



A comparative study of changes in smoking cessation attempt rates and related factors before and during COVID-19

Hyo Young Lee^{a,c,*}, Seung Hun Lee^{b,c,d}, Gyu Lee Kim^{b,c}

^a Department of Health Administration, Dongseo University, 47 Jurye-ro, Sasang-gu, Busan 47011, South Korea

^b Department of Family Medicine, Pusan National University Hospital, 179, Gudeok-ro, Seo-gu, Busan 49241, South Korea

^c Busan Tobacco Control Center, Pusan National University Hospital, 179 Gudeok-ro, Seo-gu, Busan 49241, South Korea

^d Department of Family Medicine, Pusan National University, School of Medicine, Beomeo-ri Mulgeum-eup, Yangsan, Gyeongsangnam-do 50612, South Korea

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ABSTRACT

This study aimed to identify whether smoking cessation attempts (SCA) for health promotion changed during the coronavirus disease 2019 (COVID-19) pandemic and how the characteristics of people who undertook SCA before versus during COVID-19 differed. This was a secondary data analysis of the South Korean 2019–2021 Community Health Survey data for 163,334 smokers that compared sociodemographic factors, health behaviors, and health status by SCA and year using χ^2 statistics and multiple logistic regression analysis. The SCA rate significantly decreased from 72.6 % in 2019 to 44.1 % in 2021. In 2019, the rate was high for those over 60 years old but decreased by half by 2021. The ORs for SCA were higher in women than men in all years and were lower in 2019 for all age groups except those in their 70 s; however, in 2021, the ORs for those in their 20 s were higher than those in their 70 s and were slightly higher for non-high-risk drinkers than for high-risk drinkers. ORs were higher among those trying to lose or gain weight than among those who were not. Despite its health benefits, the SCA rate significantly decreased. Issuing public statements encouraging SCA is critical. Measures are necessary to increase the rate of SCA among people in their 70 s and support those seeking to control their weight for successful smoking cessation. In addition, a strategy to maintain the SCA rate in people in their 20 s is required to ensure their future health.

1. Introduction

During the coronavirus disease 2019 (COVID-19) pandemic, existing healthcare and health promotion services were reduced or discontinued (Cambon et al., 2021). In addition, due to social restrictions such as social distancing, many health risks such as reduced exercise, weight gain, and increased social isolation increased during the COVID-19 pandemic (Sepúlveda-Loyola et al., 2020; Woods et al., 2020; Chang et al., 2021; Mutz and Gerke, 2021). Smoking cessation is a representative health promotion method, and the health benefits of smoking cessation are well known; even a short period of smoking cessation four weeks before surgery can minimize postoperative complications of COVID-19 infection (Eisenberg and Eisenberg, 2020). In addition, COVID-19 is more likely to progress in smokers than non-smokers (Patanavanich and Glantz, 2020).

Since SA has many health benefits, studies have been conducted on factors related to smoking cessation attempts (SCA), which are the first

gateway to quitting smoking; and to success in quitting smoking (Osler and Prescott, 1998; Pizacani et al., 2018; Mendoza-Romero et al., 2019; van Amsterdam and van den Brink, 2023). Osler and Prescott (1998) found that the older the person, the higher the rate of SCA, as well as a higher rate of SCA when there is a non-smoking spouse. Pizacani et al. (2018), examining the 5-year long-term smoking cessation success rate, noted that long-term support for people with low socioeconomic status is necessary because they have a low smoking cessation success rate. Mendoza-Romero et al. (2019) reported that physical inactivity and poor health status were factors associated with smoking in women, indicating that smokers have poor health status and health behaviors (Mendoza-Romero et al., 2019). In addition, a review by van Amsterdam and van den Brink (2023) found that the smoking cessation success rate was lower for drinkers than for non-drinkers, suggesting that unhealthy behaviors and smoking are linked.

Various studies have been conducted on the factors related to SCA in various populations (Siahpush et al., 2003; Kim et al., 2013; Qiu et al.,

* Corresponding author at: Department of Health Administration, Dongseo University, 47 Jurye-ro, Sasang-gu, Busan 47011, South Korea.

E-mail addresses: princesa@dongseo.ac.kr (H.Y. Lee), drjim@pusan.ac.kr (S.H. Lee), happygaru@hanmail.net (G.L. Kim).

2020). A study of Australian adults highlighted the importance of social environments and found that people who had few or no smoking friends were 3.2 times more likely to quit smoking (Siahpush et al., 2003). Kim et al. (2013), targeting the Korean elderly, estimated their smoking rate to be 36.3 % and found that male smoking rates were significantly higher than female smoking rates, suggesting that depression and alcohol use disorder are factors that lower SCA; therefore, their management is necessary (Kim et al., 2013). In addition, in a study of factors related to SCA in Chinese middle-aged adults, older age and first smoking at 20 years of age or older were found to be related to smoking cessation attempts (Qiu et al., 2020).

