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# Impact of the COVID-19 Pandemic on Esophagogastroduodenoscopy and Gastric Cancer Claims in South Korea: A Nationwide, Population-Based Study

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**Purpose:** There has been little information about the impact of coronavirus disease 2019 (COVID-19) pandemic on esophagogastroduodenoscopy (EGD) and gastric cancer claims. This study aimed to measure the impact of COVID-19 pandemic on EGD and gastric cancer claims in South Korea.

**Materials and Methods:** This nationwide, population-based study compared the claims data of EGD, gastric cancer, early gastric cancer (EGC), advanced gastric cancer (AGC) and gastric cancer operation in 2020 and 2021 (COVID-19 era) to those in 2019 (before COVID-19 pandemic).

**Results:** The annual claims of EGD, gastric cancer, EGC, and AGC were reduced by 6.3%, 5.0%, 4.7%, and 3.6% in 2020 and by 2.2%, 1.0%, 0.6%, and 1.9% in 2021, respectively, compared to 2019. The amount of annual claims of gastric cancer operation was reduced by 8.8% in 2020, but increased by 0.9% in 2021, compared to those in 2019. The monthly claims of EGD, gastric cancer, EGC, AGC, and gastric cancer operation were mainly reduced in the first epidemic wave of COVID-19, but decreased in the 2nd to 4th epidemic wave. Compared to 2019, the monthly claim of EGD, gastric cancer, EGC, AGC, and gastric cancer operation were reduced by 28.8%, 14.3%, 18.1%, 9.2%, and 5.8% in March 2020 and by 17.2%, 10.8%, 10.3%, 7.2%, and 35.4% in April 2020, respectively.

**Conclusion:** Negative impact of the COVID-19 pandemic on EGD, gastric cancer, EGC, AGC, and gastric cancer operation was worst during the first surge of COVID-19, but decreased in the 2nd to 4th epidemic wave of the disease in 2020 and 2021.

**Key Words:** COVID-19, advanced gastric cancer, early gastric cancer, EGD, gastric cancer

## INTRODUCTION

In South Korea, the first case of coronavirus disease 2019 (COVID-19) was confirmed on January 20, 2020.<sup>1</sup> After the declaration of the COVID-19 pandemic by the World Health Orga-

nization on March 12, 2020, outbreaks of the COVID-19 have continued in 2020 and 2021. According to the American Gastroenterological Association (AGA) guidelines, esophagogastroduodenoscopy (EGD) is classified as an aerosol-generating procedure that may generate small droplet nuclei at high concentrations and permit airborne transmission of COVID-19.<sup>2</sup> The AGA also recommended that EGD should be delayed in asymptomatic patients during the COVID-19 pandemic, as it is a non-time-sensitive procedure.<sup>2</sup> The Korean Cancer Association guidelines also recommended that gastric cancer screening should be determined according to the shortage of medical devices or healthcare workers and the COVID-19 infection statutes.<sup>3</sup>

There are concerns that the COVID-19 pandemic has had a worse effect on the management of gastric cancer, since many patients may experience a delay in EGD examination and gas-

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tric cancer management. In a systemic review of the impact of the COVID-19 pandemic on gastric cancer, COVID-19 reduced the number of screenings, altered treatment, and delayed or discontinued the treatment of gastric cancer.<sup>4</sup> In Italy, for example, a greater number of metastatic or advanced gastric cancers (AGCs) were diagnosed during the COVID-19 period, especially after the “full lockdown” period.<sup>5</sup> However, the impact of the COVID-19 pandemic on gastric cancer may be different in South Korea, as there have been fewer cases of COVID-19 and less mortality in South Korea than those in Western countries.<sup>6</sup> Currently, few population-based study has quantified negative effects of the COVID-19 pandemic on gastric cancer during the COVID-19 pandemic, especially in Asian countries.

In this study, we aimed to evaluate the impact of EGD and gastric cancer claim during the COVID-19 pandemic, based on the nationwide population-based data in South Korea.

## MATERIALS AND METHODS

### Data source

In South Korea, the National Health Insurance program covers almost 98% of the total population as a universal health coverage.<sup>7,8</sup> All healthcare providers and Korean citizens are required to be covered under this program, which is based on fee-for-services.<sup>8</sup> Health Insurance Review and Assessment (HIRA) data are generated in the process of reimbursement and contain comprehensive information on relevant healthcare services, including procedures, operations, examinations, treatment, and prescriptions.<sup>8</sup> Procedure codes on physician claims database has had a very high level of agreement with the data in medical charts. For the present study, the index date for extracting study data from the HIRA database was August 1, 2022. This study was approved by the Institutional Review Board of Kyung Hee University Hospital in Gangdong, Seoul, South Korea (approval no. KHNMCMC 2022-05-036). The requirement for written informed consent was waived for this claims-based study, as all participants' data were anonymous.

