

Factors associated with long-term smoking relapse in those who succeeded in smoking cessation using regional smoking cessation programs

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Abstract

It is known that approximately 10% of successful quitters relapse annually. This study aimed to investigate the factors related to long-term smoking relapse in individuals who succeeded in maintaining smoking cessation for 6 months after attending a regional smoking cessation program.

This study enrolled 943 individuals registered for the regional smoking cessation program at the Busan Smoking Cessation Center in 2018–2019 who maintained smoking cessation for 6 months. A survey was conducted using a smartphone link or through phone calls, and the data for 305 participants who finally completed the survey were analyzed. The questionnaire addressed individual, inter-individual, organizational, and community-level factors related to smoking relapse. Multivariate logistic regression analysis was performed to evaluate the factors associated with smoking relapse by period. The Cox proportional hazard regression model was used for the factors associated with smoking relapse for the entire period.

The smoking relapse rate at the time of the survey was 25.4%. In the analysis of smoking relapse by period, relapse was associated with the belief that smoking relieves stress, the number of single-person households, and poor subjective health status. In the analysis of smoking relapse during the entire period, we observed a significant association with the belief that smoking relieves stress (hazard ratio [HR]: 2.65, 95% confidence interval [CI]: 1.52–4.61), single-person households (HR: 1.95, 95% CI: 1.16–3.26), and high levels of emotional stress (HR: 1.72, 95% CI: 1.04–2.85).

Long-term follow-up is necessary to prevent smoking relapse in single-person households, individuals who believe that smoking relieves stress, and those experiencing high levels of subjective emotional stress. Interventional therapies for stress relief and awareness improvement in smokers need to be developed.

Abbreviations: CAGE = cut-down, annoyed, guilty and eye-opener, CI = confidence interval, FCTC = framework convention on tobacco control, HR = hazard ratio, WHO = World Health Organization.

Keywords: cessation programs, long-term smoking relapse

1. Introduction

Smoking is known to increase the morbidity and mortality associated with various diseases such as cancer and cardiovascular disease and consequently reduce the lifespan of smokers.^[1–4] In smokers who quit smoking, the incidence of cardiovascular disease, lung disease, and various cancers and the overall mortality rate decrease depending on the time of quitting.^[1,3,4] The Framework Convention on Tobacco Control (FCTC) was adopted by the World Health Organization

(WHO) in 2003 and came into force in 2005 to reduce diseases and deaths caused by smoking worldwide.^[5] The FCTC includes major measures to reduce the demand for tobacco and reduce tobacco addiction and quit smoking, and this agreement has had a significant impact on reducing tobacco consumption and dissemination.^[6]

South Korea joined FCTC in 2003, and the National Smoking Cessation Program started operating at public health centers across the country in 2005.^[7] In 2015, 18 regional smoking cessation centers were established to provide a new customized service.

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Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Regional smoking cessation centers operate a smoking cessation camp for severe smokers, a visiting smoking cessation program for the neglected class, and a smoking cessation program for hospitalized patients.^[8] In addition, the National Health Insurance Service has been operating a support program for outpatient smoking cessation drug treatment.^[9] The 6-month smoking cessation success rate was reported to be 46.8% in public health centers and 30.5 to 44.7% in the National Health Insurance Service.^[9–11] According to previous studies, individual factors such as age at first smoking, nicotine dependence, mental stress, depression, anxiety, alcohol problems, education level, and economic status influence the success of smoking cessation programs. In addition, interpersonal factors such as marital status and the presence of smokers in the household or at the workplace also influence participants' success in smoking cessation.^[12–15]

According to a meta-analysis of the patterns of relapse after quitting smoking, about 10% of successful quitters relapse annually.^[16] Thus, a long-term follow-up of at least 1 year is needed to evaluate the effectiveness of smoking cessation programs.^[17] Predictive factors for smoking relapse include individual factors such as the degree of craving, depression, stress, and alcohol consumption. Moreover, interpersonal or organizational factors, such as coworkers' smoking habits and the social atmosphere at the work unit, have been also reported to influence smoking relapse in quitters.^[18–21] In South Korea, many studies have been conducted to analyze the factors influencing smoking relapse among quitters using the National Smoking Cessation Program. However, most of these studies analyzed individual factors, such as smoking history, alcohol consumption, and smoking cessation treatment methods.^[22–24] Thus, the purpose of this study is to analyze the individual, interpersonal, organizational, and community factors related to long-term smoking relapse among quitters who participated in a smoking cessation program of a single regional smoking cessation center and successfully maintained smoking cessation for 6 months.

2. Materials and Methods

2.1. Participants

Among registrants over 19 years of age who completed a smoking cessation camp, visiting smoking cessation program, or inpatient smoking cessation program from January 1, 2018 to

December 31, 2019 at a regional smoking cessation center, 943 individuals who succeeded in maintaining smoking cessation for 6 months were selected as participants in this study. Sixty-four individuals were excluded due to reasons such as duplicate registration and missing numbers, and a survey was conducted with the remaining 879 individuals. The survey was conducted using a mobile questionnaire provided through a link from a smartphone, and an oral questionnaire survey by phone was additionally conducted for nonrespondents. After excluding 574 individuals who did not respond to the survey or rejected the survey, we analyzed the findings for the remaining 305 participants (Fig. 1). This study was conducted after receiving approval from the Ministry of Health and Welfare (RTCC2021FH001) and deliberation by the Institutional Review Board of the Pusan National University Hospital (2104-004-101). Informed consent was obtained from all participants. Due to the coronavirus disease outbreak, a nonface-to-face survey was conducted; therefore, informed consent was obtained as follows. A mobile questionnaire was provided through a link, which could be accessed on participants' smartphones. Participants who accessed the link were asked to choose whether they would participate in the survey or not after reading an explanation of the study. Those who participated in the oral questionnaire survey by a phone call provided verbal consent, which was recorded.