Even during the COVID-19 pandemic, studies related to SCA have been conducted; however, such studies are limited. Eisenberg and Eisenberg (2020) reported that smokers are more likely to be infected with COVID-19 and suffer serious complications if infected. In addition, although not a study on SCA, one smoking study (Elling et al., 2020) during the COVID-19 pandemic reported that the amount of smoking decreased in 18.5 % of the total subjects but increased in 13.8 %, and that the risk of COVID-19 infection was higher for smokers. It was found that the willingness to try to quit smoking increased when beliefs were high (Elling et al., 2020). Bandi et al. (2022) studied 788,008 adults in the United States to examine changes in SCA since 2011, including during the COVID-19 pandemic. In the overall decreasing trend, the SCA rate was maintained between 62 % and 68 %, although it decreased further in 2022. However, the factors related to SCA or their changes were not examined (Bandi et al., 2022).

More research is needed to confirm how the SCA rate changed during the COVID-19 pandemic. In addition, even in situations where the rate of SCA has decreased, identifying the characteristics of those who attempt smoking cessation in the event of an infectious disease pandemic can aid in devising strategies for supporting people to quit smoking. Therefore, this study aimed to examine the change in the rate of SCA before and after COVID-19 and to identify changes in factors related to SCA.

2. Methods

This cross-sectional study analyzed secondary data from the 2019–2021 Community Health Survey conducted by the Korea Disease Control and Prevention Agency (KDCA). There were 164,334 participants (SCA rate: 72.6 % in 2019, 47.7 % in 2020, and 44.1 % in 2021), all of whom were current smokers. Sociodemographic factors (sex, age group, housing type, living alone, monthly household income, education level, marital status, and occupation), health behaviors (walking practices, high-risk alcohol drinking, weight control practices, sleeping hours, strenuous physical activity, and moderate physical activity), and health status (subjective stress, depression, hypertension, diabetes, and subjective health) were compared. All the questions were self-reported and completed using structured questionnaires.

The SCA rate was defined as the percentage of all current smokers who had attempted to quit smoking for more than 24 h in the past year. Walking practices were classified as “yes” if walking for more than 30 min a day for more than 5 days a week during the recent week and “no” if not. High-risk drinking refers to drinking more than seven drinks for men and more than five drinks for women more than twice a week (Korea Disease Control and Prevention Agency, 2021; Korea Disease

Control and Prevention Agency, 2022). Strenuous physical activity refers to “physical activity that makes the body a little harder than usual or causes shortness of breath,” whereas moderate physical activity means “physical activity that makes the body a little harder than usual or makes breathing slightly short of breath.”

In responding to the question regarding subjective stress, “How much stress do you feel in your daily life?,” the respondents were asked to choose from “very much,” “much,” “less,” or “much less.” Depression was rated as “yes” if they had experienced depression (sadness or despair, etc.) that interfered with their daily life for more than two consecutive weeks in the past year; if not, it was classified as “no.” Hypertension and diabetes were classified as “yes” if diagnosed by a doctor and “no” otherwise. Subjective health was assessed using the question, “How would you rate your health?” This variable was classified as “bad,” “common,” or “good.” Changes in behavior and health status related to SCA were compared using χ^2 statistics, and related factors were confirmed using multiple logistic regression analysis. Additionally, the statistical significance of the odds ratio of variables related to SCA by year was confirmed through the p-value for trend (significance of interaction terms of survey year*variables), which is the odds ratio of variables affecting SCA by year. It means that the change is statistically significant. Ethical approval was obtained from the Institutional Ethics Committee of the university to which the researcher belonged (IRB; D University approval number:1041493-E-2022-003).

3. Results

Table 1 presents the rate of SCA among smokers by year, which was high at 72.6 % in 2019 but decreased significantly to 47.7 % in 2020 and 44.1 % in 2021. The changes in the rate of SCA by subject characteristics and year are shown in Table 2. The proportion of smokers is higher in males, but the rate of SCA is higher in females. In terms of age groups, although the rate of SCA was high in those aged >60 years in 2019, the rate of SCA was highest in 2020 and 2021 for those aged 19–29. The rate of SCA among apartment residents was higher than among house residents. In 2019, the rate of SCA was higher among people living with their families than among people living alone, but in 2020 and 2021, the rate of SCA among people living alone was higher than among people living with their families. By household monthly income, the rate of SCA was highest in all years among those with an income of less than 2 million won. Regarding education level, the rate of SCA was highest among elementary school graduates or lower in 2019, but it was highest among university graduates in 2020 and 2021. In terms of occupation, the rate of SCA was highest among the unemployed in all years.

Table 3 shows the change in SCA rate according to health status and health behavior. Overall, the rate of SCA decreased in 2020 and 2021 compared with 2019, but people with the same characteristics showed a higher pattern of SCA in 2019. People who engaged in walking practice; were not high-risk alcohol drinkers; slept less than 6 h a day; did strenuous exercise for more than 30 min a week; did moderate-intensity exercise for more than 30 min; experienced depression in the past 2 weeks (those with a total score of 10 or more as measured by the PHQ-9); and had high blood pressure, diabetes, and poor subjective health showed a higher rate of SCA. The SCA rate showed different patterns of weight control efforts and subjective stress.

