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Impact of the COVID-19 Pandemic on the Pathological Stage of Gastric and Colorectal Cancers: A Retrospective Single-Center Study

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Research Article

Keywords: COVID-19, gastric adenocarcinoma, colon adenocarcinoma, tumor stage, endoscopy, pathology

Posted Date: August 31st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10392884/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

The COVID-19 pandemic substantially disrupted healthcare systems worldwide, resulting in reduced access to diagnostic and therapeutic services for patients with cancer. Delays in endoscopic procedures and surgical treatment may have contributed to more advanced disease at diagnosis. This study aimed to evaluate the impact of the COVID-19 pandemic on pathological tumor stage in patients with gastric and colon adenocarcinoma at a tertiary referral center.

Methods

This retrospective single-center study included patients diagnosed with gastric or colon adenocarcinoma during the 2.5-year periods before and after the first confirmed COVID-19 case in Türkiye (March 11, 2020). Patients diagnosed by endoscopic biopsy who subsequently underwent curative surgical resection at our institution were included. Clinicopathological characteristics, including pathological T stage, tumor size, interval between biopsy and surgery, neoadjuvant treatment, age, and sex, were compared between the pre-pandemic and pandemic cohorts.

Results

Before the pandemic, 9.263 gastric biopsies and 4.928 colon biopsies were evaluated, yielding 188 and 280 adenocarcinoma diagnoses, respectively. During the pandemic, 8.349 gastric biopsies and 4.437 colon biopsies were performed, with 221 gastric and 316 colon adenocarcinomas identified. Among surgically treated patients, the proportion of early-stage (T1–T2) tumors decreased, whereas advanced-stage (T3–T4) tumors increased during the pandemic in both gastric and colon cancer groups. In gastric cancer, advanced-stage tumors were approximately 16% more frequent after the onset of the pandemic, although this difference did not reach statistical significance. Similar stage migration toward advanced disease was observed in colon cancer.

Conclusions

The COVID-19 pandemic was associated with delayed presentation and a shift toward more advanced pathological stages at diagnosis in patients with gastric and colon adenocarcinoma. Although statistical significance was not demonstrated, the observed increase in advanced-stage disease suggests that disruptions in cancer screening, endoscopic services, and elective surgical care may have had clinically important consequences. Strategies ensuring uninterrupted access to oncological diagnosis and treatment during future healthcare crises are essential.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic profoundly affected healthcare systems worldwide, disrupting routine medical services and substantially reducing access to diagnostic and therapeutic procedures. To accommodate the increasing burden of patients with COVID-19 and to minimize viral transmission, many healthcare institutions postponed elective procedures, restricted outpatient services, and reallocated medical resources. Although these measures were necessary to control the pandemic, they inadvertently compromised the timely diagnosis and management of many chronic diseases, particularly cancer (1).

Early diagnosis is a key determinant of prognosis in gastrointestinal malignancies. Gastric and colorectal cancers remain among the leading causes of cancer-related morbidity and mortality worldwide despite advances in screening, endoscopic techniques, and multimodal treatment strategies. Because both malignancies frequently develop insidiously, endoscopic evaluation plays a central role in early detection. Any interruption in endoscopic services may therefore delay diagnosis, allowing tumors to progress to more advanced pathological stages before treatment (2, 3).

During the pandemic, several countries reported marked reductions in upper gastrointestinal endoscopy, colonoscopy, and cancer screening programs. In addition to restrictions within healthcare systems, many individuals postponed medical consultations because of concerns regarding SARS-CoV-2 transmission. Consequently, fewer patients underwent diagnostic investigations, and treatment pathways were often prolonged. These disruptions raised concerns that patients with gastrointestinal malignancies would present with larger tumors, more advanced pathological stages, and ultimately poorer oncological outcomes (4).

Previous studies investigating the oncological consequences of the COVID-19 pandemic have demonstrated substantial reductions in newly diagnosed gastrointestinal cancers and delays in surgical treatment. However, the reported impact on pathological tumor stage has been inconsistent. While some studies observed a significant increase in advanced-stage disease after the onset of the pandemic, others found only modest or statistically insignificant changes. Furthermore, evidence from middle-income countries remains limited, and relatively few studies have evaluated both gastric and colon adenocarcinoma within the same institutional setting (5).

Türkiye experienced similar disruptions following the confirmation of the first COVID-19 case on March 11, 2020 (6). Elective endoscopic procedures, outpatient visits, and non-urgent surgical interventions were temporarily restricted, potentially affecting the diagnostic pathway of patients with gastrointestinal malignancies. Evaluating the long-term consequences of these healthcare disruptions may provide valuable evidence for maintaining essential oncological services during future public health emergencies.