2.2. Smoking cessation programs

Individuals participating in this study underwent a smoking cessation program operated by a regional smoking cessation center established by the government in 2015. A smoking cessation camp is designed for heavy smokers over 20 pack-years who have failed to quit smoking in the past. Program participants are prescribed varenicline, bupropion, or nicotine replacements in consideration of their medical conditions. They are admitted to Pusan National University Hospital, and 10 to 15 people live together and receive medical examinations, smoking cessation education, group counseling, and individual counseling for 5 days and 4 nights. After discharge from the camp, they visit the regional smoking cessation center and receive regular counseling for 6 months. The visiting smoking cessation program provides face-to-face counseling for women, college students, out-of-school youth, workplace workers, and the

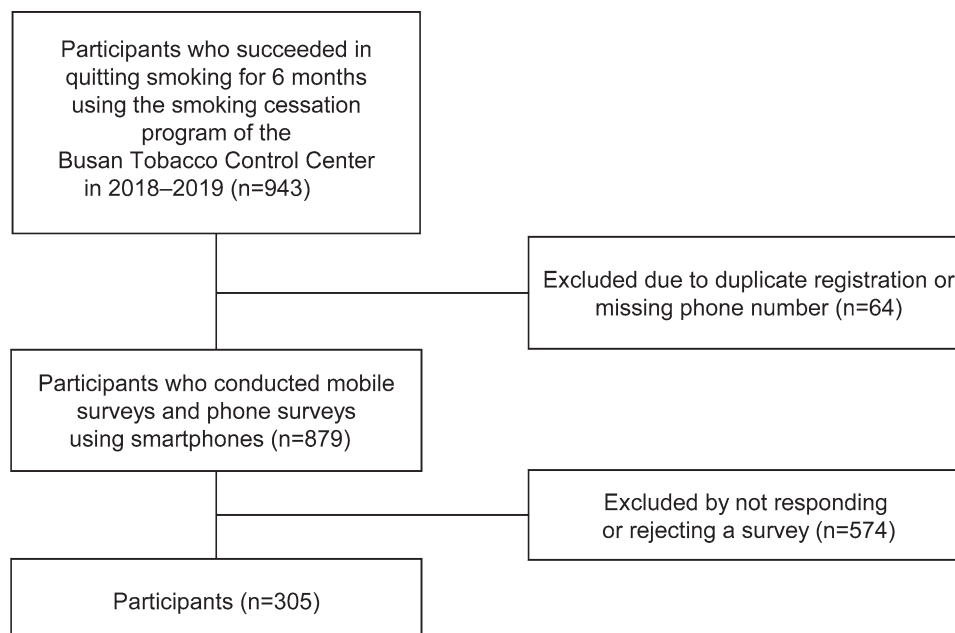


Figure 1. Participant selection process.

disabled, who have difficulty accessing the smoking cessation program at public health centers, by visiting their workplaces or living areas. Participants who wish to receive nicotine replacement therapy are provided the therapy according to the standards recommended by the National Tobacco Center, and visits are arranged regularly for 6 months. In contrast, the inpatient smoking cessation program is provided for patients admitted to the Pusan National University Hospital with acute diseases such as stroke and myocardial infarction. During hospitalization, a professional counselor visits the ward to conduct face-to-face counseling, and if the patient wishes, varenicline, bupropion, or nicotine replacement therapy can be prescribed by the attending physician in consideration of their medical conditions. The participants visit the regional smoking cessation center regularly for 6 months after discharge and receive face-to-face counseling. The success of smoking cessation in all program participants is evaluated by a urine cotinine test.

2.3. Questionnaire

The questionnaire items were selected through literature review and expert meetings. Factors related to current smoking status were preferentially included in the questionnaire survey. Alcohol use, stress, and health management were selected as individual factors, while the interpersonal factors were cohabitation with family members, leisure time spent with family members, smoking among family members, and exposure to secondhand smoke in the home.^[12,13,25] Organizational factors that can affect smoking relapse were smoking among colleagues or friends, exposure to secondhand smoke, interpersonal relationships, organizational stress, attitude toward smoking in the organization, presence of designated nonsmoking areas in the organization, and the distance to a smoking room.^[20] Since community factors could also influence smoking relapse, we also evaluated the smoking rates in the participants' residential districts, smoking rates in their schools or workplaces, and their proximity to stores selling tobacco products.^[26]