The factors related to SCA are listed in Table 4. First, in the

Table 1

Proportions of subjects by smoking cessation attempts and years: n (%).

	Survey year	Smoking cessation attempts		Total	χ^2 (p-value)
		Yes	No		
	2019	61,784(72.6)	22,342(27.4)	84,126(51.2)	2532243.359 (p < 0.000)
	2020	18,267(47.7)	21,640(52.3)	39,907(24.3)	
	2021	17,207(44.1)	23,094(55.9)	40,301(24.5)	
	Total	97,258(59.0)	67,076(41.0)	164,334(100.0)	

Table 2
Socioeconomic characteristics of subjects according to smoking cessation attempts in 2019, 2020, and 2021 (unit: weighted row %).

		2019				2020				2021						
		Smoking cessation attempts		<i>n</i>	%	χ^2	Smoking cessation attempts		<i>n</i>	%	χ^2	Smoking cessation attempts		<i>n</i>	%	χ^2
		Yes	No			(<i>p</i> -value)	Yes	No			(<i>p</i> -value)	Yes	No			(<i>p</i> -value)
		(72.6 %) (27.4 %)					(47.7 %) (52.3 %)					(44.1 %) (55.9 %)				
Sex	Male	72.4	27.6	76,429	90.8	4683.5	47.2	52.8	36,304	91.4	9306.9	43.7	56.3	36,512	91.1	5638.3
	Female	75.0	25.0	7,697	9.2	(<i>p</i> < 0.001)	53.1	46.9	3,603	8.6	(<i>p</i> < 0.001)	48.2	51.8	3,789	8.9	(<i>p</i> < 0.001)
Age group	19–29	62.9	37.1	6,148	12.6	388162.9	50.9	49.1	5,108	17.5	16722.5	47.4	52.6	5,021	18.0	10951.6
	30–39	69.6	30.4	9,567	16.2	(<i>p</i> < 0.001)	46.0	54.0	5,819	19.2	(<i>p</i> < 0.001)	43.0	57.0	5,809	18.1	(<i>p</i> < 0.001)
	40–49	69.3	30.7	14,780	22.0		47.1	52.9	9,275	25.6		44.5	55.5	9,137	24.8	
	50–59	71.5	28.5	17,693	22.7		47.3	52.7	9,425	22.0		42.4	57.6	9,392	22.3	
	60–69	80.3	19.7	17,707	14.3		50.5	49.5	6,648	10.8		44.4	55.6	7,229	11.7	
	Over 70	86.0	14.0	18,231	12.3		42.2	57.8	3,632	4.9		42.2	57.8	3,713	5.1	
Housing type	House	69.7	30.3	50,860	45.6	59934.3	46.1	53.9	23,777	48.2	8332.2	42.8	57.2	23,878	47.8	5498.2
	Apartment	75.1	24.9	33,266	54.4	(<i>p</i> < 0.001)	49.2	50.8	16,130	51.8	(<i>p</i> < 0.001)	45.3	54.7	16,423	52.2	(<i>p</i> < 0.001)
Living alone	Alone	67.0	33.0	11,570	12.0	36375.8	49.1	50.9	7,058	16.2	1327.4	46.0	54.0	8,131	18.9	2961.5
	With family members	73.4	26.6	72,494	88.0	(<i>p</i> < 0.001)	47.4	52.6	32,848	83.8	(<i>p</i> < 0.001)	43.7	56.3	32,170	81.1	(<i>p</i> < 0.001)
Household monthly income (unit: ten thousand won)	Less than 200	75.1	24.9	24,529	18.3	13030.1	49.5	50.5	9,864	17.9	3427.1	45.4	54.6	9,783	17.4	4206.317
	200–400	71.6	28.4	26,377	31.3	(<i>p</i> < 0.001)	47.8	52.2	13,356	33.5	(<i>p</i> < 0.001)	44.1	55.9	13,086	32.1	(<i>p</i> < 0.001)
	400–600	72.1	27.9	19,615	28.6		46.7	53.3	9,867	28.0		42.6	57.4	10,126	28.2	
	Over 600	73.1	26.9	13,006	21.8		46.9	53.1	6,458	20.5		45.2	54.8	7,088	22.3	
Education level	Below elementary	77.7	22.3	13,891	8.0	64686.5	43.9	56.1	3,902	5.2	11655.7	42.5	57.5	3,697	4.8	10910.9
	Middle	75.7	24.3	10,743	8.8	(<i>p</i> < 0.001)	48.3	51.7	3,809	6.5	(<i>p</i> < 0.001)	42.1	57.9	3,704	6.2	(<i>p</i> < 0.001)
	High school	69.1	30.9	29,122	34.7		45.9	54.1	15,632	37.7		42.3	57.7	15,818	37.2	
Marital status	University	73.8	26.2	30,290	48.5		49.4	50.6	16,522	50.6		45.8	54.2	17,051	51.8	
	Married	76.7	23.3	61,017	68.9	325253.6	47.3	52.7	23,229	55.7	891.6	44.0	56.0	23,259	55.3	825.9
	Divorced/ Separated	68.8	31.2	10,382	9.5	(<i>p</i> > 0.000)	48.8	51.2	6,300	12.2	(<i>p</i> < 0.001)	45.4	54.6	6,509	12.4	(<i>p</i> < 0.001)
Occupation	Single	61.6	38.4	12,642	21.6		48.0	52.0	10,346	32.1		43.9	56.1	10,514	32.3	
	Professional administrators	76.1	23.9	8,534	18.8	67555.7	48.9	51.1	4,348	17.6	6832.4	45.4	54.6	4,710	18.7	7934.6
	Office workers	74.2	25.8	7,451	16.5	(<i>p</i> < 0.001)	48.1	51.9	3,953	16.0	(<i>p</i> < 0.001)	44.4	55.6	4,097	16.7	(<i>p</i> < 0.001)
	Sales and service jobs	68.6	31.4	9,801	18.4		48.2	51.8	5,575	19.9		44.6	55.4	5,317	19.1	
	Agriculture, forestry, fishing	74.3	25.7	11,546	5.5		42.1	57.9	3,852	3.7		40.5	59.5	3,889	3.8	
	Laborer	68.5	31.5	23,671	40.3		46.2	53.8	12,925	42.2		42.3	57.7	13,090	41.1	
	Unemployed	76.9	23.1	454	0.6		54.3	45.7	249	0.5		55.1	44.9	296	0.6	
Total	<i>N</i>	61,784	22,342	84,126			18,267	21,640	39,907			17,207	23,094	40,301		