Therefore, the present study aimed to investigate the impact of the COVID-19 pandemic on pathological tumor stage in patients with gastric and colon adenocarcinoma diagnosed and treated at a tertiary

referral center. We compared clinicopathological characteristics, including pathological T stage, tumor size, neoadjuvant treatment, and the interval between diagnosis and surgery, during the 2.5-year periods before and after the onset of the COVID-19 pandemic. We hypothesized that pandemic-related delays in diagnosis and treatment would be associated with a shift toward more advanced pathological tumor stages.

Materials and Methods

Study design and study population

This retrospective, single-center cohort study was conducted at the Department of Pathology, Faculty of Medicine, Ondokuz Mayıs University, Türkiye. The pathology database and hospital information system were retrospectively reviewed to identify patients who underwent upper gastrointestinal endoscopic biopsy or colonoscopic biopsy between September 1, 2017, and August 31, 2022.

The study period was divided into two consecutive 2.5-year intervals according to the onset of the COVID-19 pandemic in Türkiye. The **pre-pandemic period** was defined as September 1, 2017, to February 29, 2020, and the **pandemic period** was defined as March 1, 2020, to August 31, 2022. To evaluate temporal changes, each 2.5-year period was further divided into five consecutive 6-month intervals, enabling comparisons between corresponding time periods before and during the pandemic.

All patients diagnosed with gastric or colorectal malignancies on endoscopic biopsy during the study period were identified. Patients who subsequently underwent surgical resection at Ondokuz Mayıs University and had available pathological resection specimens were included in the detailed clinicopathological analysis. Patients without surgical specimens, those who underwent surgery at another institution, patients with recurrent tumors, and those with incomplete clinical or pathological records were excluded.

Data collection

Clinical and pathological data were retrospectively collected from the hospital information system and pathology archives. The numbers of upper gastrointestinal endoscopic biopsies, colonoscopic biopsies, gastric cancer cases, and colorectal cancer cases were recorded for both the pre-pandemic and pandemic periods.

Demographic and clinicopathological variables included age, sex, tumor location, pathological tumor (pT) stage, pathological lymph node (pN) stage, tumor size, neoadjuvant treatment status, and the interval between histopathological diagnosis and surgical treatment. Temporal changes in these parameters were compared between the pre-pandemic and pandemic periods, as well as across the corresponding 6-month intervals.

Histopathological diagnoses were established according to the **World Health Organization Classification of Tumours of the Digestive System (5th edition, 2019)**, and pathological staging was performed using the **8th edition of the American Joint Committee on Cancer (AJCC) TNM staging system**.

Study outcomes

The primary outcome was to evaluate the impact of the COVID-19 pandemic on pathological tumor stage in patients with gastric and colorectal malignancies.

Secondary outcomes included age, sex, comparisons of biopsy volume, numbers of diagnosed gastric and colorectal cancers, pathological lymph node stage, tumor size, neoadjuvant treatment status, and the interval between diagnosis and surgery between the pre-pandemic and pandemic periods.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (Version XX.0; IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range), according to data distribution, whereas categorical variables were expressed as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro–Wilk test. Student's *t*-test or the Mann–Whitney *U* test was used for continuous variables, as appropriate. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test. A two-sided p value < 0.05 was considered statistically significant.

Ethics approval

The study was approved by the Ondokuz Mayıs University Clinical Research Ethics Committee (Approval No: 2023/367; Date: 22.11.2023). The study was conducted in accordance with the principles of the Declaration of Helsinki. Owing to the retrospective nature of the study, the requirement for informed consent was waived by the Ethics Committee.

Results

A total of **26.977** patients were included in the study, comprising **17.612 upper gastrointestinal endoscopic biopsies** and **9.365 colonoscopic biopsies** performed between September 1, 2017, and August 31, 2022.

The number of gastric biopsies increased progressively during the pre-pandemic period, from **1.500** in the first 6-month interval (Pre-5) to **2.292** in the final interval before the pandemic (Pre-1). Following the onset of the COVID-19 pandemic, the number of gastric biopsies decreased by **48%**, reaching **1.193** during the first pandemic interval (Pan-1). Biopsy numbers subsequently increased to **1.488**, **1.798**, **1.988**, and **1.882** in the following intervals. A similar trend was observed for colonoscopic biopsies. The

number of colon biopsies increased from **768** in Pre-5 to **1.183** in Pre-1, followed by a **47% reduction** to **625** during Pan-1, with gradual recovery during subsequent intervals (Fig. 1).

Overall, **414 gastric cancers** and **610 colorectal cancers** were diagnosed during the study period. Of the gastric cancer cases, **188 (45.4%)** were diagnosed during the pre-pandemic period and **226 (54.6%)** during the pandemic period. Similarly, **281 (46.1%)** colorectal cancers were diagnosed before the pandemic and **329 (53.9%)** during the pandemic. The number of newly diagnosed gastric and colorectal cancers did not differ significantly between the two periods ($p > 0.05$) (Table 1).