### Study population

This was a retrospective nationwide population-based study using the HIRA database of South Korea. In this study, the period from January 1, 2020 to December 31, 2021 was defined as the COVID-19 period, as the first case of COVID-19 was reported in January 2020, and several epidemic waves occurred during this period in South Korea.<sup>9</sup> We compared the number of claims of EGD and gastric cancer management during the COVID-19 period (2020–2021) to those of the pre-COVID-19 period (2019). Gastric cancer included early gastric cancer (EGC), AGC, and unspecified gastric cancer.

The first surge period of COVID-19 was defined as March and April 2020, as there was an initial peak in COVID-19 cases and the Korean government implemented the first social dis-

tancing during this period.<sup>9</sup> The second epidemic wave started from July to October 2020 with a mass infection breaking out at a church in Seoul, and the Korean government upgraded social distancing to level 2 in the Seoul metropolitan area.<sup>9</sup> From October 2020 to February 2021, the third epidemic wave began with a gradual increase in COVID-19 cases without any apparent major incidents, and the social distancing level was upgraded twice on December 1 and 8, 2020. In July to September 2021, the fourth epidemic wave started with 2000 to 4000 new daily cases COVID-19 being reported. During the COVID-19 era, the Korean government offered guidance on changes in standard medical practices to minimize transmission of the disease, and many Koreans postponed non-urgent endoscopic procedures and medical services.<sup>2</sup>

### Definition of variables

Based on the HIRA claims codes, EGD without therapeutic intervention was defined as EGD (E7611). Gastric cancers were classified as EGC (C1600, C1610, C1620, C1630, C1640, C1650, C1660, C1680, C1690), AGC (C1601, C1611, C1621, C1631, C1641, C1651, C1661, C1681, C1691), and unspecified gastric cancer (C1609, C1619, C1629, C1639, C1649, C1659, C1669, C1689, C1699) based on major diagnostic codes of the International Classification of Disease-9 codes. Gastric cancer diagnosis coding in South Korea are quite reliable, since cancer diagnosis coding is strictly registered in the HIRA system as cancer patients could pay only 5% of their medical costs for 5 years as a co-payment policy. Operations of gastric cancer was defined as total gastrectomy (QA536, Q2533, Q2534, Q2536, Q2537), subtotal gastrectomy (Q0259, Q2594, Q2598, Q0251, Q0252, Q0253, Q0258, Q0256, Q0257, Q0255, Q0254), gastroenterostomy (Q2571, Q2572, Q2573), vagotomy (Q2550, Q2551, Q2552), or pyloroplasty (Q2561, Q2562) in patients with gastric cancer or carcinoma in situ of the stomach (Supplementary Table 1, only online).

### Statistical analysis

The number of claims of EGD and gastric cancer management were presented as the monthly and annual number of cases from 2019 to 2021. Descriptive analysis was performed on the entire population during the study period. Annual or monthly comparative analysis between two groups was done using the chi-squared tests. All statistical tests were two-sided, and  $p$  value  $< 0.05$  was considered statistically significant and  $p$  value  $\geq 0.10$  was considered as no significance (NS). All statistical analyses were conducted using the R software package (R Foundation for Statistical Computing, Vienna, Austria; <http://www.R-project.org>).

## RESULTS

### Claims data of EGD

The annual number of EGD in 2020 and 2021 was reduced by 6.3% and 2.2%, respectively, compared to those in 2019 (Table 1). The annual volume of EGDs in 2020 and 2021 was reduced by 6.2% and 2.4% in male, and by 6.4% and 2.1% in female, respectively, compared with those in 2019 (both  $p=NS$ ). The negative impact of COVID-19 on EGD was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021 (Fig. 1). During the first surge of COVID-19, the monthly number of EGD was reduced by 28.8% and 17.2% in March and April 2020, respectively, compared to March and April 2019. In March 2020, the monthly number of EGD was declined by 26.1% in male and by 31.5% in female, compared to March 2019 ( $p<0.001$ ). In April 2020,

the monthly number of EGD was reduced by 17.8% in male and by 16.6% in female, compared to April 2019 ( $p=0.029$ ).

