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Original Article

Trends of Colorectal Cancer Screening Rates in Korea: Korean National Cancer Screening Survey 2005–2020

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Background/Aims: Screening for colorectal cancer (CRC) is important in reducing the morbidity and mortality of CRC. Thus, this study aimed to describe the trends of CRC screening in both organized and opportunistic settings in Korea from 2005 to 2020 according to sociodemographic characteristics.

Methods: This study analyzed the data of adults aged 50 to 74 years from the Korean National Cancer Screening Survey. Trends for CRC screening rates (fecal immunochemical test [FIT] within the last year, double-contrast barium enema within the last 5 years, or colonoscopy within the last 10 years for 2005–2018 and FIT within the last year or colonoscopy within the last 10 years for 2019–2020) were analyzed using Joinpoint regression. The trends were also analyzed according to sociodemographic characteristics, including age, sex, monthly household income, education level, and residential area.

Results: A total of 29,040 participants were included in the analysis. The CRC screening rate significantly increased from 25.0% to 60.1%, with an annual percent change (APC) of 9.2% between 2005 and 2014, followed by a nonsignificant increase to 64.4% between 2014 and 2020 (APC,1.7%). When the participants were stratified according to sociodemographic factors, the participants with higher household income and education levels generally had higher screening rates.

Conclusions: There has been substantial improvement in CRC screening rates in the general Korean population. However, it is necessary to determine why the screening rate has stabilized since 2014 and identify barriers that cause disparities in CRC screening rates among populations with lower socioeconomic status. **(Gut Liver, Published online April 22, 2022)**

Key Words: Colorectal neoplasms; Early detection of cancer; Healthcare disparities; Social class

INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer-related deaths worldwide.[1] CRC is also a major public health problem in Korea as the fourth most incident, the third most prevalent cancer, and the third most deadly cancer in Korea in 2018.[2] Most colorectal premalignant or malignant lesions are asymptomatic for years, with symptoms developing insidiously, and the prognosis for CRC is strongly related to the stage at diagnosis.[3] CRC screening enables the detection of precancerous lesions or CRC in its early stages, and has been shown to reduce late-stage cancer.[4-6] and consequently decrease the incidence and mortality associated with CRC by at least 60%.[7,8]

There are various commonly used and available CRC screening methods, including stool-based tests, such as fecal occult blood test and fecal immunochemical test (FIT), and optical approaches to direct examination of the colon and rectum, such as sigmoidoscopy and colonoscopy.[9] The Korean Guideline for CRC Screening, initially developed in 2002[10] and revised in 2015,[11] recommends annual or biennial FIT in asymptomatic adults aged 45 to 80 years (recommendation B; high certainty of moderate net benefit or moderate certainty of moderate to substantial net benefit) and selective colonoscopy based on professional judgment and individual preference (recommendation C; at least moderate certainty of small net befit). In Korea, CRC screening can be offered either through a population-based organized screening program or opportunistic cancer screening. A population-based organized screening program offers a standardized system of care based on a comprehensive guideline including eligible subjects, screening interval, screening modality, quality assurance, and public financing. On the other hand, attendance and services of opportunistic screening depends on individual or a health care professional. The Korean government established the National Cancer Screening Program (NCSP), a population-based organized screening program, and for CRC screening, the NCSP has provided annual FIT for adults aged 50 years or older, and colonoscopy or a double-contrast barium enema test to those with positive results from the FIT since 2004.[12] Table 1 summarizes the Korean Guideline for CRC screening and the NCSP protocol for CRC. Opportunistic cancer screening is also available with various screening methods available and all fees paid entirely by the examinees.

The main objective of this study was to describe the trends in CRC screening rates in Korea from 2005 to 2020 and investigate whether the trends vary according to demographic and socioeconomic status. We analyzed comprehensive data encompassing information on the screening rates from both opportunistic and population-based organized screening to understand the overall CRC screening rates in Korea. In addition, we considered various demographic and socioeconomic factors that might be associated with the screening rates.

MATERIALS AND METHODS

1. Data source and study population

This study analyzed data from the Korean National Cancer Screening Survey (KNCSS) conducted between 2005 and 2020. Although the KNCSS has been conducted since 2004, the results of the 2004 survey, which were conducted through telephone rather than face-to-face interviews, were excluded in this analysis. KNCSS is a cross-sectional nationwide, population-based survey of cancer-free men aged 40 to 74 years and women aged 20 to 74 years, conducted by the National Cancer Center. The KNCSS uses a stratified, multistage cluster sampling method based on geographical area, sex, and age, and excluded people who have already been diagnosed with cancer at the time of recruitment. The details of the sampling methods are described in a previous study.[13] Of the participants in the KNCSS, the present study included men and women aged 50 to 74 years who were eligible for CRC screening according to the NCSP.

2. Variable definition

The experience of CRC screening was determined based on self-reports on whether the participants had been screened for CRC, and when and how the participants were screened. CRC screening rate was defined as the proportion of individuals who had FIT within the last 1 year, double-contrast barium enema within the last 5 years, or colonoscopy within the last 10 years for the survey year 2005–2018 and FIT within the last 1 year or colonoscopy within the last 10 years for the survey year 2019–2020.