Table 3
Health behaviors and health status of subjects according to smoking cessation attempts in 2019, 2020, and 2021 (unit: weighted row %).

		2019					2020					2021				
		Smoking cessation attempts		n	%	χ^2 (p-value)	Smoking cessation attempts		n	%	χ^2 (p-value)	Smoking cessation attempts		n	%	χ^2 (p-value)
		Yes	No				Yes	No				Yes	No			
Walking practices	Yes	73.5	26.5	35,067	46.5	5925.265	50.1	49.9	16,207	43.7	15941.809	46.4	53.6	17,058	46.2	15043.224
	No	71.9	28.1	49,059	53.5	(p < 0.001)	45.8	54.2	23,700	56.3	(p < 0.001)	42.2	57.8	23,243	53.8	(p < 0.001)
High-risk alcohol drinking	Yes	65.2	34.8	23,551	30.4	203933.66	43.2	56.8	9,658	24.8	23011.061	40.5	59.5	10,030	24.6	14858.019
	No	75.9	24.1	60,575	69.6	(p < 0.001)	49.2	50.8	30,249	75.2	(p < 0.001)	45.3	54.7	30,271	75.4	(p < 0.001)
Weight control	To lose weight	77.2	22.8	28,244	39.3	174394.51	53.6	46.4	13,789	39.6	151445.68	49.7	50.3	13,486	38.0	131541.3
	To maintain weight	74.8	25.2	12,925	16.8	(p < 0.001)	48.6	51.4	5,450	14.9	(p < 0.001)	45.0	55.0	6,162	16.3	(p < 0.001)
	To gain weight	71.0	29.0	6,361	7.9		55.2	44.8	3,120	8.0		50.7	49.3	3,423	8.6	
	None	67.0	33.0	36,592	35.9		39.5	60.5	17,548	37.6		36.5	63.5	17,230	37.0	
Sleeping hours	Less than 6 h	73.8	26.2	13,855	16.1	3363.77	50.3	49.7	4,616	10.4	3464.555	46.1	53.9	5,416	11.9	2530.645
	6–7 h less	72.9	27.1	24,861	32.0	(p < 0.001)	47.6	52.4	9,314	22.9	(p < 0.001)	44.1	55.9	9,885	24.3	(p < 0.001)
	7–8 h less	72.2	27.8	26,132	32.0		46.8	53.2	13,170	34.1		44.3	55.7	12,901	33.4	
	More than 8 h	71.9	28.1	19,278	19.9		47.9	52.1	12,794	32.6		43.3	56.7	12,087	30.5	
Strenuous physical activity (/week)	Less than 30 min	71.1	28.9	61,015	68.9	44180.711	45.5	54.5	29,596	72.4	45012.458	41.3	58.7	30,044	71.6	72896.885
	30–150 min less	77.2	22.8	6,840	10.3	(p < 0.001)	55.2	44.8	3,251	9.7	(p < 0.001)	52.1	47.9	3,488	10.7	(p < 0.001)
	More than 150 min	75.4	24.6	16,202	20.8		52.5	47.5	7,043	17.9		50.9	49.1	6,742	17.7	
Moderate physical activity (/week)	Less than 30 min	70.7	29.3	51,630	60.9	60084.087	45.5	54.5	26,075	65.6	33732.572	41.8	58.2	26,776	66.2	36547.631
	30–150 min less	78.2	21.8	9,092	13.1	(p < 0.001)	53.7	46.3	4,311	12.6	(p < 0.001)	49.6	50.4	4,324	12.9	(p < 0.001)
	More than 150 min	74.4	25.6	23,344	26.0		50.8	49.2	9,504	21.7		48.0	52.0	9,174	21.0	
Subjective stress	Very much	69.6	30.4	2,752	3.9	47213.53	49.6	50.4	2,016	5.8	6631.622	47.3	52.7	2,035	5.7	5430.655
	Much	69.9	30.1	16,654	22.9	(p < 0.001)	49.6	50.4	9,729	27.5	(p < 0.001)	45.1	54.9	9,593	25.8	(p < 0.001)
	Less	72.5	27.5	43,955	54.1		47.0	53.0	20,265	51.2		44.0	56.0	20,651	52.1	
	Much less	76.9	23.1	20,731	19.2		45.9	54.1	7,893	15.6		42.0	58.0	8,019	16.4	
Depression	Yes	75.3	24.7	4,800	6.1	3890.221	57.9	42.1	2,487	6.9	26493.866	52.7	47.3	3,031	7.6	21261.142
	No	72.5	27.5	79,295	93.9	(p < 0.001)	47.0	53.0	37,410	93.1	(p < 0.001)	43.4	56.6	37,267	92.4	(p < 0.001)
Hypertension	Have	79.9	20.1	24,836	23.3	132822.32	48.1	51.9	8,390	17.5	99.845	44.9	55.1	8,911	18.2	493.425
	None	70.5	29.5	59,279	76.7	(p < 0.001)	47.6	52.4	31,512	82.5	(p < 0.001)	44.0	56.0	31,387	81.8	(p < 0.001)
Diabetes	Have	79.4	20.6	11,586	10.7	46227.475	50.3	49.7	4,325	8.9	2259.289	45.4	54.6	4,766	9.6	582.282
	None	71.8	28.2	72,524	89.3	(p < 0.001)	47.5	52.5	35,579	91.1	(p < 0.001)	44.0	56.0	35,533	90.4	(p < 0.001)
Subjective health	Bad	76.7	23.3	16,504	14.7	24287.204	50.0	50.0	3,801	7.8	1526.08	45.6	54.4	4,848	9.7	1278.45
	Common	71.9	28.1	38,212	47.4	(p < 0.001)	47.5	52.5	15,760	39.3	(p < 0.001)	43.6	56.4	17,853	43.8	(p < 0.001)
	Good	71.9	28.1	29,405	38.0		47.5	52.5	20,344	52.9		44.4	55.6	17,599	46.5	