Smoking relapse was defined as smoking for more than 7 consecutive days. Participants who relapsed were asked questions about the duration of quitting (months), reasons for relapsing, and the types of tobacco used. Alcohol consumption was evaluated, and drinkers were asked about the weekly amount and frequency of alcohol consumption. Consumption of more than 5 drinks for women and 7 drinks for men more than twice a week was defined as high-risk drinking.^[27] Cut-down, Annoyed, Guilty and Eye-opener (CAGE) questions were also surveyed, and to increase the sensitivity of this analysis, a total score of 1 or more was defined as positive.^[28,29]

A 4-point scale was used to evaluate perceived emotional stress, and a score of 2 or less was defined as low, while a score of 3 or more was defined as high to simplify statistical analysis. A 5-point scale was used for other questions. To simplify the statistical analysis, a score of 2 or less was defined as low, and a score of 3 or more was defined as high. The yearly frequency of viewing or participating in cultural and artistic events was evaluated, and it was defined as low if the participation rate was less than 4 times a year, and high if it was more than 5 times a year. Days of walking at least 10 minutes and average walking time each week were evaluated, and total walking time <150 minutes per week was defined as low while walking time >150 minutes was defined as high.^[30]

Questions about the number of current family members were used to confirm whether the participants belonged to single-person households. For participants with family members living together, the presence of smokers in the family and any exposure to secondhand smoke at home in the past 7 days were investigated. The frequency of spending leisure time with family was investigated and defined as low when less than twice a week and high when more than twice a week.

Questions were also constructed to investigate organizational factors (relationships with coworkers, schoolmates, or close acquaintances). The presence of smokers in the organization and exposure to secondhand smoke during the past 7 days were queried. Stress caused by organizational members was assessed using a 4-point scale, and interpersonal relationships with members of the organization and the degree to which smoking was encouraged were evaluated on a 5-point scale, wherein a score of 2 or less was defined as low, and a score of 3 or more was defined as high. We assessed whether the workplace or school had designated nonsmoking areas, and the travel time to the smoking room was defined as close if it was <3 minutes.

Regarding the community-related environmental factors, the travel time from home to the place of purchase of cigarettes was queried, and if the duration was <3 minutes, the place of purchase was defined as close. Administrative districts at home and work (or school) were surveyed, and the smoking rate was evaluated and defined as high if it was higher than the median of the smoking rate in the region.

2.4. Statistical analysis

A chi-square test was used to compare the characteristics of relapsed smokers and nonsmoking maintainers. The Kaplan-Meier method and the life-table method were used to evaluate the smoking relapse rate by period. Smoking relapse periods were set at 6 months, 12 months, 18 months, and 24 months. Multiple logistic regression analysis was used to analyze the factors related to smoking relapse by period, including age, sex, type of smoking cessation program, and variables that showed a difference between the 2 groups with $P < .20$ in cross-over analysis.^[13]

The Cox proportional hazards regression model was used to analyze the factors related to smoking relapse during the entire period. The confounding variable selection method was applied in the same way as in the multiple logistic regression analysis described above. Two-tailed P -values less than .05 were considered to be statistically significant, and IBM SPSS version 22.0.0 (SPSS Inc., Armonk, NY) was used for all statistical analyses. The size of the sample was calculated through the PS:power and sample size calculations version 3.0 (Dupont WD, Plummer WD: "Power and Sample Size Calculations: A Review and Computer Program", *Controlled Clinical Trials* 1990; 11:116-28). A previous study using the Cox proportional hazards regression model reported a 1.6-fold increase in the smoking relapse rate in the presence of friends who were smokers.^[31] In this study, the smoking relapse rate was 73%, and the proportion of participants with friends who were smokers was 29%. The sample size was calculated for time-to-event analysis by setting the power to 0.8 and type I error to 5%; calculations were performed for at least 219 people. Since the response rate of the nonface-to-face survey was expected to be low, a survey of all 943 registrants who successfully quit smoking using the smoking cessation program of a single smoking cessation center from 2018 to 2019 was conducted.

3. Results

The interval from the end of the program to the time of the survey was 19 to 40 months, with a median value of 30 months (Fig. 2). Among the 305 participants, 229 (75.1%) responded that they had maintained smoking cessation until the time of the survey after the end of the smoking cessation program, and 77 (25.5%) responded that they had smoked again. In an additional survey conducted to determine the reasons for smoking again among participants who had relapsed from smoking, 51 (66.2%) attributed the relapse to stress, 25 (32.5%) attributed it to weakness of their will, 11 (13%) stated that their relapse was caused by friends (or colleagues), 4 (5.2%) started smoking

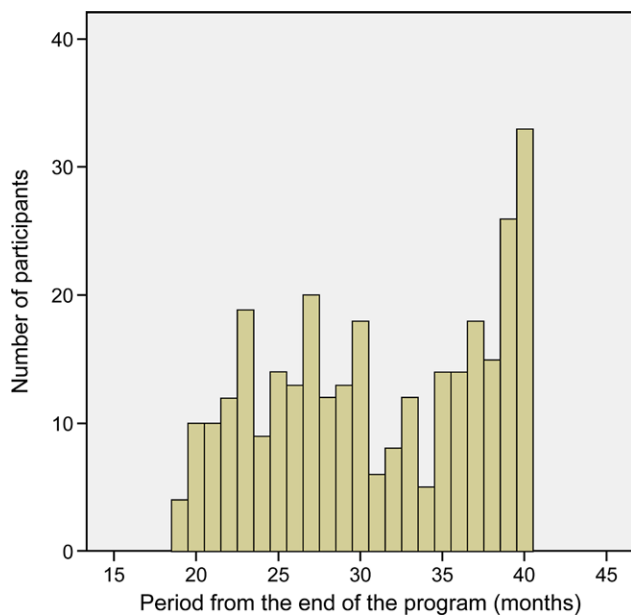


Figure 2. Distribution of participants by period after quitting the smoking cessation program