We considered the following sociodemographic factors: sex, age, monthly household income, educational level, and residential area. Age was grouped into 50–59 years, 60–69 years, and 70–74 years. Monthly household income was

Table 1. The Korean Guideline and the NCSP Protocol for CRC Screening

	Korean Guideline for CRC Screening		Protocol of NCSP for CRC	
	2002[10]	2015[11]	2004	2016
Target population	Adults aged ≥50 years	Adults aged 45–80 years	Adults aged ≥50 years	Adults aged ≥50 years
Test	Colonoscopy	FIT	FIT†	FIT†
	Sigmoidoscopy & DCBE (not available for colonoscopy only)	Colonoscopy*		
Interval	Colonoscopy: 5–10 years	FIT: 1–2 years	2 Years	1 Year‡
	Sigmoidoscopy & DCBE: 5 years	Colonoscopy*		
Additional study for confirmation			DCBE or colonoscopy & biopsy	DCBE or colonoscopy & biopsy

NCSP, National Cancer Screening Program; CRC, colorectal cancer; FIT, fecal immunochemical test; DCBE, double-contrast barium enema.
*Selectively offered or provided to individual screeners based on professional judgment and screening preferences (recommendation C); †Conducted quantitatively or qualitatively; ‡Performed from biennially rather than annually since 2012.

divided into three groups based on tertiles for each year: lower, medium, and higher. Educational level was categorized into three groups depending on the number of years of education: lower (11 years or less), medium (between 12 and 15 years), and higher (16 years or more). Residential areas were categorized as rural and metropolitan.

3. Statistical analysis

A descriptive analysis was performed to evaluate the distribution of the participants' sociodemographic characteristics. All estimates were weighted to account for the complex sampling design, so that the results could represent the entire Korean population.

Joinpoint regression analysis using raw values of the screening rates was used to fit a series of joined log-linear segments to the trends in the CRC screening rates from 2005 to 2020 and identify the points in which there is a statistically significant change in trend (p-value <0.05) using the best-fit data series.[14,15] Joinpoint analysis tested whether a multi-segmented line that allows a maximum of two Joinpoints is a significantly better fit than a straight line. Then, the annual percentage changes (APCs) of each segment were calculated. Joinpoint regression analysis was also conducted according to sex, age group, monthly household income, education level, and residential area to identify differences in patterns of trends between subgroups. The trend was characterized according to the methodology of the National Cancer Institute.[16] The trend was characterized as stable if the trend changed by ≤0.5% per year and the APC was not statistically significant. In contrast, the trend was characterized as nonsignificant change if the trend changed by >0.5% per year, and the APC was not statistically significant. The trend was characterized as rising or falling when the trend was statistically significant. Descriptive analyses were performed using the SAS software version 9.4 (SAS Institute, Cary, NC, USA), and Joinpoint regression analysis was performed using the Joinpoint Regression Program, version 4.7.0.0 (Statistical Research and Applications Branch; National Cancer Institute, Rockville, MD, USA).

4. Ethical statement

This study was approved by the Institutional Review Board of the National Cancer Center in Korea (IRB number: NCC2019-0233). All participants provided written informed consent.

RESULTS

The sample consisted of 29,040 participants aged 50 to 74 years who participated in the KNCSS from 2005 to 2020. In 2005 and 2020, 968 and 2,467 adults aged 50 to 74 years participated in the KNCSS, respectively, and the number of participants generally increased from 2005 to 2020. Supplementary Table 1 presents the number of participants and the sociodemographic characteristics of the participants for each survey year.

The screening rates are summarized in Table 2. Generally, the screening rate of all participants has increased from 25.0% in 2005 to 64.4% in 2020. The Joinpoint regression analysis showed that there was a significant increasing trend between 2005 and 2014 (APC, 9.2%), followed by a nonsignificant increase between 2014 and 2020 (APC, 1.7%) (Fig. 1A). Both men and women demonstrated a significant increase in the screening rate from 2005 to 2020, but the values of screening rates were generally higher in men (Fig. 1B and C). When the participants were grouped based on their age, the screening rate for the age group of 60 to 69 years was generally the highest for each survey year (Fig. 2).

When the participants were grouped according to their monthly household income level (Fig. 3), the screening rates of participants with lower income exhibited a significant increase between 2005 and 2014 (APC, 9.7%), followed by a stable trend from 2014 to 2020. On the other hand, the slope of the screening rates significantly increased from 2005 to 2020 in the middle- and high-income groups (APC, 5.5% and 5.1%, respectively). Generally, the screening rate in the high-income group was higher than that in the middle- or lower-income groups over the study period. Fig. 4 demonstrates the results of the Joinpoint regression analysis when the participants were stratified according to education level. In the lower and middle education level groups, the screening rates were significantly increased between 2005 and 2014, and the slope afterwards were stable. On the other hand, the screening rate showed an increasing trend for the recent time period in the higher education level groups. The higher education level group generally showed the highest screening rate compared to the other groups. When the participants were stratified according to residential area (Fig. 5), the screening rates of participants living in both rural and metropolitan areas exhibited a significant increase between 2005 and 2014, followed by a stable trend from 2014 to 2020.