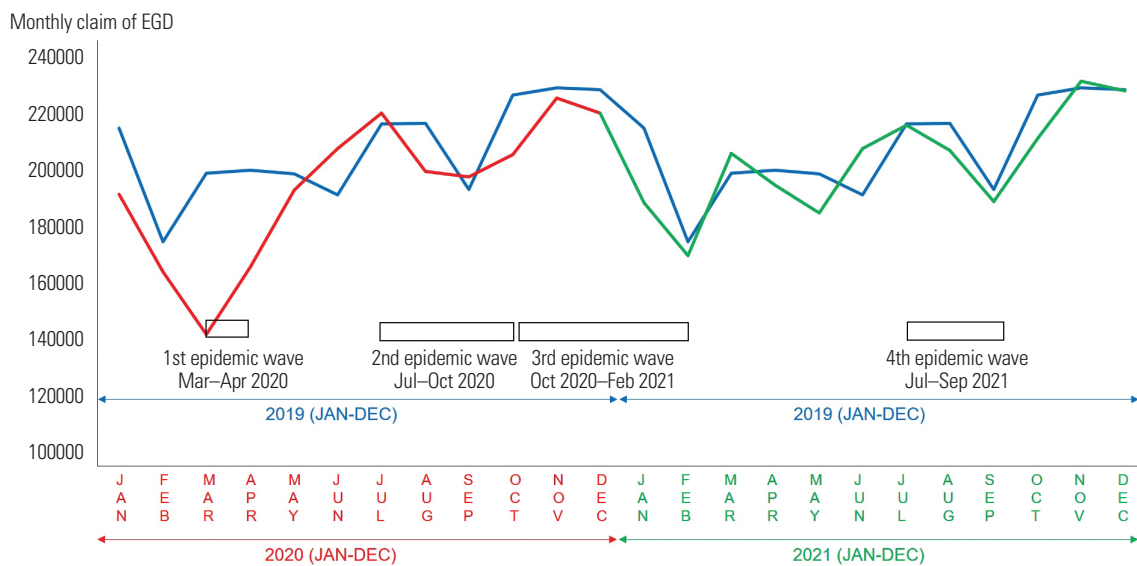
### Claims data of gastric cancer

The annual number of patients who filed claims for gastric cancer in 2020 and 2021 was reduced by 5.0% and 1.0%, respectively, compared to 2019 (Table 2). The annual number of patients filing claims for gastric cancer in 2020 and 2021 was reduced by 5.0% and 1.2% in male, and by 5.1% and 0.7% in female, respectively, compared to 2019 (both  $p=NS$ ). The negative impact of COVID-19 on gastric cancer claims was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 (Fig. 2). During the first surge of COVID-19, the monthly number of patients filing claims for gastric cancer declined by 14.3% and 10.8% in March and April 2020, respectively, compared to March and April 2019. In March

**Table 1.** Monthly Number of Patients Who Underwent EGD\* between 2019 and 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
<b>Total</b>														
2019	215339	174834	199215	200295	199112	191597	216927	217014	193394	227168	229843	229207	2493945	Ref.
2020	191853	163987	141800	165843	193193	208001	220779	199846	198053	205908	226160	220815	2336238	-6.3%
2021	188691	169862	206426	194950	185017	208025	216388	207487	189147	211681	232107	228645	2438426	-2.2%
<b>Male</b>														
2019	105196	87167	97322	98235	98543	94005	105820	105307	94011	109607	114245	116951	1226409	Ref.
2020	96393	83543	71969	80737	93271	101368	106986	96767	94483	100551	112174	111785	1150027	-6.2%
2021	92629	82777	99606	94977	91303	101958	106027	102082	92211	103478	114648	115466	1197162	-2.4%
<b>Female</b>														
2019	110143	87667	101893	102060	100569	97592	111107	111707	99383	117561	115598	112256	1267536	Ref.
2020	95460	80444	69831	85106	99922	106633	113793	103079	103570	105357	113986	109030	1186211	-6.4%
2021	96062	87085	106820	99973	93714	106067	110361	105405	96936	108203	117459	113179	1241264	-2.1%

\*EGD was defined as esophagogastroduodenoscopy without therapeutic interventions (E7611).

