

# Resilience Gap in Gastrointestinal Endoscopy Activity during the COVID-19 Pandemic in South Korea

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This study assessed the impact of distancing measures during the COVID-19 pandemic on cancer diagnostic activities, including gastrointestinal endoscopy (GIE). It analyzed GIE volumes from 2020 to 2022 in comparison to 2018-2019, considering variations in resilience linked to socioeconomic status (SES). The analysis utilized data from the Korean Health Insurance Review and Assessment Services database, covering the entire population and medical facilities. Diagnostic GIE rates (2018-2022) in Gwangju Metropolitan City and Jeonnam province were examined, comparing age-standardized rates (ASRs) by area, gender, and SES. The results indicated a decline in ASRs for colonoscopy and endoscopic gastroduodenoscopy (EGD) in 2020 compared to 2018-2019, followed by an increase in 2021-2022, except for EGD in the medical aid population. SES based and rural-urban disparities were evident in the recovery of GIE rates. The findings suggest that equity-focused strategies are needed to ensure equitable healthcare access among different socioeconomic groups after pandemic.

**Key Words:** COVID-19; Pandemic; Early Detection of Cancer; Resilience

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## INTRODUCTION

As the world grappled with the enduring challenges posed by the coronavirus-19 (COVID-19) pandemic, a cascade of collateral impacts reverberated through clinical and preventive health care services. Notably, the utilization of gastrointestinal endoscopy (GIE), a vital diagnostic and preventive tool, faced a pronounced diminishment during this pandemic era.<sup>1-6</sup> The enforced lockdown of medical facilities, the implementation of rigorous social distancing measures, and the reprioritization of healthcare resources to confront COVID-19's immediate ramifications collectively precipitated a notable decline in public demand for preventive services. As a result, GIE appointment cancellations have surged and endoscopic facility operations have been curtailed, making it a challenge for healthcare systems.

Furthermore, the pandemic introduced concerns regarding the safety of GIE procedures, including the heightened risk of viral exposure through aerosolization of respiratory secretions,<sup>7</sup> potential fecal-to-oral transmission via

GI secretions,<sup>8</sup> and the increased propensity for gastrointestinal bleeding in COVID-19 patients.<sup>9</sup> Consequently, both the Centers for Disease Control and Prevention (CDC) and the Centers for Medicare and Medicaid Services issued recommendations to defer "non-urgent procedures," encompassing preventive care screenings, during the pandemic.<sup>10,11</sup> In parallel, the European Society of Gastrointestinal Endoscopy and the European Society of Gastroenterology and Endoscopy Nurses and Associates provided guidelines advocating the postponement of GIE procedures for high-risk patients following a comprehensive assessment of the COVID-19 risk and the morbidity/mortality implications of GI diseases.<sup>12</sup> These decisions had reverberations across the globe, with numerous nations reporting a substantial decline in diagnostic GIEs<sup>1,5,6,13</sup> and GI cancer screening rates compared to the pre-pandemic era.<sup>2-4,14-17</sup> This inevitably leads delayed diagnoses and missed opportunities for timely treatment of GI cancers, thereby now assuming pivotal significance in the post-pandemic era.<sup>18,19</sup> Notably, a systematic review and meta-analysis, encompassing 39 publications, revealed a global -44.9% decline in colorectal cancer (CRC) diagnoses in 2020 in com-

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parison to the pre-pandemic period.<sup>17</sup> The downtrend in screening outcomes was equally pronounced, with a meta-analysis reporting an approximate –90% reduction in the incidence rate ratio of CRC during the COVID-19 pandemic.<sup>14</sup> In Korea, participation rates in gastric cancer screening, predominantly reliant on endoscopic gastro-duodenoscopy (EGD) as part of the National Cancer Screening Program (NCSP), reduced by -11.8% in 2020 relative to 2019.<sup>15</sup> The undeniable consequence of these changes is a deterioration of GI cancer prognosis and mortality, foreshadowing a health crisis.<sup>20</sup>

