

# Trends in prevalence of smoking in South Korea, 2014-2021: A post-hoc secondary analysis

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## Abstract

Little is known about how the COVID-19 pandemic will comprehensively affect prevalence of cigarette and e-cigarette smoking. Through a post-hoc secondary analysis from a nationwide, long-term serial, and representative study of 1.2 million individuals, the prevalence of traditional smoking decreased less than expected during the pandemic; however, that of e-cigarette smoking decreased. Our results provide an improved epidemiological understanding of smoking status before and during the COVID-19 pandemic, and suggest that more individualized and precise strategies to prevent and quit smoking are needed to improve public and global health during the pandemic.

**Keywords:** COVID-19, pandemic, Korea, smoking, smoker, cigarette, e-cigarette

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## 1. Introduction

Previous studies reported that the COVID-19 pandemic affected trends in the prevalence of smoking; however, the results are inconclusive owing to small sample sizes, inadequate study designs, non-representative enrolled samples, short-term follow-up periods including only the early pandemic (2020), and non-comprehensive smoking type (i.e., only traditional smoking usage).[1, 2]

The hypothesis of our study was that the COVID-19 pandemic will affect cigarette smoking and e-cigarette usage, compared to before the pandemic. In the past, we published preliminary research findings; however, we have since elaborated on additional papers through a more comprehensive analysis.[3] Consequently, our objective was to conduct a thorough examination of the enduring prevalence of cigarette smoking and e-cigarette usage both prior to (2014 to 2019) and during the COVID-19 pandemic (2020 to 2021) within the Korean adult population.

## 2. Methods

We aimed to investigate the long-term prevalence of cigarette and e-cigarette smoking before (2014 to 2019) and during the COVID-19 pandemic (2020 to 2021) among Korean adults. Data were obtained from the Community Health Survey (CHS) between 2014 and 2021 (nationwide long-term serial study). The data utilized in this study were derived from the Community Health Survey (CHS), conducted by the Korea Disease Control and Prevention

Agency (KDCA).[3, 4] Korean adults (age  $\geq 19$  years) were enrolled and their baseline information, body measurements, and health-related outcomes were obtained (n=1,539,982). The protocol used in the study was approved by the Korea Disease Control and Prevention Agency (KDCA). Every participant provided written informed consent at the time of their enrollment into the study. In our previous study, we provided a demographic description of the population distribution.[3]

Smoking was considered as having smoked a cigarette or an e-cigarette within the last year. Current smokers were divided into two groups: traditional smokers (cigarettes) and e-cigarette smokers.

We included age (19 to 39, 40 to 59, and  $\geq 60$  years), sex, residence region (urban areas [Seoul, Gyeonggi, Incheon, Daejeon, Sejong, Gwangju, Ulsan, Daegu, and Busan] and rural areas [Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam, and Jeju]),[5, 6] basic livelihood security recipient, household income (low, middle-low, middle-high, and high), education background (less than elementary school, middle school, high school, and above than college), occupational group (white-collar, blue-collar, soldier, and unemployed), marital status, subjective health level (good, normal, and bad), walking activities ( $\leq 1$ , 2 to 4, and  $\geq 5$  times/week), body mass index (BMI, kg/m<sup>2</sup>; underweight [ $<18.5$ ], normal [ $18.5$  to  $23$ ], overweight [ $23$  to  $25$ ], and obese [ $\geq 25$ ]),[7] and depressive experience within one year.

A post-hoc secondary analysis was performed separately by age group (19 to 39, 40 to 59, and  $\geq 60$  years), sex (male and female), residence region (urban and rural), basic livelihood security recipient, income (low, middle-low, middle-high, and high), education background (elementary school or less, middle school, high school, and college or more), occupational group (white-collar, blue-collar, soldier, and unemployed), marital status (married or single), subjective health level (good, normal, and bad), walking practice days ( $\leq 1$ , 2–4, and  $\geq 5$  times/week), BMI group (underweight, normal, overweight, and obese), and depressive experience. Statistical analyses were performed using the SAS software (version 9.4; SAS Institute, Cary, NC, USA). A two-sided p value  $<0.05$  was considered statistically significant.

