

Special Article



Impact of the COVID-19 Pandemic on Gastric Cancer Screening in South Korea: Results From the Korean National Cancer Screening Survey (2017–2021)

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ABSTRACT

Purpose: The coronavirus disease 2019 (COVID-19) pandemic has significantly disrupted cancer screening services worldwide. We aimed to measure the impact of COVID-19 on gastric cancer screening rates based on age, sex, household income, and residential area.

Materials and Methods: We analyzed data from the Korean National Cancer Screening Survey from 2017 to 2021 for adults aged 40–74 years. We evaluated the gastric cancer screening rate within two years in accordance with the National Cancer Screening Program protocol recommendations and that within the previous year. We compared the trends in the pre- and post-COVID-19 outbreak periods.

Results: Before the COVID-19 outbreak, there was little change in the gastric cancer screening rates until 2019. After the COVID-19 outbreak, the screening rate as per recommendation decreased from 70.8% in 2019 to 68.9% in 2020 and that for one year decreased from 32.7% in 2019 to 27.2% in 2020. However, as the COVID-19 pandemic continued after 2020, both gastric cancer screening rates as per recommendations and for one year rebounded. Although a similar trend was observed for the upper endoscopy screening rate, the upper gastrointestinal series screening rate decreased from 7.8% in 2020 to 3.1% in 2021. During the pandemic, the screening rate decreased among younger adults (40–49), those residing in metropolitan regions, and those with high incomes.

Conclusions: Despite a decline in gastric cancer screening rate during the COVID-19 pandemic, the rate surged in 2021. Further studies are needed to estimate the impact of cancer screening delays on future cancer-related mortalities.

Keywords: COVID-19; Cancer screening; Gastric cancer; SARS-CoV-2; Stomach neoplasm

INTRODUCTION

Gastric cancer is the fifth most common cancer and the third leading cause of cancer-related mortality worldwide [1]. South Korea reported the highest age-standardized incidence rate of gastric cancer globally; however, the gastric cancer-related mortality to incidence ratio was significantly lower than that in other countries [1,2]. Since 2002, the Korean National Cancer

Conflict of Interest

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

Author Contributions

Conceptualization: C.K.S.; Data curation: S.M.;

Formal analysis: L.K.; Funding acquisition:

C.K.S.; Investigation: L.K.; Methodology:

C.K.S.; Project administration: C.K.S., S.M., J. J.

K.; Supervision: C.K.S.; Validation: C.K.S., S.M.,

J.J.K.; Visualization: L.K.; Writing - original

draft: L.K.; Writing - review & editing: C.K.S.

Screening Program (NCSP) has invited adults aged over 40 years to undergo gastric cancer screening using upper endoscopy or alternatively, upper gastrointestinal series (UGIS) every 2 years. Hence, the lower mortality could be possibly explained by the increased number of early stage gastric cancers detected through the NCSP that eventually improved the overall survival rate of patients with gastric cancer [2-6].

At the end of December 2019, the first case of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was reported in Wuhan, China, leading to being declared a global pandemic by the World Health Organization on March 11, 2020 [7]. Because the virus is mainly transmitted via close personal contact, many governments implemented lockdowns, stay-at-home orders, and social distancing regulations to prevent the spread of COVID-19 [8,9]. These measures were necessary to control the number of new COVID-19 cases. Therefore, ongoing cancer control and prevention activities, especially cancer screening, were significantly disrupted. Many countries had temporarily paused or suspended cancer screening programs for asymptomatic patients to conserve health system resources and reduce virus transmission [10].

Delays in cancer screening may adversely affect the diagnosis of late-stage cancers and eventually increase cancer mortality [11-13]. Delays in colorectal cancer screening of beyond 6 months significantly led to an increase in advanced colorectal cancer by up to 33% [12]. A modeling study conducted in the United States (US) also predicted that delays in screening and treatment due to COVID-19 would cause almost 10,000 deaths from breast and colorectal cancers [14]. Similarly, a recent study from the United Kingdom estimated that, compared to the pre-COVID-19 period, there was a 76% reduction in the number of cancer referrals for early diagnosis and a 60% reduction in chemotherapy attendance, which can lead to 20%–30% increased cancer-related mortality [15].