Among these patients, **325 underwent surgical resection** at Ondokuz Mayıs University. Gastric cancer resection specimens were available for **94 patients**, including **52 (55.3%)** from the pre-pandemic period and **42 (44.7%)** from the pandemic period. A total of **231 colorectal cancer patients** underwent surgical resection, including **113 (48.9%)** before and **118 (51.1%)** during the pandemic.

Among patients with gastric cancer, **131 (31.6%)** were female and **283 (68.4%)** were male. Sex distribution did not differ significantly between the pre-pandemic and pandemic periods ($p > 0.05$). Likewise, among patients with colorectal cancer, **210 (34.4%)** were female and **400 (65.6%)** were male, with no significant difference in sex distribution between the two periods ($p > 0.05$) (Table 1).

The mean age of patients with gastric cancer was **64.5 ± 11.0 years** (range, 24–101 years), whereas the mean age of patients with colorectal cancer was **64.2 ± 12.4 years** (range, 15–92 years). No significant differences in age were observed between the pre-pandemic and pandemic cohorts for either cancer type ($p > 0.05$) (Table 1).

Tumor characteristics

Among patients undergoing gastric cancer resection, the median tumor size was **40 mm** (IQR: 1–180 mm), with a mean size of **44.7 ± 24.0 mm**. Mean tumor size increased from **40.2 ± 23.7 mm** before the pandemic to **51.0 ± 26.3 mm** during the pandemic; however, this difference was not statistically significant ($p > 0.05$) (Table 1).

For colorectal cancer, the median tumor size was **35 mm** (range, 1–150 mm), with a mean size of **38.0 ± 16.7 mm**. Mean tumor size decreased from **41.7 ± 19.9 mm** before the pandemic to **36.2 ± 13.1 mm** during the pandemic, without statistical significance ($p > 0.05$) (Table 1).

No significant difference was observed in the pathological T stage between the pre-pandemic and pandemic periods among patients with gastric cancer ($p > 0.05$) (Table 1,Fig. 2).

Similarly, no overall difference in pathological T stage was observed among patients with colorectal cancer. However, comparison of the individual 6-month intervals demonstrated a significant difference between the Pre-pandemic period and the fourth pandemic interval (Pan-4) ($p = 0.044$) (Table 1, Fig. 2).

Among patients with gastric cancer, pathological lymph node stage differed significantly between the pre-pandemic and pandemic periods ($p = 0.034$). A significant difference was also observed between the pre-pandemic period and the fourth pandemic interval (Pan-4) ($p = 0.038$), whereas no significant differences were identified for the remaining interval comparisons (Table 1, Fig. 2).

No significant differences in pathological lymph node stage were observed among patients with colorectal cancer ($p > 0.05$) (Table 1, Fig. 2).



Gastric Cancer T-Stage Distribution

A total of 94 gastric cancer patients were evaluated to compare the distribution of local tumor stages between the pre-pandemic (n = 52) and post-pandemic (n = 42) periods. For this analysis, patients were categorized into an early/intermediate stage group (T1a+T1b+T2) and an advanced stage group (T3 + T4a+T4b). In the pre-pandemic cohort, 30.7% (n = 16) of patients presented with early/intermediate stage disease, while 69.3% (n = 36) presented with advanced stage tumors. Following the pandemic, the proportion of early/intermediate stage presentations decreased to 19.0% (n = 8), and advanced stage presentations rose to 81.0% (n = 34)(p = 0.23).

Colon Cancer T-Stage Distribution

The local tumor stage distribution of 231 colon cancer patients was analyzed by comparing the pre-pandemic (n = 113) and post-pandemic (n = 118) cohorts. Patients were stratified into an early/intermediate stage group (Tis + T1 + T2) and an advanced stage group (T3 + T4). Prior to the pandemic, early/intermediate stage tumors accounted for 30.1% (n = 34) of the cases, whereas advanced stage tumors constituted 69.9% (n = 79). In the post-pandemic cohort, early/intermediate stage cases dropped to 19.5% (n = 23), while advanced stage cases increased to 80.5% (n = 95) (p = 0.06).

Gastric Cancer Lymph Node Status

The regional lymph node involvement of 94 gastric cancer patients was cross-examined between the pre-pandemic (n = 52) and post-pandemic (n = 42) eras. The patient population was divided into a lymph node-negative group (N0) and a lymph node-positive group (N1 + N2+N3a+N3b). In the pre-pandemic group, 51.9% (n = 27) of the cases were node-negative, and 48.1% (n = 25) presented with nodal metastases. In stark contrast, the post-pandemic cohort demonstrated a sharp decline in node-negative cases to 28.6% (n = 12) and a significant escalation of lymph node positivity to 71.4% (n = 30). This shift toward regional nodal metastasis in post-pandemic gastric cancer patients was found to be statistically significant (Table 2) (p = 0.03).