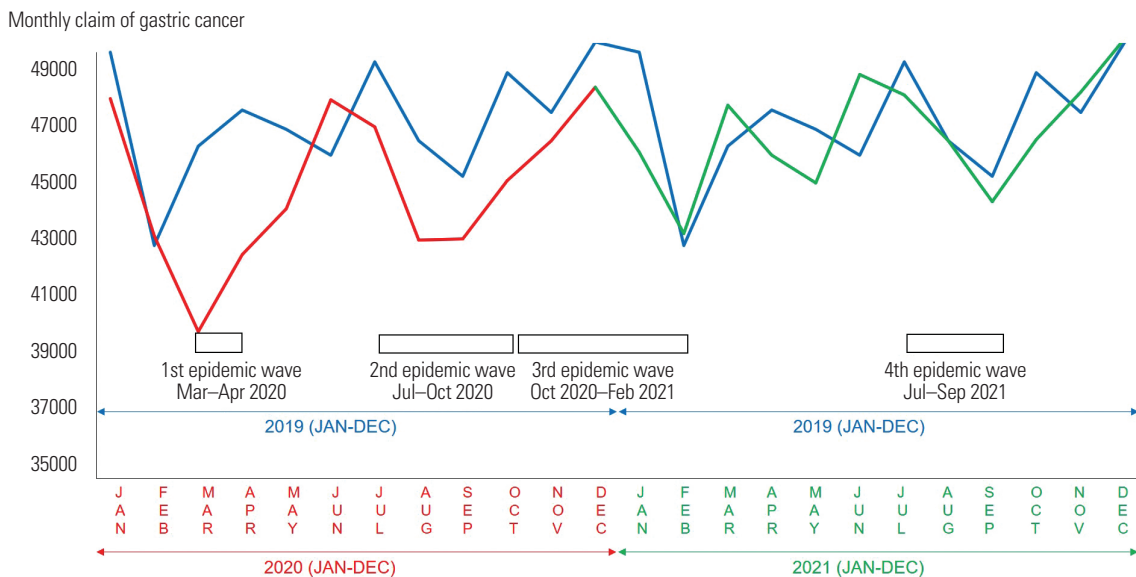


**Fig. 1.** Negative impact of COVID-19 on EGD was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021. Claims data of EGD in 2020 (red line) and 2021 (green line) were compared to those in 2019 (blue line). COVID-19, coronavirus disease 2019; EGD, esophagogastroduodenoscopy.

**Table 2.** Monthly Number of Patients Who Filed Claims for Gastric Cancer\* between 2019 and 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
<b>Total</b>														
2019	49679	42791	46318	47615	46933	46008	49323	46517	45245	48945	47525	50041	566940	Ref.
2020	48023	43125	39711	42466	44099	47972	47020	42967	43024	45090	46528	48437	538462	-5.0%
2021	46111	43216	47788	46007	45021	48881	48156	46513	44353	46552	48255	50178	561031	-1.0%
<b>Male</b>														
2019	33350	28567	31011	31618	31134	30690	32806	30844	30327	32522	31598	33532	377999	Ref.
2020	32198	29025	26995	28337	29299	31899	31181	28553	28655	29843	30870	32213	359068	-5.0%
2021	30796	28765	31915	30661	29990	32527	31951	30853	29525	30893	32076	33374	373326	-1.2%
<b>Female</b>														
2019	16329	14224	15307	15997	15799	15318	16517	15673	14918	16423	15927	16509	188941	Ref.
2020	15825	14100	12716	14129	14800	16073	15839	14414	14369	15247	15658	16224	179394	-5.1%
2021	15315	14451	15873	15346	15031	16354	16205	15660	14828	15659	16179	16804	187705	-0.7%

\*Gastric cancer included early gastric cancer, advanced gastric cancer, and unspecified gastric cancer.



**Fig. 2.** Negative impact of COVID-19 on gastric cancer claim was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021. Claims data of gastric cancer in 2020 (red line) and 2021 (green line) were compared to those in 2019 (blue line). COVID-19, coronavirus disease 2019.

2020, the monthly number of patients who filed claims for gastric cancer declined by 13.0% in male and by 16.9% in female, compared to March 2019 ( $p < 0.001$ ). In April 2020, the monthly number of patients who filed claims for gastric cancer declined by 10.4% in male and by 11.7% in female, compared to April 2019 ( $p = NS$ ).

**Claims data of EGC**

The annual number patients who filed claims for EGC in 2020 and 2021 was reduced by 4.7% and 0.6%, respectively, compared to 2019 (Table 3). The annual number of claims for EGC in 2020 and 2021 was reduced by 4.7% and 0.9% in male, and reduced by 4.8% and increased by 0.0% in female, respectively, compared to 2019 ( $p = 0.035$  in 2020 and  $p = NS$  in 2021). The negative impact of COVID-19 on EGC claims was the worst during the first surge of the pandemic, but it decreased in the

2nd to 4th epidemic wave of COVID-19 (Fig. 3). During the first surge of COVID-19, the monthly number of patients claimed for EGC was reduced by 18.1% and 10.3% in March and April 2020, respectively, compared to March and April 2019. In March 2020, the monthly number of patients who filed claims for EGC was declined by 16.2% in male and by 22.0% in female, compared to March 2019 ( $p = 0.003$ ). In April 2020, the monthly number of patients filing claims for EGC was declined by 9.7% in male and by 11.6% in female, compared to April 2019 ( $p = NS$ ).