DISCUSSION

The present study demonstrated that the CRC screening rate increased significantly from 2005 to 2014, with an APC of 9.2%. When we analyzed the CRC screening

Table 2. Colorectal Cancer Screening Rates of Sociodemographic Characteristics of the Study Participants in the Korean National Cancer Screening Survey, 2005–2020

Characteristics	Colorectal cancer screening rate of survey year, %																
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	AAPC
Total	25.0	29.4	34.1	39.8	36.7	35.5	35.3	44.7	55.6	60.1	59.5	54.6	56.8	58.4	62.6	64.4	6.2*
Sex																	
Male	27.2	31.2	36.7	39.4	36.5	38.6	37.4	46.7	56.3	64.1	64.2	55.3	60.9	60.8	63.8	67.3	4.8*
Female	23.1	27.9	31.9	40.1	36.8	32.5	33.3	42.8	54.9	56.2	55.0	53.9	52.7	56.1	61.5	61.6	5.1*
Age																	
50–59 yr	22.9	26.2	30.7	40.2	35.5	33.3	32.7	42.9	54.7	59.0	59.0	53.8	56.9	58.6	61.2	63.4	6.8*
60–69 yr	28.7	37.1	38.3	40.7	38.8	38.4	38.3	48.0	57.4	63.3	62.9	55.7	57.2	59.6	66.2	68.0	4.6*
70–74 yr	25.9	18.6	29.0	35.3	35.6	36.9	39.6	44.4	55.0	56.4	52.6	55.0	54.6	53.8	59.8	60.3	6.9*
Monthly household income																	
Lower	27.5	27.6	28.3	40.2	35.3	37.9	37.9	45.8	57.6	60.0	57.3	55.7	58.7	51.7	58.3	58.4	5.5*
Medium	23.3	26.1	36.6	35.4	35.5	31.5	31.9	42.9	55.6	58.7	57.6	51.0	54.0	60.7	61.3	63.1	5.5*
Higher	23.6	35.8	38.7	45.6	41.9	37.5	36.8	46.1	53.0	61.7	63.8	56.5	58.7	62.0	67.9	71.1	5.1*
Education																	
Lower	24.9	28.8	33.1	38.9	35.0	36.1	35.6	43.8	54.9	56.1	56.6	57.5	53.3	49.3	55.1	56.3	5.0*
Medium	24.5	32.5	36.5	38.3	34.3	33.7	34.4	44.7	55.5	59.8	58.0	52.9	57.1	59.3	64.3	65.3	6.6*
Higher	29.2	24.7	34.8	56.0	56.5	39.9	37.9	47.0	56.5	63.9	66.8	56.3	60.2	64.7	67.0	70.5	3.9*
Residential area																	
Rural	29.1	28.6	29.6	45.2	42.4	37.2	36.6	48.6	53.3	63.1	59.9	57.6	60.4	57.0	59.9	53.4	5.2*
Urban	24.2	29.6	34.9	39.1	35.9	35.1	35.1	42.9	56.0	59.8	59.5	54.1	56.2	58.6	63.0	65.8	6.3*

*Average annual percent change (AAPC) is significantly different from 0 at α=0.05.