In South Korea, the NCSP functioned without suspension, and cancer prevention activities continued during the COVID-19 pandemic. Nevertheless, the pandemic significantly influenced the general population's health-seeking behaviors, especially those with non-specific symptoms of cancer, mainly attributable to fear and anxiety about contracting COVID-19 in a healthcare setting [16,17]. Endoscopic screening, especially upper procedures, is aerosol-generating and increases the risk of SARS-CoV-2 transmission [10,18]. Additionally, during endoscopy, patients are instructed to remove their face masks, which may increase their fear of contracting COVID-19. Here, we aimed to compare the trends in gastric cancer screening rates in the pre- and post-COVID-19 outbreak periods and measure the impact of COVID-19 on gastric cancer screening by age, sex, income status, and residential area.

MATERIALS AND METHODS

Study population

Since 2004, the National Cancer Center has conducted the Korean National Cancer Screening Survey (KNCS), an annual, cross-sectional, population-based screening survey for cancer in Korean men aged 40–74 years and women aged 20–74 years. Study participants with no history of cancer were selected through stratified, multistage random sampling based on geographical area, age, and sex [19]. A professional agency recruited the participants through door-to-door contact and conducted face-to-face interviews. At least three attempts were made to contact each household, and informed consent was obtained from all the

participants. Among the participants in the KNCSS, men and women aged 40–74 years between 2017 and 2021 were included in the final analysis.

Measures

Using a structured questionnaire, the experience of gastric cancer screening was explored based on the participants' self-reports on when and how they had been screened. Participants answered the following questions: "Have you ever undergone gastric cancer screening?" and "If yes, which screening method (endoscopy or/and UGIS) have you undergone?" To obtain the time of screening, participants were asked, "When did you last undergo gastric cancer screening using this method?" In this study, two measures of cancer screening rates were used. Screening rate with recommendation was defined as the proportion of individuals who had undergone upper endoscopy and/or UGIS within 2 years according to the NCSP protocol. In addition, to measure the latest cancer screening rate, the screening rate for 1 year was defined as the proportion of individuals who underwent an upper endoscopy and/or UGIS within the year previous to that of the survey. To obtain the residential areas, 17 administrative districts were classified into three categories as follows: metropolitan (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Woolsan), urban (Sejong, Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeongbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju), and rural (urban regions with sub-municipal level divisions, either Eup [town] or Myeon [township]).

Statistical analysis

Descriptive statistics were used to summarize the general characteristics of the survey respondents as unweighted numbers and proportions. Survey sample weights from the Population and Housing Census of Statistics Korea were used to calculate gastric cancer screening rates. The analysis was then stratified according to age, sex, monthly household income, and residential area. Statistical analysis was performed using SAS software (version 9.4; SAS Institute, Inc., Cary, NC, USA).

Ethical statement

The study protocol was approved by the National Cancer Center Institutional Review Board of Korea (approval number: NCC2019-0233). All the participants consented to participate in the survey for public benefit, and the requirement for written informed consent was waived.

RESULTS

In total, 17,717 respondents participated in the KNCSS from 2017 to 2021. The sociodemographic characteristics of the participants in each survey year are presented in **Supplementary Table 1**.

Before the COVID-19 pandemic, there was little change in the gastric cancer screening rates (**Table 1**). The screening rate for the recommended time period for gastric cancer showed a downward trend by 2019, whereas the screening rate for the previous year showed an increasing trend by 2019. However, after the COVID-19 outbreak, the screening rate for the recommended time period declined from 70.8% in 2019 to 68.9% in 2020. Moreover, the screening rate for the previous year declined from 32.7% in 2019 to 27.2% in 2020. However, as the COVID-19 pandemic continued after 2020, both gastric cancer screening rates, those with the recommendation and those for the previous year, rebounded. Regarding screening modality, the endoscopic screening rates with the recommendation and for the previous

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Table 1. Gastric cancer screening rates (%) and 95% confidence interval, 2017–2021

Screening rate	Screening method	Survey year				
		2017	2018	2019	2020	2021
Screening rate with recommendation*	Overall	72.2 (70.7–73.6)	72.8 (71.3–74.3)	70.8 (69.3–72.2)	68.9 (67.5–70.4)	76.6 (75.2–78.0)
	Endoscopy	64.3 (62.8–65.9)	64.7 (63.2–66.3)	62.1 (60.6–63.7)	61.4 (59.8–62.9)	72.9 (71.4–74.3)
	UGIS	28.5 (27.1–29.9)	24.9 (23.5–26.2)	25.9 (24.4–27.3)	23.3 (22.0–24.6)	7.8 (7.0–8.8)
Screening rate for the previous year	Overall	30.1 (28.6–31.6)	32.6 (31.1–34.2)	32.7 (31.2–34.3)	27.2 (26.0–28.9)	29.5 (28.0–31.1)
	Endoscopy	27.3 (25.9–28.7)	28.1 (26.6–29.5)	27.0 (25.6–28.5)	24.1 (22.7–25.4)	27.7 (26.2–29.2)
	UGIS	11.9 (10.9–12.9)	9.4 (8.5–10.4)	10.0 (9.0–11.0)	7.8 (6.9–8.6)	3.1 (2.5–3.6)

UGIS = upper gastrointestinal series.