Colon Cancer Lymph Node Status

Nodal involvement status was evaluated in a total of 226 colon cancer patients across the pre-pandemic (n = 109) and post-pandemic (n = 117) cohorts. The patients were classified as lymph node-negative (N0) or lymph node-positive (N1a+N1b+N2a+N2b). Before the pandemic, 53.2% (n = 58) of the cases were node-negative, while 46.8% (n = 51) displayed nodal involvement. Conversely, the post-pandemic group presented with an increased rate of node-negative disease at 65.0% (n = 76) and a decreased rate of node-positive disease at 35.0% (n = 41). Chi-square analysis showed that this inverse trend toward lower nodal positivity in the post-pandemic cohort did not reach formal statistical significance (t p = 0.07).

Neoadjuvant treatment

Among patients with gastric cancer who underwent surgery, **19 of 52 (36.5%)** patients received neoadjuvant therapy before the pandemic compared with **27 of 42 (64.3%)** during the pandemic. The proportion of patients receiving neoadjuvant therapy was significantly higher during the second and third pandemic intervals (Pan-2 and Pan-3) compared with the corresponding pre-pandemic intervals (p = 0.029 for both comparisons) (Table 1).

Among colorectal cancer patients, neoadjuvant treatment was administered to **28 of 113 (24.8%)** patients before the pandemic and **39 of 118 (33.1%)** during the pandemic. A significant increase was observed only during the fourth pandemic interval (Pan-4) (p = 0.039).

Interval between diagnosis and surgery

The median interval between histopathological diagnosis on endoscopic biopsy and surgical resection was **90 days** before the pandemic and **95 days** during the pandemic among patients with gastric cancer. For colorectal cancer, the corresponding median intervals were **45.5 days** and **60 days**, respectively. No statistically significant differences were observed between the pre-pandemic and pandemic periods for either cancer type (p > 0.05) .

Table 1
Comparison of patients' demographic data and cancers according to pre-COVID and COVID periods.

Variable	Pre-pandemic	Pandemic	p value
GASTRIC			
Number of gastric biopsies	n = 9263	n = 8349	
pT stage			p > 0.05
T1a	7	3	
T1b	3	2	
T2	6	3	
T3	25	24	
T4	9	10	
pN stage			p > 0.05
N0	27	12	
N1	5	9	
N2	13	7	
N3	1	6	
Sex (Male/Female)	122 / 66	161/65	p > 0.05
Tumor size (mm)	40.15 ± 23.71	50.95 ± 26.31	p > 0.05
Neoadjuvant therapy	19/52 (36.5%)	27/42 (64.3%)	p > 0.05
COLORECTAL			
Number of colon biopsies	n = 4928	n = 4437	
pT stage			p > 0.05
Tis	3	1	
T1	3	2	
T2	28	20	
T3	54	67	
T4	25	28	
pN stage			p > 0.05
(pT: patholog ic tumor stage, nT: lymph node stage, mm:milimeter)			

Variable	Pre-pandemic	Pandemic	p value
N0	58	66	
N1a	16	13	
N1b	17	13	
N2	16	15	
Sex (Male/Female)	194/87	206/123	p > 0.05
Tumor size (mm)	41.73 ± 19.89	36.21 ± 13.07	p > 0.05
(pT: patholog ic tumor stage, nT: lymph node stage, mm:milimeter)			

Table 2
Comparison of tumor stages during the pre-COVID and COVID periods.

Variable	Pre-pandemic	Pandemic	p value
GASTRIC CANCER BIOPSIES			
T-Stage Distribution (n = 94)	n = 52	n = 42	
Early / Intermediate (T1a+T1b+T2)	16 (30.7%)	8 (19.0%)	p = 0.19
Advanced (T3 + T4a+T4b)	36 (69.3%)	34 (81.0%)	
Lymph Node Status (n = 94)	n = 52	n = 42	
Node-Negative (N0)	27 (51.9%)	12 (28.6%)	**p = 0.02**
Node-Positive (N1 + N2+N3a+N3b)	25 (48.1%)	30 (71.4%)	
COLORECTAL CANCER BIOPSIES			
T-Stage Distribution (n = 231)	n = 113	n = 118	
Early / Intermediate (Tis + T1 + T2)	34 (30.1%)	23 (19.5%)	p = 0.06
Advanced (T3 + T4)	79 (69.9%)	95 (80.5%)	
Lymph Node Status (n = 226)	n = 109	n = 117	
Node-Negative (N0)	58 (53.2%)	76 (65.0%)	p = 0.07
Node-Positive (N1a+N1b+N2a+N2b)	51 (46.8%)	41 (35.0%)	

Discussion

The present study evaluated the impact of the COVID-19 pandemic on the pathological characteristics of gastric and colorectal adenocarcinomas diagnosed and treated at a tertiary referral center in Türkiye. Although the overall numbers of newly diagnosed gastric and colorectal cancers remained relatively

stable between the pre-pandemic and pandemic periods, the pathological characteristics of surgically treated tumors demonstrated a clear tendency toward more advanced disease after the onset of the pandemic. Specifically, the proportion of advanced T-stage tumors increased in both gastric and colorectal cancers, while gastric cancer patients also exhibited a significantly higher rate of lymph node metastasis during the pandemic period. These findings suggest that disruptions in cancer diagnostic pathways and treatment services during the COVID-19 pandemic may have resulted in delayed diagnosis and disease progression before surgical intervention (1–5).