Table 4
The changes of smoking cessation attempts related factors and their influences by year of 2019, 2020, and 2021.

Variables		2019				2020				2021				<i>P</i> for trend
		Odds ratio	95 % CI		<i>P</i> -value	Odds ratio	95 % CI		<i>P</i> -value	Odds ratio	95 % CI		<i>P</i> -value	
			Lower	Upper			Lower	Upper			Lower	Upper		
Sex (ref. men)	Women	1.163	1.155	1.171	<0.001	1.241	1.232	1.249	<0.001	1.157	1.149	1.164	<0.001	<0.001
Age group	19–29 years	0.300	0.296	0.303	<0.001	1.118	1.103	1.134	<0.001	1.096	1.082	1.111	<0.001	<0.001
	30–39 years	0.327	0.324	0.330	<0.001	0.933	0.921	0.945	<0.001	0.896	0.884	0.908	<0.001	<0.001
	40–49 years	0.327	0.324	0.330	<0.001	1.022	1.010	1.035	<0.001	0.958	0.946	0.970	<0.001	<0.001
	50–59 years	0.374	0.370	0.377	<0.001	1.078	1.064	1.091	<0.001	0.877	0.866	0.888	<0.001	<0.001
	60–69 years	0.633	0.628	0.639	<0.001	1.322	1.305	1.338	<0.001	0.911	0.900	0.922	<0.001	<0.001
Housing (ref. apartment)	House	0.800	0.798	0.803	<0.001	0.894	0.891	0.897	<0.001	0.939	0.936	0.942	<0.001	<0.001
Living (ref. with family)	Alone	1.045	1.040	1.050	<0.001	1.063	1.058	1.069	<0.001	1.196	1.190	1.202	<0.001	<0.001
Monthly income	Less than 200	0.987	0.982	0.993	<0.001	1.223	1.215	1.231	<0.001	1.102	1.095	1.109	<0.001	<0.001
	200–400	1.031	1.027	1.034	<0.001	1.097	1.092	1.101	<0.001	1.046	1.041	1.050	<0.001	<0.001
	400–600	1.004	1.001	1.008	0.017	1.037	1.032	1.041	<0.001	0.956	0.952	0.960	<0.001	<0.001
Education level	Middle school	1.208	1.195	1.222	<0.001	1.093	1.081	1.106	<0.001	0.940	0.929	0.951	0.058	<0.001
	High school	1.215	1.203	1.228	<0.001	1.040	1.029	1.050	<0.001	0.935	0.925	0.945	<0.001	<0.001
	University of higher	1.379	1.364	1.394	<0.001	1.184	1.172	1.196	<0.001	1.017	1.006	1.028	<0.001	<0.001
Marital status (ref. single)	Married	1.551	1.545	1.558	<0.001	1.138	1.133	1.144	<0.001	1.335	1.328	1.342	<0.001	<0.001
	Divorced/ Separated	1.032	1.026	1.038	<0.001	1.116	1.109	1.123	<0.001	1.323	1.315	1.332	<0.001	<0.001
Occupation	Office workers	0.970	0.966	0.974	<0.001	0.993	0.988	0.998	0.009	0.975	0.970	0.980	<0.001	<0.001
	Sales and service jobs	0.836	0.832	0.839	<0.001	1.011	1.006	1.016	<0.001	0.983	0.978	0.988	<0.001	<0.001
	Agriculture, forestry and fishing	0.831	0.825	0.837	<0.001	0.843	0.835	0.851	<0.001	0.917	0.908	0.926	<0.001	<0.001