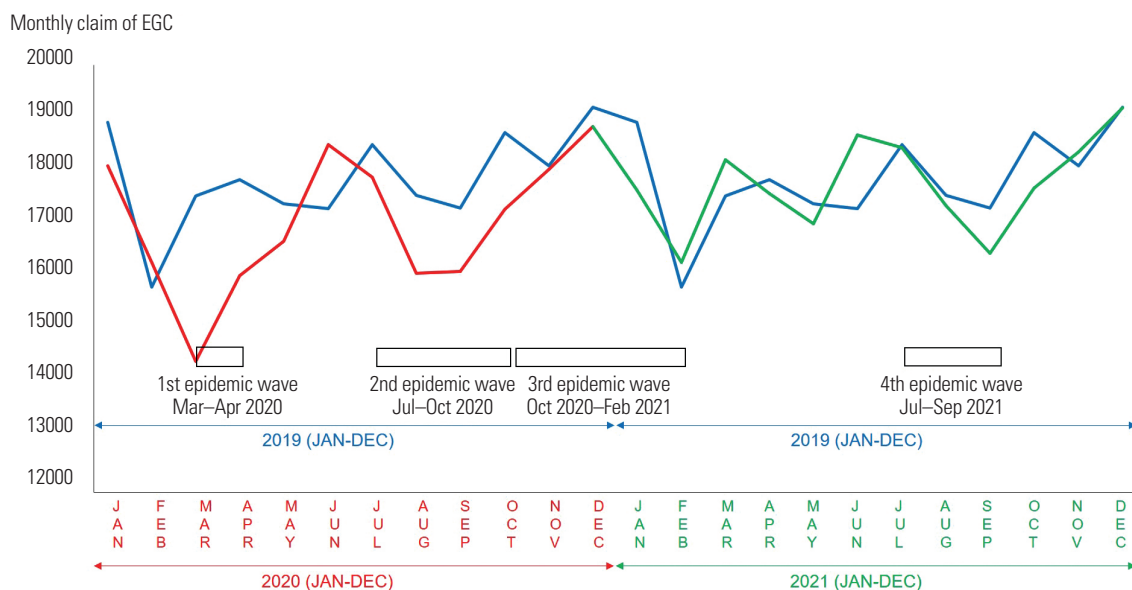
**Claims data of AGC**

The annual number patients who filed claims for AGC in 2020 and 2021 was reduced by 3.6% and 1.9%, respectively, compared to 2019 (Table 4). The annual number of claims for AGC in 2020 and 2021 was reduced by 3.8% and 1.4% in male, and by 3.4% and 3.2% in female, respectively, compared to 2019 (both

**Table 3.** Monthly Number of Patients Who Filed Claims for Early Gastric Cancer\* between 2019 and 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
<b>Total</b>														
2019	18736	15607	17336	17648	17190	17099	18319	17355	17117	18547	17915	19030	211899	Ref.
2020	17916	16086	14203	15826	16483	18310	17700	15873	15909	17094	17846	18654	201900	-4.7%
2021	17459	16076	18033	17385	16809	18502	18262	17163	16249	17494	18178	19018	210628	-0.6%
<b>Male</b>														
2019	12687	10538	11682	11810	11455	11553	12271	11515	11604	12388	11973	12824	142300	Ref.
2020	12165	10957	9791	10664	10972	12194	11791	10627	10673	11384	11904	12518	135640	-4.7%
2021	11814	10718	12046	11659	11203	12418	12287	11418	10852	11649	12202	12756	141022	-0.9%
<b>Female</b>														
2019	6049	5069	5654	5838	5735	5546	6048	5840	5513	6159	5942	6206	69599	Ref.
2020	5751	5129	4412	5162	5511	6116	5909	5246	5236	5710	5942	6136	66260	-4.8%
2021	5645	5358	5987	5726	5606	6084	5975	5745	5397	5845	5976	6262	69606	+0.0%

\*Early gastric cancer was defined as diagnostic code of C1600, C1610, C1620, C1630, C1640, C1650, C1660, C1680, or C1690.



**Fig. 3.** Negative impact of COVID-19 on advanced gastric cancer claim was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021. Claims data of advanced gastric cancer in 2020 (red line) and 2021 (green line) were compared to those in 2019 (blue line). COVID-19, coronavirus disease 2019; EGC, early gastric cancer.

$p=NS$ ). The negative impact of COVID-19 on AGC claims was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 (Fig. 4). During the first surge of COVID-19, the monthly number of patients filing claims for AGC was reduced by 9.2% and 7.2% in March and April 2020, respectively, compared to March and April 2019. In March 2020, the monthly number of patients who filed claims for AGC was declined by 8.4% in male and by 10.9% in female, compared to March 2019 ( $p=NS$ ). In April 2020, the monthly number of AGC was declined by 7.2% in male and by 7.1% in female, compared to April 2019 ( $p=NS$ ).

