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Original Article

Impact of Coronavirus Disease 2019 on Gastric Cancer Diagnosis and Stage: A Single-Institute Study in South Korea

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ABSTRACT

Purpose: Gastric cancer (GC) is among the most prevalent and fatal cancers worldwide. National cancer screening programs in countries with high incidences of this disease provide medical aid beneficiaries with free-of-charge screening involving upper endoscopy to detect early-stage GC. However, the coronavirus disease 2019 (COVID-19) pandemic has caused major disruptions to routine healthcare access. Thus, this study aimed to assess the impact of COVID-19 on the diagnosis, overall incidence, and stage distribution of GC.
Materials and Methods: We identified patients in our hospital cancer registry who were diagnosed with GC between January 2018 and December 2021 and compared the cancer stage at diagnosis before and during the COVID-19 pandemic. Subgroup analyses were conducted according to age and sex. The years 2018 and 2019 were defined as the "before COVID" period, and the years 2020 and 2021 as the "during COVID" period.
Results: Overall, 10,875 patients were evaluated; 6,535 and 4,340 patients were diagnosed before and during the COVID-19 period, respectively. The number of diagnoses was lower during the COVID-19 pandemic (189 patients/month vs. 264 patients/month) than before it. Notably, the proportion of patients with stages 3 or 4 GC in 2021 was higher among men and patients aged ≥40 years.
Conclusions: During the COVID-19 pandemic, the overall number of GC diagnoses decreased significantly in a single institute. Moreover, GCs were in more advanced stages at the time of diagnosis. Further studies are required to elucidate the relationship between the COVID-19 pandemic and the delay in the detection of GC worldwide.

Keywords: COVID-19; Stomach neoplasms; Gastric cancer; Incidence

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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

Author Contributions
Conceptualization: H.M., C.M., L.J.; Data curation: C.M., H.M., L.C.K., K.H.S., R.S.Y., P.G.Y., C.Y.J., J.D.H., P.J.C., S.S.K., L.S.K., L.Y.C., C.M., K.Y.M., K.H.I., C.J.H., H.W.J., J.M.; Formal analysis: C.M., H.M., K.K.H., K.H.; Supervision: S.J., J.M.; Writing - original draft: C.M., H.M.; Writing - review & editing: H.M., C.M.

INTRODUCTION

Gastric cancer (GC) is one of the most common cancers and leading causes of death worldwide [1]. Its high incidence and mortality rate have led to the implementation of nationwide cancer screening programs in Asian countries, including South Korea and Japan [2,3], which have resulted in earlier detection and better clinical outcomes [4,5]. Although screening programs for GC are a controversial issue in some countries [6], previous studies have emphasized the importance of early detection, as a delayed diagnosis is associated with a poor prognosis [7].

The first case of coronavirus disease 2019 (COVID-19) in South Korea was reported in February 2020, and recently, the prevalence has been decreasing after over 30 million cases have been recorded. In response to the pandemic, the European Society of Gastrointestinal Endoscopy and Endoscopy Nurse and Associates position statement recommended the postponement of endoscopy for non-urgent cases [8]. In contrast, the Korean guidelines recommended that cancer screening should only be delayed for COVID-19-positive patients, with the exception of endoscopic screening, owing to the high incidence of gastric and colon cancers in the Korean population [9].

Unlike diagnostic delays, postponement of treatment modalities such as surgery, chemotherapy, and radiation therapy has been anticipated since the start of the COVID-19 pandemic [10]. A Japanese multicenter study reported a decline in the number of GC surgeries from the early stages of the pandemic [11]. These reports prompted us to design the present study to determine whether COVID-19 delayed the diagnosis of GC in Korea. Furthermore, we evaluated whether potential delays were associated with a more advanced cancer stage at the time of diagnosis.