	Simple labor work	0.825	0.822	0.828	<0.001	1.001	0.996	1.006	0.659	0.967	0.963	0.972	<0.001	<0.001
	Unemployed	1.057	1.038	1.076	<0.001	1.129	1.106	1.153	<0.001	1.213	1.189	1.237	<0.001	<0.001
Walking practices (ref. yes)	No	0.979	0.976	0.981	<0.001	0.874	0.872	0.877	<0.001	0.892	0.889	0.895	<0.001	<0.001
High-risk drinker (ref. yes)	No	1.182	1.178	1.186	<0.001	1.265	1.219	1.270	<0.001	1.219	1.215	1.223	<0.001	<0.001
Weight control (ref. none)	To lose weight	1.640	1.634	1.646	<0.001	1.685	1.679	1.692	<0.001	1.626	1.620	1.632	<0.001	<0.001
	To maintain weight	1.328	1.322	1.334	<0.001	1.327	1.321	1.334	<0.001	1.331	1.324	1.337	<0.001	<0.001
	To gain weight	1.672	1.662	1.682	<0.001	1.724	1.714	1.735	<0.001	1.707	1.697	1.717	<0.001	<0.001
Sleeping hours	Less than 6 h	1.121	1.116	1.126	<0.001	1.072	1.066	1.078	<0.001	1.102	1.096	1.109	<0.001	<0.001
	6–7 h less	1.056	1.052	1.060	<0.001	0.955	0.951	0.959	<0.001	0.992	0.988	0.996	<0.001	<0.001
	7–8 h less	1.023	1.019	1.027	<0.001	0.948	0.944	0.951	<0.001	1.022	1.018	1.026	<0.001	<0.001
Strenuous physical activity (/week) (ref. more than 150 min)	Less than 30 min	0.791	0.789	0.794	<0.001	0.853	0.850	0.857	<0.001	0.764	0.761	0.767	<0.001	<0.001
	30–150 min less	1.054	1.048	1.059	<0.001	1.079	1.072	1.085	<0.001	0.994	0.988	1.000	0.046	<0.001
Moderate physical activity (/week) (ref. more than 150 min)	Less than 30 min	0.926	0.923	0.929	<0.001	0.896	0.893	0.900	<0.001	0.930	0.927	0.934	<0.001	<0.001
	30–150 min less	1.212	1.207	1.218	<0.001	1.072	1.066	1.078	<0.001	1.094	1.087	1.100	<0.001	<0.001
Subjective stress	Much	0.896	0.889	0.903	<0.001	1.038	1.030	1.045	<0.001	0.916	0.909	0.922	<0.001	<0.001
	Less	0.827	0.820	0.833	<0.001	0.993	1.986	1.000	0.050	0.912	0.905	0.918	<0.001	<0.001
	Much less	0.948	0.940	0.957	<0.001	1.050	1.042	1.059	<0.001	0.926	0.919	0.933	<0.001	<0.001
Depression (ref. yes)	No	0.735	0.730	0.740	<0.001	0.752	0.747	0.758	<0.001	0.779	0.774	0.784	<0.001	<0.001
Hypertension (ref. none)	Have	1.188	1.184	1.193	<0.001	0.953	0.948	0.957	<0.001	1.055	1.050	1.060	<0.001	<0.001
Diabetes (ref. none)	Have	1.055	1.049	1.060	<0.001	1.069	1.062	1.075	<0.001	1.049	1.043	1.055	<0.001	<0.001
Subjective Health (ref. good)	Bad	1.038	1.033	1.043	<0.001	1.048	1.040	1.056	<0.001	1.014	1.007	1.021	<0.001	0.007
	Common	0.970	0.968	0.973	<0.001	0.999	0.996	1.003	0.728	0.993	0.990	0.997	<0.001	0.002