### 3. Discussion

The study sample consisted of adults (aged  $\geq 19$  years) living in South Korea between 2014 and 2021 (Table 1). Smoking was considered as having smoked a cigarette (traditional smoker) or an e-cigarette (e-cigarette smoker) within the previous year (Fig. 1). 1,282,599 adults were included from 2014 to 2021, and the prevalence of total, traditional, and e-cigarette smokers were 22.4% (22.3 to 22.5; 95% CI), 20.8% (20.8 to 20.9; 95% CI), and 1.5% (1.5 to 1.6; 95% CI), respectively.[3] The prevalence of total and traditional smokers decreased before the pandemic ( $\beta$  -0.047 [95% CI, -0.051 to -0.044] and  $\beta$  -0.074 [95% CI, -0.078 to -0.070]); however, they decreased less than expected during the pandemic ( $\beta$  -0.023 [95% CI, -0.026 to -0.020] and  $\beta$  -0.001 [95% CI, -0.005 to 0.002]).[3] E-cigarette smokers increased before the COVID-19 pandemic ( $\beta$  0.247 [95% CI, 0.235 to 0.259]); however, they decreased during the pandemic ( $\beta$  -0.203 [95% CI, -0.212 to -0.193]).[3]

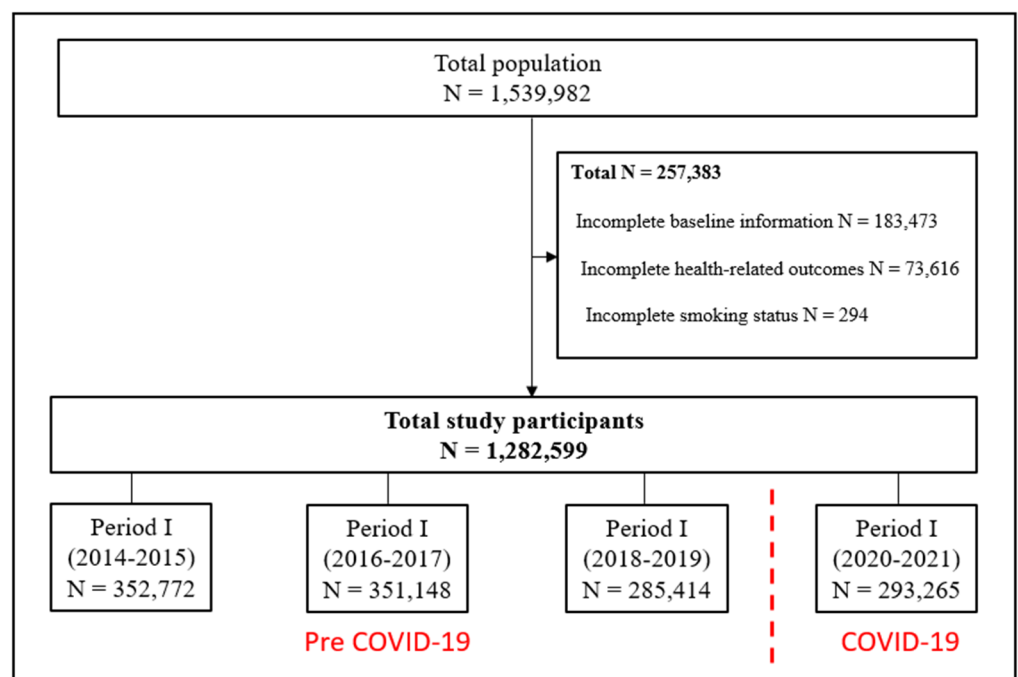
**Table 1.** Basic variables among Korean adults in community health survey, 2014-2021 (Total N= 1,282,599)