Several reports have described the current status of GC screening. Park et al. reported that a significant difference was observed in cancer screening between 2020 and 2019 [12]. In another study using the Korean National Cancer Screening Survey, the GC screening rate reportedly increased again in 2021 compared with that in 2020 and has returned to a level similar to that before the COVID-19 pandemic [13]. We hypothesized that the COVID-19 pandemic resulted in a decrease in endoscopic screening among the general population owing to the risk of infection as well as barriers to medical care access during social quarantining. We first predicted that the overall rate of newly diagnosed GC cases decreased during the pandemic. Second, we predicted that the proportion of newly diagnosed early-stage GC cases decreased since such cases are more often diagnosed via asymptomatic screening as opposed to an endoscopic investigation prompted by the presence of symptoms. Lastly, we predicted that the incidence of GC remained stable in patients under 40 years of age (i.e., young adult patients with GC) since the national GC screening program does not cover this age group. Furthermore, GC in young adult patients is typically not detected via mass screening, because the cancer is often aggressive and symptomatic at the time of diagnosis in such cases [14,15]. The purpose of this study, therefore, was to evaluate the impact of the COVID-19 pandemic on the diagnosis of GC in Korea by comparing the number of annual cases of GC in a single institution before and during COVID-19 to elucidate the relationship between COVID-19 and GC incidence.

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MATERIALS AND METHODS

Data and study population

This retrospective cohort study included patients diagnosed with GC at the Yonsei Cancer Center before and during the COVID-19 pandemic (from January 2018 to December 2021). Data obtained from the electronic medical records included basic characteristics (e.g., age and sex) and GC stage. The first COVID-19 patient in Korea was diagnosed on January 19, 2020, and a "super-spreader event" was identified in February 2020 [16]. Therefore, the entire cohort from 2018 to 2021 was divided into individual years for analysis, categorizing the years 2018 and 2019 as the "before COVID" period and the years 2020 and 2021 as the "during COVID" period.

Ethics statement

This study was approved by the Institutional Review Board (IRB) of the Yonsei University Health System (IRB 2020-3790-004) and conducted according to the tenets of the Declaration of Helsinki [17]. All patients provided written informed consent. Results are reported in accordance with Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines [18].

The primary outcome was a change in GC stage distribution before and during the COVID-19 pandemic. The secondary outcome was a change in the overall number of cases of GC before and during the pandemic at the Yonsei Cancer Center. Subgroup analyses were conducted according to differences in sex (male or female) and age (<40 or ≥40 years) between the two time periods.

Statistical analysis

Categorical variables were compared between groups by using the χ^2 and Fisher's exact tests, whereas continuous variables were compared using the unpaired Student's t-test. All statistical analyses were conducted using the svy suite of commands in Stata version 16.0. P<0.05 was considered statistically significant. Observations with missing data were excluded from the analyses.

RESULTS

Overall, 10,875 patients (6,971 [64.1%] men; mean age, 66.1±11.8 years) were included in the analysis; of these, 3,370, 2,966, 2,225, and 2,314 patients were diagnosed in 2018, 2019, 2020, and 2021, respectively. Significant sex-related differences were not observed between the years (P=0.602); however, the average age was significantly lower in 2021 than in the other years (P<0.001; **Table 1**). The number of new GC diagnoses was significantly lower during the COVID-19 pandemic (189 patients/month) than in the period before the pandemic (264 patients/month), representing a 28% decrease in the monthly incidence rate. **Fig. 1** presents the number of patients newly diagnosed with GC per month at Yonsei Cancer Center and the number of COVID-19-positive cases per month in Korea. The increase in the number of COVID-19-positive cases was associated with a decrease in the number of GC diagnoses. This was readily apparent in 2020, after which the number of GC diagnoses gradually increased until October 2021. The number of COVID-19-positive cases subsequently increased exponentially after November 2021, and this was accompanied by a large decrease in the number of GC diagnoses.