**Claims data of gastric cancer operation**

The annual number of patients who underwent operation for gastric cancer in 2020 and 2021 was reduced by 8.8% and in-

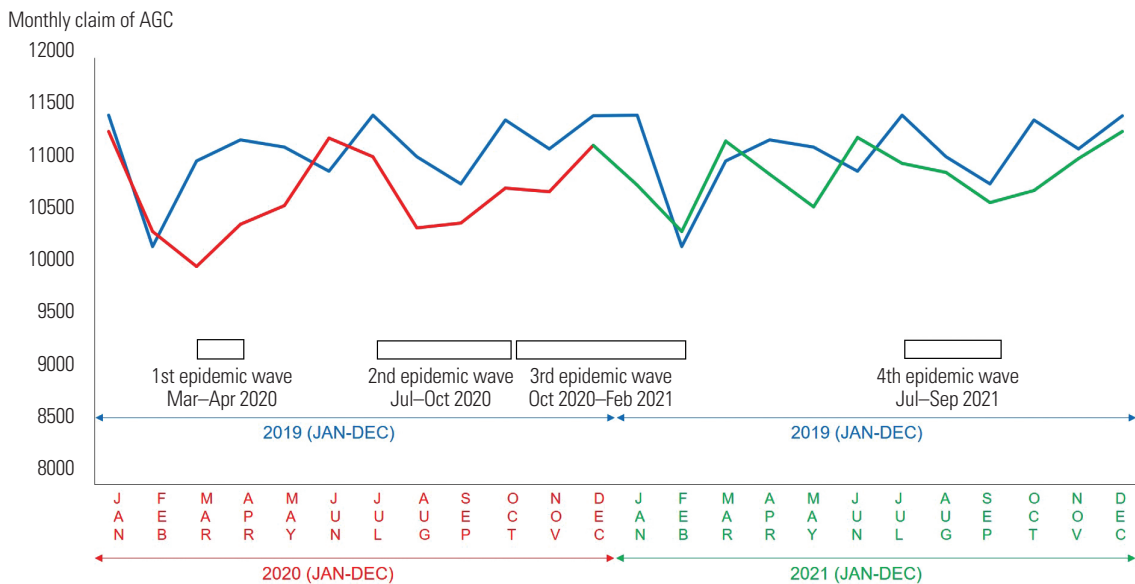
creased by 0.9%, respectively, compared to 2019 (Table 5). The annual number of patients who received surgery for gastric cancer in 2020 and 2021 was reduced by 8.8% and increased by 0.8% in male, and it was reduced by 8.8% and increased by 0.9% in female, respectively, compared to 2019. The negative impact of COVID-19 on gastric cancer operation was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 (Fig. 5). During the first surge of COVID-19, the monthly number of patients who underwent operation for gastric cancer was declined by 5.8% and 35.4% in March and April 2020, respectively, compared to March and April 2019. In March 2020, the monthly number of patients who received surgery for gastric cancer was declined by 2.7% in male and by 12.0% in female ( $p<0.01$ ), compared to March 2019 ( $p=NS$ ). In April 2020, the monthly number of patients operated



**Table 4.** Monthly Number of Patients Who Filed Claims for Advanced Gastric Cancer\* between 2019 and 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
<b>Total</b>														
2019	11369	10119	10933	11132	11065	10834	11371	10975	10714	11325	11046	11364	132247	Ref.
2020	11216	10263	9931	10332	10511	11152	10973	10301	10344	10675	10643	11085	127426	-3.6%
2021	10707	10265	11124	10810	10498	11158	10912	10828	10541	10654	10957	11215	129669	-1.9%
<b>Male</b>														
2019	7765	6885	7479	7549	7507	7311	7726	7434	7310	7670	7485	7773	89894	Ref.
2020	7606	7013	6852	7005	7164	7606	7441	6983	7004	7170	7173	7496	86513	-3.8%
2021	7285	7003	7638	7367	7233	7643	7435	7398	7215	7298	7462	7685	88662	-1.4%
<b>Female</b>														
2019	3604	3234	3454	3583	3558	3523	3645	3541	3404	3655	3561	3591	42353	Ref.
2020	3610	3250	3079	3327	3347	3546	3532	3318	3340	3505	3470	3589	40913	-3.4%
2021	3422	3262	3486	3443	3265	3515	3477	3430	3326	3356	3495	3530	41007	-3.2%

\*Advanced gastric cancer was defined as diagnostic code of C1601, C1611, C1621, C1631, C1641, C1651, C1661, C1681, or C1691.



**Fig. 4.** Negative impact of COVID-19 on early gastric cancer claim was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021. Claims data of early gastric cancer in 2020 (red line) and 2021 (green line) were compared to those in 2019 (blue line). COVID-19, coronavirus disease 2019; AGC, advanced gastric cancer.

for gastric cancer was declined by 33.3% in male and by 39.7% in female, compared to April 2019 ( $p=NS$ ).