	Total smokers	Traditional smokers	E-cigarettes smokers
Overall, % (95% CI)	22.4 (22.3 to 22.5)	20.8 (20.8 to 20.9)	1.5 (1.5 to 1.6)
<b>Age, % (95% CI)</b>			
19~39 years	29.6 (29.4 to 29.7)	27.4 (27.2 to 27.5)	59.4 (58.7 to 60.1)
40~59 years	46.8 (46.6 to 47.0)	47.7 (47.5 to 47.9)	35.0 (34.3 to 35.7)
≥60 years	23.6 (23.5 to 23.8)	25.0 (24.8 to 25.1)	5.6 (5.3 to 5.9)
<b>Sex, % (95% CI)</b>			
Man	90.9 (90.8 to 91.0)	90.9 (90.8 to 91.0)	91.2 (90.8 to 91.6)
Woman	9.1 (9.0 to 9.2)	9.1 (9.0 to 9.2)	8.8 (8.4 to 9.2)
<b>Residence region, % (95% CI)</b>			
Urban	51.2 (51.0 to 51.4)	50.1 (49.9 to 50.2)	66.9 (66.2 to 67.6)
Rural	48.8 (48.6 to 49.0)	49.9 (49.8 to 50.1)	33.1 (32.4 to 33.8)
<b>Basic livelihood security recipient, % (95% CI)</b>			
	4.5 (4.4 to 4.5)	4.7 (4.6 to 4.7)	1.8 (1.7 to 2.0)
<b>Income, % (95% CI)</b>			
Low	13.0 (12.9 to 13.2)	13.6 (13.5 to 13.7)	5.2 (4.9 to 5.6)
Middle-low	35.2 (35.0 to 35.3)	35.7 (35.6 to 35.9)	27.3 (26.7 to 27.9)
Middle-high	30.1 (29.9 to 30.3)	29.8 (29.6 to 30.0)	34.4 (33.7 to 35.0)
High	21.7 (21.6 to 21.9)	20.9 (20.7 to 21.0)	33.1 (32.4 to 33.8)
<b>Education background, % (95% CI)</b>			
Elementary school or less	11.1 (11.0 to 11.3)	11.8 (11.7 to 11.9)	2.1 (1.9 to 2.3)
Middle school	10.3 (10.2 to 10.4)	10.8 (10.7 to 10.9)	3.8 (3.5 to 4.0)
High school	39.0 (38.9 to 39.2)	39.6 (39.4 to 39.7)	31.9 (31.3 to 32.6)
College or more	39.5 (39.3 to 39.7)	37.8 (37.6 to 38.0)	62.2 (61.5 to 62.9)
<b>Occupational group, % (95% CI)</b>			
White-collar	21.2 (21.0 to 21.3)	20.1 (20.0 to 20.3)	35.1 (34.4 to 35.8)
Blue-collar	57.6 (57.4 to 57.8)	58.2 (58.0 to 58.4)	49.2 (48.5 to 49.8)
Soldier	0.7 (0.7 to 0.7)	0.7 (0.6 to 0.7)	1.4 (1.3 to 1.6)
Unemployed	20.5 (20.4 to 20.7)	21.0 (20.8 to 21.1)	14.3 (13.8 to 14.8)
<b>Marital status, yes, % (95% CI)</b>			
	65.4 (65.3 to 65.6)	66.2 (66.0 to 66.3)	55.9 (55.2 to 56.6)
<b>Subjective health level, % (95% CI)</b>			
Good	41.0 (40.8 to 41.1)	40.7 (40.5 to 40.9)	44.7 (44.0 to 45.3)
Normal	44.4 (44.2 to 44.6)	44.4 (44.2 to 44.6)	44.8 (44.1 to 45.5)
Bad	14.6 (14.5 to 14.8)	14.9 (14.8 to 15.1)	10.5 (10.1 to 11.0)
<b>Walking activities, % (95% CI)</b>			
≤1 times/week	29.6 (29.4 to 29.7)	30.0 (29.9 to 30.2)	23.4 (22.8 to 24.0)
2 to 4 times/week	21.0 (20.8 to 21.1)	20.9 (20.7 to 21.0)	22.3 (21.7 to 22.8)

