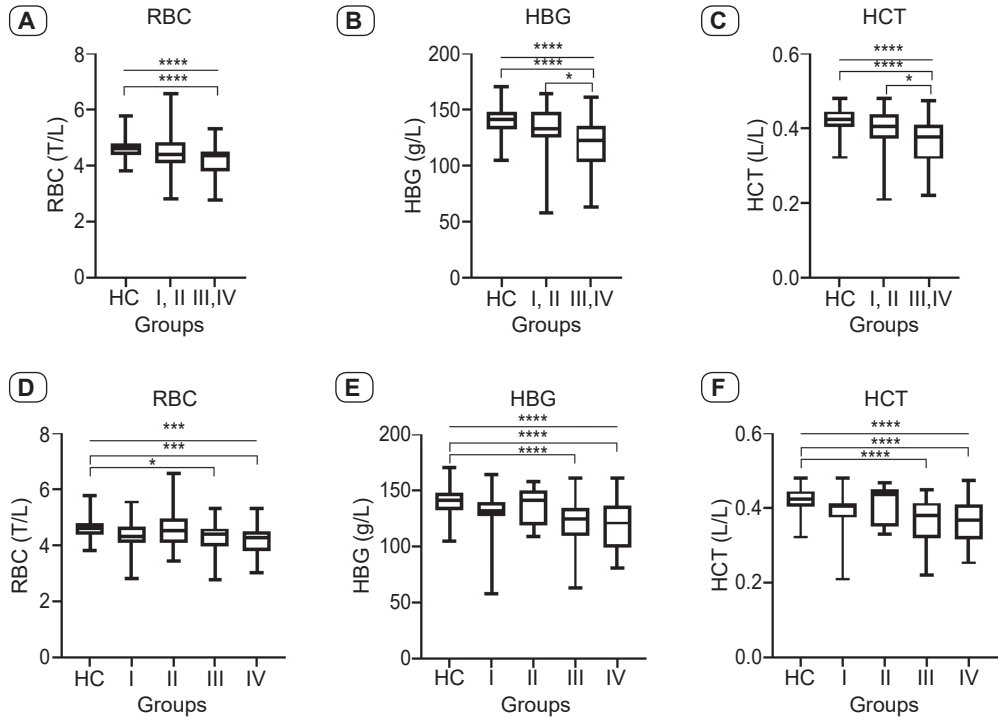


**Fig. 2. The anemia-related indexes among healthy control (HC) and different stages of gastric cancer patients (GC). Different anemia-related indexes were compared between different stages of GC and HC. (A, D) Red blood cell count (RBC); (B, E) Hemoglobin (HBG); (C, F) Hematocrit (HCT).**

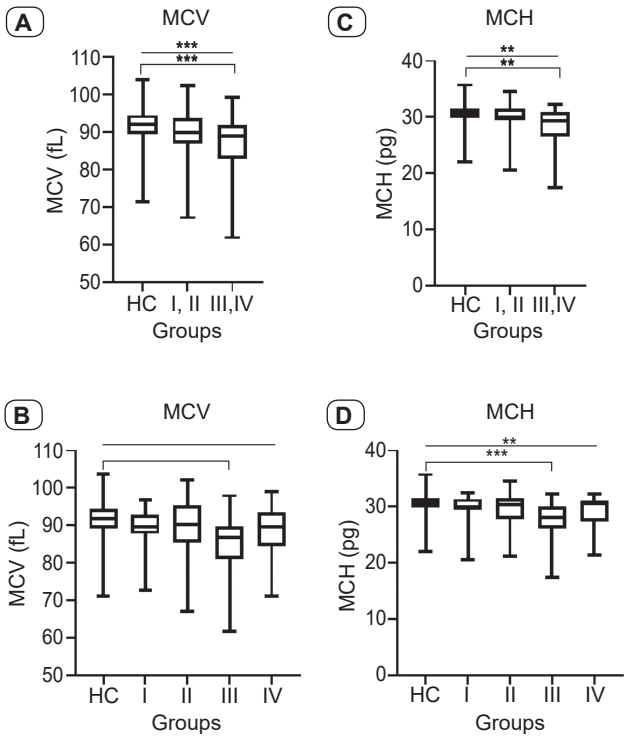


**Fig. 3. The mean corpuscular hemoglobin (MCV) and the mean corpuscular hemoglobin concentration (MCHC) among healthy control (HC) and different stages of gastric cancer patients (GC). (A, B) The mean corpuscular hemoglobin (MCH); (C, D) The mean corpuscular hemoglobin concentration (MCHC).**

Vietnam Military Medical University, Hanoi, Vietnam. All participants signed the consent agreement form.

