

ORIGINAL ARTICLE

소화기내시경 수행에 대한 코로나19 팬데믹의 영향

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Impact of COVID-19 Pandemic on Performance of Gastrointestinal Endoscopy

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Background/Aims: Non-time-sensitive gastrointestinal endoscopy was deferred because of the risk of exposure to coronavirus disease 2019 (COVID-19), but no population-based studies have quantified the adverse impact on gastrointestinal procedures. This study examined the impact of the COVID-19 pandemic on the performance of esophagogastroduodenoscopy (EGD), colonoscopy, ERCP, and abdominal ultrasonography (US) in South Korea.

Methods: This nationwide, population-based study compared the claim data of EGD, colonoscopy, ERCP, and abdominal US in 2020 and 2021 (COVID-19 era) with those in 2019 (before the COVID-19 era).

Results: During the first year (2020) of the COVID-19 pandemic, the annual claim data of EGD and colonoscopy were reduced by 6.3% and 6.9%, respectively, but those of ERCP and abdominal US were increased by 1.0% and 2.9%, compared to those in 2019. During the first surge (March and April 2020) of COVID-19, the monthly claim data of EGD, colonoscopy, ERCP, and abdominal US were reduced by 28.8%, 43.8%, 5.1%, and 21.6%, respectively, in March 2020, and also reduced by 17.2%, 32.8%, 4.4%, and 9.5%, respectively, in April 2020, compared to those in March and April 2019. During March and April 2020, the monthly claims of ERCP, compared with those in 2019, declined less significantly than those of EGD and colonoscopy (both $p < 0.001$).

Conclusions: The claims of EGD and colonoscopy were reduced more significantly than those of ERCP and abdominal US during the COVID-19 pandemic because ERCPs are time-sensitive procedures and abdominal USs are non-aerosolized procedures. (Korean J Gastroenterol 2023;82:239-247)

Key Words: Esophagogastroduodenoscopy; Colonoscopy; COVID-19; ERCP; Ultrasonography

INTRODUCTION

In South Korea, the first case of coronavirus disease 2019 (COVID-19) was confirmed on January 20, 2020.¹ After the declaration of the COVID-19 pandemic by the World Health Organization on March 12, 2022, many outbreaks occurred in South Korea between 2020 and 2021. According to the

American guidelines, endoscopic procedures, such as esophagogastroduodenoscopy (EGD), ERCP, and colonoscopy, were classified as aerosol-generating procedures, which may generate tiny nuclei droplets in high concentrations and permit the airborne transmission of COVID-19.² As a result, there were concerns that the COVID-19 pandemic reduced the number of gastrointestinal endoscopy (GIE) procedures. For exam-

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ple, data from England and Hong Kong revealed a decrease in patients who underwent colonoscopy and EGD.^{3,4} On the other hand, the impact of COVID-19 on GIE could vary significantly from country to country, as the status of COVID-19 varies across countries.⁵

Abdominal ultrasonography (US) is similar to GIEs in that it is performed face-to-face between the patient and medical staff. Nevertheless, it is a non-aerosolized procedure that can be performed while wearing a mask. Therefore, the impact of the COVID-19 pandemic on abdominal US may differ from those in GIEs. The American guidelines recommended that non-time-sensitive procedures, such as screening or surveillance endoscopies, should be delayed in asymptomatic patients during the COVID-19 pandemic.² As a result, many non-time-sensitive procedures were deferred because of the risk of exposure to COVID-19.⁶ Therefore, the magnitude of the negative impact of the COVID-19 pandemic on GIE may be different from their time-sensitive characteristics. On the other hand, no population-based studies have quantified these issues in gastrointestinal procedures. A better understanding of the COVID-19 impact on gastrointestinal procedures may be the first step toward the successful rearrangement of medical resources.

This study examined the impact of the COVID-19 pandemic on gastrointestinal procedures using population-based data in South Korea.

SUBJECTS AND METHODS

1. Data source

In South Korea, the National Health Insurance program has covered almost 98% of the total population with universal health coverage.^{7,8} All healthcare providers and Koreans must be covered under the NHI program based on a fee-for-service.⁸ Health Insurance Review and Assessment (HIRA) data is generated to reimburse providers and contains comprehensive information on the relevant healthcare services, including prescriptions and procedures, such as surgeries, examinations, and treatment.⁸ Procedure codes in the HIRA databases had a very high level of agreement with the data in medical charts. This was a retrospective nationwide population-based study using the HIRA database in South Korea. The index date for extracting the study data from the HIRA database was August 1, 2022. The requirement for informed consent was waived

because the information in this study was related only to pseudonyms. This study was approved by the Institutional Review Board of Kyung Hee University Hospital in Gangdong, Seoul, Republic of Korea (IRB number: KHNMC 2022-05-040).

2. Study design

This was a retrospective nationwide population-based study using the HIRA database of South Korea. For this study, the period from January 1, 2020, to December 31, 2021, was defined as the COVID-19 period because the first case of COVID-19 was reported in January 2020, and many outbreaks continued during 2020 and 2021. The annual claim data of EGD, colonoscopy, ERCP, and abdominal US during the COVID-19 period (2020–2021) were compared with the results of the same period in 2019 as a reference. For a monthly comparison during the first surge of COVID-19, monthly claim data for March and April 2019 were compared with those of the same months in 2020 and 2021.