One of the most striking observations in the present study was the abrupt decline in endoscopic biopsy volume immediately after the onset of the pandemic. Gastric and colon biopsy numbers decreased by approximately half during the first six-month pandemic interval, followed by a gradual recovery over subsequent periods. This pattern closely reflects the worldwide disruption of endoscopic services reported during the first waves of COVID-19. Many healthcare systems postponed elective procedures, suspended population-based screening programs, and redirected personnel and hospital resources toward the management of patients with COVID-19 (2, 8, 13). Simultaneously, patients frequently delayed seeking medical attention because of concerns regarding viral exposure, movement restrictions, or limited access to outpatient services. Collectively, these factors substantially reduced opportunities for the early detection of gastrointestinal malignancies (7–10).

Interestingly, despite the marked reduction in biopsy procedures, the total number of gastric and colorectal cancer diagnoses did not significantly decrease during the study period. This finding may initially appear contradictory but has also been described in several institutional studies (3, 5, 7). Rather than representing a true preservation of cancer detection rates, it likely reflects the gradual resumption of diagnostic services after the initial lockdown period, together with the referral of symptomatic patients requiring urgent evaluation. Consequently, patients who ultimately underwent diagnostic investigations during the pandemic may have represented a population with more advanced or clinically apparent disease, thereby explaining the observed stage migration despite relatively stable overall cancer numbers (3, 5, 9).

The most clinically relevant finding of our study was the shift toward advanced pathological T stage in both gastric and colorectal cancers. Although the differences did not reach conventional statistical significance when the entire study periods were compared, the absolute increase in advanced-stage tumors was clinically meaningful. In gastric cancer, the proportion of T3–T4 tumors increased from 69.3% before the pandemic to 81.0% during the pandemic, whereas in colorectal cancer the corresponding increase was from 69.9% to 80.5%. Moreover, temporal analysis demonstrated significant differences during specific six-month intervals, suggesting that the oncological consequences of healthcare disruption may have become more apparent after the initial phase of the pandemic rather than immediately following the implementation of restrictions (4, 5, 9, 11).

These observations are consistent with reports from several countries demonstrating stage migration following pandemic-related delays in cancer diagnosis. Population-based analyses from England

showed substantial reductions in colorectal cancer detection together with increases in emergency presentations and advanced disease (12). Likewise, Canadian and South Korean studies reported larger tumors, higher pathological stages, and reduced rates of early-stage gastrointestinal cancer diagnosis after temporary suspension of screening and endoscopic services (4, 5). Although not every published study identified statistically significant differences in pathological stage, most consistently described trends toward more advanced disease, supporting the hypothesis that even relatively short delays in diagnostic evaluation may adversely influence tumor progression (5, 9, 11, 14).

An additional important finding was the significant increase in lymph node-positive gastric cancer during the pandemic period. While pathological T stage demonstrated only a numerical increase, nodal involvement increased from 48.1% before the pandemic to 71.4% afterward, reaching statistical significance. Lymph node metastasis remains one of the strongest prognostic indicators in gastric cancer and directly influences disease stage, recurrence risk, and long-term survival. Therefore, this finding may indicate that pandemic-related delays affected not only local tumor growth but also regional disease dissemination (11). The biological behavior of gastric adenocarcinoma, characterized by relatively early lymphatic spread, may explain why nodal stage appeared more sensitive than primary tumor invasion in reflecting delayed diagnosis.

In contrast, colorectal cancer demonstrated a different pattern. Although advanced T-stage tumors became more frequent during the pandemic, lymph node positivity did not increase and even showed a non-significant reduction. Several explanations may account for this discrepancy. First, colorectal cancer represents a biologically heterogeneous disease in which lymphatic dissemination does not always parallel local tumor invasion. Second, the relatively larger colorectal cohort may have included greater variability in tumor location, molecular characteristics, and treatment strategies. Finally, increased utilization of neoadjuvant therapy during the pandemic may have contributed to partial downstaging of nodal disease in selected patients, thereby masking potential increases in pathological lymph node involvement (4, 5, 10).