*According to the KNCSPP protocols, adults aged ≥ 40 years and above are recommended to undergo screening for gastric cancer using either UGIS or endoscopy every two years.

year (+11.5% and +3.6%, respectively) increased in 2021, whereas the UGIS screening rates decreased (–15.5% and –4.7%, respectively).

The gastric cancer screening rates with recommendations for overall, UGIS, and upper endoscopy stratified by sex, age group, monthly household income status, and residential area are presented in **Figures 1–4**. Regardless of sex, age, household income, and residential area, the overall screening rates and the screening rates for upper endoscopy declined in 2020 and strongly rebounded in 2021, whereas the screening rate for UGIS markedly decreased by 2021. **Figure 1** shows that the overall and upper endoscopy screening rates were lower in women in 2020 (68.6% vs. 69.3% and 60.4% vs. 62.4%, respectively). Screening rates by age group are shown in **Figure 2**. In 2020, the overall, UGIS, and upper endoscopy screening rates mainly decreased in adults aged 40–49 years compared to those in 2019 (–4.0%, –1.7%, and –4.7%, respectively), whereas the screening rates increased in adults aged between 70 and 74 years (+5.0%, +3.6%, and +6.9%, respectively). Based on the monthly household income status, the magnitude of the reduction in the cancer screening rates between 2019 and 2020 was greater among those with high monthly household income status than that among those with middle- and low-income statuses (–5.6%, –8.3% and –5.9% for the overall, UGIS, and upper endoscopy screening rates, respectively; **Figure 3**). Based on the residential area, the overall screening rates for UGIS and upper endoscopy declined in the metropolitan regions (–4.7%, –4.0%, and –3.3%, respectively). In comparison, the screening rates markedly increased in rural areas (+14.6%, +10.4% and +20.4% for the overall, UGIS, and upper endoscopy screening rates, respectively) between 2019 and 2020 (**Figure 4**).

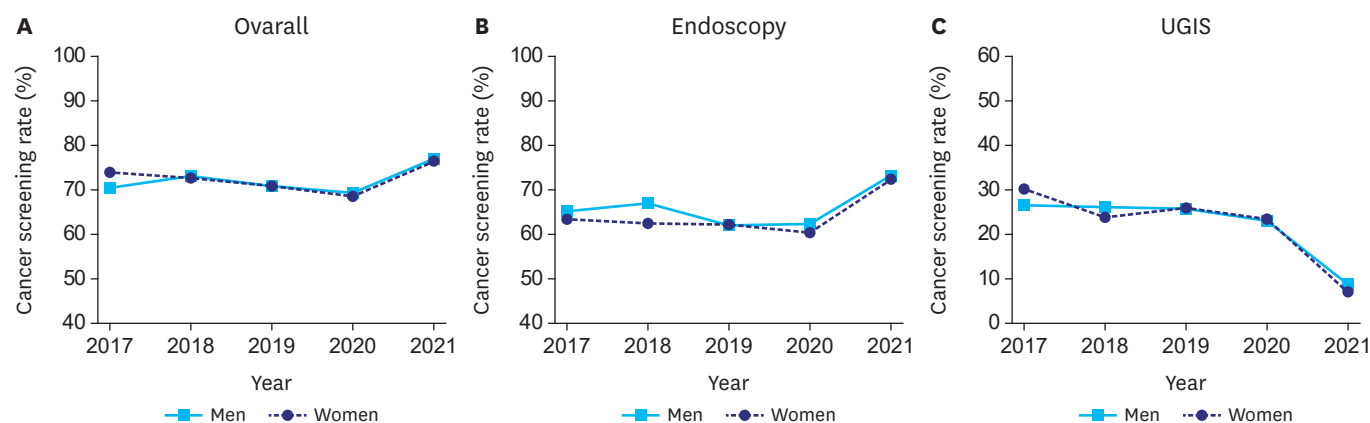


Fig. 1. Trends in gastric cancer screening rates with recommendation by sex from 2017–2021. (A) Overall stomach cancer screening rate using either UGIS or endoscopy. (B) Stomach cancer screening rate using UGIS. (C) Stomach cancer screening rate using endoscopy. UGIS = upper gastrointestinal series.