The first surge period of COVID-19 was defined as March and April 2020 because there was an initial peak of COVID-19 cases, and the Korean government implemented the first social distancing policy.⁹ The second epidemic wave started from July to October 2020 with the mass infection at a church in Seoul, and the Korean government upgraded the social distancing to level 2 in the Seoul metropolitan area.⁹ During October 2020 to February 2021, the third epidemic wave started with a gradual increase in the number of COVID-19 cases, and the social distancing level was upgraded twice on 1 and 8 December 2020. The fourth epidemic wave started from July to September 2021, with 2,000–4,000 new COVID-19 cases daily. During the COVID-19 era, the Korean government offered guidance on the changes in standard medical practices to minimize COVID-19 transmission, and many Koreans postponed non-urgent GIE, which may increase the risk of exposure to COVID-19.² Medical institutions also reduced the performance of GIE due to major workloads from COVID-19 management.²

3. Definition of variables

The most common procedures in the gastroenterology department are EGD, colonoscopy, ERCP, and abdominal US. Based on the HIRA claim codes, GIEs were defined as follows: EGD, EGD without therapeutic intervention (E7611); colonoscopy, colonoscopy without polypectomy (E7660); ERCP, ERCP

without therapeutic intervention (E7621 or E7622). Compared with the aerosolized GIEs, abdominal US was analyzed as a control procedure because it is a non-aerosolized procedure performed while wearing a mask. Abdominal US was defined as abdominal US without a pelvic examination (EB441). Abdominal US may include all abdominal US with a pelvic examination (EB441-EB457, EB458), but the pelvic US for women was reimbursed from February 1, 2020, which resulted in the increased claim for abdominal US with pelvic examination from February 2020 in women (Supplementary Table 1). This study used abdominal US without a pelvic examination for a precise comparison of the claims data in abdominal US between 2019 and 2021.

A 'time-sensitive procedure' was defined as one that, if deferred, may adversely impact a patient's important outcomes by the American Gastroenterological Association.² Time-sensitive procedures may threaten the patient's life or cause permanent dysfunction of an organ, e.g., diagnosis and treatment of cholangitis. In contrast, a 'non-time sensitive procedure' has no short-term impact on patient-important outcomes, e.g., screening or surveillance colonoscopy.² Therefore, ERCP is considered a time-sensitive procedure, and EGD, colonoscopy, and abdominal US are considered non-time-sensitive procedures.

4. Statistical analysis

The claim data are presented as the annual and monthly number of claims in 2019–2021. Descriptive analysis was performed on the entire population during the study period. Annual or monthly comparative analysis between the two

groups was conducted using the Chi-squared tests. All statistical tests were two-sided, and a p-value <0.05 was considered significant. All statistical analyses were conducted using the R software package R (R Foundation for Statistical Computing, Vienna, Austria; <https://www.r-project.org/>).

RESULTS

1. Claim data of EGD

The annual claim data of EGD in 2020 and 2021 was reduced by 6.3% and 2.2%, respectively, compared to that in 2019 (Table 1). The annual claim data of EGD in 2020 and 2021 was reduced by 6.2% and 2.4% in men, respectively, and by 6.4% and 2.1% in women, respectively, compared to that in 2019 (both p=NS). The monthly claim data of EGD was reduced dramatically on the 1st epidemic wave and less affected on the 2nd–4th epidemic waves during the COVID-19 pandemic (Fig. 1). During the first surge of COVID-19, the monthly claim data of EGD was reduced by 28.8% in March 2020 and 17.2% in April 2020 compared to that in March and April 2019. In March 2020, the monthly claim data of EGD declined by 26.1% and 31.5% in men and women, respectively, compared to March 2019 (p<0.001). In April 2020, the monthly claim data of EGD declined by 17.8% and 16.6% in men and women, respectively, compared with that in April 2019 (p=0.029).

2. Claim data of colonoscopy

The annual claim data of colonoscopies in 2020 and 2021

Table 1. Monthly Claim Data of Patients Who Underwent EGD^a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
Total														
2019	215,339	174,834	199,215	200,295	199,112	191,597	216,927	217,014	193,394	227,168	229,843	229,207	2,493,945	Ref.
2020	191,853	163,987	141,800	165,843	193,193	208,001	220,779	199,846	198,053	205,908	226,160	220,815	2,336,238	-6.3%
2021	188,691	169,862	206,426	194,950	185,017	208,025	216,388	207,487	189,147	211,681	232,107	228,645	2,438,426	-2.2%
Male														
2019	105,196	87,167	97,322	98,235	98,543	94,005	105,820	105,307	94,011	109,607	114,245	116,951	1,226,409	Ref.
2020	96,393	83,543	71,969	80,737	93,271	101,368	106,986	96,767	94,483	100,551	112,174	111,785	1,150,027	-6.2%
2021	92,629	82,777	99,606	94,977	91,303	101,958	106,027	102,082	92,211	103,478	114,648	115,466	1,197,162	-2.4%
Female														
2019	110,143	87,667	101,893	102,060	100,569	97,592	111,107	111,707	99,383	117,561	115,598	112,256	1,267,536	Ref.
2020	95,460	80,444	69,831	85,106	99,922	106,633	113,793	103,079	103,570	105,357	113,986	109,030	1,186,211	-6.4%
2021	96,062	87,085	106,820	99,973	93,714	106,067	110,361	105,405	96,936	108,203	117,459	113,179	1,241,264	-2.1%

^aEGD was defined as esophagogastroduodenoscopy without therapeutic interventions (E7611).