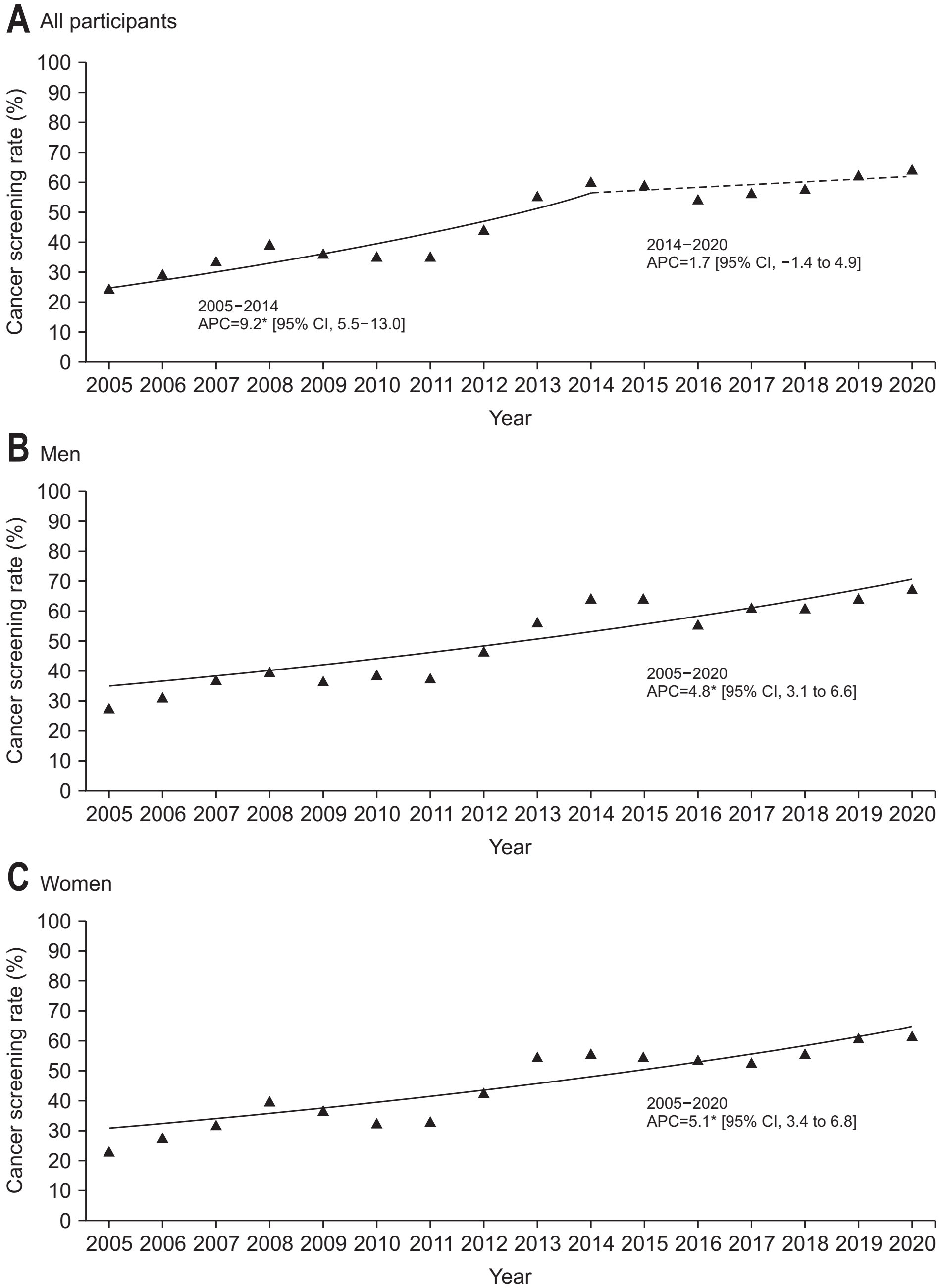

Fig. 1. Trends in colorectal cancer screening rates by sex, 2005–2020. (A-C) The solid line denotes a significant increasing trend, while the dashed line denotes a nonsignificant change.
CI, confidence interval. *p-value for the trend of annual percent change (APC) <0.05.

rates according to participants' socioeconomic status, the participants with higher household income and education level generally showed higher screening rates.

The screening rate in 2020 (64.4%) significantly improved compared to that in 2005 (25.0%). This could be because the number of medical institutions that provide CRC screening has increased continuously from 1,767 in 2007 to 4,367 in 2020, and thus the accessibility to CRC screening has improved. In addition, as of 2020, all but four out of 229 administrative districts had CRC screening institutions. In addition, mobile screening program is provided in remote areas to increase access to cancer screening. Therefore, it is unlikely that there is an issue with access to the CRC screening depending on the residential areas.

The CRC screening rate in Korea has improved to a relatively higher level compared to that in other countries. Although there are wide variations in terms of the types of screening programs, target age ranges, screening methods, and screening intervals among countries, participation rates are generally between 15% and 70% globally. In the United Kingdom, where the nationwide coverage for CRC screening started earlier than in Korea,[17] a population-based organized screening program provides guaiac-based