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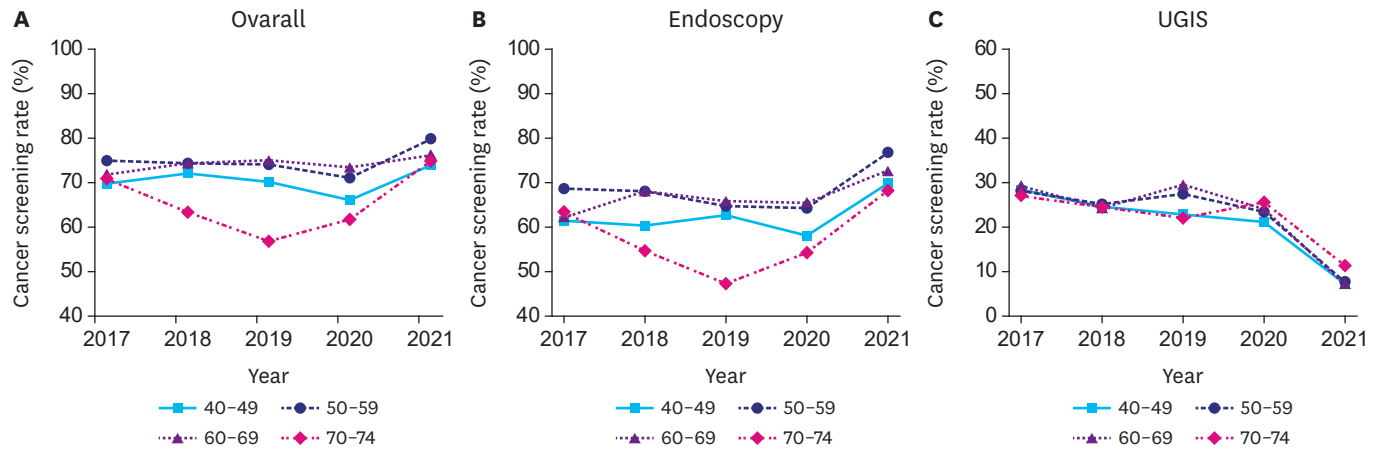


Fig. 2. Trends in gastric cancer screening rates with recommendation by age from 2017–2021. (A) Overall stomach cancer screening rate using either UGIS or endoscopy. (B) Stomach cancer screening rate using UGIS. (C) Stomach cancer screening rate using endoscopy. UGIS = upper gastrointestinal series.

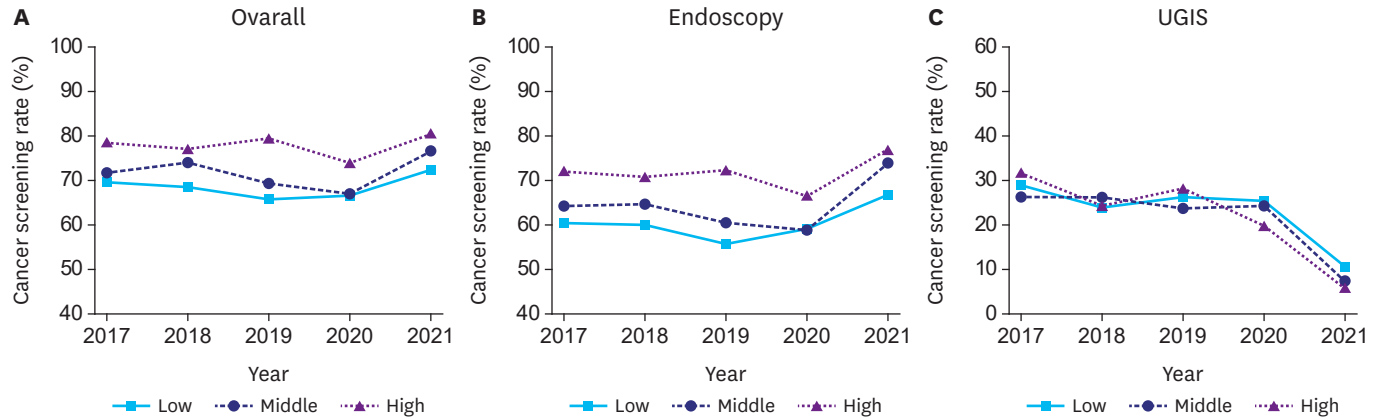


Fig. 3. Trends in gastric cancer screening rates with recommendation by monthly household income status from 2017–2021. (A) Overall stomach cancer screening rate using either UGIS or endoscopy. (B) Stomach cancer screening rate using UGIS. (C) Stomach cancer screening rate using endoscopy. UGIS = upper gastrointestinal series.