were reduced by 6.9% and increased by 8.0%, respectively, compared to that in 2019 (Table 2). The annual claim data of colonoscopy in 2020 and 2021 was reduced by 7.6% and increased by 6.1% in men, respectively, and reduced by 6.2% and increased by 10.0% in women, respectively, compared to that in 2019 (both $p<0.001$). The monthly claim data for colonoscopies was reduced dramatically during the 1st epidemic wave and less affected during the 2nd and 4th epi-

demic waves during the COVID-19 pandemic (Fig. 2). During the first surge period of COVID-19, the monthly claim data of colonoscopies was reduced by 43.8% in March 2020 and by 32.8% in April 2020, compared with that in March and April 2019. In March 2020, the monthly claim data of colonoscopies declined by 41.4% and 46.2% in men and women, respectively, compared to that in March 2019 ($p<0.001$). In April 2020, the monthly claim data of colonoscopies declined

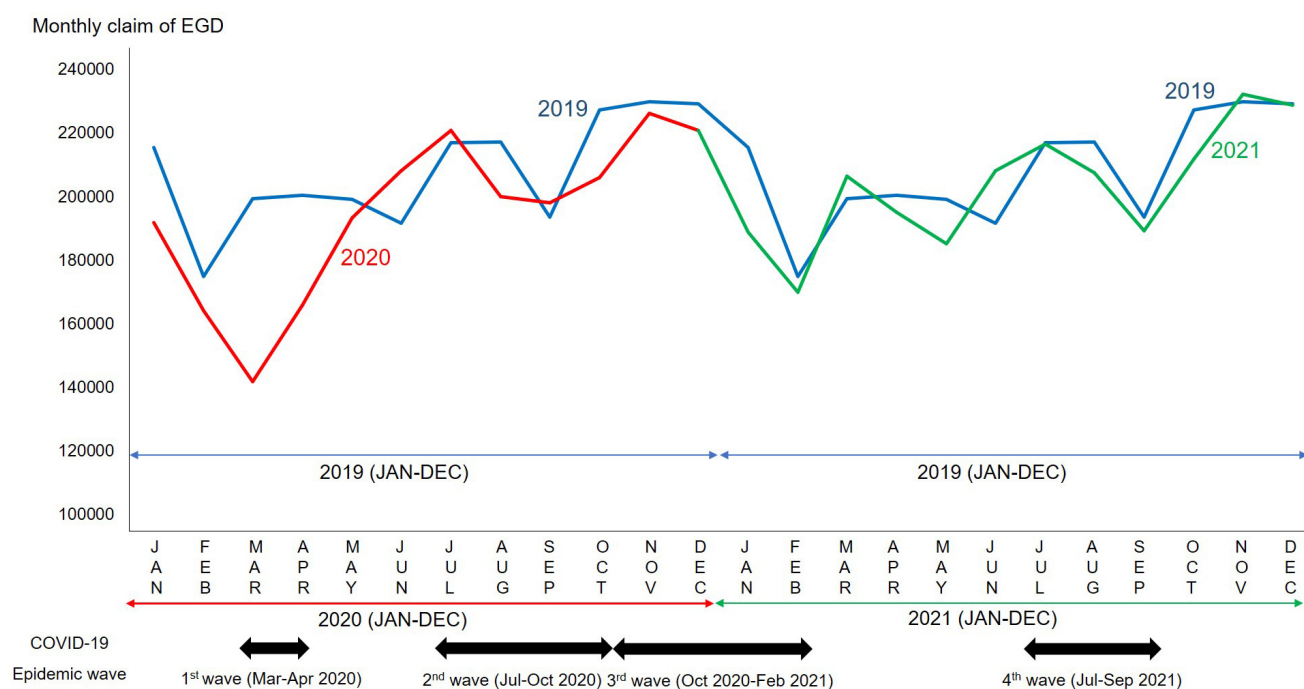


Fig. 1. The monthly claim data of EGD was reduced dramatically on the 1st epidemic wave and less affected on the 2nd-4th epidemic waves during the COVID-19 pandemic. EGD, esophagogastroduodenoscopy; COVID-19, coronavirus disease 2019.

Table 2. Monthly Claim Data of Patients Who Underwent Colonoscopy^a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
Total														
2019	141,443	117,018	144,932	146,699	143,228	134,599	155,918	156,819	130,339	168,245	186,025	192,268	1,817,533	Ref.
2020	130,084	113,111	81,477	98,633	127,636	148,228	159,886	154,106	144,272	154,628	190,462	189,205	1,691,728	-6.9%
2021	140,062	121,640	165,229	167,748	152,213	169,648	170,826	155,917	133,932	171,414	202,385	212,165	1,963,179	+8.0%
Male														
2019	73,949	61,011	73,072	73,188	72,514	67,584	78,039	79,883	66,797	85,248	97,519	103,644	932,448	Ref.
2020	68,894	59,376	42,819	48,718	62,403	72,369	78,648	77,123	71,560	78,073	99,809	101,847	861,639	-7.6%
2021	71,815	60,928	79,554	81,013	75,112	84,556	85,262	79,725	68,127	86,015	104,278	112,816	989,201	+6.1%
Female														
2019	67,494	56,007	71,860	73,511	70,714	67,015	77,879	76,936	63,542	82,997	88,506	88,624	885,085	Ref.
2020	61,190	53,735	38,658	49,915	65,233	75,859	81,238	76,983	72,712	76,555	90,653	87,358	830,089	-6.2%
2021	68,247	60,712	85,675	86,735	77,101	85,092	85,564	76,192	65,805	85,399	98,107	99,349	973,978	+10.0%

^aColonoscopy was defined as colonoscopy without polypectomy (E7660).

by 33.4% and 32.1% in men and women, respectively, compared with that in April 2019 ($p=0.016$).