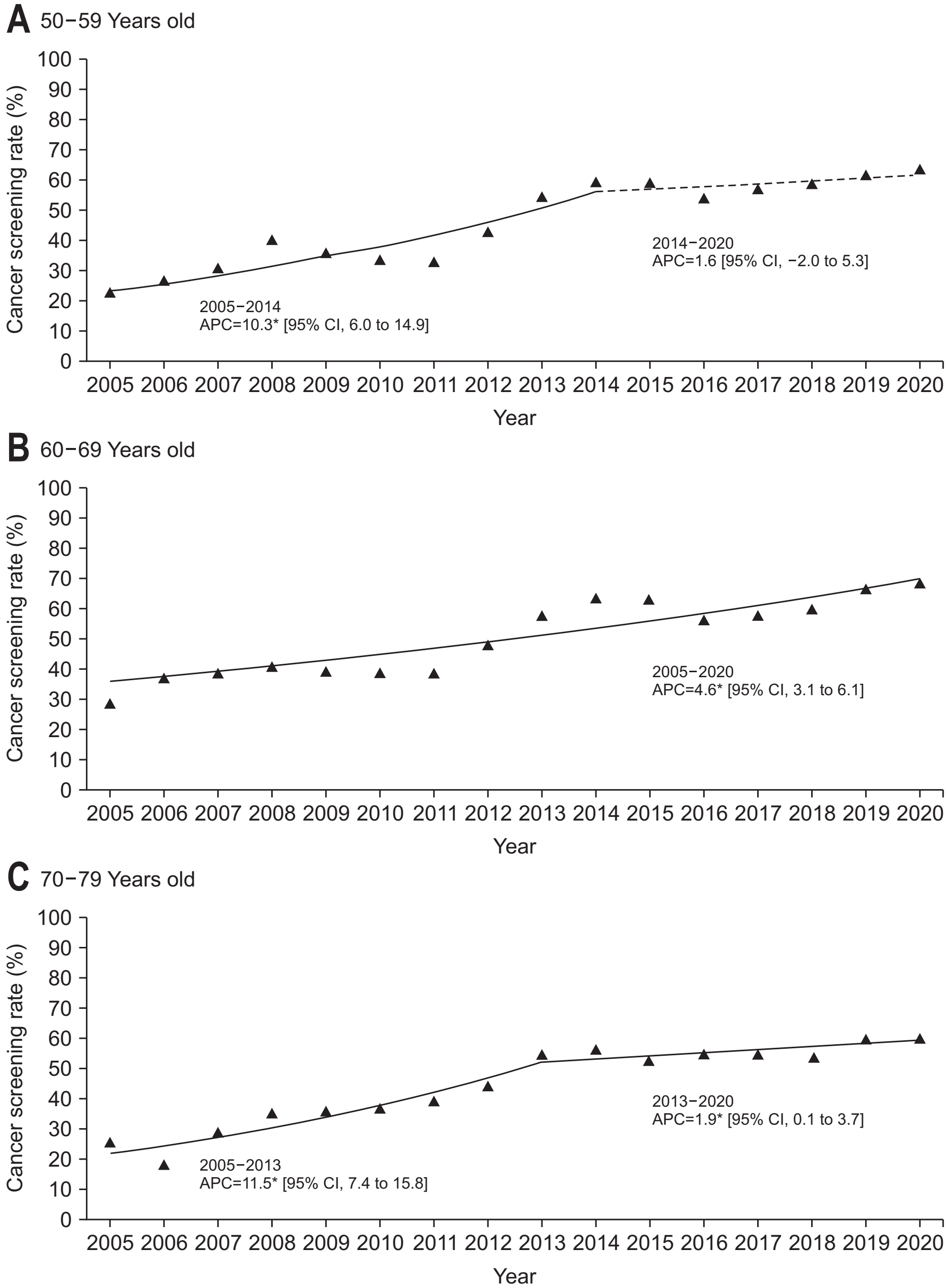

Fig. 2. Trends of colorectal cancer screening rates by age group, 2005–2020. (A-C) The solid line denotes a significant increasing trend, while the dashed line denotes a nonsignificant change.
CI, confidence interval. *p-value for the trend of annual percent change (APC) <0.05.

fecal occult blood test and FIT once every 2 years or flexible sigmoidoscopy once in a lifetime, with a screening rate of approximately 55.4%.[18] In the United States, the U.S. Preventive Services Task Force recommended annual screening with FIT, screening every 10 years with sigmoidoscopy and annual screening with FIT, screening every 10 years with colonoscopy, or screening every 5 years with computed tomography colonography; it has been reported that approximately 60% of adults in the USA had been screened by endoscopy in 2015 under the opportunistic screening program.[19]

Although the CRC screening rate has improved substantially in Korea, there has been no significant increase in the screening rate from 2014 to 2020. The reason why the screening rate did not show a significant increase after 2014 is not fully understood. Because improving CRC screening rate is important to decrease morbidity and mortality from CRC,[20-24] understanding the reasons for non-attendance for CRC screening and developing strategies to improve screening rates are necessary. Han *et al.*[25] demonstrated the primary reasons for non-attendance for CRC screening through a survey and the reasons included "Without any symptoms (56.5%)," "Lack of time (14.4%)," and "Fear of exam procedure (11.0%)." In addition, accord-