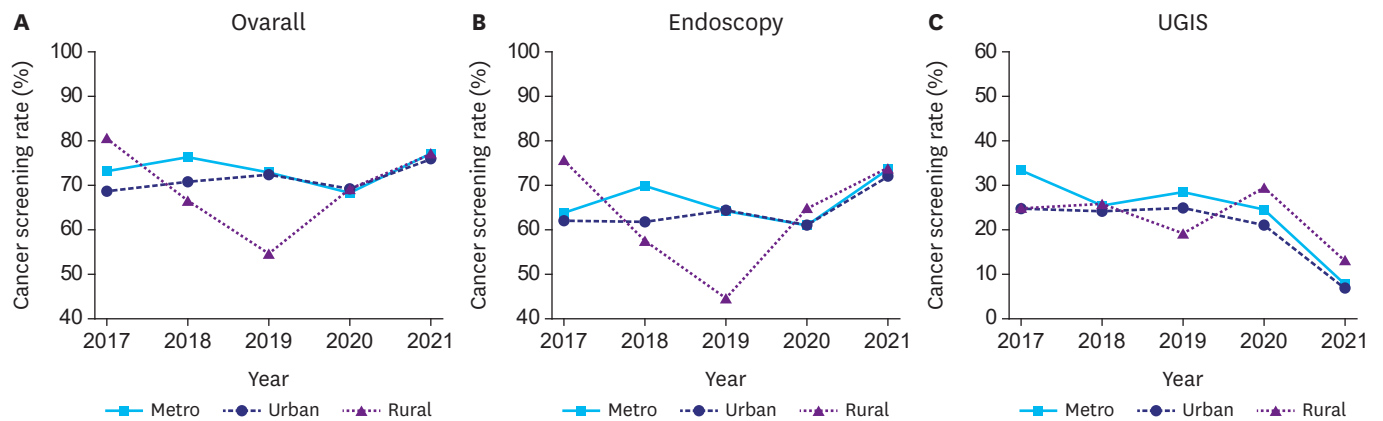


Fig. 4. Trends in gastric cancer screening rates with recommendation by residential status from 2017–2021. (A) Overall stomach cancer screening rate using either UGIS or endoscopy. (B) Stomach cancer screening rate using UGIS. (C) Stomach cancer screening rate using endoscopy. UGIS = upper gastrointestinal series.

In **Supplementary Figure 1**, cancer screening rates for the previous year and those with recommendations are compared for the four major cancer types (gastric, colorectal, breast, and cervical cancers) from 2017 to 2021. During the COVID-19 pandemic, the cancer screening rates for all cancer types declined. Between 2019 and 2020, the most significant reductions were observed in the screening rates for gastric (-5.5% for the screening rate for the previous year and -1.9% for the screening rate with the recommendation) and colorectal cancers in 2020 (-4.3%), compared to those in 2019. In 2021, the screening rates for all cancer types markedly rebounded; however, the increases in the screening rates for gastric cancer were lower than those for other cancer types.

DISCUSSION

The emergence of COVID-19 has severely affected preventive cancer screening worldwide. In the pre-COVID-19 period, the differences in gastric screening rates, including those of UGIS and upper endoscopy, were generally non-significant until 2019. With the emergence of COVID-19, the gastric cancer screening rate noticeably reduced in 2020. In the US, screening for breast, colorectal, and cervical cancers dropped abruptly by 94%, 86%, and 94%, respectively, from January to April 2020 [11]. Moreover, an Italian study revealed that, because of the COVID-19 pandemic, screening test rates decreased by 37.6% for breast cancer; 45.5%, colorectal cancer; and, 43.4%, for cervical cancer in 2020 compared to the rates in 2019 [20]. In addition, a Korean study that analyzed data from the NCSP reported that the screening participation rates decreased by 8.0% (63.8 vs. 55.8%) for breast cancer; 7.3% (61.9 vs. 54.6%), gastric cancer; 5.6% (57.8 vs. 52.2%), cervical cancer; and, 5.2% (40.5 vs. 35.3%), for colorectal cancer in 2020, compared to the rates in 2019 [21].