3. Claim data of ERCP

The annual claim data of ERCP in 2020 and 2021 increased by 1.0% and 0.8%, respectively, compared to that in 2019 (Table 3). The annual claim data of ERCP in 2020 and 2021 was increased by 3.8% and 1.3% in men, re-

spectively, and reduced by 2.7% and increased by 0.2% in women, respectively, compared to that in 2019 ($p=0.021$ and $p=NS$, respectively). The monthly claim data of ERCP was virtually unaffected on the 1st–4th epidemic waves during the COVID-19 pandemic (Fig. 3). During the first surge period of COVID-19, the monthly claim data of ERCP was reduced by 5.1% and 4.4% in March 2020 and April 2020, respectively, than in March and April 2019. In March 2020, the monthly

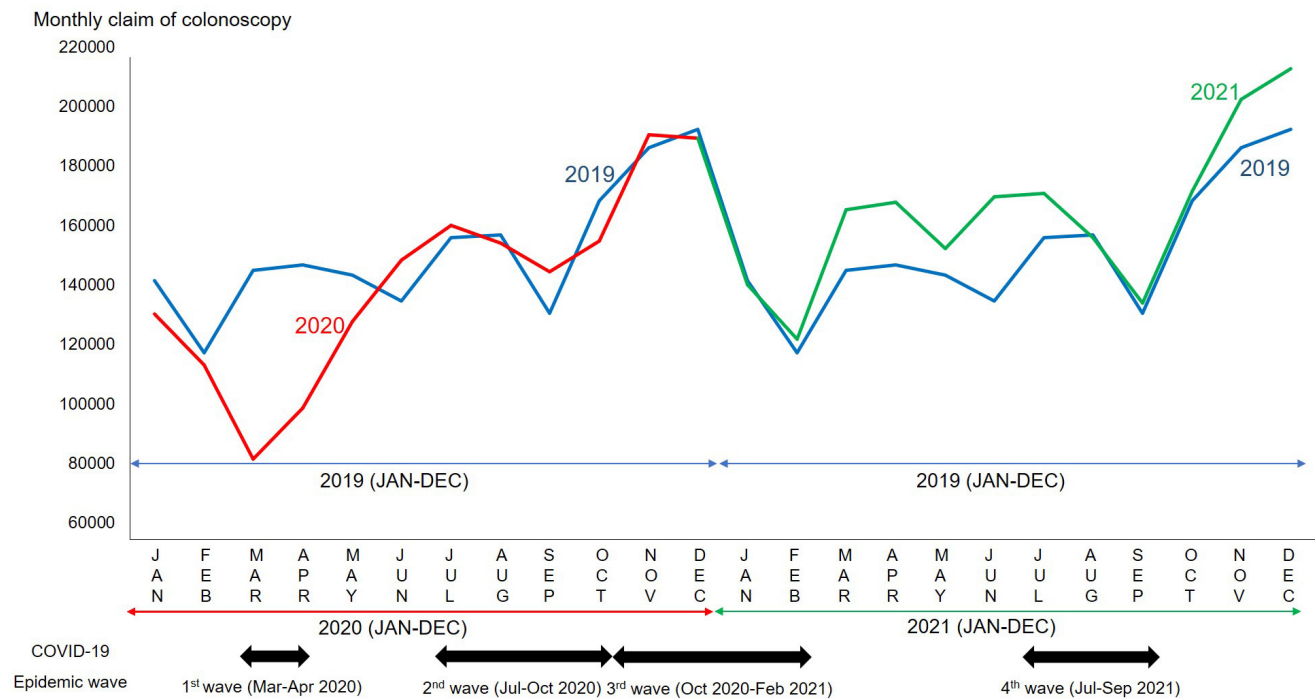


Fig. 2. The monthly claim data of colonoscopy was reduced dramatically on the 1st epidemic wave and less affected on the 2nd–4th epidemic waves during the COVID-19 pandemic. COVID-19, coronavirus disease 2019.

Table 3. Monthly Claim Data of Patients Who Underwent ERCP^a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
Total														
2019	871	788	867	910	795	845	890	929	927	892	827	900	10,441	Ref.
2020	872	768	823	870	949	956	980	844	892	912	850	834	10,550	+1.0%
2021	881	763	967	823	884	945	892	905	826	894	878	866	10,524	+0.8%
Male														
2019	494	449	506	514	467	492	522	548	544	498	456	513	6,003	Ref.
2020	513	452	487	522	572	560	598	481	520	545	492	489	6,231	+3.8%
2021	518	434	547	468	507	552	523	532	482	548	492	476	6,079	+1.3%
Female														
2019	377	339	361	396	328	353	368	381	383	394	371	387	4,438	Ref.
2020	359	316	336	348	377	396	382	363	372	367	358	345	4,319	-2.7%
2021	363	329	420	355	377	393	369	373	344	346	386	390	4,445	+0.2%

^aERCP was defined as endoscopic retrograde cholangiopancreatography without therapeutic interventions (E7621, E7622).

claim data of ERCP declined by 3.8% in men and 6.9% in women compared to that in March 2019 ($p=NS$). In April 2020, the monthly claim data of ERCP increased by 1.6% in men and declined by 12.1% in women, compared to that in April 2019 ($p=NS$).