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Table 1. Baseline characteristics of patients newly diagnosed with gastric cancer before (2018 and 2019) and during (2020 and 2021) the COVID-19 pandemic

Variables	2018	2019	2020	2021
Total	3,370	2,966	2,275	2,314
Sex				
Male	2,132 (63.3)	1,907 (64.3)	1,429 (64.2)	1,503 (65.0)
Female	1,238 (36.7)	1,059 (35.7)	796 (35.8)	810 (35.0)
Age (yr)	66.5±11.6	66.6±12.0	66.2±11.6	64.7±11.8
Male	67.6±11.1	68.1±11.1	67.4±10.9	66.2±11.5
Female	64.6±12.4	64.2±13.0	64.0±12.6	63.5±13.1
Age group				
10–19 yr	0 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)
20–29 yr	2 (0.1)	1 (0.0)	3 (0.1)	7 (0.3)
30–39 yr	31 (0.9)	47 (1.6)	31 (1.4)	51 (2.2)
40–49 yr	259 (7.7)	233 (7.9)	173 (7.8)	198 (8.6)
50–59 yr	596 (17.7)	501 (16.9)	372 (16.7)	467 (20.2)
60–69 yr	1,077 (32.0)	910 (16.9)	745 (16.7)	751 (20.2)
70–79 yr	892 (26.5)	828 (27.9)	614 (27.6)	605 (26.1)
80–89 yr	486 (14.4)	420 (14.2)	267 (12.0)	228 (9.9)
≥90 yr	27 (0.8)	25 (0.8)	20 (0.9)	6 (0.3)
Primary sites				
Body of the stomach	1,489 (44.2)	1,303 (43.9)	994 (44.7)	998 (43.1)
Cardia, NOS	174 (5.2)	157 (5.3)	122 (5.5)	150 (6.5)
Fundus of the stomach	13 (0.4)	18 (0.5)	12 (0.5)	18 (0.8)
Gastric antrum	1,175 (34.9)	1,056 (35.6)	798 (35.9)	813 (35.1)
Greater curvature	3 (0.1)	1 (0.0)	1 (0.0)	3 (0.1)
Lesser curvature	132 (3.9)	154 (5.2)	103 (4.6)	90 (3.9)
Overlapping lesion	132 (3.9)	97 (3.3)	66 (3.0)	86 (3.7)
Pylorus	76 (2.3)	50 (1.7)	55 (2.5)	52 (2.2)
Stomach, NOS	176 (5.2)	130 (4.4)	74 (3.3)	104 (4.5)

Values are presented as mean±standard deviation or number (%).
NOS = not otherwise specified.