95 % CI = 95 % confidence interval.

relationship between sociodemographic factors and SCA, women's SCA was 1.157–1.241 times higher than that of men, with little change by year; compared to those in their 70 s or older, who had the highest SCA in 2019, the SCA rate of those aged 19–29 years was 1.118 times and 1.096 times higher, respectively, in 2020 and 2021. Compared with apartment dwellers, the odds of SCA for people living in houses were approximately 0.800–0.939 times lower. The odds of SCA for those living alone compared to those living with family increased slightly, from 1.045 times in 2019 to 1.196 times in 2021. In terms of education level, the odds of SCA were 1.208–1.379 times higher in 2019 for those with more than elementary school education than for those with only elementary school education; however, in 2021, only for college graduates, the odds of SCA was 1.017 times higher than for elementary school graduates. In addition, the odds of SCA were higher for the married or divorced/bereaved than for the single. In 2019, married persons' SCA odds were 1.551 times higher; in 2021, the SCA odds for married persons were 1.335 times higher and for divorced/separated people were 1.323 times higher than those for singles. In terms of occupation, the unemployed, including housewives and students, had a higher SCA rate than professional administrators, which increased gradually from 1.057 times higher in 2019 to 1.129 times in 2020 and 1.213 times in 2021.

In terms of the relationship between health behavior, health status, and SCA, the odds of SCA of those who did not practice walking were lower than that of those who practiced walking, and the odds of SCA of non-high-risk drinkers were higher than those of high-risk drinkers, ranging from 1.182 to 1.265. In addition, the odds of SCA were higher in those who tried to lose, maintain, or increase their weight than in those who did not make any effort to control their weight, and the pattern by year was similar. Most of those who engaged in 30–150 min of strenuous physical activity or moderate physical activity presented higher odds of SCA than those who engaged in more than 150 min of moderate physical activity per week. However, in 2021, people who performed between 30 and 150 min of strenuous physical activity per week had a lower SCA than those who performed more than 150 min of strenuous physical activity. Regarding health status and SCA, the odds of SCA were significantly lower in the case of “much less” stress or more than “very much,” and the pattern was similar in all years. Depression, hypertension, diabetes, and subjective health were significantly associated with SCA. Compared to those without hypertension, the SCA of patients with diabetes was 1.055–1.188 times higher in 2019 and 2021 but decreased to 0.953 times in 2020 (Table 4). In addition, one important result was explained by comparing the change in relevance by year and factor, but the most important change was the change in explanatory power of the entire analysis model. The change in R^2 , which indicates the explanatory power of the model, decreased significantly from 56.8 % in 2019 to 4.4 % in 2020 and 4.3 % in 2021.

4. Discussion

Compared to 2019, the influence of personal factors on SCA significantly decreased in 2020 and 2021, and it is judged that the influence of personal factors decreased owing to social distancing, quarantine, and restrictions on various social activities under COVID-19. The results showed that social programs enabling daily health promotion and management should be strengthened. The smoking rate in South Korea decreased to 21.5 %, 20.6 %, and 19.3 % in 2019, 2020, and 2021, respectively, compared to 25.8 % in 2012. This indicated a decrease of 6.5 percentage points over the last decade. (Korea Disease Control and Prevention Agency, 2023). Considering that the subjects of this study are smokers, it is natural that sample size will be reduced given the decreasing smoking rate. Therefore, the number of eligible participants in 2019 may be higher than that in 2020 and 2021. A decrease in smoking rates means an increase in the proportion of people who have attempted and succeeded in SC. These people, who are not current smokers, are not included in this study. In this study, the SCA rate is for

current smokers who have made an effort to quit. An increase in the proportion of current smokers who do not attempt to quit can predict the rate of decrease in smoking in the future.

First, women had higher SCA rates than men, which did not change significantly during the COVID-19 pandemic. A previous study showed that the smoking rate of women was lower than that of men, but attempts to quit smoking were high (Ayo-Yusuf and Szymanski, 2010). COVID-19 lowered SCA in all age groups, but it was clear that it lowered SCA the most in those in their 70 s and above. According to previous studies, SCA increases with age (Ayo-Yusuf and Szymanski, 2010; Hiscock et al., 2011). However, it was confirmed that SCA decreased the most for those in their 70 s during the COVID-19 pandemic, and the possibility of health promotion for the elderly decreased during this period. In addition, in the case of those in their 20 s, the decrease in SCA was the lowest, but compared to other age groups, the SCA in this age group was lower before the COVID-19 pandemic, so it is necessary to consider this in health promotion interventions. Additionally, regarding education level, the change in SCA was smaller in college graduates or higher than in elementary school graduates or lower, and the odds of SCA remained similar from 2019 to 2021. In terms of occupation, the rate of decrease in SCA for unemployed people was lower than that of other occupational groups. As a result, the odds of SCA compared to professional administrators increased from 1.057 times in 2019 to 1.213 times in 2021. Several studies have shown that highly educated people have more SCA than other educated people (Hiscock et al., 2011; Pizacani et al., 2018), because highly educated people tended to be more motivated toward a healthy life and adopt a positive attitude toward healthcare during the COVID-19 pandemic than other groups. In addition, it is speculated that the unemployed experienced less change in their lives than the employed, and in the case of SCA, the change was small. In the study by Pizacani et al. (2018), when identifying the long-term success rate over five years, it was mentioned that people with low socioeconomic status needed regular support because of the low success rate.