again because of weight gain during the cessation period, 2 (2.6%) attributed their relapse to withdrawal symptoms, and 1 (1.3%) attributed it to curiosity about new cigarettes. As for the types of tobacco currently smoked by participants who had relapsed from smoking, 61 reported (79.2%) cigarettes, 6 (7.8%) reported liquid-type e-cigarettes, 3 (3.9%) reported heated cigarettes, and 9 reported others (11.7%).

3.1. Characteristics of the study participants

When the participants were categorized by age, the 60- to 69-year group included the most participants (89; 29.2%), and the 30- to 39-year group had the fewest (17; 5.6%). The proportion of male participants was 90.2%. The distribution of participants based on the type of smoking cessation programs was as follows: 112 (36.7%) in visiting smoking cessation programs, 131 (43%) in smoking cessation camps, and 62 (20.3%) in inpatient smoking cessation programs. No significant differences were observed in age, sex, and program type between the group that maintained smoking cessation and the group that showed relapse.

The study population included 55 high-risk drinkers (18.0%), although the number of high-risk drinkers did not differ significantly between the 2 groups. However, 97 drinkers (31.8%) had positive CAGE scores, and the proportion of these participants in the group that maintained smoking cessation was significantly higher than that in the group that showed smoking relapse (35.1% vs 22.1%; $P = .034$).

The overall rate of participants who reported experiencing high emotional stress in daily life was 34.4%, which was significantly higher in the smoking relapse group (49.4%) than in the smoking cessation group (29.4%; $P = .001$). The rate of participants who believed that smoking relieves stress was 56.7%, which was significantly higher in the smoking relapse group (77.9%) than in the smoking cessation group (49.6%; $P < .001$). The rate of participants with a poor subjective health status was 22.6%, which was significantly higher in the smoking relapse group (33.8%) than in the smoking cessation group (18.9%; $P = .007$). The rate of participants who reported experiencing low life satisfaction in daily life was 18.4%, which was not significantly different between groups, but showed a higher trend in the smoking relapse group (23.4%) than in the

smoking cessation group (16.7%) ($P = .189$). The rate of participants who participated in fewer than 5 cultural activities each year was 92.1%, and the rate of participants who walked <150 minutes per week was 22.6%, with no significant differences between the 2 groups.

The proportion of single-person households was 20%, and the rate in the smoking relapse group (32.5%) was 2.06 times higher than that in the smoking cessation group (15.8%; $P = .003$). The proportion of participants who spent leisure time with family less than twice a week was 72.5%, which was significantly higher in the smoking relapse group (81.8%) than in the smoking cessation group (69.3%; $P = .033$). The percentage of participants with smokers in the family was 19.3%, and the percentage of those exposed to secondhand smoke in the home was 14.3%, with no significant differences between the 2 groups.

The rate of participants exposed to environments encouraging smoking at work or school was 50.2%, which was not statistically different between the groups, but showed a higher trend in the smoking relapse group (59.7%) than in the smoking cessation group (46.9%; $P = .052$). The percentage of participants in schools or workplaces without designated non-smoking areas was 28.9%, and this value did not differ significantly between the groups, although it showed a higher trend in the smoking relapse group (35.1%) than in the smoking cessation group (26.8%; $P = .164$). The 2 groups showed no significant differences in the proportions of those who smoked at work or school, were exposed to secondhand smoke, had poor interpersonal relationships, experienced high work stress, and required <3 minutes to travel to the smoking room.

The proportion of participants who required <3 minutes to travel from their home to a cigarette store was 41.6%, which was not significantly different between the groups, but showed a higher trend in the smoking relapse group (48.1%) than in the smoking cessation group (37.5%; $P = .187$). The proportion of smoking rate in the residential area higher than the regional median was 56.6% in the smoking cessation group, which was not significantly different between groups, but showed a higher trend compared to 45.5% in the smoking relapse group ($P = .09$). There was no significant difference in smoking rates between the 2 groups in the workplace or school districts (Table 1).

We compared the characteristics of the participants on the basis of the smoking cessation program and observed a significant difference in the age distribution among the 3 programs ($P < .001$). In the visiting smoking cessation programs, the group aged 20 to 29 years was predominant (44 participants; 39.3%), while the smoking cessation camp predominantly included participants aged 60 to 69 years (58 participants; 44.3%), and the inpatient program predominantly included participants aged 50 to 59 years (22 participants; 35.5%). The number of female participants showed a significant difference, with 27 (24.1%) female participants in the visiting smoking cessation program, 3 (2.3%) in the smoking cessation camp, and none in the inpatient program ($P < .001$). The number of participants who reported a poor subjective health status differed significantly ($P = .003$): 19 participants (17.0%) in the visiting smoking cessation program, 26 (19.8%) in the smoking cessation camp, and 4 (6.5%) in the inpatient program. The proportion of participants whose workplace or school did not have designated nonsmoking areas also differed significantly among the programs: 19 participants (17.0%) in the visiting smoking cessation program, 46 (35.1%) in the smoking cessation camp, and 23 (37.1%) in the inpatient program ($P = .002$).