One notable concern during the pandemic was the persistent disparities according to socioeconomic determinants such as economic level, residential areas, gender, and ethnicity.<sup>17,21-25</sup> The social and economically vulnerable populations found themselves at a pronounced disadvantage, exhibiting lower rates of testing,<sup>26</sup> diminished access to vaccination,<sup>27</sup> accelerated transmission rates,<sup>28</sup> elevated COVID-19 morbidity,<sup>26</sup> case-fatality,<sup>23</sup> and mortality rates,<sup>24</sup> alongside a marked reduction in access to essential healthcare services, including cancer screening examination.<sup>29</sup> These negative impacts of reduced cancer screening are probably more pronounced in women than in men due to higher volume of screenings in women, such as breast cancer and cervical cancer screening. In addition, higher SES and small counties of United State showed the slower growth in incidence of COVID-19<sup>23,24</sup> and significant geographic differences in reducing cancer screening rates during pandemic also identified in a global study.<sup>17</sup> As we navigate the transition to the post-COVID-19 era, rapid and equitable restoration of preventive health services, including GIE, is becoming increasingly important.<sup>30</sup> This recovery process may paradoxically provide both challenges and opportunities to improve methodologies and reduce disparities.<sup>31</sup>

Therefore, this study aimed to analyze the quantitative changes in colonoscopy and EGD in the peri-pandemic periods through the analysis of data from two municipal regions in South Korea, and to assess whether differences in resilience existed according to socioeconomic variables.

## MATERIALS AND METHODS

### 1. Data sources

Data on the number of diagnostic GIE procedures performed in all medical facilities located in Gwangju metropolitan city and Jeonnam province was extracted from the database of Korean Health Insurance Review and Assessment Services (HIRA), also known as National Health Insurance Service (NHIS) data. The health insurance system in Korea is based on fee-for-services, single-payer, universal coverage, and compulsory healthcare insurance model, covering almost 98% of the total population and entire medical facilities. NHIS data is generated from the reimbursement process of healthcare provider's claims for medical services; therefore, the HIRA data can provide a representative and the closest to real-world data for

healthcare utilization in Korea.<sup>32</sup> Diagnostic colonoscopy was defined as data claims with E7660 code and diagnostic EGD as E7611 code. Local endoscopy, such as sigmoidoscopy (E7680) and proctoscopy (E7670), was excluded from analysis because it is usually performed for therapeutic purposes rather than diagnostic purposes. We used NHIS claim data from January 2018 through December 2022. The study protocol complied with the ethical guidelines of the Declaration of Helsinki of 1975 and was approved by the Institutional Review Board of Chonnam National University Hwasun Hospital (No: CNUHH-2021-061).

### 2. Study areas and subjects

Gwangju metropolitan city is the 7th largest city in Korea with a population of 1.45 million, while Jeonnam province is a typical rural region consisting of 5 cities with populations under 300,000 and 17 counties (called 'gun') with populations around 40,000. Because of their geographical proximity, the two regions are in the same healthcare coverage area, have similar healthcare utilization patterns, and experienced a similar scale and pattern COVID-19 pandemic. To compare the number of GI endoscopies by socioeconomic status (SES), all data were categorized into national health insurance (NHI) population and medical aid (MA) beneficiaries, rural (Jeonnam) and urban (Gwangju), and under 65 years and over 65 years. In Korea, entire population is covered by NHI or MA. MA is a public assistance program to ensure access to healthcare service for the lowest income population, about 5% of the population, who are waived from paying out-of-pocket for most healthcare services. NHI population is categorized into self-employed and employed, but we did not distinguish between two groups as the difference in socioeconomic level is not clear. Urban and rural areas were distinguished based on the address of the medical facilities where the endoscopy was performed, not the address of the endoscopy recipients. Since Korean NCSP recommends screening for gastric cancer starting at age 40 and CRC starting at age 50, so we defined the target age for each GIE as 40 years or older for EGD and 50 years or older for colonoscopy.

