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Article

Sex Distribution and Hematological Profiles of Selected Gastrointestinal Cancers in Nineveh Governorate, Iraq

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Abstract: Gastrointestinal cancers and their treatment may substantially alter peripheral blood indices, making routine hematological assessment important during clinical management. This study described the sex distribution of selected gastrointestinal cancers recorded in Nineveh Governorate and evaluated hematological profiles among affected patients. A descriptive study combined a retrospective review of hospital records from 2017–2023 with a cross-sectional laboratory component conducted from October to December 2025. The laboratory dataset comprised 100 venous blood samples, including 63 patients (27 males and 36 females) and 37 apparently healthy nonsmoking controls. Hemoglobin, packed cell volume, red and white blood cell counts, platelet count, and leukocyte differential percentages were measured using an automated Sysmex hematology analyzer. The highest male proportion among pancreatic cancer cases was 64% in 2020, whereas the highest female proportion was 51% in 2019. Rectal cancer cases were predominantly male (56%) from 2017–2020, while females represented 59% in 2023. Compared with controls, most patient groups showed lower hemoglobin, packed cell volume, red blood cell, platelet, and white blood cell values. The lowest male hemoglobin and packed cell volume were observed in liver cancer, whereas the lowest female hemoglobin and packed cell volume occurred in pancreatic cancer. Selected gastrointestinal cancers were associated with distinct sex distributions and broad reductions in hematological indices. Regular complete blood count monitoring is warranted, particularly during chemotherapy, to identify cytopenias early and guide supportive care.

Keywords: Gastrointestinal Cancer, Complete Blood Count, Chemotherapy, Hematological Parameters, Nineveh, Iraq

Introduction

Gastrointestinal (GI) cancers comprise malignancies of the esophagus, stomach, small and large intestines, rectum, liver, pancreas, gallbladder, and biliary tract. Collectively, they account for a substantial proportion of global cancer incidence and mortality, although their distribution varies markedly by anatomical site, sex, geography, and level of socioeconomic development [1]. Recent advances in imaging, endoscopy, molecular characterization, surgery, targeted therapy, and

immunotherapy have improved management; nevertheless, delayed diagnosis and treatment-related toxicity remain major clinical challenges [2].

The development of GI cancers is influenced by modifiable and nonmodifiable factors. Tobacco use, alcohol consumption, obesity, physical inactivity, and unhealthy dietary patterns contribute to risk, while specific infections and conditions—including Helicobacter pylori infection, chronic hepatitis B or C virus infection, and hereditary predisposition—are linked to particular tumor sites [3]. Local disease patterns may also reflect differences in environmental exposure, access to screening, referral practices, and completeness of cancer registration.

Peripheral blood indices provide clinically useful information in patients with cancer. Anemia may arise from chronic blood loss, nutritional deficiency, inflammation, marrow infiltration, renal dysfunction, or cytotoxic treatment. White blood cell and platelet abnormalities may likewise reflect tumor-related inflammation, bone marrow suppression, or chemotherapy toxicity. Complete blood count components have therefore been investigated as diagnostic, prognostic, and treatment-monitoring markers in colorectal and other GI malignancies [4], [5]. Chemotherapy-related hematotoxicity can vary among patients and across treatment cycles, emphasizing the need for repeated laboratory assessment [6].

Accordingly, this study aimed to describe the sex distribution of selected GI cancers recorded in Nineveh Governorate between 2017 and 2023 and to compare key hematological parameters in patients and healthy controls. The study focused on hemoglobin concentration, packed cell volume, red and white blood cell counts, platelet count, and selected leukocyte differential percentages.

Materials and Methods

Study Design and Setting

This descriptive investigation included two components. First, a retrospective review was conducted using records of patients diagnosed with selected GI cancers at the Specialized Oncology and Nuclear Medicine Hospital in Mosul during 2017–2023. Second, a cross-sectional laboratory component was carried out from October to December 2025 in the laboratories of the Department of Biology, College of Science, University of Mosul.