**Table 1.** Continued

	Total smokers	Traditional smokers	E-cigarettes smokers
≥ 5 times/week	49.5 (49.3 to 49.6)	49.1 (48.9 to 49.3)	54.4 (53.7 to 55.1)
<b>BMI group, % (95% CI)</b>			
Underweight	3.6 (3.5 to 3.6)	3.6 (3.5 to 3.7)	2.9 (2.7 to 3.1)
Normal	38.1 (37.9 to 38.3)	38.6 (38.5 to 38.8)	30.6 (30.0 to 31.3)
Overweight	25.2 (25.1 to 25.4)	25.4 (25.2 to 25.6)	23.0 (22.4 to 23.6)
Obese	33.1 (32.9 to 33.3)	32.4 (32.2 to 32.5)	43.4 (42.8 to 44.1)
Depressive experience within one year, yes, % (95% CI)	6.7 (6.6 to 6.8)	6.6 (6.5 to 6.7)	7.6 (7.2 to 8.0)

BMI, body mass index; CI, confidence interval.



**Fig. 1.** Total study participants in CHS, 2014-2021. CHS, community health survey.

#### 4. Plausible mechanism

Our study shows that traditional, total, and e-cigarette smokers tended to decrease less after the pandemic. During the COVID-19 pandemic, increased working from home, time spent alone, prevalence of unemployment, social isolation, and a lack of social contact due to social distancing may lead to loneliness and feeling stressful.[8-11] This plausible mechanism may support our main findings that the prevalence of smokers who were unemployed, and obese increased during the pandemic. In addition, along with growing evidence that e-cigarettes are no longer harmless alternatives to traditional cigarette,[12] preference for e-cigarettes has declined. Also, wearing masks has been legally mandated in South Korea during the COVID-19 pandemic.[13] Therefore, the inconvenience of smoking e-cigarettes indoors has increased, which would have led to a decrease in the e-cigarette smoking status as the result of our study.

## 5. Policy implication

Smoking is associated with an increased risk of respiratory diseases related to COVID-19,[14, 15] and it is necessary to determine the risk of cigarette and e-cigarette use during the COVID-19 pandemic. In particular, the prevalence of smokers who were unemployed and obese have increased during the pandemic. This supports the hypothesis that smokers may have vulnerable factors due to employment instability and economic stress across society due to the influence of the pandemic.[16] Especially, smokers with obesity have an increased risk of heart disease when they have severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection; thus, such individuals as well as physicians should be more careful[17]. A more active and precise strategy to prevent and quit smoking campaign (MPOWER, monitor tobacco use, protect from smoking, offer help to quit smoking, warn about the dangers of smoking, enforce bans on smoking sponsorship, and raise taxes) is needed during and after the pandemic.[18-20]

## 6. Conclusion

Through a post-hoc secondary analysis from a nationwide, long-term serial, and representative study of 1.2 million individuals, the prevalence of traditional smoking decreased less than expected during the pandemic; however, that of e-cigarette smoking decreased. Our results provide an improved epidemiological understanding of smoking status before and during the COVID-19 pandemic, and suggest that more individualized and precise strategies to prevent and quit smoking are needed to improve public and global health during the pandemic.

### Capsule Summary

This brief review paper aims to investigate the long-term prevalence of cigarette and e-cigarette smoking before (2014 to 2019) and during the COVID-19 pandemic (2020 to 2021) in South Korea.

### Patient and public involvement

No patients were directly involved in designing the research question or in conducting the research. No patients were asked for advice on interpretation or writing up the results. There are no plans to involve patients or the relevant patient community in dissemination at this moment.

### Transparency statement

The leading authors (Dr. SYR) are an honest, accurate, and transparent account of the study being reported.

### Acknowledgements

None

### Author Contribution

All authors made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

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### Conflicts of Interest

All authors state that they have no actual or potential conflict of interest including any financial, personal, or other relationships with other people or organizations.

### Provenance and peer review

Not commissioned; externally peer reviewed.

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