### 3. Statistical analysis

In all analyses, data are presented as an annual number of GIEs, crude rate, and age-standardized rates (ASR) of the number of GI endoscopies per 1,000 populations according to the area, sex, and insured type. The ASRs were calculated by direct standardization method using the age distribution of the Korean population in 2005. The percent change of the annual rate between periods was calculated by dividing the difference from the average pre-pandemic rate by during pandemic rate. To determine the difference in the change in ASR of diagnostic GIEs before and after the pandemic was different for each socioeconomic variable, regression analysis was conducted to test for interactions of socioeconomic variables, using the interaction terms of health insurance status (insured or MA), resi-

dential area (urban or rural), and age (under 65 years or 65 years and older). All data analysis and statistical tests were performed using R software (version 4.3.1 for Windows).

## RESULTS

The number of diagnostic colonoscopies and EGD performed in the study areas over a five-year period (2018-2022) is presented in Table 1. For EGD, there were 188,018 and 184,700 diagnostic gastroscopies performed in 2018 and 2019, respectively, in the pre-pandemic period, but the number decreased to 175,137 in 2020 ( $-5.37\%$  from the 2-year average crude rate, CR), when social distancing was tightened after the pandemic, and then rebounded to 181,787 and 176,857 in 2021 and 2022, respectively, but still below pre-pandemic levels. In the case of colonoscopy, it decreased by about  $-2.01\%$  of CR from 110,375 and 117,465 in 2018 and 2019, respectively, in the pre-pandemic period, to 110,897 in 2020, and then recovered to a higher level than before the pandemic, to 127,536 and 122,913 in 2021 and 2022 (Table 1).

A rebound in the AST of the number of GIEs after a temporary decline in 2020 was observed similarly for urban and rural areas, men and women, and those with NHI, but not for the population with MA. Unlike the insured, no re-

bound was observed for the population with MA in 2021 and 2022. A statistically significant interaction effect was only observed for the insurance type ( $p$  for interaction=0.005). For colonoscopies, however, similar patterns of change were observed across sex, areas, and health insurance type, with no interaction observed (Fig. 1). When stratified by the Korean NCSP target criteria for gastric cancer into those aged under 40, 40 and older, and 65 and older, the difference between NHI and MA was observed for those aged 40 and older, but not for those aged younger than 40 ( $p$  for interaction=0.011). A statistically significant interaction was also observed in the subgroup analysis of only those aged 65 years and older ( $p$  for interaction=0.015) (Fig. 2). For colonoscopy, no statistically significant interactions were observed when stratified by age under 50, age 50 and more, and age 65 and more (data not shown).