Another noteworthy observation in the present study was the increased use of neoadjuvant therapy during the pandemic, particularly among patients with gastric cancer. The proportion of patients receiving preoperative treatment increased substantially after the onset of COVID-19, with significant differences observed during the second and third pandemic intervals. This finding likely reflects changes in multidisciplinary treatment strategies adopted during the pandemic rather than alterations in tumor biology alone. International surgical societies recommended the increased use of neoadjuvant systemic therapy to bridge delays in elective surgery, reduce perioperative risk, and optimize hospital resource utilization (15, 16). Consequently, the higher frequency of neoadjuvant treatment observed in our cohort probably represents an adaptive response to healthcare system constraints. Nevertheless, despite this increased use of preoperative therapy, the tendency toward more advanced pathological disease persisted, suggesting that treatment modifications could only partially compensate for delays in diagnosis and definitive surgical management (2, 15).

Interestingly, the interval between histopathological diagnosis and surgical treatment did not differ significantly between the pre-pandemic and pandemic periods for either gastric or colorectal cancer. At first glance, this finding appears inconsistent with the observed shift toward advanced pathological stage. However, the interval measured in this study reflects only the period between diagnostic biopsy and surgery and therefore does not capture delays occurring before diagnosis. Patients may have experienced prolonged symptom duration, delayed primary care consultation, postponed referral for endoscopy, or reduced access to screening programs before tissue diagnosis was established (8, 10, 12). Consequently, the true diagnostic delay may have been substantially longer than the biopsy-to-surgery interval analyzed in our study. This explanation is supported by the marked reduction in endoscopic biopsy volume immediately after the onset of the pandemic, indicating that access to diagnostic evaluation, rather than surgical scheduling alone, represented the principal bottleneck in the cancer care pathway (8, 9, 13).

The present findings underscore the critical importance of maintaining uninterrupted access to diagnostic endoscopy during future public health emergencies. Gastrointestinal cancers frequently remain asymptomatic until relatively advanced stages, making timely endoscopic evaluation indispensable for early detection and curative treatment (8, 10, 13). Although healthcare systems appropriately prioritized the management of COVID-19 during the pandemic, the indirect consequences for oncological care have become increasingly evident. The observed shift toward more advanced pathological disease in our cohort supports recommendations from international oncology organizations advocating the preservation of essential cancer diagnostic and treatment services even during periods of healthcare crisis. Future contingency planning should therefore include protected endoscopy capacity, rapid referral pathways for patients with alarm symptoms, and prioritization strategies for high-risk individuals requiring urgent investigation (10, 13, 16).

Our study possesses several important strengths. First, all pathological diagnoses and staging evaluations were performed at a single tertiary referral center using standardized pathological assessment according to the World Health Organization classification and the AJCC 8th edition staging system, minimizing interobserver variability. Second, the comparison of equivalent 2.5-year periods before and after the onset of the pandemic reduced the influence of seasonal fluctuations and provided a balanced temporal assessment. Third, dividing the study period into consecutive six-month intervals enabled identification of dynamic changes throughout the pandemic rather than relying solely on overall comparisons. This approach demonstrated that the impact of healthcare disruption evolved over time and became more evident during later pandemic intervals.

Several limitations should also be acknowledged. The retrospective design inevitably introduces the possibility of selection bias and limits the ability to establish causal relationships. As a single-center study, our findings may not be fully generalizable to other institutions or healthcare systems with different organizational structures or pandemic responses. Furthermore, only patients who ultimately underwent surgical resection at our institution were included in the detailed pathological analysis. Patients treated non-operatively, referred to other centers, or presenting with unresectable disease were

excluded, potentially resulting in underestimation of the true impact of the pandemic on disease stage. In addition, important clinical variables such as symptom duration, socioeconomic status, comorbidities, postoperative outcomes, disease recurrence, and overall survival were unavailable because of the retrospective nature of the study. Finally, although several clinically relevant trends were observed, particularly regarding pathological T stage, some comparisons did not reach statistical significance, most likely because of the relatively limited sample size of surgically treated patients. Larger multicenter studies with longer follow-up are warranted to confirm these observations and evaluate their long-term prognostic implications (5, 11, 14).

Despite these limitations, the present study contributes valuable evidence regarding the indirect oncological consequences of the COVID-19 pandemic in a middle-income healthcare setting. The combination of a substantial reduction in endoscopic procedures, increased utilization of neoadjuvant therapy, and a consistent shift toward more advanced pathological disease suggests that interruptions in diagnostic pathways may have lasting effects beyond the immediate pandemic period (9, 11, 14). These findings emphasize that continuity of cancer diagnosis should remain a healthcare priority during future pandemics or similar public health emergencies. Strategies aimed at preserving diagnostic capacity, minimizing delays in referral and endoscopic evaluation, and maintaining multidisciplinary cancer services are likely to reduce the risk of stage migration and improve long-term oncological outcomes for patients with gastrointestinal malignancies (10, 15, 16).