3.2. Smoking relapse rate by period

Among the 77 cases involving smoking relapse, 15 (19.5%) showed relapse within 6 months of quitting the smoking cessation program, 29 (37.7%) showed relapse within 6 to 11 months, and 22 (28.6%) showed relapse within 12 to 17 months after

Table 1
Characteristics of the relapsed and successful participants.

Variable	Total (n = 305)		Success (n = 228)		Relapse (n = 77)		P value				
	No.	%	No.	%	No.	%					
Individual	Age (yr)	20–29	45	14.8	31	13.6	14	18.2	.22		
		30–39	17	5.6	16	7	1	1.3			
		40–49	45	14.8	37	16.2	8	10.4			
		50–59	69	22.6	53	23.2	16	20.8			
		60–69	89	29.2	62	27.2	16	20.8			
	≥70	40	13.1	29	12.7	11	14.3				
	Sex	Male	275	90.2	204	89.5	71	92.2	.486		
		Female	30	9.8	24	10.5	6	7.8			
	Program	Visiting	112	36.7	83	36.4	29	37.7	.678		
		Camp	131	43	96	42.1	35	45.5			
		Inpatient	62	20.3	49	21.5	13	16.9			
	High-risk alcohol consumption	Yes	55	18	40	17.5	15	19.5	.702		
		CAGE scale score	≥1	97	31.8	80	35.1	17		22.1	
		Perceived emotional stress	High	105	34.4	67	29.4	38		49.4	
		Lower life satisfaction	Yes	56	18.4	38	16.7	18		23.4	
Belief that smoking relieves stress		Helpful	173	56.7	113	49.6	60	77.9			
Leisure life activities		<5/year	281	92.1	209	91.7	72	93.5			
Perceived health status		Bad	69	22.6	43	18.9	26	33.8			
Physical activity per week		<150 min	111	36.4	83	36.4	28	36.4			
Interpersonal		Single-person household/living alone	Yes	61	20	36	15.8	25		32.5	.003
		Family smoking	Yes	47	19.3	35	18.2	12		23.1	
	Passive smoking at home	Yes	35	14.3	28	14.6	7	13.5			
	Family leisure activities	<2/week	221	72.5	158	69.3	63	81.8			
Organizational	Friends smoking	Yes	247	81	184	80.7	63	81.8	.829		
	Exposure to secondhand smoke in the organization (work, school, or close acquaintances)	Yes	167	54.8	120	52.6	47	61			
	Poor peer relationships within the organization (workplace or close friends)	Yes	12	3.9	8	3.5	4	5.2			
	Companies encouraging smoking	Yes	153	50.2	107	46.9	46	59.7			
	Smoking workplace	Yes	88	28.9	61	26.8	27	35.1			
	Travel time from work or school to a smoking area <3 minutes	Yes	194	63.6	114	63.2	50	64.9			
	High perceived emotional stress at work	Yes	76	24.9	55	24.1	21	27.3			
Social	Travel time from home to cigarette shop <3 min	Yes	127	41.6	90	39.5	37	48.1	.187		
	High smoking rates in residential areas	Yes	164	53.8	129	56.6	35	45.5			
	High smoking rates in workplace or school	Yes	162	53.1	124	54.4	38	49.4			

Abbreviations: CAGE = cut-down, annoyed, guilty, and eye-opener. P values from χ^2 test comparing differences between any groups.

quitting the smoking cessation program. Three patients (3.9%) showed relapse within 18 to 23 months, 5 (6.5%) showed relapse within 24 to 29 months, and 1 (1.0%) showed relapse within 30 to 36 months. Overall, the relapse rate decreased with the passage of time (Fig. 3).

3.3. Factors related to resmoking by period

None of the variables were significantly associated with smoking relapse within 6 months. For smoking relapse after 12 months, the relapse rate significantly increased by 4.577 times (1.905–10.996, $P = .001$) with the belief that smoking relieves stress. For relapse after 18 months, the relapse rate increased by 2.961 times (1.526–5.745, $P = .001$) with the belief that smoking relieves stress and 2.338 times (1.155–4.730, $P = .018$) in single-person households. For smoking relapse at 24 months, the relapse rate increased by 2.799 times (1.345–5.826, $P = .006$) with the belief that smoking relieves stress, 2.235 times (1.036–4.821, $P = .040$) with poor subjective health, and 3.071 times (1.402–6.727, $P = .005$) in single-person households. If the participant lived in a place with a high smoking rate, the smoking relapse rate decreased by 0.488 times (0.251–0.947, $P = .034$) (Table 2).

3.4. Cox proportional hazard model for factors associated with smoking relapse

In the analysis of smoking relapse over the entire period, the relapse rate was 1.720 times (1.039–2.846, $P = .035$) higher with high emotional stress, 2.649 times (1.524–4.607, $P = .001$) higher with the belief that smoking relieves stress, and 1.947 times (1.162–3.261, $P = .011$) higher in single-person households (Table 3).