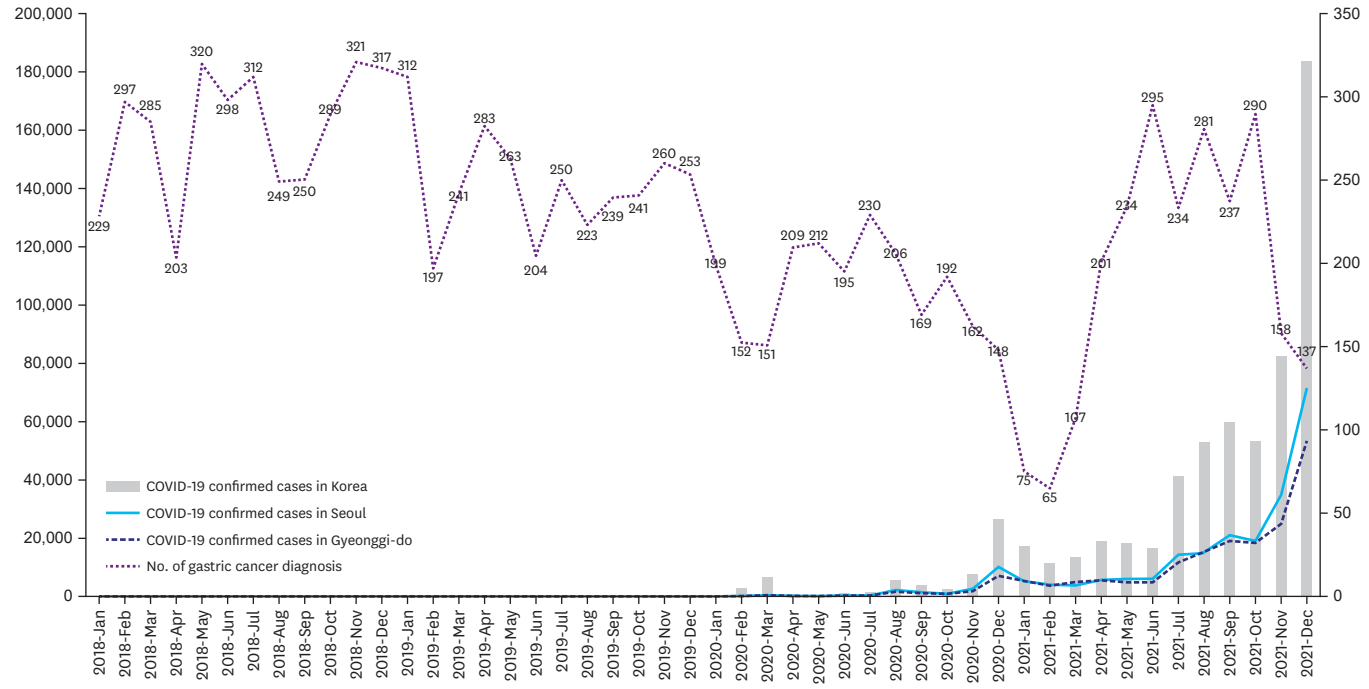

Fig. 1. Number of gastric cancer diagnoses by month.

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Table 1 summarizes the baseline demographics of patients diagnosed with GC for each year from 2018 to 2021. The cancer stage at diagnosis was significantly different (**Table 2**). Notably, the proportion of patients with stage 4 GC at the time of diagnosis was higher in 2021 than in 2018, 2019, and 2020 (P=0.028, 0.036, and 0.035, respectively). The proportion of patients with stage 3 or 4 GC was also significantly higher in 2021 than in the other years (**Supplementary Table 1**).

Subgroup analyses were performed for the GC stage according to sex and age. A significantly higher proportion of men were diagnosed at more advanced stages in 2021 than in 2018, 2019, and 2020 (P=0.006, 0.019, 0.012, respectively). However, no significant difference was observed in women (P=0.406). Because the National Cancer Screening Program in Korea is free of charge for individuals aged ≥40 years, we conducted a sub-analysis comparing patients aged <40 and ≥40 years at the time of diagnosis. The cancer stage did not significantly differ before and during the pandemic among patients aged <40 years (P=0.084); however, a significantly higher proportion of patients aged ≥40 years had advanced cancer during the

Table 2. Distribution of gastric cancer diagnosis before and during the COVID-19 pandemic