*Data collection and study design*

This is a cross-sectional descriptive study. The study recruited 77 hospitalized patients who were firstly diagnosed with GC at Military Hospital 103 from June 2020 to September 2022. Patients is selected if fulfilled eligibility criteria: firstly confirmed diagnosis with GC, hospitalized patients and participant agreement. The healthy control (HC) group included 90 people who visited Military Hospital 103 for regular health check and did not detected disease after examination and willing to participate in the study. All participants were explained clearly about the purpose of the study and participated voluntarily. The clinical and preclinical data of participants were collected from Hospital Information Management System. Based on the absolute concentration, the preclinical data were also categorized to different levels according to the referent range (Tab. 1). The results accuracy of preclinical parameter using in the study was controlled and warranted by ISO 15189 standard.

*Statistical analysis*

The statistical analysis was performed using GraphPad Prism 8.0 (GraphPad Software, USA) and Stata 14.0 (Stata Software, USA). The distribution of all variables were determined via Skewness test. The difference between more-than-two groups was analysed by one-way of variance (ANOVA) if the variable follows normal distribution or Kruskal–Wallis if the variable

does not follow normal distribution. The difference between two groups was analysed by unpair t-test or Mann–Whitney if the variable follows and not follow normal distribution, respectively. The association between two categorical variables was checked by Chi-square (Fisher exact). The difference was referred significance $^{*}$, $^{**}$, $^{***}$ and $^{****}$ if $p<0.05$, $p<0.01$, $p<0.001$ and $p<0.0001$, respectively.

## Results

*Description of study cohort*

This study recruited 77 GC patients including 15 stage I-GC (19.5%), 12 stage II-GC (15.5%), 27 stage III-GC (35.1%) and 23 stage IV-GC (29.9%). The male patients was predominant with 51 patients (66.23%). HC group had 90 healthy individuals, the male was predominant with 55 individuals (61.11%). The age and gender distribution of the study cohort were reported previously (13).

*Anemia among GC patients in comparison to HC*

To determine the nutrient status of GC, we compared the anemia-related indicators, including Red blood cell (RBC), Hemoglobin (HBG), Hematocrit (HCT), The Mean corpuscular volume (MCV), The Mean corpuscular hemoglobin (MCH), and The Mean corpuscular hemoglobin concentration (MCHC) between GC and HC. Our results consistently showed the lower level of RBC, HGB, HCT, MCV, MCH and MCHC of GC patients, compared to HC (Fig. 1 A-F). In addition, we categorized participants into increased, normal and decreased levels, based on their absolute value in comparison to referent range (Tab. 1). The rate of decreased RBC, HGB and HCT were respectively 33.77%, 53.25% and 58.44%, indicating the frequent anemia occurring

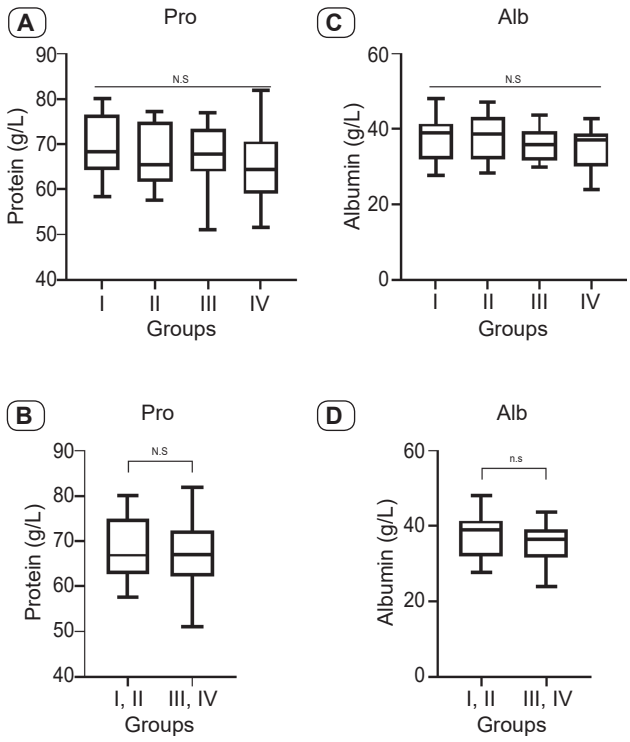


**Fig. 4. The hypoproteinemia among different stages of gastric cancer patients (GC). The comparison of the plasma protein (Pro) concentration (A, B) and plasma albumin (Alb) concentration (C, D) between GC in different stages.**