Participants and Clinical Data

The laboratory component included 100 venous blood samples. Sixty-three samples were obtained from patients with GI cancers (27 males and 36 females), and the remaining 37 samples constituted an apparently healthy, nonsmoking control group. The laboratory analyses represented colon, stomach, liver, rectal, pancreatic, and biliary tract cancers; the retrospective sex-distribution dataset additionally included small-intestinal cancer. Diagnoses were established by specialist physicians. Demographic and clinical information was recorded using a structured data form.

Blood Collection and Hematological Analysis

Approximately 2 mL of venous blood was collected into tubes containing ethylenediaminetetraacetic acid (EDTA). Samples were analyzed within two hours of collection using an automated Sysmex hematology analyzer. The measured variables were hemoglobin (Hb, g/dL), packed cell volume (PCV, %), red blood cell count (RBC, $\times 10^{12}$/L), white blood cell count (WBC, $\times 10^{9}$/L), platelet count (PLT, $\times 10^{9}$/L), lymphocyte percentage, and granulocyte percentage.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 24. Group means were compared using one-way analysis of variance followed by Duncan's multiple-range test. A probability value of $p \leq 0.05$ was considered statistically significant. The analytical approach followed standard procedures for descriptive and group-comparison statistics [7].

Results

The retrospective data are presented as the percentage distribution of recorded cases by sex within each cancer type and year. Because population denominators were unavailable, these percentages should not be interpreted as population incidence rates.

Sex Distribution of Recorded Gastrointestinal Cancer Cases

Pancreatic cancer showed a variable sex distribution across the study period. Males represented the highest proportion in 2020 (64%), whereas females represented the highest proportion in 2019 (51%). Rectal cancer was predominantly recorded among males from 2017 through 2020 (56% in each year); however, females accounted for 58% of cases in 2021 and 59% in 2023. The male proportion of small-intestinal cancer reached 71% in 2022, and the male proportion of biliary tract cancer reached 73% in 2023 (Table 1).

These local records suggest temporal and sex-related variation in the case mix. An earlier national report also documented a substantial cancer burden in Nineveh Governorate, although differences in data sources and reporting periods limit direct comparison [8][9][10].

Table 1. Sex distribution (%) of recorded gastrointestinal cancer cases in Nineveh Governorate, 2017–2023.

Cancer type	Sex	2017	2018	2019	2020	2021	2022	2023
Pancreatic	**Male**	50%	52%	49%	64%	55%	54%	51%
Pancreatic	**Female**	50%	48%	51%	36%	45%	46%	49%
Rectal	**Male**	56%	56%	56%	56%	42%	63%	41%
Rectal	**Female**	44%	44%	44%	44%	58%	37%	59%
Small intestine	**Male**	67%	55%	60%	43%	55%	71%	61%
Small intestine	**Female**	33%	45%	40%	57%	45%	29%	39%
Biliary tract	**Male**	0%	29%	56%	67%	63%	56%	73%
Biliary tract	**Female**	0%	71%	44%	33%	37%	44%	27%

Note: Percentages represent the sex composition of recorded cases within each cancer type and year; they are not population incidence rates.

Hemoglobin Concentration and Packed Cell Volume

Mean Hb and PCV values were lower in most cancer groups than in the corresponding controls. Among males, the lowest values were recorded in liver cancer (Hb 9.47 g/dL; PCV 28.4%), followed by pancreatic and rectal cancer. Among females, the lowest Hb and PCV values were observed in pancreatic cancer (10.33 g/dL and 31.17%, respectively), closely followed by biliary tract and stomach cancer (Figures 1 and 2).

