Asian Nursing Research 13 (2019) 53–60

Contents lists available at ScienceDirect

Asian Nursing Research

journal homepage: www.asian-nursingresearch.com

Research Article

Effectiveness of a Workplace Smoking Cessation Program based on Self-determination Theory Using Individual Counseling and Tailored Text Messaging: A Pilot Study

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ARTICLE INFO

Article history:
Received 13 March 2018
Received in revised form
8 January 2019
Accepted 9 January 2019

Keywords:
counseling
smoking cessation
text messaging
workplace

ABSTRACT

Purpose: Adverse health effects of smoking could be made worse by worker's tobacco use, and combining tobacco use with occupational hazards could enhance the likelihood of occupational disease and injury. This study was aimed to develop a workplace smoking cessation program based on self-determination theory (SDT) and then to examine the effectiveness of the program.
Methods: A quasi-experimental design with nonequivalent control group pretest–posttest design was used. An intervention group (n = 30) received a smoking cessation program using individual counseling and tailored text messaging based on SDT during 12 weeks. Participants in the control group (n = 30) received a smoking cessation leaflet and telephonic follow-up for 3 times.
Results: At 6 and 12 weeks, there were significant differences between the two groups on autonomous regulation, perceived competence, nicotine dependence, tobacco abstinence rate, and exhaled carbon monoxide concentration. At 12 weeks, the abstinence rate in the intervention group was 96.7%, whereas that in the control group was 12.9%.
Conclusion: SDT-based workplace smoking cessation program using individual counseling and tailored text messaging is effective in encouraging autonomous regulation and competence for workers.

Introduction

Developed countries around the world face a major challenge in maintaining a healthy and productive worker due to increasing aging workforce [1]. A previous study on the impact of aging workforce demonstrated that aging workers experienced an increased prevalence of chronic diseases and occupational injuries [2]. Health problems of workers are not limited to the individual, and those cause a social burden by leading to an increase in health-care costs and a decrease in the company productivity due to sickness absence and presenteeism [1,3]. As a worker's health problems have negatively affected workplace and society, the US Centers for Disease Control and Prevention began the National Healthy Worksite Program in October 2011 to improve worker health and productivity [4]. As Korean government has recognized that the workplace is an important setting for health protection and health promotion, the workplace health promotion program is adopted as a main component of Health Plan 2020 [5]. The workplace health promotion programs including physical activity and smoking cessation help Korean workers adopt healthier lifestyles and prevent their chronic diseases. From employers' perspective, implementing workplace wellness programs may offer the opportunity not only to improve worker's health but also to reduce health-care costs generated by chronic diseases [6].

According to findings from a nationally representative sample of Korean workers, the smoking rate of Korean male workers is 54.1% [7], which is even higher than that of Korean male adults, 49.8% [8]. A finding from the National Health Interview Survey for 2014–2016 is that 22.1% of working US adults reported current use of tobacco, and smoking prevalence varied widely by industry, ranging from about 10% in education services to more than 30% in construction and food services [9]. Based on a review about the economic impact of smoking, tobacco use costs the world an estimated $500 billion each year in health-care expenditures due to smoking-related illness,

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https://doi.org/10.1016/j.anr.2019.01.004
p1976-1317 e2093-7482/

productivity losses, fire damage, and other costs [10]. Smoking is a known risk factor for major chronic diseases. In particular, adverse health effects of smoking could be made worse by workers' tobacco use, and combining tobacco use with occupational hazards could enhance the likelihood of occupational disease and injury [11]. For example, heat generated by smoking in the workplace can transform some workplace chemicals into more toxic chemicals and explosions when flammable materials in the workplace are ignited by sources associated with tobacco [11]. The National Institute for Occupational Safety and Health recommends that all workplaces become tobacco-free environments and that employers make smoking cessation programs available to workers [11]. Accordingly, careful attention is needed to tobacco use among workers, and a tailored workplace smoking cessation program should be implemented to improve the general health and wellness of workers.

Nicotine is known to be highly addictive, and thus, it is difficult not only to maintain the decrease in smoking but also to continue quitting tobacco use due to nicotine addiction. In a systematic literature review analyzing 51 studies on workplace smoking cessation programs from 1966 to 2008, individual or group counseling and nicotine replacement therapy were shown to be effective to overcome nicotine addiction [12]. One of individual counseling using electronic communication technologies, mobile phone text messaging, has a great potential to deliver smoking cessation support to large populations. The counseling contents of smoking cessation text messages using mobile phones can be customized based on individuals' needs, and smoking cessation text messaging is shown to be effective in the advantage of not being limited by time and place [13].

Self-determination theory (SDT) provides a comprehensive theoretical framework through which to understand motivated behavior by addressing feelings of competence as well as needs for autonomy and relatedness [14]. SDT has been used recently for the development of effective smoking cessation programs, which explains the beginning and continuation of smoking cessation through intrinsic and varied extrinsic sources of motivation [15,16]. The smoking cessation program based on SDT was implemented under the support of the US National Institutes of Health, and autonomous regulation and perceived competence appeared an effective strategy for starting and maintaining smoking cessation for adults [16–18]. However, little is known about evaluation of the effectiveness of a smoking cessation program based on SDT for smokers in various workplace settings. Given that the prevalence of smoking in workers is higher than the smoking rate of adults, tailored smoking cessation program for workers should be implemented. Therefore, this study aimed to develop a workplace smoking cessation program based on SDT using individual counseling and tailored text messages and then to examine its effectiveness on autonomous regulation, perceived competence, nicotine dependence, and tobacco abstinence.