4. Claim data of abdominal US

The annual claim data of abdominal US in 2020 and 2021

increased by 2.9% and 17.5%, respectively, compared to that in 2019 (Table 4). The annual claim data of abdominal US in 2020 and 2021 was increased by 2.1% and 15.3% in men, respectively, and was increased by 3.6% and 19.5% in women, respectively, compared to that in 2019 (both $p<0.001$). The monthly claim data of abdominal US were reduced dramatically on the 1st epidemic wave and less affected during the 2nd–4th epidemic waves during the COVID-19 pandemic

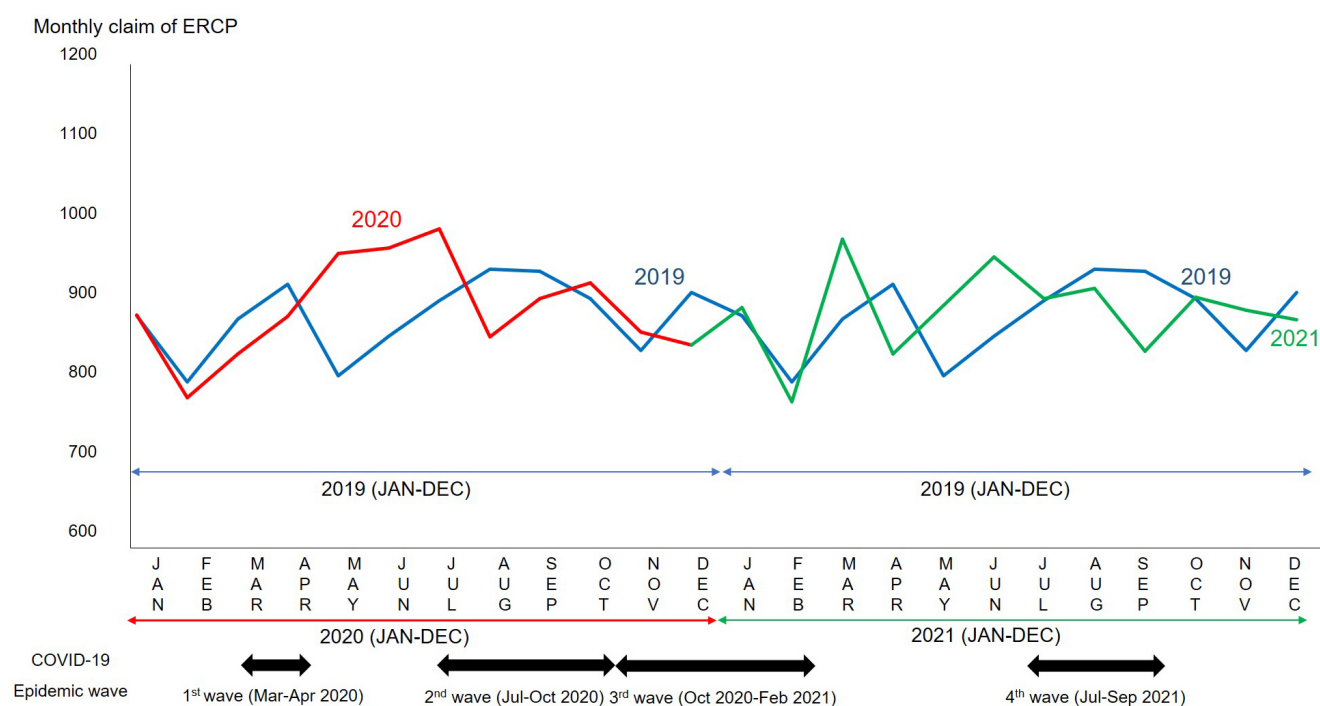


Fig. 3. The monthly claim data of ERCP was relatively unaffected by the 1st–4th epidemic waves during the COVID-19 pandemic. COVID-19, coronavirus disease 2019.

Table 4. Monthly Claim Data of Patients Who Underwent Abdominal Ultrasonography^a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
Total														
2019	208,760	178,627	216,622	214,105	215,104	201,208	234,175	225,067	193,470	226,604	240,124	245,992	2,599,858	Ref.
2020	213,987	187,692	169,809	193,689	227,840	242,509	256,684	227,904	217,605	226,013	255,638	255,565	2,674,935	+2.9%
2021	239,837	214,869	273,488	257,416	237,278	263,897	268,849	250,343	224,056	254,806	282,655	287,504	3,054,998	+17.5%
Male														
2019	99,280	85,863	101,302	99,599	101,215	93,736	109,814	105,210	89,768	104,095	115,154	120,371	1,225,407	Ref.
2020	103,954	91,129	81,119	88,985	103,870	110,138	116,983	105,915	99,759	104,028	121,522	124,147	1,251,549	+2.1%
2021	112,466	98,812	122,243	116,512	108,959	121,347	124,797	117,125	103,417	116,026	132,805	138,102	1,412,611	+15.3%
Female														
2019	109,480	92,764	115,320	114,506	113,889	107,472	124,361	119,857	103,702	122,509	124,970	125,621	1,374,451	Ref.
2020	110,033	96,563	88,690	104,704	123,970	132,371	139,701	121,989	117,846	121,985	134,116	131,418	1,423,386	+3.6%
2021	127,371	116,057	151,245	140,904	128,319	142,550	144,052	133,218	120,639	138,780	149,850	149,402	1,642,387	+19.5%

^aAbdominal ultrasonography was defined as abdominal ultrasonography without pelvic examination (EB441).

(Fig. 4). During the first surge period of COVID-19, the monthly claim data of abdominal US was reduced by 21.6% and 9.5% in March 2020 and April 2020, respectively, compared to that in March and April 2019. In March 2020, the monthly claim data of abdominal US declined by 19.9% and 23.1% in men and women, respectively, compared to that in March 2019

($p<0.001$). In April 2020, the monthly claim data of abdominal US declined by 10.7% and 8.6% in men and women, respectively, compared to that in April 2019 ($p<0.001$).