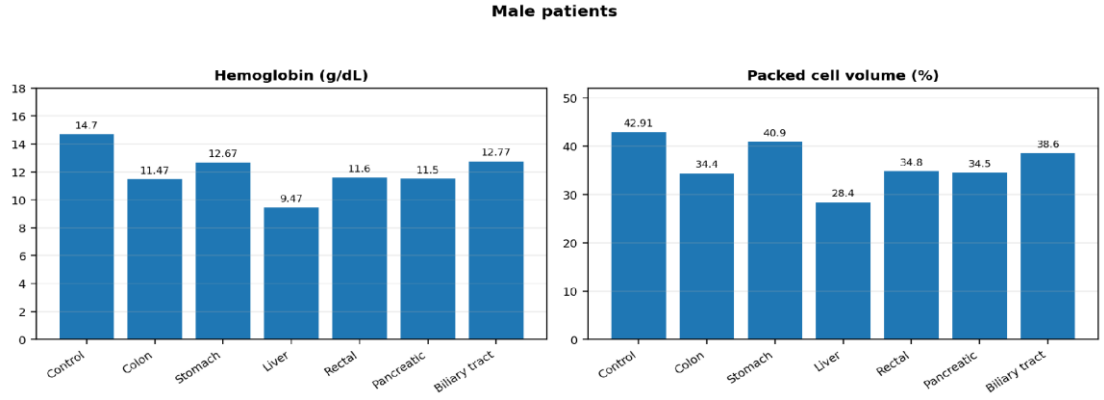

Figure 1. Mean hemoglobin concentration and packed cell volume in male patients with selected gastrointestinal cancers and controls.

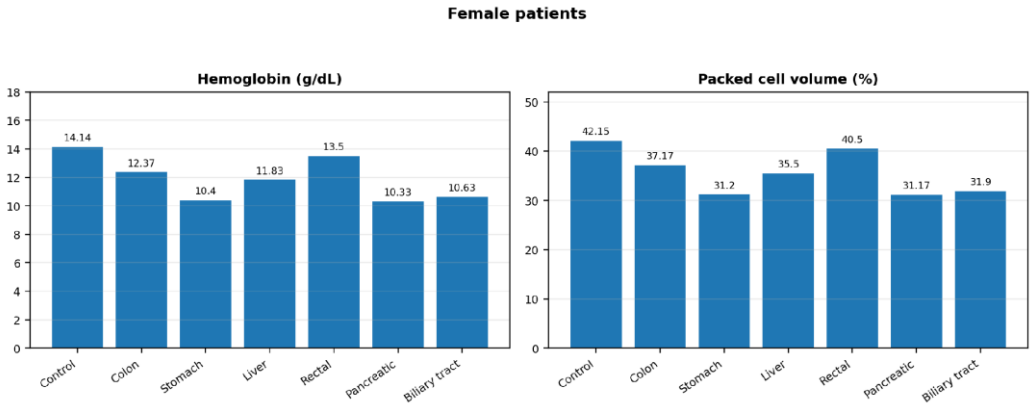

Figure 2. Mean hemoglobin concentration and packed cell volume in female patients with selected gastrointestinal cancers and controls.

Red Blood Cell and Platelet Counts

RBC counts were generally reduced relative to controls. The lowest male RBC count was observed in liver cancer (3.55 $\times 10^{12}$/L), while the lowest female value was found in pancreatic cancer (3.67 $\times 10^{12}$/L). Platelet counts were also lower in all patient groups than in controls; the lowest values were recorded in male biliary tract cancer (151.67 $\times 10^{9}$/L) and female stomach cancer (143.00 $\times 10^{9}$/L) (Figures 3 and 4).

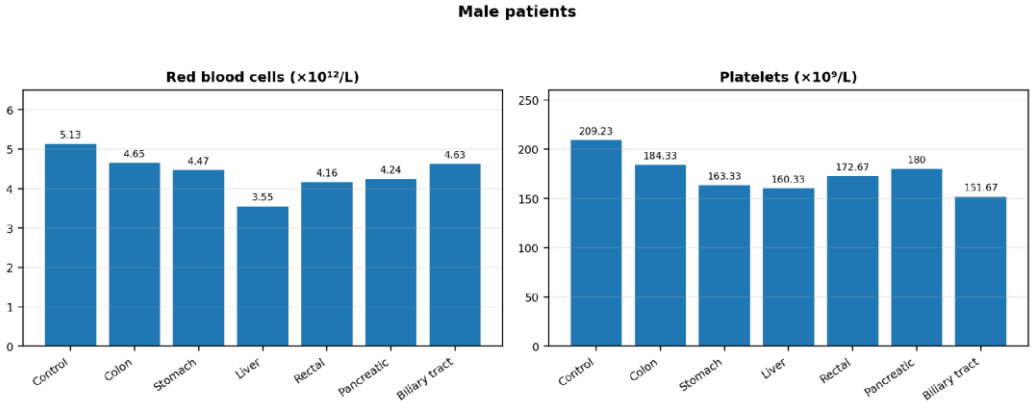

Figure 3. Mean red blood cell and platelet counts in male patients with selected gastrointestinal cancers and controls.