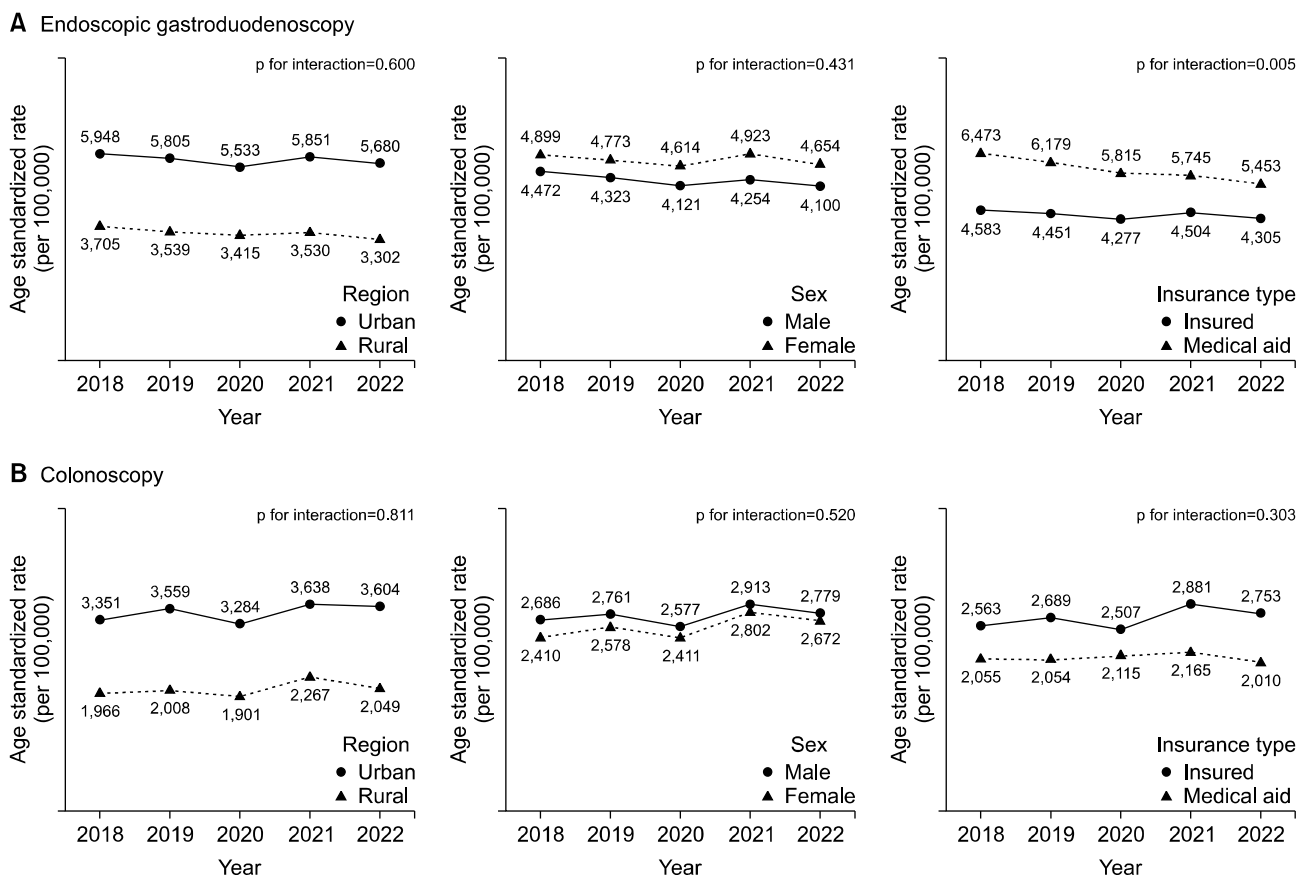
## DISCUSSION

This study found disparities in the recovery of community GIE activities during the COVID-19 pandemic period according to SES. For both EGD and colonoscopy, ASRs in rural areas were lower than in urban areas, but no differences were observed between the two areas in terms of changes in trends during the pandemic. ASR for EGD was higher for women and colonoscopy was higher for men, and