4. Discussion

This study evaluated the factors related to smoking relapse in individuals who had successfully maintained smoking cessation for 6 months using the smoking cessation program of a regional smoking cessation center. Seventy-seven of the 305 patients relapsed at the time of the survey, and 66 patients (85.7%) relapsed within 18 months. Higher relapse rates were associated with the belief that smoking reduces stress, poor subjective health, single-person households, and perceived high emotional stress. Factors related to smoking relapse differed slightly by period, and this trend was similar to that in a study obtained using longitudinal cohort data from the

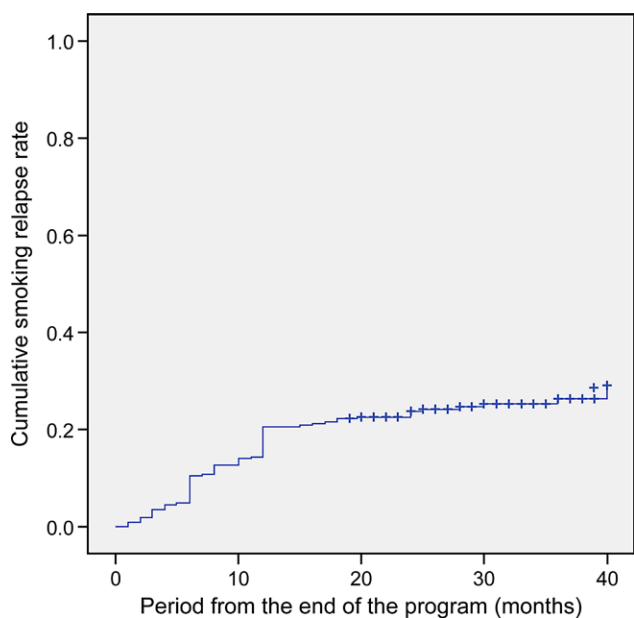


Figure 3. Pattern of smoking relapse over time (Kaplan–Meier analysis).

International Tobacco Control Four Countries Survey with annual follow-up assessments conducted between 2002 and 2015.^[32]

In the analysis of the smoking relapse pattern in this study, the relapse rate decreased sharply after 18 months of quitting the smoking cessation program. This is consistent with a previous study conducted on individuals who were successful in quitting smoking for 6 months using a public health center smoking cessation program, which showed a reduction in the relapse rate over time (30% within 6 months, and 9% between 7 and 12 months).^[23] Similarly, a previous study that followed smoking relapse for 4 years after quitting smoking with nicotine gum reported that the recurrence rate was significantly reduced when smoking cessation was maintained for a long time.^[33] The results of previous studies and this study suggest that follow-up for an additional 18 months for ex-smokers who succeeded in quitting smoking for 6 months using the smoking cessation program could be effective in maintaining smoking cessation for a long time.

Participants who believed that smoking relieved stress showed significantly higher rates of relapse at 12, 18, and 24 months, and also had a significantly higher overall risk of smoking relapse. Most smokers believe that they are using tobacco to reduce stress.^[34] In a study on e-cigarette smoking among college students, 33% of those using e-cigarettes answered that they used it for stress control.^[35] However, in a study to evaluate smokers' smoking motives, participants who responded that they used tobacco for stress management showed significantly higher nicotine dependence.^[36] A study of smokers who believed that smoking reduced their stress levels reported a lower perception of stress in these subjects after quitting, contrary to their beliefs.^[37] In addition, in a systematic review, when smokers succeeded in quitting smoking, their stress symptoms reduced further.^[38] These findings imply that smokers experience withdrawal symptoms, not stress, and that stress can be reduced by quitting smoking, contrary to their beliefs. Therefore, for smokers who believe that cigarettes relieve stress, interventions that can correct these false beliefs are needed, and continuous follow-up management is necessary even if smoking cessation is successful.

Smoking relapse rates at the 8-month and 24-month time points were significantly higher in single-person households than in households with 2 or more members, and the overall

risk of relapse was also significantly higher in single-person households. Many previous studies have demonstrated that living alone negatively affects health behaviors and health outcomes.^[39–41] According to a study using the Community Health Survey in Korea, the smoking rate among men was 1.8 times higher in the case of single-person households.^[42] Although evidence is still lacking about the role of smoking cessation partners in quitting attempts and their effects on smoking cessation, family is one of the various reasons smokers decide to quit smoking.^[43,44] In a cohort study conducted in Japan, smoking cessation success rates were higher in those with family members living together.^[45] Similarly, in a longitudinal study conducted in the United States, smoking relapse rates were also reported to be lower in the presence of family members living with them.^[18] In addition, the long-term smoking cessation rate has been reported to significantly increase when the spouse is a nonsmoker.^[46] Therefore, in single-person households, long-term follow-up management is necessary because the risk of smoking relapse after successful quitting is high.