Conclusion

In conclusion, the COVID-19 pandemic was associated with a clear trend toward more advanced pathological presentation of both gastric and colorectal adenocarcinomas at our tertiary referral center. Although the increase in advanced pathological T stage did not reach statistical significance in the overall cohort, the consistent shift toward higher-stage disease, together with the significant increase in lymph node metastasis among patients with gastric cancer, suggests that pandemic-related disruptions adversely affected the timely diagnosis and management of gastrointestinal malignancies. The marked reduction in endoscopic biopsy volume during the early pandemic period further supports the hypothesis that restricted access to diagnostic services contributed to delayed cancer detection. Importantly, the absence of a significant increase in the interval between diagnosis and surgery indicates that delays likely occurred before histopathological diagnosis, emphasizing the crucial role of uninterrupted access to endoscopic evaluation and referral pathways. These findings highlight the need for healthcare systems to prioritize essential oncological diagnostic and treatment services during future public health emergencies in order to minimize stage migration and preserve long-term cancer outcomes. Prospective multicenter studies with long-term survival data are warranted to further clarify the oncological consequences of healthcare disruptions and to guide future preparedness strategies.

Declarations

Ethics approval

The study was approved by the Ondokuz Mayıs University Clinical Research Ethics Committee (Approval No: 2023/367; Date: 22.11.2023). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Human Ethics and Consent to Participate declarations: not applicable. Owing to the retrospective nature of the study, the requirement for informed consent was waived by the Ethics Committee.

Clinical Trial Number: not applicable.

Financial disclosure statement: Authors declare that they have no financial interests.

Funding: The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

No writing assistance was utilized in the production of this manuscript.

Conflict of interest statement: Authors declare that they have no conflict of interest**.**

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Supervision: BYP, FK, CGG, HS