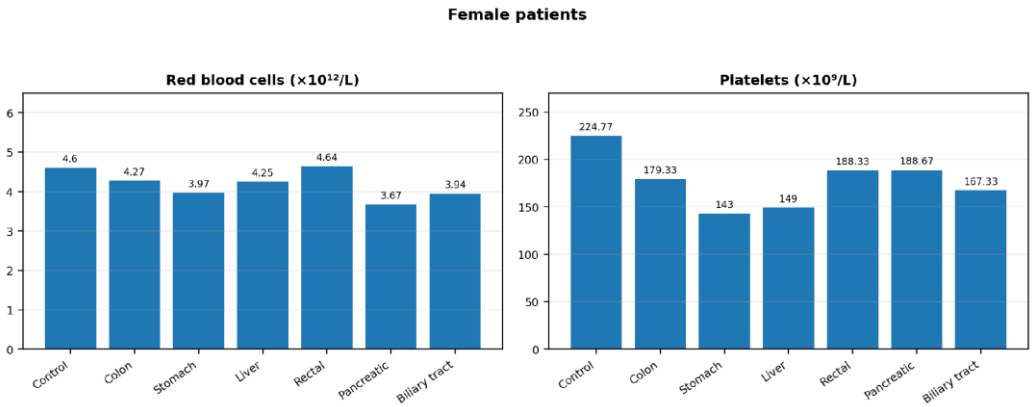

Figure 4. Mean red blood cell and platelet counts in female patients with selected gastrointestinal cancers and controls.

White Blood Cell Count and Leukocyte Differential

The lowest WBC count among males occurred in biliary tract cancer (5.28 ×10⁹/L), whereas the lowest female value occurred in rectal cancer (4.97 ×10⁹/L). The lowest lymphocyte percentages were observed in male pancreatic cancer (46.53%) and female biliary tract cancer (51.13%). Granulocyte percentages were lowest in male rectal cancer (19.93%) and female pancreatic cancer (23.80%) (Figures 5 and 6).

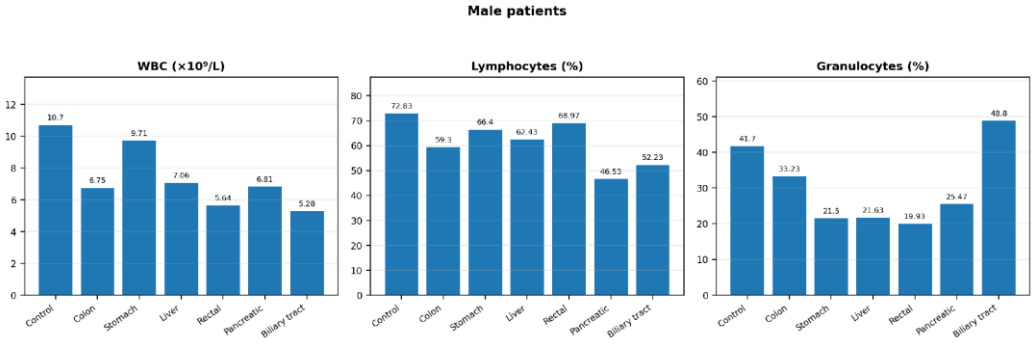

Figure 5. Mean white blood cell count and leukocyte differential percentages in male patients with selected gastrointestinal cancers and controls.

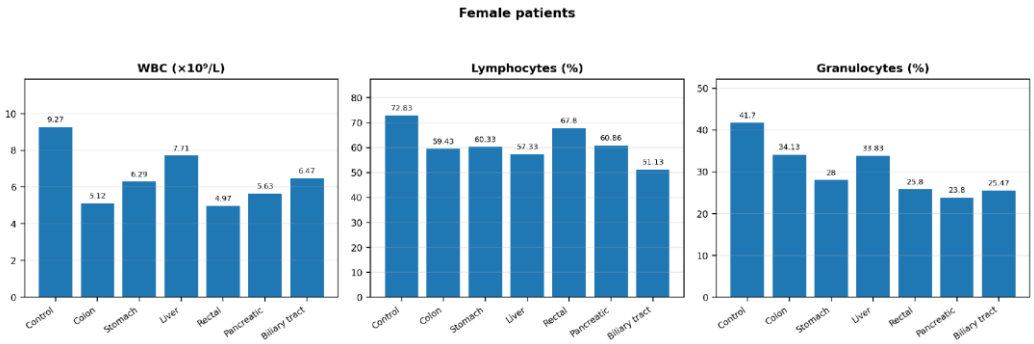

Figure 6. Mean white blood cell count and leukocyte differential percentages in female patients with selected gastrointestinal cancers and controls.