**Tab. 2. The changes of anemia-related indexes in early and late stages of gastric cancer.**

| Indexes | Levels | Stages | | p |
|---|---|---|---|---|
| | | I+II | III+IV | |
| **Change RBC** | Decrease | 27 | 43 | **0.041** |
| | | 100 | 86 | |
| | Normal | 0 | 7 | |
| | | 0 | 14 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |
| **Change HGB** | Decrease | 8 | 27 | 0.111 |
| | | 29.63 | 54 | |
| | Increase | 1 | 2 | |
| | | 3.7 | 4 | |
| | Normal | 18 | 21 | |
| | | 66.67 | 42 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |
| **Change HCT** | Decrease | 8 | 30 | **0.014** |
| | | 29.63 | 60 | |
| | Increase | 1 | 4 | |
| | | 3.7 | 8 | |
| | Normal | 18 | 16 | |
| | | 66.67 | 32 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |
| **Change MCV** | Decrease | 5 | 17 | 0.273 |
| | | 18.52 | 34 | |
| | Increase | 5 | 5 | |
| | | 18.52 | 10 | |
| | Normal | 17 | 28 | |
| | | 62.96 | 56 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |
| **Change MCH** | Decrease | 4 | 20 | **0.075** |
| | | 14.81 | 40 | |
| | Increase | 3 | 4 | |
| | | 11.11 | 8 | |
| | Normal | 20 | 26 | |
| | | 74.07 | 52 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |
| **Change MCHC** | Decrease | 3 | 13 | 0.124 |
| | | 11.11 | 26 | |
| | Normal | 24 | 37 | |
| | | 88.89 | 74 | |
| | Total | 27 | 50 | |
| | | 100 | 100 | |

Red blood cell (RBC), Hemoglobin (HBG), Hematocrit (HCT), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC)

among newly diagnosed GC. Our analysis showed the significant association between the decrease of RBC, HGB, HCT, MCV, MCH and MCHC and GC (The results indicated the frequent anemia among newly diagnosed GC patients) (Tab. 2).

*The comparison between anemia levels and GC stages*

To determine the change of hematological system during GC progress, we compared some hematological indexes between HC, early and late stages of GC. We found the decreased tendency of some anemia-related indexes (including RBC, HGB and HCT) from HC to GC early stages (I, II) to GC late stages (III, IV) (Fig. 2 A-C). These anemia-related indexes gradually decreased from HC to GC stage I, II, III, IV (Fig. 2 D-F). Similar partern was observed in the mean corpuscular hemoglobin (MCV) (Fig. 3 A, B) and the mean corpuscular hemoglobin concentration (MCHC) (Fig. 3 C, D). All anemia-related investigation indexes gradually decreased from HC to GC stage I, II, III, IV. Basically, the significant decrease was observed between stage III and IV, compared to HC, but not between HC and early GC stages (I, II). Thus, the data showed worse anemia during the GC progression.

*Hypoproteinemia among GC patients and association with GC stages*

To determine the nutrient status of GC, we categorized the GC patients depending on their levels of nutrient-related indicators, including protein and albumin concentration in plasma. We found that the decreased protein and albumin was observed in 44.29% and 34.67% of GC patients, respectively (Tab. 3).

In addition, we compared the protein and albumin concentration between different GC stages. The results showed a comparable level of protein and albumin between GC stage I, II, III, IV as well as between early and advanced GC (Fig. 4 A-D). Additionally, we determined the association between hypoproteinemia and GC stages. No association between protein and albumin levels and GC stage was found (Tab. 3). Briefly, anemia and insufficient protein, the indicator of malnutrition occurred in around 40–50% of GC patients.