In this study, the risk of smoking relapse was significantly higher in participants who reported experiencing high emotional stress. A study conducted to analyze the correlation between stress cognition and smoking across 41 countries showed a significant correlation between smoking and stress in most countries, although there were differences by country.^[47] High emotional stress is a risk factor for smoking and may aggravate nicotine withdrawal symptoms.^[48] In addition, in a study conducted on mothers who quit smoking during pregnancy, the risk of smoking relapse was greater if depression and stress symptoms worsened after quitting smoking.^[49] Similarly, in a study conducted on people who succeeded in quitting smoking for 6 months through a smoking cessation clinic at a public health center in South Korea, the most important reason for smoking relapse was stress.^[50] In a study using biomarkers, the pattern of changes in salivary cortisol concentration in response to stress in heavy smokers was different from that of healthy adults and similar to that in gambling addicts.^[51] From a different perspective, 1 study reported that when counseling, including interventions for stress, is conducted, the higher the counseling frequency, the higher the success rate of quitting smoking.^[52] Therefore, for smokers complaining of high stress, long-term follow-up is necessary because the risk of smoking relapse is high even if smoking cessation is successful. Moreover, since drug treatment has been proven to be effective in preventing relapse of smoking,^[53] research to develop and verify a program that can control stress to prevent relapse of smoking should be conducted.

The 24-month smoking relapse rate was significantly higher in participants who answered that they had poor subjective health. Smoking is generally known to be associated with lower subjective health status. In studies of adolescents in the United States, adolescents who had smoked had more physically unhealthy days and a lower quality of life related to health.^[54] In addition, the health-related quality of life of participants who smoked again after quitting was lower than that of former smokers who maintained smoking cessation.^[55] In a study to investigate the changes in the subjective health status of past smokers after quitting smoking, over 11 years after quitting smoking, the proportion of respondents with poor health decreased over time, making them similar to nonsmokers.^[56] These previous studies, including this study, suggest that long-term smoking cessation is associated with good subjective health.

In this study, significant differences were observed in the program type in relation to age, gender, subjective health status, and the presence of designated nonsmoking areas at work or school. The high participant age at the smoking cessation camp can be attributed to the fact that smokers with more than 20 years of smoking history were able to participate, and that there were barriers to participating while working because the program was conducted after being hospitalized for 4 nights and 5 days. In the case of the inpatient program, the percentage

Table 2
Adjusted odds ratios and 95% confidence intervals from the logistic regression models for the factors affecting smoking relapse over time.

Variables	AOR	95% CI	P value	Variables	AOR	95% CI	P value
6 months (Relapsed participants = 15)				12 months (Relapsed participants = 44)			
CAGE scale score			.198	CAGE scale score			.824
≥1 (reference = 0)	0.34	0.07 – 1.76		≥1 (reference = 0)	0.91	0.42 – 2.01	
High perceived emotional stress			.062	High perceived emotional stress			.315
Yes (reference = No)	3.48	0.94 – 12.87		Yes (reference = No)	1.50	0.68 – 3.31	
Low life satisfaction			.718	Low life satisfaction			.453
Yes (reference = No)	1.28	0.33 – 4.97		Yes (reference = No)	0.69	0.26 – 1.82	
Belief that smoking relieves stress			.106	Belief that smoking relieves stress			.001
High (reference = Low)	3.78	0.75 – 18.96		High (reference = Low)	4.37	1.80 – 10.58	
Poor perceived health status			.652	Poor perceived health status			.230
Yes (reference = No)	1.35	0.37 – 4.93		Yes (reference = No)	1.67	0.72 – 3.83	
Single-person household/living alone			.799	Single-person household/living alone			.192
Yes (reference = No)	0.82	0.18 – 3.72		Yes (reference = No)	1.75	0.76 – 4.05	
Lack of family leisure activities			.153	Lack of family leisure activities			.128
Yes (reference = No)	4.86	0.56 – 42.56		Yes (reference = No)	2.18	0.80 – 5.93	
Companies that encourage smoking			.420	Companies that encourage smoking			.967
Yes (reference = No)	1.68	0.48 – 5.93		Yes (reference = No)	0.98	0.46 – 2.09	
Smoking at the workplace			.262	Smoking at the workplace			.266
Yes (reference = No)	0.46	0.12 – 1.79		Yes (reference = No)	1.56	0.71 – 3.42	
Travel time from home to cigarette shop			.934	Travel time from home to cigarette shop			.853
<3 minutes				<3 min			
Yes (reference = No)	1.05	0.32 – 3.49		Yes (reference = No)	1.07	0.52 – 2.19	
High smoking rates in residential areas			.651	High smoking rates in residential areas			.368
Yes (reference = No)	0.75	0.22 – 2.61		Yes (reference = No)	0.72	0.35 – 1.48	
18 months (relapsed participants = 66)				24 months (relapsed participants = 69)			
CAGE scale score			.311	CAGE scale score			.268
≥1 (reference = 0)	0.70	0.35 – 1.39		≥1 (reference = 0)	0.64	0.29 – 1.40	
High perceived emotional stress			.058	High perceived emotional stress			.057
Yes (reference = No)	1.94	0.98 – 3.83		Yes (reference = No)	2.12	0.98 – 4.60	
Lower life satisfaction			.577	Lower life satisfaction			.170
Yes (reference = No)	0.79	0.34 – 1.82		Yes (reference = No)	0.50	0.19 – 1.34	
Belief that smoking relieves stress			.002	Belief that smoking relieves stress			.007
High (reference = Low)	2.90	1.48 – 5.68		High (reference = Low)	2.79	1.32 – 5.90	
Bad perceived health status			.048	Bad perceived health status			.020
Yes (reference = No)	2.08	1.01 – 4.27		Yes (reference = No)	2.65	1.16 – 6.04	
Single-person household/living alone			.016	Single-person household/living alone			.004
Yes (reference = No)	2.51	1.19 – 5.30		Yes (reference = No)	3.36	1.46 – 7.71	
Lack of family leisure activities			.640	Lack of family leisure activities			.625
Yes (reference = No)	1.20	0.56 – 2.60		Yes (reference = No)	1.24	0.52 – 2.98	
Companies that encourage smoking			.849	Companies that encourage smoking			.579
Yes (reference = No)	1.06	0.56 – 2.02		Yes (reference = No)	1.23	0.60 – 2.53	
Smoking workplace			.892	Smoking workplace			.373
Yes (reference = No)	1.05	0.53 – 2.07		Yes (reference = No)	1.41	0.66 – 2.98	
Travel time from home to cigarette shop			.661	Travel time from home to cigarette shop			.217
<3 minutes				<3 minutes			
Yes (reference = No)	1.15	0.62 – 2.12		Yes (reference = No)	1.54	0.78 – 3.04	
High smoking rates in residential areas			.214	High smoking rates in residential areas			.059
Yes (reference = No)	0.68	0.36 – 1.25		Yes (reference = No)	0.51	0.26 – 1.02	