By October 2021, approximately 70% of the Korean population had received the second dose of the COVID-19 vaccine, and the government announced an exit strategy for gradual return to everyday life [22]. Accordingly, the gastric cancer screening rates rebounded in 2021, to levels higher than the pre-COVID levels; in particular, the rate of upper endoscopy profoundly increased from 61.4% in 2020 to 76.7% in 2021. However, the screening rate for UGIS did not recover, whereas it substantially decreased from 23.3% to 7.3% during the same period. Since the implementation of the NCSP for gastric cancer in Korea, several studies have evaluated the effectiveness of gastric cancer screening based on screening modality, reporting that upper endoscopy had better patient prognosis and clinical outcomes. Endoscopic screening showed a higher cancer detection rate, sensitivity, and specificity and a lower interval cancer rate than UGIS [23]. In contrast, Choi et al. [24] found that, compared to never-screened patients, those screened using endoscopy had a 2.1 times higher likelihood of having localized gastric cancer, indicating that endoscopic screening is more likely to detect early stage gastric cancer than UGIS. Regarding gastric cancer-related mortality and survival, patients screened with endoscopy appeared to have a significantly lower risk of dying from gastric cancer and a higher survival rate than patients screened with UGIS [3,4]. Therefore, we suspect that those who underwent gastric cancer screening during the pandemic had shifted from UGIS to endoscopy, resuming screening with a more accurate test because of the fear of contracting gastric cancer. However, a follow-up study is required to monitor whether this decreasing trend in the UGIS screening rate will continue.

The magnitude of the decline in gastric cancer screening rates differed by age group and monthly household income. In contrast to a previous study that showed the most significant reduction in cancer screening among the older adult population, our study results showed

that younger adults (40–49 years) reduced cancer screening services more than other age groups during the pandemic [21]. We assumed that the younger population was more likely to postpone cancer screening due to the relatively lower risk of developing gastric cancer than the older age groups. Additionally, in agreement with a previous study, we found that the most significant reductions were among those with high monthly household incomes [25]. One possible reason is that people with high-income are more likely to reside in metropolitan regions, where many COVID-19 cases were reported, than in non-metropolitan areas, leading to a reduction in the cancer screening rate among people with high incomes [26]. Several studies have revealed regional variations in cancer screening rates owing to the COVID-19 pandemic [21,25,27]. Moreover, we noted regional differences in gastric cancer screening rates, and the magnitude of the reduction was more severe in metropolitan regions including Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Woosan. In South Korea, as the first case of COVID-19 was confirmed in January 2020, the first wave of the COVID-19 outbreak began in February 2020. With a gradual increase in social activities, the second wave of COVID-19 outbreak occurred between August 2020 and September 2020. As a result, the Korean government upgraded the social distancing level in Seoul from standard level 2 to strengthened level 2 for early mitigation of the second wave [28]. Further, the third wave started in November 2020, and social distancing policies were further strengthened to level 2.5 level in December 2020. We assume that the increased fear of infection due to the higher number of COVID-19 cases and the strong social distancing measures implemented in metropolitan cities may have resulted in these decreases in the urban regions.

his study has several limitations. First, survey data, such as history of gastric cancer screening and household income, were collected based on individual self-reports; thus, there is a possibility of recall bias while describing their past experiences or status. Second, although there was a decline in the gastric cancer screening rate during the COVID-19 outbreak, the reasons for non-participation, specifically in gastric cancer screening, were not investigated. Thus, we cannot ascertain whether the deficits in gastric cancer screening rates were solely induced by the COVID-19 pandemic. Third, although we measured the trends in gastric cancer screening in rates before, during, and post-COVID-19 outbreak, we could not analyze the impact of postponing cancer screening on future gastric cancer incidence and mortality. 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 gastric cancer screening in the Korean population.

In conclusion, despite the negative impact of the COVID-19 pandemic on gastric cancer screening, in 2021, we observed a strong rebound in the gastric cancer screening rate for endoscopy, whereas the screening rate for UGIS profoundly decreased, and it was lower than the pre-COVID-19 levels. The present study aimed to promote future follow-up studies intended to monitor the trends in gastric cancer screening rates and the impact of delays in gastric cancer screening on future cancer incidence and mortality in South Korea.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Sociodemographic characteristics of the survey participants, 2017–2021

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Supplementary Fig. 1

Trends in stomach cancer screening rates by cancer types, from 2017–2021, (A) Cancer screening rates for the recommended time period of 2 years, (B) Cancer screening rates for the previous year.

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