5. Claim data change of endoscopy

The annual claim data of ERCP in 2020 decreased less

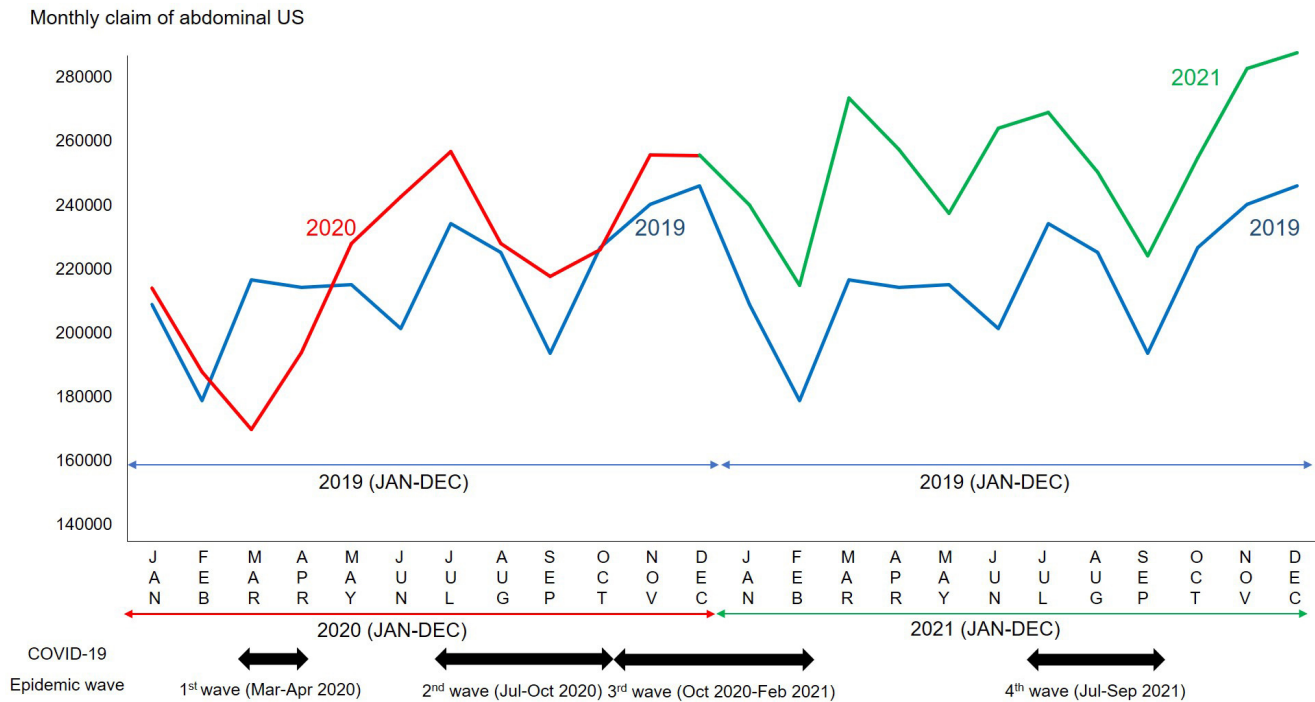


Fig. 4. The monthly claim data of abdominal US was reduced dramatically on the 1st epidemic wave and less affected on the 2nd–4th epidemic waves during the COVID-19 pandemic. COVID-19, coronavirus disease 2019; US, ultrasonography.

Table 5. Change in the Claim Data in Gastrointestinal Procedures During COVID-19

	Procedures	Total	p-value	Male	p-value	Female	p-value
Annual change of claim ^a (in 2020)	ERCP	+1.0%	Ref.	+3.8%	Ref.	−2.7%	Ref.
	EGD	−6.3%	<0.001	−6.2%	<0.001	−6.4%	<0.001
	Colonoscopy	−6.9%	<0.001	−7.6%	<0.001	−6.2%	<0.001
	Abdominal US	+2.9%	0.191	+2.1%	0.373	+3.6%	0.004
First surge of COVID-19							
Monthly change of claim ^a (in March 2020)	ERCP	−5.1%	Ref.	−3.8%	Ref.	−6.9%	Ref.
	EGD	−28.8%	<0.001	−26.1%	<0.001	−31.5%	<0.001
	Colonoscopy	−43.8%	<0.001	−41.4%	<0.001	−46.2%	<0.001
	Abdominal US	−21.6%	<0.001	−19.9%	<0.001	−23.1%	<0.001
Monthly change of claim ^a (in April 2020)	ERCP	−4.4%	Ref.	+1.6%	Ref.	−12.1%	Ref.
	EGD	−17.2%	<0.001	−17.8%	<0.001	−16.6%	0.476
	Colonoscopy	−32.8%	<0.001	−33.4%	<0.001	−32.1%	<0.001
	Abdominal US	−9.5%	0.245	−10.7%	0.040	−8.6%	0.589

COVID-19, coronavirus disease 2019; EGD, esophagogastroduodenoscopy; US, ultrasonography. ^aAnnual claim data in 2020 and monthly claim data in March and April 2020 of each procedure were compared with those in 2019.

significantly than those of EGD and colonoscopy (both $p<0.001$) (Table 5). The monthly claim data of ERCP in March 2020 showed a significantly smaller decrease than those of EGD, colonoscopy, and abdominal US (all $p<0.001$). The change in monthly claims of ERCP in April 2020 also decreased less significantly than those of EGD and colonoscopy (both $p<0.001$).