## DISCUSSION

This nationwide, population-based study aimed to investigate the negative impact of COVID-19 on the EGD and gastric cancer claims in South Korea. During the COVID-19 era, the annual claims data of EGD, gastric cancer, EGC, and AGC were reduced by 6.3%, 5.0%, 4.7%, and 3.6% in 2020, and by 2.2%, 1.0%, 0.6%, and 1.9% in 2021, respectively, compared to 2019. The annual claims data of gastric cancer operation was reduced by 8.8% in 2020 but increased by 0.9% in 2021, compared to 2019. Our data were consistent with the results of the Korean

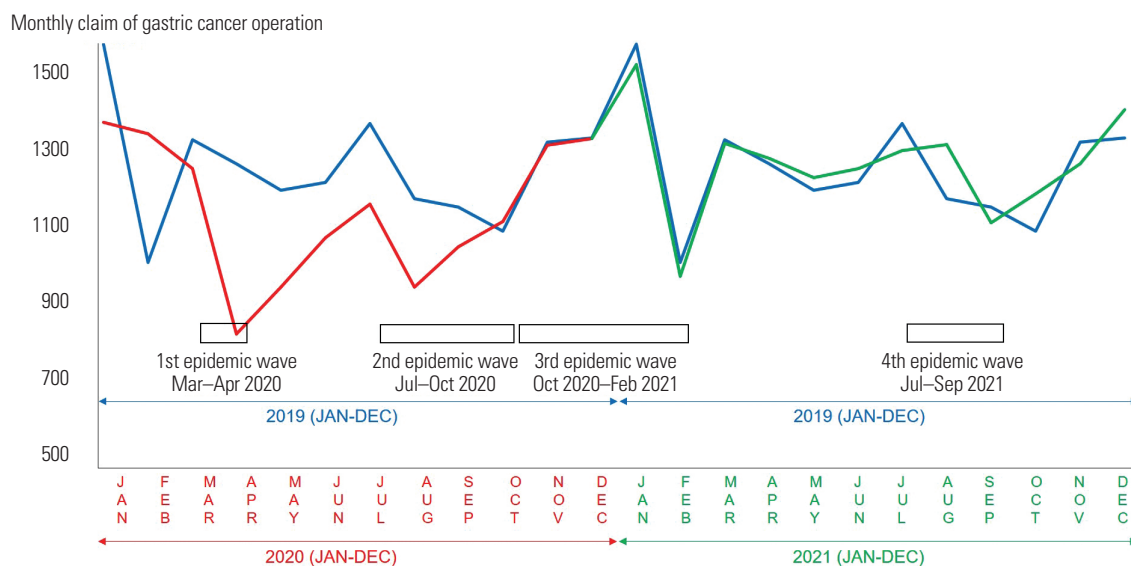
National Cancer Screening survey.<sup>10</sup>

The negative impact of the COVID-19 on EGD, gastric cancer, EGC, AGC, and gastric cancer operation was the worst during the first surge of COVID-19, but decreased in the 2nd to 4th epidemic wave of the disease in 2020 and 2021 (Figs. 1-5). During the first surge of COVID-19, the monthly claims data of EGD, gastric cancer, EGC, AGC, and gastric cancer operation were reduced by 28.8%, 14.3%, 18.1%, 9.2%, and 5.8% in March 2020, and reduced by 17.2%, 10.8%, 10.3%, 7.2%, and 35.4% in April 2020, respectively, compared to 2019. EGD and gastric cancer management may have been significantly delayed during the first surge COVID-19 pandemic, as international gastroenterology and gastrointestinal endoscopy societies have advised gastrointestinal endoscopy units to delay elective and non-urgent procedures.<sup>11</sup> For example, gastrointestinal endoscopy proce-

**Table 5.** Monthly Number of Patients Who Underwent Operation for Gastric Cancer\* between 2019 and 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
<b>Total</b>														
2019	1572	1000	1321	1258	1188	1210	1364	1166	1145	1081	1314	1326	14945	Ref.
2020	1367	1337	1245	813	935	1065	1153	936	1041	1107	1307	1324	13630	-8.8%
2021	1518	963	1312	1272	1222	1246	1292	1309	1103	1180	1258	1399	15074	+0.9%
<b>Male</b>														
2019	1056	675	888	845	759	787	878	783	779	714	882	885	9931	Ref.
2020	903	915	864	564	618	696	773	611	685	721	837	869	9056	-8.8%
2021	1031	673	887	811	817	794	865	868	758	761	827	922	10014	+0.8%
<b>Female</b>														
2019	516	325	433	413	429	423	486	383	366	367	432	441	5014	Ref.
2020	464	422	381	249	317	369	380	325	356	386	470	455	4574	-8.8%
2021	487	290	425	461	405	452	427	441	345	419	431	477	5060	+0.9%

\*Operation of gastric cancer was defined as any surgical procedures (QA536, Q2533, Q2534, Q2536, Q2537, Q2550, Q2551, Q2552, Q2561, Q2562, Q2571, Q2572, Q2573, Q0259, Q2594, Q2598, Q0251, Q0252, Q0253, Q0258, Q0256, Q0257, Q0255, Q0254) for patients with cancer or carcinoma in situ of the stomach.