*The distribution of anemia-related indexes with age*

To determine the interference of age on malnutrition-related indexes, such as RBC, HGB, HCT, MCV, MCH, MCHC, protein and albumin, their mean value were compared between age groups. Our analysis showed the equal value of above indexes between different age groups. Among GC, the absolute value of RBC, HGB, HCT, MCV, MCH, MCHC, protein and albumin were comparable between different age groups (Tab. 4). Among HC, the value of MCV were slightly lower in elder group (≥60 years old), compared to the younger groups. Our analysis showed the equal value of almost investigated hyponutrition indexes (except MCV) among different age groups.

**Tab. 3. The changes of protein and albumin concentration in different stages of gastric cancer.**

| Indexes | Levels | | Stages | | | | Total | p |
|---|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | | |
| Change Pro | Decrease | n | 4 | 6 | 10 | 11 | 31 | 0.437 |
| | | % | 30.77 | 54.55 | 38.46 | 55 | 44.29 | |
| | Normal | n | 9 | 5 | 16 | 9 | 39 | |
| | | % | 69.23 | 45.45 | 61.54 | 45 | 55.71 | |
| | Total | n | 13 | 11 | 26 | 20 | 70 | |
| | | % | 100 | 100 | 100 | 100 | 100 | |
| **Indexes** | **Levels** | | **Stages** | | | | **Total** | **p** |
| | | | **I+II** | | **III+IV** | | | |
| Change Pro | Decrease | n | 10 | | 21 | | 31 | 0.75 |
| | | % | 41.67 | | 45.65 | | 0.44 | |
| | Normal | n | 14 | | 25 | | 39 | |
| | | % | 58.33 | | 54.35 | | 0.56 | |
| | Total | n | 24 | | 46 | | 70 | |
| | | % | 100 | | 100 | | 100 | |
| **Indexes** | **Levels** | | **Stages** | | | | **Total** | **p** |
| | | | **I** | **II** | **III** | **IV** | | |
| Change Alb | Decrease | n | 4 | 4 | 11 | 7 | 26 | 0.828 |
| | | % | 26.67 | 33.33 | 40.74 | 33.33 | 34.67 | |
| | Normal | n | 11 | 8 | 16 | 14 | 49 | |
| | | % | 73.33 | 66.67 | 59.26 | 66.67 | 65.33 | |
| | Total | n | 15 | 12 | 27 | 21 | 75 | |
| | | % | 100 | 100 | 100 | 100 | 100 | |
| **Indexes** | **Levels** | | **Stages** | | | | **Total** | **p** |
| | | | **I+II** | | **III+IV** | | | |
| Change Alb | Decrease | n | 8 | | 18 | | 26 | 0.75 |
| | | % | 29.63 | | 37.5 | | 0.35 | |
| | Normal | n | 19 | | 30 | | 49 | |
| | | % | 70.37 | | 62.5 | | 0.65 | |
| | Total | n | 27 | | 48 | | 75 | |
| | | % | 100 | | 100 | | 100 | |

Protein (Pro), Albumin (Alb)

## Discussion

Being the prevalent malignancy for many decades, GC showed poor and stage-dependent prognosis (3). Patients with operable GC have a longer overall survival compared to inoperable GC. Meanwhile, preoperative and postoperative nutritional supplement reduces the length of hospitalization, complications and support the recovery (9). Nutrition not only supports the recovery, incision healing and combat against cancer postoperatively but also affects treatment tolerance and response to the systematic treatment therapy. Thus, malnutrition is an important concern of cancer treatment, especially with GC due to its digestive function.

Several indicators have been used to evaluate the nutritional status, but none of them present enough reliability (11). The

prognostic value of serum hepatic proteins, such as albumin, prealbumin, and transferrin relating to nutrition is restricted by their decrease in other dysregulation, such as infection, injury, inflammation, kidney and liver failure (11, 14). Thus, the combination of different indexes to build the nutritional scores increase the reliability of investigation. Unfortunately, our study lack the nutritional evaluation by nutritional scores (nutritional screening and nutritional assessment tools) and mainly focused on some basic and convenient malnutrition-related tests, such as complete blood count (CBC), protein and albumin tests (11). However, these cheap and common tests gave the useful information relating nutrition status among the newly diagnosed GC patients.