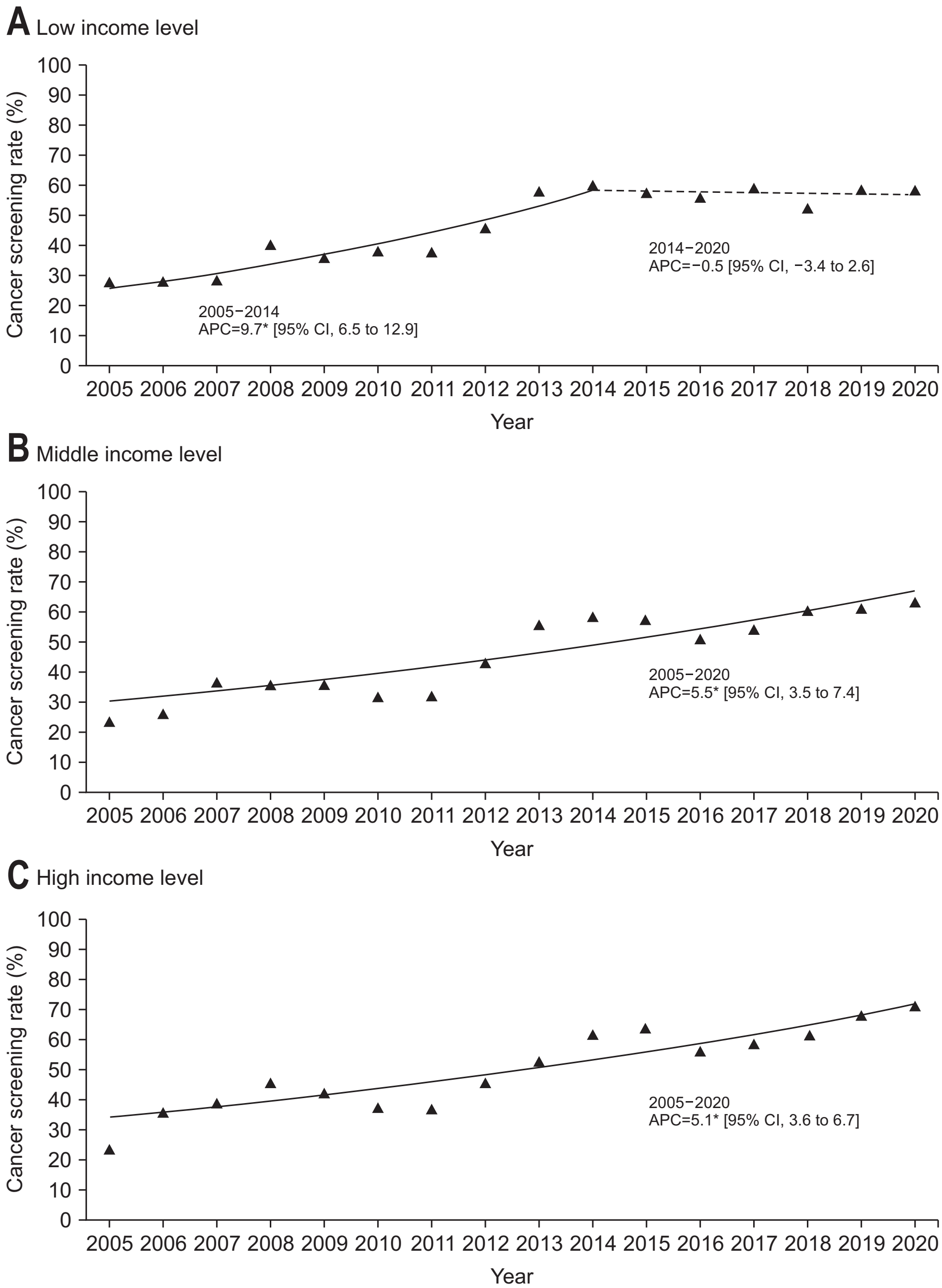

Fig. 3. Trends of colorectal cancer screening rates by household income level, 2005–2020. Monthly household income status is classified by tertile. (A-C) The solid line denotes a significant increasing trend, while the dashed line denotes a non-significant change.
CI, confidence interval. *p-value for the trend of annual percent change (APC) <0.05.

ing to the results of the 2019 KNCSS, 75.8% of people who have had a CRC screening according to the NCSP protocol reported to have a plan to receive a CRC screening again in the future, while 96.9% of those who have not had a screening reported that they have no plan of receiving it. This suggests that people who have not been screened have a fixed negative attitude toward screening; thus, a targeted strategy to improve their attitude toward screening seems to be needed.

In an effort to increase the CRC screening rate, the interval for the FIT provided by the NCSP has been changed from 2 years to 1 year since 2012. In addition, studies have been conducted to identify and lower the barriers that prevent an increase in CRC screening rates. Hong *et al.*[26] found that CRC screening rates in rural areas in Korea increased when the FIT kit for stool sampling was postally distributed and collected to and from each subject. Shin *et al.*[27] also found that the participants' satisfaction and intention to undergo subsequent screening became higher when the conventional container for stool sampling was changed to a more convenient sampling bottle. These results suggest that an improvement in the inconvenience of FIT can increase CRC screening rates.