Population	Stage	Before COVID-19 (2018.01–2020.01)		During COVID-19 (2020.02–2021.12)		P-value
		2018	2019	2020	2021	
Overall	0	146 (4.3)	165 (5.6)	117 (5.3)	120 (5.2)	<0.001
	1	2,254 (66.9)	1,916 (64.6)	1,407 (63.2)	1,355 (58.6)	
	2	323 (9.6)	299 (10.1)	241 (10.8)	284 (12.3)	
	3	332 (9.9)	284 (9.6)	243 (10.9)	280 (12.1)	
	4	315 (9.3)	302 (10.2)	217 (9.8)	275 (11.9)	
	Total	3,370	2,966	2,225	2,314	
Men	0	111 (5.2)	124 (6.5)	79 (5.5)	89 (5.9)	<0.001
	1	1,412 (66.2)	1,247 (65.4)	889 (62.2)	879 (58.5)	
	2	199 (9.3)	176 (9.2)	169 (11.8)	179 (11.9)	
	3	213 (10.0)	178 (9.3)	161 (11.3)	175 (11.6)	
	4	197 (9.2)	182 (9.5)	131 (9.2)	181 (12.0)	
	Total	2,132	1,907	1,429	1,503	
Women	0	35 (2.8)	41 (3.9)	38 (4.8)	31 (3.8)	0.006
	1	842 (68.0)	669 (63.2)	518 (65.1)	475 (58.6)	
	2	124 (10.0)	123 (11.6)	72 (9.0)	105 (13.0)	
	3	119 (9.6)	106 (10.0)	82 (10.3)	105 (13.0)	
	4	118 (9.5)	120 (11.3)	86 (10.8)	94 (11.6)	
	Total	1,238	1,059	796	810	
Age <40 yr	0	0 (0)	1 (2.0)	0 (0)	0 (0)	0.065
	1	13 (39.4)	24 (49.0)	12 (35.3)	34 (58.6)	
	2	6 (18.2)	0 (0)	6 (17.6)	7 (12.1)	
	3	3 (9.1)	9 (18.4)	5 (14.7)	9 (15.5)	
	4	11 (33.3)	15 (30.6)	11 (32.4)	8 (13.8)	
	Total	33	49	34	58	
40 yr≤ Age ≤75 yr	0	105 (4.2)	119 (5.5)	82 (4.8)	92 (5.0)	<0.001
	1	1,712 (67.9)	1,406 (64.8)	1,077 (63.4)	1,072 (58.8)	
	2	222 (8.8)	210 (9.7)	187 (11.0)	229 (12.6)	
	3	249 (9.9)	212 (9.8)	187 (11.0)	210 (11.5)	
	4	235 (9.3)	222 (10.2)	166 (9.8)	220 (12.1)	
	Total	2,523	2,169	1,699	1,823	
Age >75 yr	0	41 (5.0)	45 (6.0)	35 (7.1)	28 (6.5)	<0.001
	1	529 (65.0)	486 (65.0)	318 (64.6)	248 (57.4)	
	2	95 (11.7)	89 (11.9)	48 (9.8)	48 (11.1)	
	3	80 (9.8)	63 (8.4)	51 (10.4)	61 (14.1)	
	4	69 (8.5)	65 (8.7)	40 (8.1)	47 (10.9)	
	Total	814	748	492	432	

Values are presented as number (%).
For categorical analysis, Pearson's χ^2 test was performed.
COVID-19 = coronavirus disease 2019.