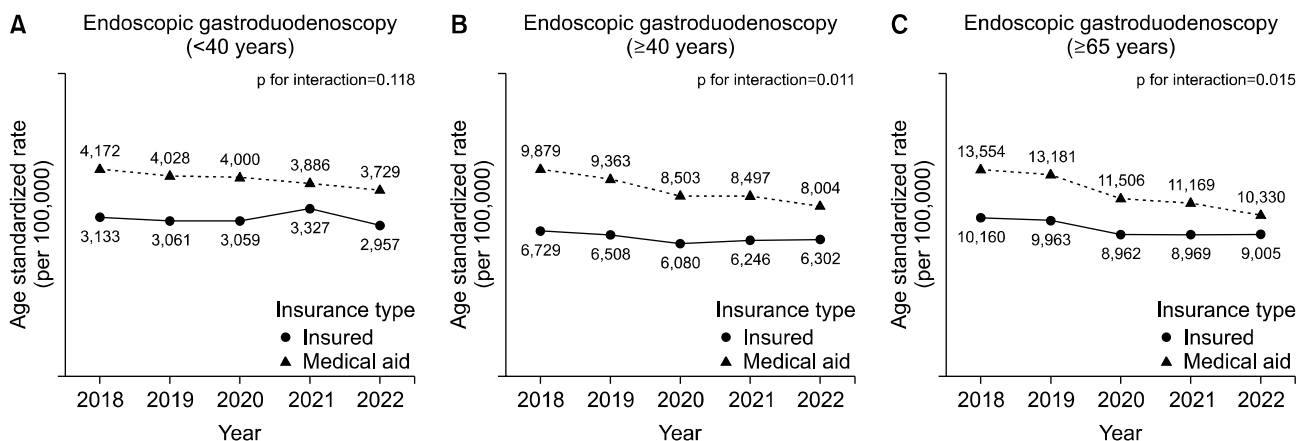
**TABLE 1.** Changes in the number of endoscopic gastroduodenoscopy performed in study areas during the period 2018-2022

	EGD					Colonoscopy				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Total (count)	188,018	184,700	175,137	181,787	176,857	110,375	117,465	110,897	127,536	122,913
CR (/1,000 person)	55.83	54.90	52.39	54.60	53.14	32.78	34.92	33.17	38.30	36.93
% change of CR	Reference		-5.37	-1.38	-4.02	Reference		-2.01	10.93	6.99
Men	90,274	88,967	84,850	87,675	85,641	57,249	59,877	56,685	64,365	62,085
CR (/1,000 person)	53.72	52.86	50.68	52.62	51.40	34.07	35.58	33.86	38.63	37.26
% change of CR	Reference		-4.90	-1.26	-3.55	Reference		-2.77	10.93	6.99
Women	97,744	95,733	90,287	94,112	91,216	53,126	57,588	54,212	63,171	60,828
CR (/1,000 person)	57.95	56.95	54.10	56.58	54.87	31.49	34.26	32.48	37.98	36.59
% change of CR	Reference		-5.83	-1.51	-4.49	Reference		-1.20	15.53	11.30
Metropolitan area	100,100	99,804	94,907	100,442	99,016	60,200	65,208	61,140	68,362	67,978
CR (/1,000 person)	68.08	67.29	64.67	68.47	67.51	40.94	44.28	41.66	46.60	46.35
% change of CR	Reference		-4.45	1.16	-0.26	Reference		-2.23	9.36	8.78
Non-metropolitan area	87,918	85,616	80,230	81,345	77,841	50,175	52,257	49,757	59,174	54,935
CR (/1,000 person)	46.35	45.26	42.77	43.67	41.81	26.45	27.63	26.53	31.77	29.51
% change of CR	Reference		-6.63	-4.66	-8.72	Reference		-1.89	17.49	9.13
NCSP target age*	142,300	140,833	132,600	136,749	137,001	79,011	85,042	81,188	93,294	90,816
CR (/1,000 person)	74.99	72.99	67.76	68.96	69.05	57.42	60.20	56.03	62.78	61.05
% change of CR	Reference		-8.42	-6.80	-6.68	Reference		-4.73	6.75	3.81
Insured	176,187	173,394	164,644	171,650	167,344	106,329	113,413	106,776	123,224	118,977
CR (/1,000 person)	54.58	53.71	51.33	53.65	52.31	32.94	35.13	33.29	38.52	37.19
% change of CR	Reference		-5.20	-0.91	-3.39	Reference		-2.19	13.18	9.27
Medical aids	11,831	11,306	10,493	10,137	9,513	4,046	4,052	4,121	4,312	3,936
CR (/1,000 person)	84.79	83.36	77.41	77.78	73.67	29.00	29.87	30.40	33.09	30.48
% change of CR	Reference		-7.93	-7.49	-12.38	Reference		3.28	12.42	3.55

\*Target age was defined as 40 years and more for EGD and 50 years and more for colonoscopy. Reference defined as average value of 2018 and 2019. EGD: endoscopic gastroduodenoscopy, CR: crude rate, NCSP: National Cancer Screening Program.