DISCUSSION

This nationwide population-based study was the first Asian study to examine the impact of COVID-19 on GIE and abdominal US. The annual claim data of EGD and colonoscopy in 2020 were reduced by 6.3% and 6.9%, respectively, but those of ERCP and abdominal US in 2020 increased by 1.0% and 2.9%, respectively, than those in 2019. During the first surge of COVID-19, the monthly claim data of EGD, colonoscopy, ERCP, and abdominal US were reduced by 28.8%, 43.8%, 5.1%, and 21.6%, respectively, in March 2020, and by 17.2%, 32.8%, 4.4%, and 9.5% in April 2020, respectively, compared to those in March and April 2019. The monthly claims data of ERCP in March and April 2020, compared to those of 2019, was reduced less significantly than those of EGD and colonoscopy. The annual changes in the claims in EGD and colonoscopy during the first surge of COVID-19 in South Korea were consistent with the Western findings.^{10,11} One notable finding, however, was that the monthly claim data of EGD and colonoscopy were reduced more significantly than those of ERCP and abdominal US during the COVID-19 pandemic because most ERCPs are time-sensitive procedures and abdominal US examinations are non-aerosolized procedures. During the COVID-19 pandemic, non-time-sensitive procedures, such as screening or surveillance endoscopies, were canceled or postponed because of the risk of COVID-19 transmission.¹²⁻¹⁴ As most ERCPs are time-sensitive procedures, there was no change in the indications or therapeutic interventions of ERCP during the COVID-19 pandemic in South Korea.¹⁵

During the first surge of the COVID-19 pandemic (March and April 2020), the monthly claim data of EGD, colonoscopy, and abdominal US were reduced more significantly in women than in men. These sex differences are because women were more likely to perceive COVID-19 as a severe health problem and agree with the restraining public policy measures.^{16,17}

In addition, women appear to score higher than men in terms of agreeability and conscientiousness. They are more willing to comply with preventive health behaviors, such as social distancing, personal hygiene, and wearing a mask.¹⁸ On the other hand, there was no sex difference for ERCP, possibly because of their time-sensitive characteristics compared to EGD and colonoscopy. In Western countries, there were concerns that delayed GIE during COVID-19 may worsen the oncologic outcomes after the end of the COVID-19 pandemic.^{10,19-21} A recent study reported that CRC screening delays beyond 12 months would significantly increase advanced CRC cases and their mortality.¹⁹ A surgical resection may be delayed three months without worsening oncologic outcomes for early gastric cancer. On the other hand, there was insufficient evidence to recommend delayed surgery for advanced gastric cancer.²⁰ For gastric cancer, delayed surgery up to two months after the end of the staging process did not worsen the oncological outcomes.²¹ As the reduced performance of GIE was recovered within three months during the COVID-19 pandemic, the oncologic outcomes for gastrointestinal cancers may not have worsened during the COVID-19 pandemic in South Korea.

The HIRA database was used to assess the impact of COVID-19 on GIE, and the results were virtually free from referral bias and were readily generalizable owing to the population-based design. Nevertheless, this study had some limitations. First, data derived from administrative coding systems have inherent limitations regarding miscoding or data entry errors. One of the limitations of this study was the secondary data with uncertainty regarding the indication of each procedure. On the other hand, previous studies using HIRA as a data source showed that procedures and diagnoses are coded accurately. Second, no specific details regarding the indication or clinical information of each GIE were recorded in the HIRA. As described in the Methods section, however, HIRA data is reliable because of the universal and nationwide reimbursement system in South Korea. Third, there was a decline in the GIE performance during the COVID-19 pandemic, but the precise reasons for the declined claims were not investigated. Before the COVID-19 pandemic between 2017 and 2019, the annual claim data of endoscopy was rarely changed in South Korea,⁹ so the effect of COVID-19 may have reduced the use of GIE. Finally, it is difficult to generalize these findings to other countries because the COVID-19 status and healthcare systems differ from country

to country.

In conclusion, the claims of EGD and colonoscopy were reduced more significantly than those of ERCP and abdominal US during the COVID-19 pandemic because ERCPs are time-sensitive procedures and abdominal USs are non-aerosolized procedures. These differences should be considered during the next infectious pandemic to rearrange medical resources successfully.

SUPPLEMENTARY MATERIAL

Supplementary material is available at the *Korean Journal of Gastroenterology* website (<https://www.kjg.or.kr/>).