Discussion

The retrospective component demonstrated year-to-year variation in the sex composition of recorded gastrointestinal cancer cases. These percentages should be interpreted as the distribution of registered cases rather than population incidence because age- and sex-specific population denominators were not available. Even with this limitation, the observed male predominance in several pancreatic, rectal, small-intestinal, and biliary tract categories is broadly compatible with the well-recognized variation in gastrointestinal cancer burden by sex, anatomical site, geography, and level of development [11], [12], [13]. However, the reversal toward a higher female proportion in some years, particularly for rectal cancer in 2021 and 2023, may reflect changes in referral patterns, access to diagnostic services, case ascertainment, or relatively small yearly case numbers rather than a true biological shift.

Sex-related differences in gastrointestinal cancer may arise from a combination of behavioral exposures, hormonal and metabolic factors, genetic susceptibility, comorbidity profiles, and differences in healthcare-seeking behavior [3], [12]. Sex may also influence treatment tolerance. A pooled analysis of randomized trials in metastatic colorectal cancer reported sex-associated differences in chemotherapy toxicity and efficacy, indicating that the interpretation of local hematological findings should consider both biological sex and treatment exposure [14]. Because chemotherapy regimens and

cycle numbers were not available in the present dataset, the observed male-female differences cannot be attributed to sex alone and should be examined prospectively.

The most consistent laboratory finding was a reduction in hemoglobin and packed cell volume in several cancer groups. This pattern is compatible with the multifactorial nature of anemia in malignancy. Gastrointestinal tumors may cause chronic occult bleeding, reduced dietary intake, impaired absorption, inflammation-driven iron sequestration, renal dysfunction, bone marrow infiltration, or treatment-related suppression of erythropoiesis. Importantly, cancer-related anemia may be present before chemotherapy. In a large prospective cohort, anemia was common at cancer diagnosis and was associated with disease stage, systemic inflammation, iron metabolism, and nutritional status [15]. Similarly, iron deficiency has been documented across solid tumors and was particularly frequent in pancreatic and colorectal malignancies [16]. These mechanisms provide a plausible explanation for the low Hb and PCV values observed in the liver, pancreatic, gastric, and biliary groups, although the current study did not measure ferritin, transferrin saturation, C-reactive protein, vitamin B12, folate, renal function, or evidence of gastrointestinal bleeding.

The relatively low hemoglobin and red blood cell values in pancreatic and gastric cancer deserve particular attention. Patients with pancreatic cancer frequently have reduced intake, malabsorption, inflammation, and advanced disease, all of which may impair erythropoiesis and iron availability [16]. In gastric cancer, anemia may result from tumor bleeding, chronic inflammation, poor intake, and impaired iron absorption; a Canadian retrospective study reported a high frequency of anemia and iron-deficiency anemia at diagnosis [17][18]. Therefore, low Hb in these groups should not automatically be ascribed to chemotherapy. A structured diagnostic work-up is needed to distinguish absolute iron deficiency, functional iron deficiency, nutritional deficiency, bleeding, hemolysis, renal disease, and marrow suppression.

The reduction in RBC count generally paralleled the decreases in Hb and PCV, strengthening the interpretation that erythroid abnormalities were present in multiple patient groups. Clinically, anemia may contribute to fatigue, dyspnea, reduced physical function, poorer treatment tolerance, and diminished quality of life. Management should be directed by the underlying cause rather than by hemoglobin concentration alone. A recent systematic review of patients with gastrointestinal cancer found that intravenous iron improved hemoglobin in several included studies and was often associated with favorable quality-of-life or postoperative outcomes, although effects on transfusion requirements were inconsistent [17]. Future local studies should therefore combine CBC findings with iron studies and nutritional assessment before recommending a specific intervention.