Non-high-risk drinkers had a lower reduction in SCA than high-risk drinkers, resulting in an increase in the odds of SCA during the COVID-19 pandemic. This is consistent with the finding of many studies that many smokers are drinkers, and indeed that many smokers are high-risk drinkers (van Amsterdam and van den Brink, 2023). Therefore, it may be a natural consequence that there was less of a reduction in SCA among non-high-risk drinkers. The odds of SCA were higher in the group that made efforts to lose weight than among those who made no effort to lose weight, and there was little change due to the COVID-19 pandemic. It is judged that high SCA in people who make efforts to control their weight can be interpreted as another healthy behavior of people who do healthy behaviors (Wee et al., 2001). Wee et al. (2001) found that smoking rates were lower in individuals trying to maintain or lose weight. The SCA continued to be higher for those who slept less than 6 h than for those who slept more than 8 h, but the odds of SCA decreased during the COVID-19 pandemic as the proportion of SCA decreased. It was difficult to find any studies that showed that people who slept less had more health behaviors or higher SCAs than those who slept much more. However, McNamara et al. (2014) reported that present smokers and former smokers had more sleep disturbance than non-smokers; therefore, further research on SCA and sleep time should be conducted in the future.

The odds of SCA in people with diabetes remained slightly higher at 1.049–1.069 compared to people without diabetes, and the odds of SCA in people with hypertension were higher than those of people without hypertension, but decreased (from 1.188 to 0.953) from 2019 to 2020 and increased to 1.055 (95 % CI: 1.050–1.060) in 2021. It is encouraging to see that the SCA of diabetic and hypertensive people is higher than that of people without the disease, but it is not very high; therefore, it will be necessary to educate them about the need for SCA. In addition, it may be an important health promotion task to ensure successful SCAs during the COVID-19 pandemic (Holm et al., 2017); the rate of SCA in

people with diabetes was found to be approximately 13 % lower than in people without diabetes, and the rate of SCA in people with hypertension was approximately 1 % higher than in people without hypertension. These results differ slightly from those of the present study. In individuals with depression, the odds of SCA continued to be lower in the absence of depression than in the presence of depression (0.735–0.799), which should be confirmed in further studies. Haukkala et al. (2000) found that a high depression score indicates low SCA self-efficacy, supporting the results of this study.

During the COVID-19 pandemic, access to smoking cessation services decreased, or the form of smoking cessation services changed, which may have led to a decrease in SCA. Many smoking cessation services have shifted to non-face-to-face and telephone modes, and it is predicted that the service utilization rate has decreased owing to people's fear of COVID-19 infection (Kim et al., 2022). In the future, smoking cessation services should be further activated so that the rate of SCA can be restored to its original state. Moreover, SCA tends to increase with age. As explained above, the smoking rate in Korea is decreasing (Korea Disease Control and Prevention Agency, 2023), and the participants of this study are smokers; thus, the proportion of elderly people decreased in 2020 and 2021 compared to those in 2019. This could have affected the decreased rate of SCA in 2020–2021.

This study had some limitations. The amount of smoking and number of previous quits were not examined in this study, and the age at which smoking started, whether nicotine supplements were used, whether drug supplements were used, etc., were unknown and could not be reflected. However, this study examined the changes in SCA before and after the COVID-19 pandemic and related factors in terms of socioeconomic characteristics, health behaviors, and health status in a population group representative of the entire population of South Korea. This will help to establish a strategy for health promotion in Korea in the future, especially for interventions to support smoking cessation.

5. Ethics approval and consent to participate

The ethics committee of Dongseo University approved of this study. The committee's reference number is 1041493-E-2022-003. All methods were carried out in accordance with relevant guidelines and regulations.

6. Authors' contributions

Study concept and design: HYL; acquisition of data: HYL; analysis and interpretation of data: HYL and SL; drafting the manuscript: HYL, SL, and GK; critical revision of the manuscript: HYL, SL, and GK; study supervision: HYL, SL, and GK.

7. Declaration of generative AI and AI-assisted technologies in the writing process

Nothing to disclose.

8. Consent for publication

Not applicable.

Competing interests

All authors declare no conflict of interest (no potential conflict of interest was reported by authors).

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CRedit authorship contribution statement

Hyo Young Lee: Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Seung Hun Lee:** Writing – original draft, Validation, Supervision, Investigation, Formal analysis, Conceptualization. **Gyu Lee Kim:** Writing – original draft, Validation, Supervision, Investigation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available from the Korea Disease Control and Prevention Agency but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission from the Korea Disease Control and Prevention Agency.

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