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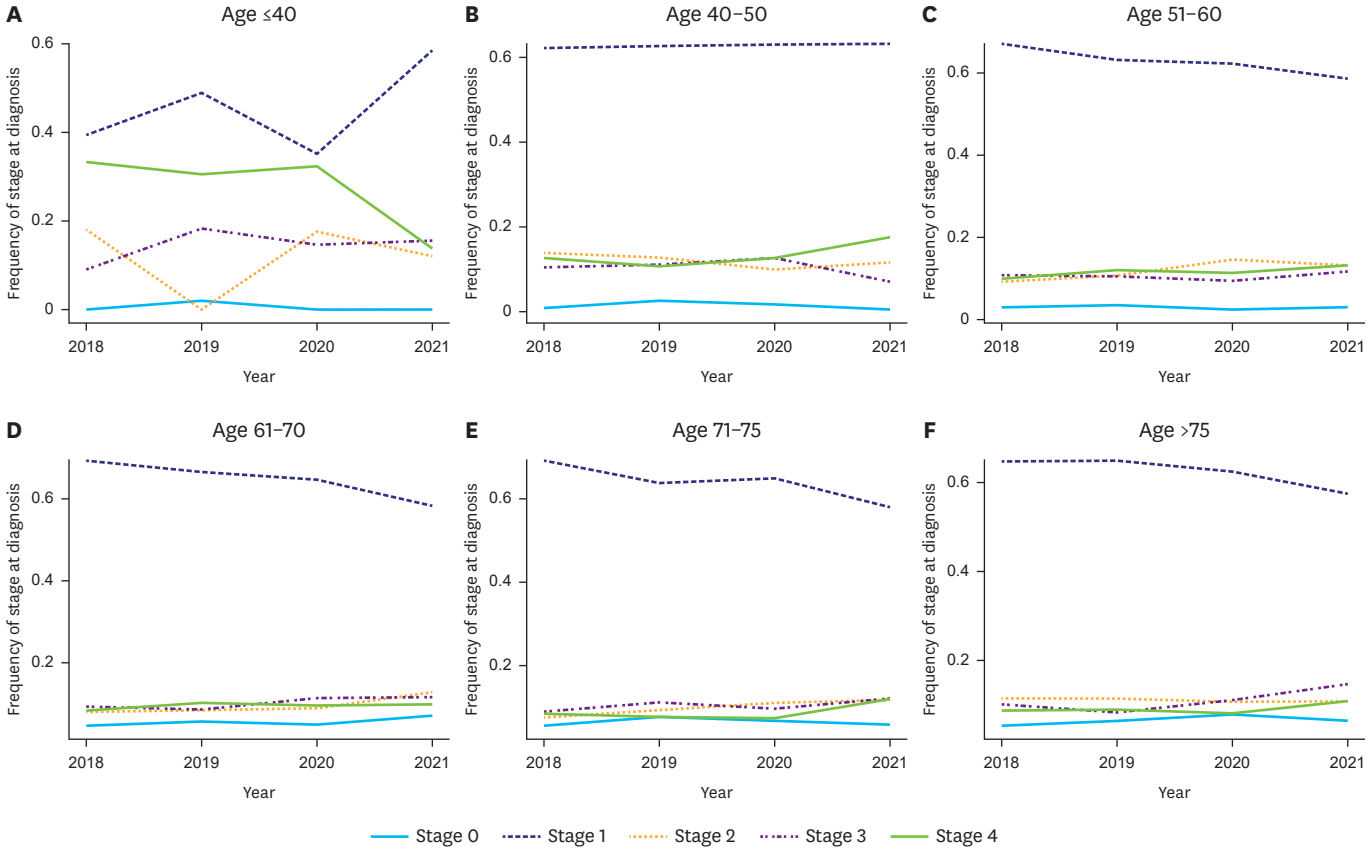

Fig. 2. Gastric cancer diagnoses by various age groups.

pandemic. These trends in age and new cases of GC are presented in **Fig. 2**, with the various age groups (except the age group of <40 years) exhibiting a similar pattern.

DISCUSSION

We evaluated the impact of the COVID-19 pandemic on the GC diagnosis rate and stage in Korea by using a large single-center cohort. The number of GC diagnoses was significantly lower in 2020 and 2021 than that before the pandemic. Moreover, the proportion of cases with advanced stages of GC (also referred to as stage migration) was higher in 2021. As the proportion of patients with early-stage GC has gradually increased in Korea over the past decade [19], stage migration owing to the COVID-19 outbreak is a crucial public health issue. Notably, stage migration was only evident in patients who were aged ≥40 years. This may be attributed to the eligibility of this age group for free GC screening in Korea since endoscopy is not covered for patients aged <40 years. Therefore, patients aged <40 years are typically diagnosed through routine employer-sponsored medical check-ups or upon symptom development. This welfare service may have led more people, especially young laborers, to undergo regular check-ups, thus resulting in a smaller difference in the diagnosis rate before and during the COVID-19 pandemic. Our results are in accordance with those of previous studies that have reported a low incidence of GC in young adults but a higher likelihood of an advanced disease stage upon diagnosis [14,15].