REFERENCES

1. Jee Y, Kim YJ, Oh J, Kim YJ, Ha EH, Jo I. A COVID-19 mortality prediction model for Korean patients using nationwide Korean disease control and prevention agency database. *Sci Rep* 2022; 12:3311.
2. Sultan S, Lim JK, Altayar O, et al. AGA rapid recommendations for gastrointestinal procedures during the COVID-19 pandemic. *Gastroenterology* 2020;159:739-758.e4.
3. Morris EJA, Goldacre R, Spata E, et al. Impact of the COVID-19 pandemic on the detection and management of colorectal cancer in England: a population-based study. *Lancet Gastroenterol Hepatol* 2021;6:199-208.
4. Lui TKL, Leung K, Guo CG, Tsui VWM, Wu JT, Leung WK. Impacts of the coronavirus 2019 pandemic on gastrointestinal endoscopy volume and diagnosis of gastric and colorectal cancers: A population-based study. *Gastroenterology* 2020;159: 1164-1166.e3.
5. Chiu HM, Su CW, Hsu WF, et al. Mitigating the impact of COVID-19 on colorectal cancer screening: Organized service screening perspectives from the Asia-Pacific region. *Prev Med* 2021;151:106622.
6. Repici A, Maselli R, Colombo M, et al. Coronavirus (COVID-19) outbreak: what the department of endoscopy should know. *Gastrointest Endosc* 2020;92:192-197.
7. Kim L, Kim JA, Kim S. A guide for the utilization of Health Insurance Review and Assessment Service National Patient Samples. *Epidemiol Health* 2014;36:e2014008.
8. Kim JA, Yoon S, Kim LY, Kim DS. Towards actualizing the value potential of Korea health insurance review and assessment (HIRA) data as a resource for health research: Strengths, limitations, applications, and strategies for optimal use of HIRA data. *J Korean Med Sci* 2017;32:718-728.
9. Lee K, Suh M, Jun JK, Choi KS. Impact of the COVID-19 pandemic on gastric cancer screening in South Korea: Results from the Korean national cancer screening survey (2017-2021). *J Gastric Cancer* 2022;22:264-272.
10. Khan A, Bilal M, Morrow V, Cooper G, Thakkar S, Singh S. Impact of the coronavirus disease 2019 pandemic on gastrointestinal procedures and cancers in the United States: A multicenter research network study. *Gastroenterology* 2021;160: 2602-2604.e5.
11. Lantinga MA, Theunissen F, Borg PCJT, Bruno MJ, Ouwendijk RJT, Siersema PD. Impact of the COVID-19 pandemic on gastrointestinal endoscopy in the Netherlands: analysis of a prospective endoscopy database. *Endoscopy* 2021;53:166-170.
12. Kim KH, Kim SB, Kim TN. Changes in endoscopic patterns before and during COVID-19 outbreak: Experience at a single tertiary center in Korean. *World J Clin Cases* 2021;9:3576-3585.
13. Mazdimoradi A, Tiznobaik A, Salehiniya H. Impact of the COVID-19 pandemic on colorectal cancer screening: a systematic review. *J Gastrointest Cancer* 2022;53:730-744.
14. Kopel J, Ristic B, Brower GL, Goyal H. Global impact of COVID-19 on colorectal cancer screening: Current insights and future directions. *Medicina (Kaunas)* 2022;58:100.
15. Kim KH, Kim SB. Comparison of the impact of endoscopic retrograde cholangiopancreatography between pre-COVID-19 and current COVID-19 outbreaks in South Korea: Retrospective survey. *World J Clin Cases* 2021;9:8404-8412.
16. Galasso V, Pons V, Profeta P, Becher M, Brouard S, Foucault M. Gender differences in COVID-19 attitudes and behavior: Panel evidence from eight countries. *Proc Natl Acad Sci U S A* 2020; 117:27285-27291.
17. Tan J, Yoshida Y, Sheng-Kai Ma K, Mauvais-Jarvis F. Gender differences in health protective behaviors during the COVID-19 pandemic in Taiwan: An empirical study. *BMC Public Health* 2022; 22:1900.
18. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. *Health Promot Int* 2015;30: 736-745.
19. Ricciardiello L, Ferrari C, Cameletti M, et al. Impact of SARS-CoV-2 pandemic on colorectal cancer screening delay: Effect on stage shift and increased mortality. *Clin Gastroenterol Hepatol* 2021;19:1410-1417.e9.
20. Fligor SC, Wang S, Allar BG, et al. Gastrointestinal malignancies and the COVID-19 pandemic: Evidence-based triage to surgery. *J Gastrointest Surg* 2020;24:2357-2373.
21. De Rosa M, Pasculli A, Rondelli F, et al. Could diagnostic and therapeutic delay affect the prognosis of gastrointestinal primary malignancies in the COVID-19 pandemic era? *Minerva Surg* 2021;76:467-476.

Supplementary Table 1. Monthly Claim Data of Patients Who Underwent All Abdominal Ultrasonography^a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Change
Total														
2019	269,603	276,189	333,253	339,624	341,610	321,973	372,899	359,237	351,279	401,000	416,791	427,394	4,210,852	Ref.
2020	384,998	600,919	560,852	637,206	745,252	789,881	826,536	748,338	736,945	766,159	819,812	832,304	8,449,202	+100.7%
2021	755,958	699,399	866,547	830,800	795,540	888,315	869,767	851,514	772,771	834,203	892,676	948,648	10,006,138	+137.6%
Male														
2019	122,762	130,124	154,409	156,349	158,319	147,947	171,023	163,756	178,426	202,996	217,356	224,918	2,028,385	Ref.
2020	203,078	176,474	161,486	174,317	195,186	206,129	218,616	195,176	189,118	195,629	219,046	224,220	2,358,475	+16.3%
2021	206,673	186,431	228,103	217,750	204,908	224,727	228,889	220,917	198,971	217,502	242,393	246,989	2,624,253	+29.4%
Female														
2019	146,841	146,065	178,844	183,275	183,291	174,026	201,876	195,481	172,853	198,004	199,435	202,476	2,182,467	Ref.
2020	181,920	424,445	399,366	462,889	550,066	583,752	607,920	553,162	547,827	570,530	600,766	608,084	6,090,727	+179.1%
2021	549,285	512,968	638,444	613,050	590,632	663,588	640,878	630,597	573,800	616,701	650,283	701,659	7,381,885	+238.2%

^aAll abdominal ultrasonography was defined as abdominal ultrasonography with or without pelvic examinations (EB441-EB457, EB458).