Malnutrition occurs frequently in chronic syndromes including cancer. Stomach is a key organ of digestive system, and GC progress directly affect nutritional absorption. Thus, the determination of nutritional status provides information for nutritional therapy which benefits patient during operation, post-operation, systematic treatment tolerance. The malnutrition occurs among 65% to 85% of GC with deteriorate tendency after hospitalization (11). The possible culprits of malnutrition in GC are the poor nutrition diet, the deficient digestion and absorption and the impaired metabolism. Nutrition deficiency related to the poor treatment response and quality of life, shorter survival, increased morbidity and mortality, prolonged hospitalization and serious postoperative complications (11, 15). Malnutrition is exacerbated by treatment or pathological disease itself, especially in case of gastric resection (12, 16). Malnutrition is an independent prevalent concern of postoperative subtotal and total gastrectomy, requiring intensive nutritional management in follow-up period (17, 18). GC patients in this study presented the significant low RBC, HCT, HBG, MCV, MCH and MCHC, compared to HC. Anemia occurred up to 50% of the newly diagnosed GC patients. Also, the value of the anemia-related indexes was the lowest on late-stage GC, followed by early-stage GC and HC. Thus, our analysis showed the high rate of anemia among GC with late stage being the aggravation. We additionally investigated the change of protein and albumin concentration among patients with different GC stages. We found that hypoproteinemia and hypoalbuminemia occurred around 45% and 35%, respectively. Taken the role of protein on health and wound healing, the hypoproteinemia and hypoalbuminemia hints the necessary to supply nutrition for GC patients. The preoperative malnutrition of GC related to a greater morbidity and mortality, lower survival, increased infective complications (19). The malnutrition might be exacerbated and impose complication, such as infection and malnourishment postoperatively (19). The nutrient status support the recovery after surgery and systematic treatment of chemotherapy. Thus, pre-surgical nutritional treatment and post-surgical nutritional therapy were highly recommended for GC patients (19). The preoperatively insufficient nutrition predicts the poor postoperative survival of GC (20). Although, our results was only restricted in pre-clinical signs of malnutrition, without clinical signs, the malnutrition was evidenced, and intensive nutrient supplement is needed.

**Tab. 4. The distribution of malnutrition-related indexes with age.**

| Indexes | Group | Age groups | | | p |
|---|---|---|---|---|---|
| | | ≤50 | 50-60 | ≥60 | |
| RBC | GC | 4.2±0.2 | 4±0.6 | 4.3±0.7 | 0.27 |
| | HC | 4.6±0.4 | 4.6±0.4 | 4.7±0.3 | 0.91 |
| HGB | GC | 116.5±17.5 | 119.2±21.6 | 125±24.4 | 0.38 |
| | HC | 139.8±11.7 | 140.6±11.7 | 139.6±9.4 | 0.95 |
| HCT | GC | 0.36±0.04 | 0.36±0.06 | 0.38±0.06 | 0.38 |
| | HC | 0.42±0.04 | 0.42±0.05 | 0.42±0.06 | 0.96 |
| MCV | GC | 85.0±10.41 | 90.4±4.5 | 87±8.0 | 0.46 |
| | HC | 91.5±4.0 | 91.9±4.9 | 86.4±1.9 | **0.02** |
| MCH | GC | 27.6±4.4 | 29.8±1.7 | 28.7±3.5 | 0.62 |
| | HC | 30.4±1.4 | 30.6±1.9 | 29±1.6 | 0.087 |
| MCHC | GC | 322.7±15.6 | 330.3±10.0 | 328.5±15.0 | 0.63 |
| | HC | 331.9±5.2 | 332.8±7.4 | 336±11.6 | 0.55 |
| Pro | GC | 70.2±7.8 | 64.6±9.1 | 67.4±6.9 | 0.37 |
| Alb | GC | 39.2±3.4 | 35.6±5.6 | 36.1±5.2 | 0.32 |

Red blood cell (RBC), Hemoglobin (HBG), Hematocrit (HCT), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC), Protein (Pro), Albumin (Alb)

Briefly, the anemia and hypoproteinemia occurred frequently among Vietnamese patients newly diagnosed with GC. The early evaluations of nutritional status, followed by early appropriate nutritional supplement potentially benefits both operable and advanced GC patients.

## References


**1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A.** Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018; 68 (6): 394–424.

**2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F.** Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin 2021; 71 (3): 209–249.

**3. Rawla P, Barsouk A.** Epidemiology of gastric cancer: global trends, risk factors and prevention. Prz Gastroenterol 2019; 14 (1): 26–38.

**4. Morgan E, Arnold M, Camargo MC, Gini A, Kunzmann AT, Matsuda T, Meheus F, Verhoeven RHA, Vignat J, Laversanne M et al.** The current and future incidence and mortality of gastric cancer in 185 countries, 2020–40: A population-based modelling study. EClinicalMedicine 2022; 47: 101404.