Many previous studies conducted in other countries

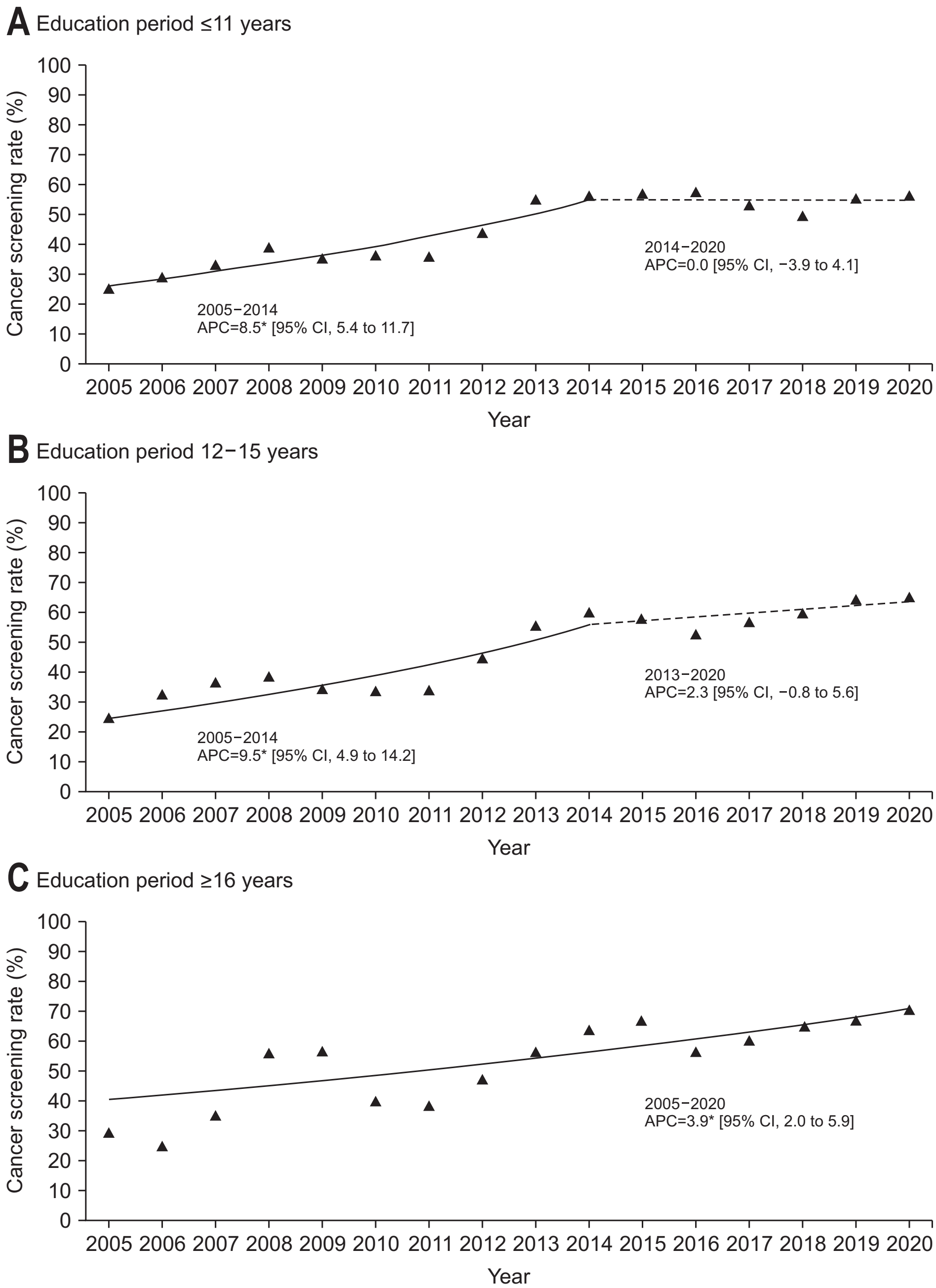

Fig. 4. Trends of colorectal cancer screening rates by education level, 2005–2020. The solid line denotes a significant increasing trend, while the dashed line denotes a non-significant change. *p-value for the trend of annual percent change (APC) <0.05.

have shown that low socioeconomic status is associated with decreased screening rate,[28-33] although it is less associated with the existence of an organized screening program.[34] The present study also demonstrated that the degree or pattern of increase in screening rates differed according to the sociodemographic characteristics of the subjects. In fact, the annual increase in the screening rate from 2005 to 2014 was larger in those who were less educated and had a lower income, probably because many national efforts have been made in Korea to expand coverage for screenings by lowering the economic burden of examinees for participating in the NCSP. Individuals eligible for free cancer screening through the NCSP have been gradually expanded so that Medical Aid recipients and National Health Insurance beneficiaries in the lower 50% income bracket have been provided with free CRC screening since 2005.[12] Furthermore, for those who are not eligible for free cancer screening through the NCSP, patient cost sharing, which was initially 50%, gradually decreased to 20% in 2006, 10% in 2010, and has become fully covered by the NHIS since 2018.

However, the screening rate in participants with lower income and less education remained stable without significant change from 2014 onwards, while the screening rate