**FIG. 1.** Differences in annual age-standardized rates of diagnostic gastrointestinal endoscopy before and after the pandemic by sex, area, and insurance type.



**FIG. 2.** Differences in annual age-standardized rates of endoscopic gastroduodenoscopy before and after the pandemic by insurance type and age group.

these trends continued regardless of the pandemic. The MA population had lower colonoscopy rates but higher EGD rates compared to the NHI population. These trends continued during the pandemic, but unlike the NHI population, ASRs for EGD in the MA population continued to decline after 2021 without recovering. These differences were larger in the age group of 40+ or 65+, and there was a statistically significant interaction between health in-

surance type and the annual change in ASRs of EGD. From these findings, it can be inferred that the economically vulnerable population has experienced further declines in diagnostic EGD activity during the pandemic and were relatively less resilient after the peak-pandemic. The findings suggest that a public health agenda is needed to identify and address the causes of these disparities.

The number of diagnostic GIEs is not a direct clinical or

public health indicator, but can be considered an indirect indicator to estimate the GI cancer screening rates or delayed cancer diagnosis in a population. Therefore, it can be useful for early assessing the impact of COVID-19 in a population and monitoring the trends. There is also public health interest in ensuring that GI endoscopy activities recover normally and equitably by SES. Since the start of COVID-19 pandemic in 2020, diagnostic GI endoscopic activity has decreased for a variety of medical and non-medical reasons. As a result, many countries have reported a decline in the number of GIEs performed<sup>1,5,6</sup> and a decrease in colorectal or gastric cancer screening rates.<sup>2-4,14,15</sup> The resulting delays in cancer diagnosis and under-diagnosis of GI diseases could be another type of potential health crisis in the post-pandemic era.<sup>14,18</sup> To reduce the negative impact of the pandemic's collateral damage on non-COVID-19 care, it will be important to identify the populations that are more vulnerable or less resilient to the negative impacts.

While most studies report a greater negative impact of COVID-19 pandemic on vulnerable populations, disparities by SES in the decline and recovery of essential health services, such as cancer screening, may still vary across the countries based on a variety of factors, including differences in health policy environments, intervention strategies, and pandemic response policies. In Korea, for example, magnitude of the reduction in cancer screening rates was significantly greater among those living in metropolitan cities, with higher monthly income, and with higher education levels.<sup>33</sup> Similarly, in China, reductions in hospital visits and township health center visits were reported to be greater in higher SES groups than in lower SES groups.<sup>30</sup> In addition, no socioeconomic disparities were observed in the provision of special clinical services such as genetic care,<sup>34</sup> use of telemedicine,<sup>35</sup> and mortality after major surgery.<sup>36</sup> However, despite these few inconsistent or controversial examples, it is clear that the COVID-19 pandemic has had a disproportionate impact on healthcare across SES levels, with negative outcomes being greater for more vulnerable populations.<sup>21-24,26-29</sup> It is also clear that these disparities may persist or even worsen in post-pandemic recovery phase<sup>37</sup> and will exacerbate existing health disparities. One of the lessons learned from the pandemic is that creating cancer screening programs more resilient to the devastating effects of a pandemic is also important to address disparities that may have been exacerbated during the pandemic<sup>16,38</sup> and pandemic could be an opportunity to adapt and evolve the new screening method.<sup>25</sup> For example, the National Cancer Institute's Population-based Research to Optimize the Screening Process (PROSPR) consortium recommended the use of remote testing, such as mailed fecal immunochemical test kits, instead of colonoscopy, to increase screening rate and decrease disparities.<sup>39</sup> In Korea, the capacity of public health organizations plays a role in providing preventive healthcare services, such as cancer screening program.<sup>15,33</sup> Therefore, maintaining the public capacity during the pandemic,

quickly restoring it after peak-pandemic, and evolution of the traditional screening model may be critical to address the disparities in cancer screening during the peri-pandemic period.