Fundings: BYP, HS, FK

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Figures

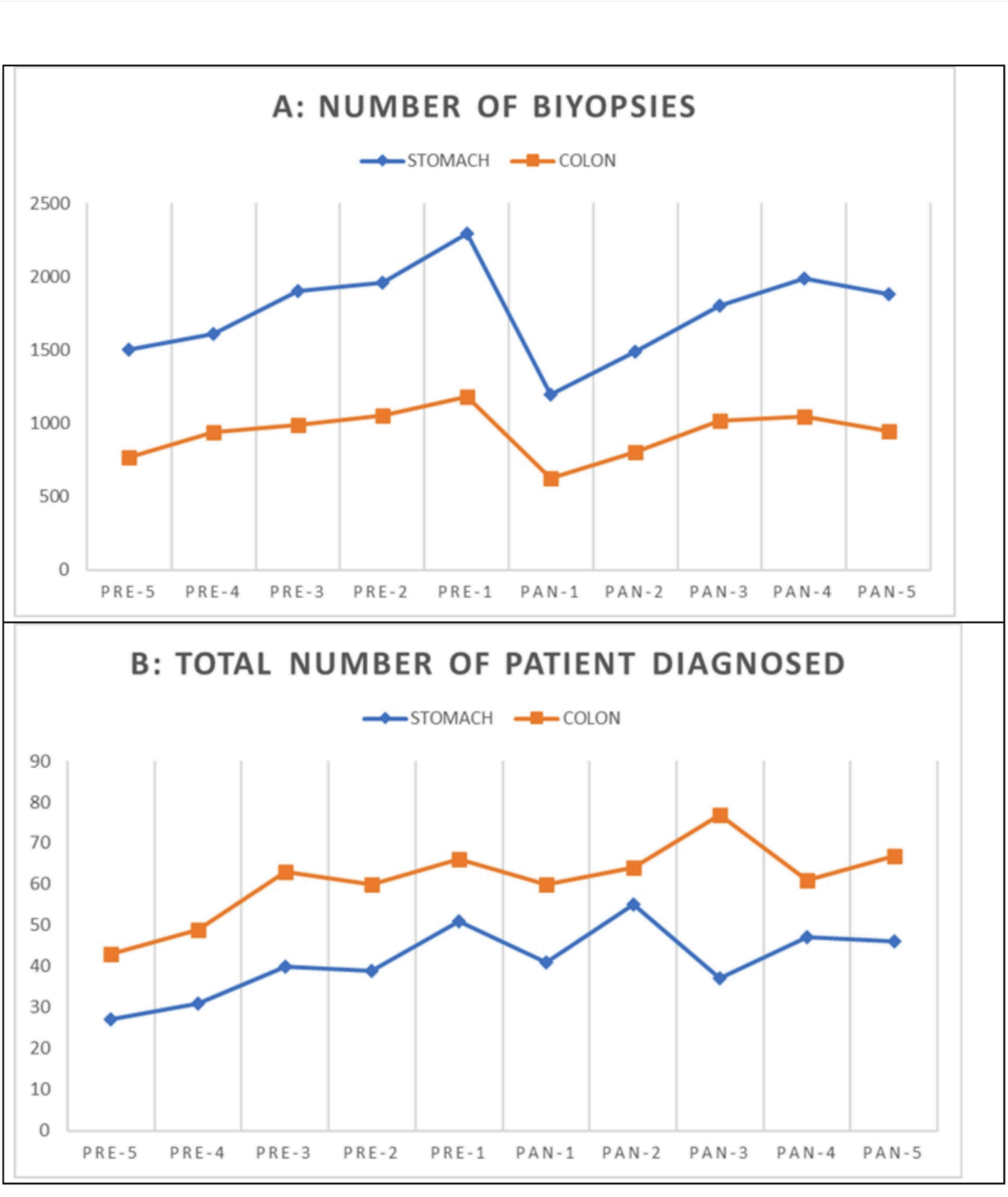


Figure 1

Pandemic-related changes in gastrointestinal pathology workload. (A) Total number of stomach and colon biopsies across 6-month intervals. (B) total number of patients diagnosed with stomach and colon cancer during the same periods.

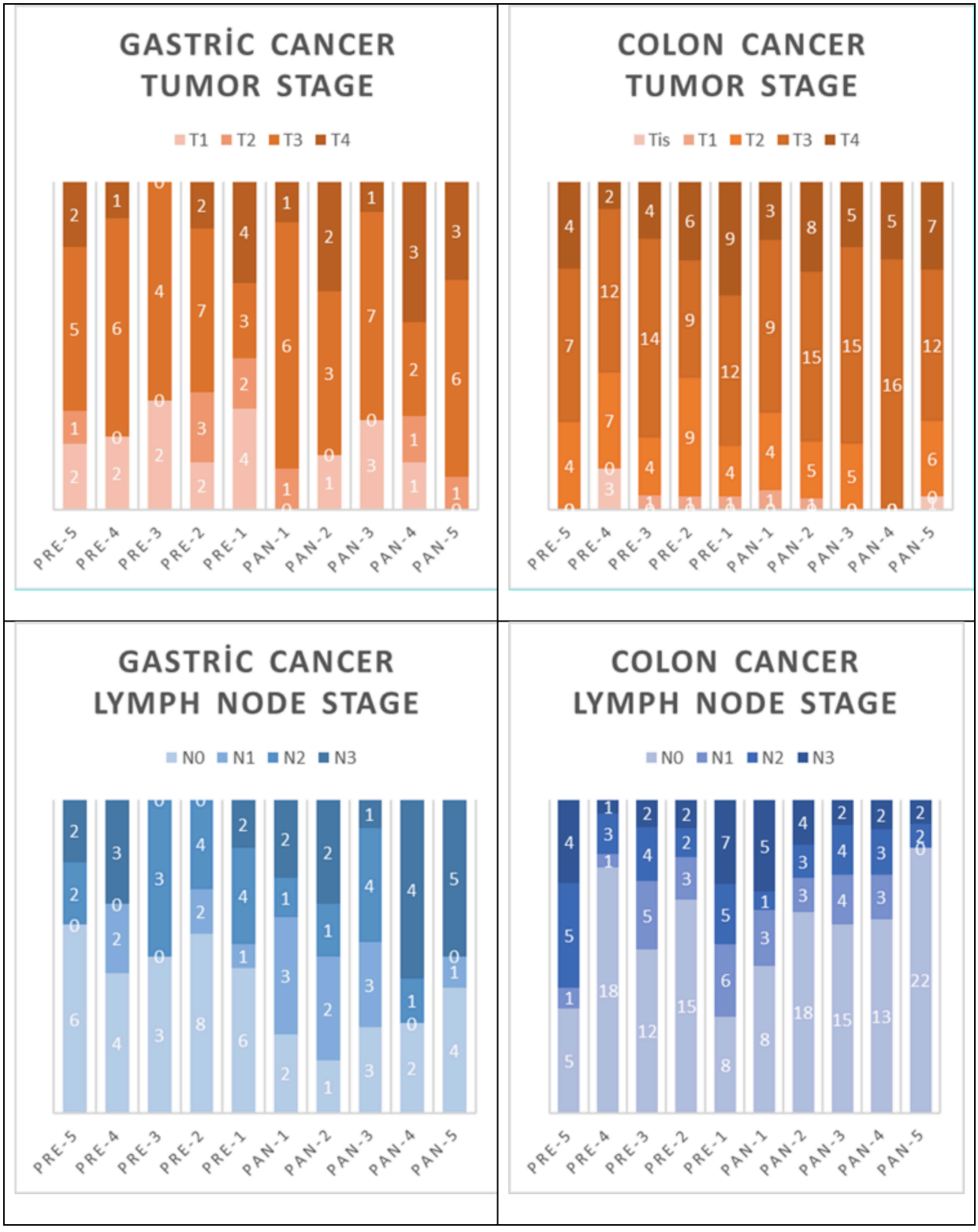


Figure 2

Distribution of tumor(T) and lymph node(N) stages across 6-month intervals before and after the COVİD-19 pandemic.