**Fig. 5.** Negative impact of COVID-19 on gastric cancer operation was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021. Claims data of early gastric cancer operation in 2020 (red line) and 2021 (green line) were compared to those in 2019 (blue line). COVID-19, coronavirus disease 2019.

dures and gastrointestinal cancer diagnoses were reduced by 88% and 66%, respectively, during the first 6 weeks of the COVID-19 crisis in the UK.<sup>12</sup> In Italy, several activities related to routine diagnostic procedures were either halted or postponed during the first surge of the COVID-19 pandemic.<sup>13</sup> Our notable finding, however, was that the monthly claims data of EGD and gastric cancer management were less declined than those in the Western countries,<sup>12,13</sup> and they were less decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021, despite the ongoing COVID-19 pandemic in South Korea. This may be explained by the fact that vaccination and knowledge for COVID-19 over time may have improved hospital visits for EGD and gastric cancer management. For example, 70% of the Korean population had received the second dose of the COVID-19 vaccine by October 2021.<sup>14</sup>

The oncologic outcomes of gastric cancer during the COVID-19 pandemic may become worse as many cases of EGD and gastric cancer management are being suspended or delayed. Currently, however, the negative effect of COVID-19 on the oncologic outcomes of gastric cancer still remains unclear. In a recent review, operation delay up to 2 months after the end of the staging process in patients with gastric cancer did not worsen the oncological outcomes.<sup>15</sup> Surgical resection may be delayed for 3 months without worsening oncologic outcomes for EGC; however, there is insufficient evidence for the safe time without worsening oncologic outcomes for AGC.<sup>16</sup> In our study, EGD and gastric cancer management significantly reduced during only the first 2 months of the COVID-19 pandemic, but decreased less in the 2nd to 4th epidemic wave of COVID-19 despite the ongoing pandemic. Therefore, we can assume



that the negative oncologic outcome of gastric cancer in South Korea may not be significant, but this issue should be evaluated through future studies in South Korea.

The present study demonstrated that the monthly claims data of EGD, gastric cancer, and EGC were more significantly declined in female than in male, but the monthly claims data of AGC and gastric cancer operation were only numerically declined in female than in male without significance during the first surge of the COVID-19 pandemic. These findings may be explained by the fact that female are more likely to perceive COVID-19 as a serious health problem and comply with public intervention.<sup>17</sup> In addition, female seem to score higher than male on agreeableness and conscientiousness, and are more willing to follow preventive health measures, such as social distancing and wearing a face mask.<sup>18</sup> However, sex difference was blunted for the claims data of AGC and gastric cancer operation, as claims for AGC and gastric cancer operation are more time-sensitive and urgent than those for EGD and EGC. There may be sex differences for the impact of COVID-19 on EGD and gastric cancer management due to different COVID-19-related beliefs and behaviors by sex. Therefore, a domain of sex differences in response to the COVID-19 pandemic on EGD and gastric cancer management should be further evaluated.

This study had some limitations. One is the secondary data with uncertainty regarding the accuracy of the diagnosis. However, previous studies using HIRA as a data source have shown that procedures and diagnoses were accurately coded. No specific details of gastric cancer were recorded in the HIRA, and we could not assess the detailed clinical information of patients with gastric cancer; however, as described in the Methods section, the cancer diagnosis code is quite reliable due to the co-payment policy in South Korea. Second, there was a decline in EGD and gastric cancer management during the COVID-19 pandemic, however, the exact reasons for reduced claims were not investigated. Before the COVID-19 pandemic, the annual volume of EGD was little changed between 2017 and 2019 in a National Cancer Screening Program data,<sup>9</sup> but the annual EGD rate declined during the period of the COVID-19 pandemic. In the same context, claims for EGD and gastric cancer management during the COVID-19 pandemic may have been declined by the effect of COVID-19. Third, the claims data of endoscopic submucosal dissection (ESD) was not analyzed in this study. However, only 43.5% of ESD cases were claimed for EGC, and other endoscopic resection methods could be used for EGC.<sup>19</sup> Therefore, it is difficult to describe ESD as a representative behavior for the management of gastric cancer. Finally, it is difficult to generalize our findings to other countries, as the COVID-19 status and healthcare systems differ from country to country. Despite these limitations, the strength of the current study is that we used population-based and nationally representative samples, which are sufficient to generalize the trends in EGD and gastric cancer management in the Korean population and are virtually free from referral bias.

In conclusion, the negative impact of COVID-19 on EGD, gastric cancer, EGC, AGC, and gastric cancer operation was the worst during the first surge of the pandemic, but decreased in the 2nd to 4th epidemic wave of COVID-19 in 2020 and 2021.

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