**5. Yang L, Ying X, Liu S, Lyu G, Xu Z, Zhang X, Li H, Li Q, Wang N, Ji J.** Gastric cancer: Epidemiology, risk factors and prevention strategies. Chin J Cancer Res 2020; 32 (6): 695–704.

**6. Iwu CD, Iwu-Jaja CJ.** Gastric Cancer Epidemiology: Current Trend and Future Direction. Hygiene 2023; 3 (3): 256–268.

**7. Stomach Cancer Survival Rates** (https: //www.cancer.org/cancer/types/stomach-cancer/detection-diagnosis-staging/survival-rates.html)

**8. Allemani C, Matsuda T, Di Carlo V, Harewood R, Matz M, Nikšić M, Bonaventure A, Valkov M, Johnson CJ, Estève J et al.** Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. Lancet 2018; 391 (10125): 1023–1075.

**9. Rosania R, Chiapponi C, Malfertheiner P, Venerito M.** Nutrition in Patients with Gastric Cancer: An Update. Gastrointest Tumors 2016; 2 (4): 178–187.

**10. Pohle T, Domschke W.** Gastric function measurements in drug development. Br J Clin Pharmacol 2003; 56 (2): 156–164.

**11. Son YG, Kwon IG, Ryu SW.** Assessment of nutritional status in laparoscopic gastrectomy for gastric cancer. Transl Gastroenterol Hepatol 2017; 2: 85.

**12. McClave SA, Kozar R, Martindale RG, Heyland DK, Braga M, Carli F, Drover JW, Flum D, Gramlich L, Herndon DN et al.** Summary points and consensus recommendations from the North American Surgical Nutrition Summit. JPEN J Parenter Enteral Nutr 2013; 37 (5 Suppl): 99s–105s.

**13. Nguyen MLT, Pham C, Le QV, Nham PLT, Tran DH, Le TS, Hoang VT, Can VM, Nguyen LT, Bui KC.** The diagnostic and prognostic value of neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio on gastric cancer patients. Medicine (Baltimore) 2023; 102 (31): e34357.

**14. Bharadwaj S, Ginoya S, Tandon P, Gohel TD, Guirguis J, Vallabh H, Jevenn A, Hanouneh I.** Malnutrition: laboratory markers vs nutritional assessment. Gastroenterol Rep (Oxf) 2016; 4 (4): 272–280.

**15. Zhao B, Zhang J, Zhang J, Zou S, Luo R, Xu H, Huang B.** The Impact of Preoperative Underweight Status on Postoperative Complication and Survival Outcome of Gastric Cancer Patients: A Systematic Review and Meta-analysis. Nutr Cancer 2018; 70 (8): 1254–1263.

**16. Mariette C, De Botton ML, Piessen G.** Surgery in esophageal and gastric cancer patients: what is the role for nutrition support in your daily practice? Ann Surg Oncol 2012; 19 (7): 2128–2134.

**17. Wang HM, Wang TJ, Huang CS, Liang SY, Yu CH, Lin TR, Wu KF.** Nutritional Status and Related Factors in Patients with Gastric Cancer after Gastrectomy: A Cross-Sectional Study. Nutrients 2022; 14 (13).

**18. Fukuda Y, Yamamoto K, Hirao M, Nishikawa K, Maeda S, Haraguchi N, Miyake M, Hama N, Miyamoto A, Ikeda M et al.** Prevalence of Malnutrition Among Gastric Cancer Patients Undergoing Gastrectomy and Optimal Preoperative Nutritional Support for Preventing Surgical Site Infections. Ann Surg Oncol 2015; 22 Suppl 3: S778–785.

**19. Carrillo Lozano E, Oses Zarate V, Campos Del Portillo R.** Nutritional management of gastric cancer. Endocrinol Diabetes Nutr (Engl Ed) 2021; 68 (6): 428–438.

**20. Konishi T, Kosuga T, Inoue H, Konishi H, Shiozaki A, Kubota T, Okamoto K, Fujiwara H, Otsuji E.** Significance of Preoperative Prognostic Nutritional Index in the Perioperative Management of Gastric Cancer. J Gastrointest Surg 2022; 26 (3): 558–569.

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Accepted December 11, 2023.