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One of the remarkable characteristics of the incidence of GC in Korea was that the actual incidence was decreasing per the data released by the Korean Statistical Information Service in 2020. Over the past five years, the incidence of GC decreased by 4.6% in the overall population, 6.1% in males, and 3.0% in females [20]. Furthermore, a cancer registry report by the National Cancer Center showed an overall decrease in GC incidence [21]. Both a decrease in the incidence and stage migration of GC are important features that need to be focused on in the future.

Furthermore, we conducted additional surveys to confirm the reasons for performing upper endoscopy in patients diagnosed with stomach cancer. However, we could not obtain meaningful results owing to a high incidence of survey loss (**Supplementary Table 2**).

To the best of our knowledge, this is the first study to report the consequences of delayed GC diagnosis owing to the COVID-19 pandemic in a large sample of Korean patients. Similar findings regarding the association between COVID-19 and GC diagnosis have been reported worldwide. In Italy, a higher number of advanced or metastatic GC cases were diagnosed during the COVID-19 pandemic than before the pandemic. However, the sample size in that study was relatively small [22]. In their review of 22 studies, Hesary and Salehiniya [23] reported the impact of COVID-19 on diagnosis, treatment, concerns, problems, and mental health in patients with GC. The COVID-19 pandemic has affected not only the management of GC but also that of many other cancers. Kuzuu et al. [24] evaluated gastrointestinal cancer (including GC, colorectal cancer, pancreatic cancer, esophageal cancer, hepatocellular cancer, and biliary tract cancer) diagnoses before and during the COVID-19 pandemic in Japan. They reported decreases in the number of gastric and colorectal cancer diagnoses as well as in the proportion of early-stage colorectal cancer cases. In France, differences in tumor burden were observed between patients diagnosed with metastatic colorectal cancer before versus after the first COVID-19 lockdown [25]. In addition, the weekly number of new pancreatic cancer cases in France was lower during the COVID-19 lockdown than in the pre-pandemic period. Furthermore, no rebound was observed in the post-lockdown period in that study [26]. The COVID-19 pandemic has been reported to affect not only the diagnosis of solid cancers but also cancer screening and oncologic clinical trials [27]. Similar findings for solid tumors could be a warning sign for the inundation of advanced-stage GC cases in the near future.

This study has a few limitations. First, because this was a single-center retrospective study, we could not elucidate a causal relationship between the COVID-19 pandemic and the rate of GC diagnoses in Korea. Second, our study period was up to December 2021; however, the COVID-19 pandemic is ongoing at the time of publication (July 2023). Thus, this study may not fully reflect the impact of the COVID-19 pandemic. A longer follow-up duration is required to evaluate the impact of the pandemic on survival in patients with GC. Third, this study targeted all patients who visited the hospital and thus may have included patients already diagnosed with stomach cancer at other hospitals or institutions who visited the current hospital for a second opinion. Fourth, the influence of the COVID-19 pandemic on the decrease in GC diagnoses observed in this single-center study may be confounded by the fact that Korea experienced a continuous decline in GC cases before the pandemic. Therefore, additional long-term nationwide studies are required to elucidate the impact of the COVID-19 pandemic on the diagnosis, stage, and prognosis of gastric and other cancers. These studies may facilitate the development of national guidelines for the management of future pandemic infections similar to COVID-19.

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The results of this study indicate that the overall rate of GC diagnosis significantly decreased in 2021. Furthermore, diagnostic delays during the pandemic led to a higher incidence of cases with an advanced disease stage at the time of diagnosis. Additional nationwide studies should be conducted to determine the number of people who refrained from undergoing GC screening owing to the COVID-19 pandemic.

In conclusion, during the COVID-19 pandemic, the overall number of GC diagnoses decreased significantly in our institute; moreover, in the cases diagnosed, the disease was in advanced stages at the time of diagnosis. Further studies are required to elucidate the relationship between the COVID-19 pandemic and the delay in the detection of GC worldwide.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1

Distribution of gastric cancer diagnosis before and during COVID-19

Click here to view

Supplementary Table 2

Distribution of gastric cancer diagnosis paths before and during COVID-19

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