Platelet counts were lower than controls across the studied cancer groups, with the lowest means in male biliary tract cancer and female gastric cancer. Chemotherapy-induced thrombocytopenia can result from injury to megakaryocytic progenitors, impaired platelet production, immune-mediated destruction, infection, liver dysfunction, hypersplenism, or extensive marrow involvement [9]. Real-world data from patients receiving gemcitabine-cisplatin for biliary tract cancer have documented clinically important anemia, neutropenia, and thrombocytopenia [19], supporting treatment-related marrow suppression as one possible explanation for the low platelet values in this study. Nevertheless, gastrointestinal malignancies may also be associated with reactive thrombocytosis and adverse prognosis, and platelet-derived indices have been explored as potential biomarkers [11]. Consequently, a single cross-sectional platelet value cannot distinguish tumor-associated inflammation from treatment toxicity; serial measurements before and after each chemotherapy cycle would be more informative.

The reductions in WBC count and selected leukocyte differential percentages are clinically relevant because myelosuppression may increase susceptibility to infection and can lead to treatment

delay, dose reduction, hospitalization, or use of growth-factor support. Chemotherapy-induced neutropenia is influenced by age, nutritional and performance status, comorbidities, cancer type, disease stage, regimen intensity, and previous treatment cycles [20][21]. Myelosuppression also has a measurable negative effect on symptoms, daily functioning, and quality of life [20]. In the present study, the lowest WBC and differential values varied by sex and tumor site; however, absolute neutrophil counts were not reported. Because febrile-neutropenia risk is assessed using absolute neutrophil count rather than granulocyte percentage alone, future investigations should report ANC values, toxicity grades, febrile episodes, documented infections, and any administration of granulocyte colony-stimulating factor.

Changes in leukocyte and platelet parameters may also reflect tumor-associated inflammation rather than cytopenia alone. CBC-derived measures such as red cell distribution width, neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and related indices have been investigated as adjunctive diagnostic or prognostic markers in colorectal cancer [10], [11], [22]. The current study measured WBC count and leukocyte percentages but did not calculate these ratios or relate them to stage, metastasis, or survival. Thus, the findings support the biological relevance of routine hematology, but they should not be interpreted as evidence that any single CBC parameter can diagnose a particular gastrointestinal cancer or replace histopathology, imaging, and established staging procedures.

From a clinical perspective, the results emphasize the value of repeated CBC monitoring rather than reliance on one measurement. Baseline assessment before treatment, evaluation at expected nadir, and reassessment before subsequent cycles can identify the direction and severity of change. Interpretation should also consider symptoms, hydration, recent transfusion, infection, bleeding, liver and renal function, nutritional status, and concomitant medications. Linking these variables to the exact chemotherapy regimen would help determine whether the observed cytopenias were expected adverse effects, manifestations of advanced malignancy, or potentially reversible deficiencies.

Several limitations should be acknowledged. The laboratory sampling period was short, the number of patients within each cancer-sex subgroup was not available, and the analysis was based on group means rather than patient-level distributions. Age, disease stage, histological subtype, chemotherapy regimen, treatment cycle, interval from chemotherapy to blood collection, nutritional status, bleeding history, transfusion, infection, and comorbidities could not be controlled. The control-group composition by sex and age was also not fully described. In addition, the retrospective percentages lacked population denominators and therefore cannot be interpreted as incidence rates. The cross-sectional design prevents causal attribution of hematological changes to chemotherapy. Larger longitudinal studies should obtain pretreatment and serial post-treatment CBCs, report absolute neutrophil counts and toxicity grades, measure iron and inflammatory markers, and use multivariable analysis to identify independent predictors of hematological toxicity.

Conclusion

Selected GI cancers recorded in Nineveh Governorate showed variable sex distributions over time. Patients also exhibited lower mean hematological values than healthy controls across several cancer groups, particularly for hemoglobin, packed cell volume, red blood cells, platelets, and white blood cells. These findings highlight the value of routine and repeated complete blood count assessment during cancer care. Future studies should use population-based denominators, larger site-specific samples, and longitudinal measurements linked to tumor stage and chemotherapy regimen.

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