P values from multivariate logistic regression analysis adjusted by age, sex, and type.
 Abbreviations: AOR = adjusted odds ratio, CAGE = cut-down, annoyed, guilty and eye-opener, CI = confidence interval.

of respondents who answered that they had poor subjective health status was high because this was a program designed for patients diagnosed with acute disease. For the visiting smoking cessation program, the ratio of nonsmoking area designations was higher than that in other types because the program was provided according to the application of institutions such as universities, schools, and workplaces. Since institutions targeting female smokers were included in the target of the visiting smoking cessation program, the proportion of female participants in these programs was higher than that in other types of programs. However, there was no significant difference in the rate of smoking relapse by program type (Table 1), and all relevant variables were included in logistic regression analysis and Cox proportional hazard models to confirm factors related to smoking relapse (Tables 2 and 3).

This study had several limitations. First, since the survey was conducted more than 18 months after the end of the smoking cessation service, the status at the time of quitting smoking cannot be confirmed. Therefore, the evaluation of temporal causality between factors related to smoking relapse is limited. Second, although the questionnaires evaluated individual, interpersonal, organizational, and community factors, a multi-level analysis could not be conducted because the questionnaire method was conducted on an individual level. Nondifferential misclassification is possible when inter-individual, organizational, or community-level factors are measured as variables dependent on the individual responses of the study participants. Third, since this was a survey study conducted by a single institution, the possibility of selection bias cannot be excluded, and the results of this study cannot be generalized. Nevertheless, this study also had

Table 3**Cox proportional hazard regression model for smoking relapse.**

Variables	HR		95.0% CI	P value
CAGE scale score				.169
≥1 (reference = 0)	0.68	0.39	–	1.18
High perceived emotional stress				.020
Yes (reference = No)	1.86	1.10	–	3.13
Low life satisfaction				.308
Yes (reference = No)	0.72	0.39	–	1.35
Belief that smoking relieves stress				.001
High (reference = Low)	2.51	1.44	–	4.38
Bad perceived health status				.049
Yes (reference = No)	1.69	1.00	–	2.85
Single-person household/living alone				.012
Yes (reference = No)	1.99	1.16	–	3.42
Lack of family leisure activities				.303
Yes (reference = No)	1.40	0.74	–	2.63
Companies that encourage smoking				.341
Yes (reference = No)	1.28	0.77	–	2.11
Smoking workplace				.746
Yes (reference = No)	1.09	0.65	–	1.82
Travel time from home to cigarette shop <3 min				.505
Yes (reference = No)	1.17	0.73	–	1.88
High smoking rates in residential areas				.206
Yes (reference = No)	0.73	0.45	–	1.19

P values from Cox proportional hazards regression model adjusted by age, sex, and type.

Abbreviations: CAGE = Cut-down, Annoyed, Guilty and Eye-opener, HR = hazard ratio.

the following strengths. It was the first study to analyze smoking relapse among all program participants of a regional smoking cessation center. Second, the variables for interpersonal organizational and community factors as well as individual factors related to smoking relapse were analyzed together.

5. Conclusions

Even in participants who show successful smoking cessation for 6 months, additional follow-up of at least 18 months is required. During smoking cessation counseling, participants who believe that smoking relieves stress, those who belong to single-person households, report poor subjective health, and report experiencing high emotional stress are at a higher risk of smoking relapse and should be followed up for longer periods. In particular, interventional therapies that can manage emotional stress and correct the belief that smoking relieves stress are important in this regard.

Author contributions

Seung Hun Lee- Conceptualization, Data curation, Funding acquisition, Investigation, Writing – original draft.
 Hyo Young Lee- Conceptualization, Methodology, Formal analysis.
 Young In Lee- Conceptualization, Formal analysis.
 Kyoung-Min Lim- Methodology, Formal analysis.
 Yu Hyeon Yi- Project administration, Conceptualization, Supervision, Writing – review & editing.

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