In this study, age groups targeted by gastric cancer screening of Korean NCSP and the MA beneficiaries were found to be the groups with a greater reduction in EGD activity during the pandemic and less resilience after the peak of the pandemic. However, no such difference was observed for colonoscopy. The possible reason for this difference between EGD and colonoscopy may be related to the characteristics of the Korean NCSP. Korean NCSP, which is free to lower-income people, including MA beneficiaries, consists of an EGD for gastric cancer for those over 40 years and a fecal occult blood test for colorectal cancer for those over 50 years. Since cancer screening for lower-income populations is very actively managed by many public health departments, including local health authorities, public health centers, and Korean NHIS, so as shown in Fig. 1, the rate of EGD among MA beneficiaries is higher than among general NHI populations. However, during the pandemic, cancer screening promotion activities managed by these community organizations were suspended or scaled back, and non-COVID-19 health activities were severely curtailed as public health resources were prioritized for the COVID-19 responses, resulting in a sharp decline in cancer screening rates in Korea.<sup>15</sup> It is estimated that this curtailment of preventive health activities of the public health departments did not fully recover until 2022, after the peak of the pandemic. On the other hand, colonoscopies, which are not included in the NCSP, are mostly paid for out-of-pocket and are therefore less affected by the governmental activities to encourage cancer screening. Therefore, unlike EGD, colonoscopy rates were lower in the MA beneficiaries than in the general NHI population, and the gap between the two populations decreased in 2020, when the pandemic began, but widened again in 2021 and 2022. Nevertheless, the interaction between these yearly trends in colonoscopy ASR and insurance type was not statistically significant. Results suggest that the longer-lasting reduction in GI endoscopy activity among low-income populations during the pandemic may be due to reduced public screening promotion activities rather than due to economic issues such as affordability.

This analysis has some limitations. First, this study, basically, is an ecological study, so it was not possible to identify factors related to GIE activities at the individual level. In particular, it was not possible to compare differences in characteristics between tested and untested individual during the peri-pandemic period because individual-level information on the target population is not available. Therefore, we could not identify individual-level factors that contribute to the recovery of testing after pandemic, but only factors related to changes in the testing rates in each population. Second, there are validity issues with in key variables, such as definition of SES, diagnostic GIE, and residential areas. Due to the privacy policy of NHIS,

data such as income level, occupation, and disease status were not available, SES was only categorized by insurance type. Similarly, classification of neighborhoods was determined based on the address of medical facilities, not the individual's residence. The rates of GIEs performed will be overestimated in urban areas and underestimated in rural areas because people typically travel from rural to urban for screening. Third, because we only analyzed data from two adjacent regions, we should be cautious about generalizing to regions with different pandemic magnitudes and different practice behaviors. Despite these limitations, this study has also several advantages. First, this was not a modeling study but an observational study that analyzed real-world data on the total number of GIEs performed in the study areas. Second, resilience or normalizing public health activities such as cancer screening is important after pandemic, and this study is the first study, to my best knowledge, to evaluate disparities in the recovery of GIE activities in Korean population.

In conclusion, unlike the general population, the EGD rates did not recover in low-income populations by 2022, and presumably related to an insufficient recovery in public health capacity to manage the organized cancer screening program after the pandemic. The findings suggest that post-pandemic response strategies should consider not only how quickly to recover GIE activity, but also how to maintain the equity by socioeconomic classes. Therefore, close monitoring of disparities in preventive health activities and targeted strengthening programs for less resilient population should be implemented after a public health crisis such as COVID-19 pandemic.

## CONFLICT OF INTEREST STATEMENT

None declared.

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