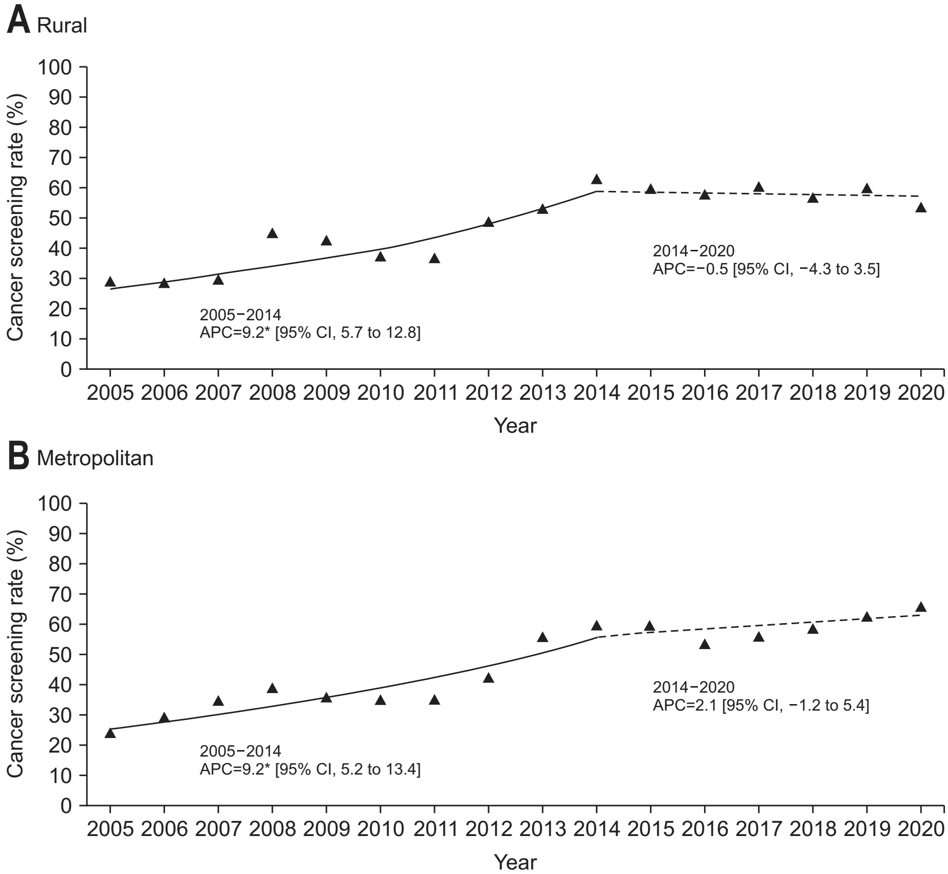

Fig. 5. Trends of colorectal cancer screening rates by residential area, 2005–2020. The solid line denotes a significant increasing trend, while the dashed line denotes a non-significant change. *p-value for the trend of annual percent change (APC) <0.05.

increased consistently until recently in those who had a higher income and were more educated. This is consistent with a previous study that found the existence of screening inequality depending on the socioeconomic status in Korea,[35,36] suggesting that there may still be remaining barriers to CRC screening participation with low socioeconomic status despite financial support through the NCSP. For example, because it is not required for employers to provide employees with mandated paid time off for cancer screening in Korea, taking paid time off to undertake a cancer screening might be more difficult for those from a lower socioeconomic status.

In addition, the increase in screening rates until recent years only in those with higher socioeconomic status could be because people with higher income and education choose to receive colonoscopy as the primary method of CRC screening through an opportunistic screening program. NCSP in Korea provides FIT as the primary CRC screening method, and colonoscopy is provided free of charge only to those with positive FIT results. On the other hand, under the opportunistic screening program, people can receive colonoscopy as the primary method of CRC screening, although the cost should be paid entirely by the examinee with no subsidy from the government. Because colonoscopy is approximately 20 times more expensive than FIT, which is even provided free of charge through the NCSP, the costs of the test can operate as a barrier to CRC screening, particularly for those with low socioeconomic status. However, a recent survey of 396 respondents who participated in the NCSP found that 68.7% of respondents preferred colonoscopy as a primary CRC screening test in the NCSP, and colonoscopy was preferred because it is accurate and can be used as a therapeutic option.[37] In response to this, the Korean Ministry of Health and Welfare and National Cancer Center has been conducting a Korean colonoscopy screening pilot study since 2019 to evaluate the effectiveness, safety, feasibility, and acceptability of colonoscopy as a primary method for CRC screening.[38]

This study has some limitations. Since KNCSS only includes a non-institutionalized population and the response rate was between 34.5% and 55.5%, the results may have been influenced by selection bias. Moreover, the history of screening was self-reported by the participants, which could introduce either misclassification bias or recall bias. In addition, since the survey-participants were notdirectly enquired about the type of CRC screening they had undergone, we were unable to correctly identify whether the participants were screened through the NCSP or opportunistic screening. Instead, when inference was drawn indirectly using the responses to the questionnaire on who paid for the screening, the screening rates of those presumed to have been screened through the NCSP showed a similar trend to the screening rate of the entire participants. On the other hand, the screening rates of participants presumed to have undergone opportunistic screening exhibited a slight decrease from 2005 to 2020 (Supplementary Fig. 1). Despite these limitations, this study was able to investigate the changes in cancer screening rates over 10 years using data from a nationwide, population-based survey. Trends studies could provide an opportunity to better identify the determinants that may influence the trends.

In conclusion, this study demonstrated that CRC screening rates increased with a significant upward trend between 2005 and 2014, followed by a nonsignificant increase from 2014 to 2020. In addition, socioeconomic disparities in CRC screening occurred throughout the study period. Although there has been a lot of improvement in CRC screening rates, the results of our study indicate that there remains a need for more research to understand why the screening rates have been stagnant since 2014 and to identify multi-level remaining barriers to CRC screening participation specific to vulnerable populations.

CONFLICTS OF INTEREST

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

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AUTHOR CONTRIBUTIONS

Data analysis and interpretation, drafting of the manuscript: B.P. Data acquisition: M.S., K.S.C. Administrative, technical, and material support: S.Y.S. Statistical analysis: Y.Y.L., H.Y.S. Study concept and design, critical revision of the manuscript for important intellectual content, obtaining funding, and study supervision: J.K.J. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIALS

Supplementary materials can be accessed at https://doi.org/10.5009/gnl210419.

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