Methods

Study design

The quasi-experimental study used a pretest–posttest nonequivalent control group design to examine the effectiveness of a workplace smoking cessation program based on SDT including individual counseling and tailored text messages.

Participants and setting

The target population for this study consisted of adults working in an oil refining company in Korea. Participants in this study were recruited from a large-sized company with more than 2500 workers. The workforce in this company consisted of blue-collar workers (e.g., oil refinery workers such as engineers and operators) and white-collar workers (e.g., office administrative workers such as human resources and executive team). The company composed of three factory buildings, and each factory building was located within a 15-minute driving distance from each other. The workers in Building A were assigned to the intervention group, and the control group was chosen from workers in Building C, which is the farthest from Building A.

The eligibility criteria of participants were as follows: first, the worker was a smoker who smoked 10 or more cigarettes per day; second, the smoker possessed a smartphone to be eligible for receiving text messages; third, the smoker should not have taken medications to quit smoking during the past 30 days; and fourth, the smoker should be willing to participate in a smoking cessation program. To recruit participants, all workers in Buildings A and C were given an email invitation about SDT-based smoking cessation program. In addition, there was a recruitment notice about participating in a smoking cessation program through online company bulletin board.

The sample size was estimated using the G*power, software version 3.1, program [19]. Sample size estimation was based on the previous literature to estimate the effectiveness of smoking cessation interventions [20,21]. The criteria for two-sided independent *t* test were as follows: statistical power (1-β) of .80, significance level (α) = .05, effect size (f) = 0.80. It was indicated that we needed a total of 52 participants (26 people per group). Allowing for attrition, we recruited a total of 60 people with 30 in the intervention group and 30 in the control group for the study. As no one in either the intervention or control group withdrew from our SDT-based smoking cessation program, a total of 60 data were analyzed (Figure 1).

Ethical considerations

This study was approved by the institutional review board of Gyeongsang National University (Approval no. GIRB-A14-Y-0029), and then data were collected from workers in an oil refining company. The aims and method of this study were explained to the participants. All participants were informed about the study purpose and procedures, voluntary participation, and confidentiality of the study, and then a written consent was obtained from each participant.

Measurements

The participants' general characteristics of age, marital status, educational level, and occupational class were assessed. The smoking-related characteristics such as total years of smoking, cigarettes per day, previous experience of smoking cessation, and attempts to quit smoking were collected. The term of smoking cessation refers to volitional efforts toward stopping smoking behavior [22], and the operational definition in this study was defined as a person not smoking a cigarette for 12 weeks.

Autonomous regulation for smoking cessation

The Treatment Self-Regulation Questionnaire assesses the degree of participants' motivation for smoking cessation [23]. The Treatment Self-Regulation Questionnaire consists of three subscales including amotivation (3 items), controlled motivation (6 items), and autonomous motivation (6 items). The scale is a 6-item questionnaire to assess autonomous motivation for smoking cessation. Responses are given using a 7-point Likert scale ranging from 1 (not at all true) to 7 (very true). Higher scores indicate

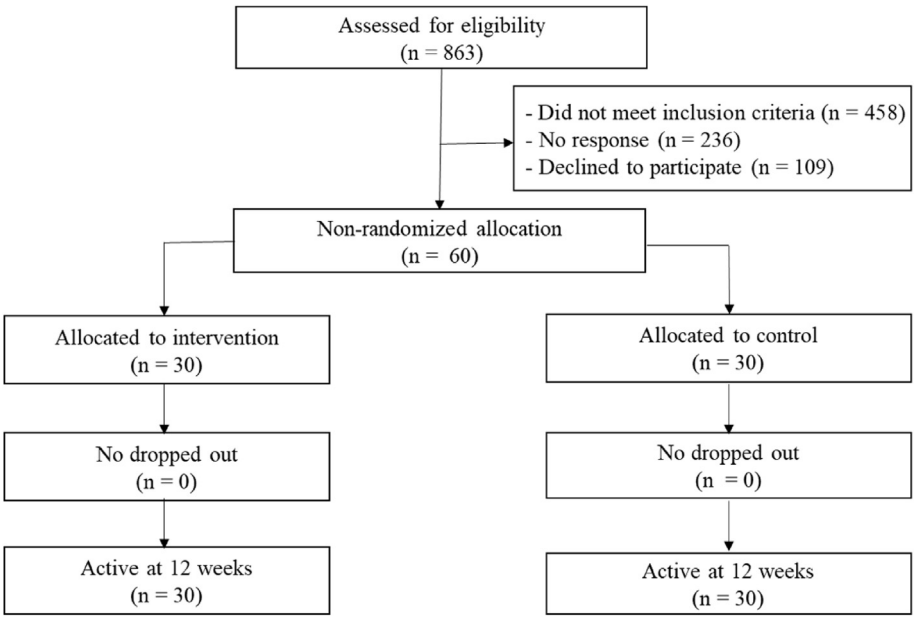

Figure 1. Flow diagram of participants.

higher levels of autonomous regulation. The Cronbach's α for this study was .88 for the autonomous regulation.

Perceived competence for quitting smoking

The Perceived Competence Scale for quitting smoking assesses the degree to which participants feel able to quit smoking successfully [24]. The scale consists of 4 items, and higher scores represent higher perceived competence. Responses are made on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). The Cronbach's α for this study was .94 for the perceived competence.

Nicotine dependence

Nicotine dependence was measured using the Fagerstrom Test for Nicotine Dependence (FTND) [25]. The FTND consists of 6 items, with 0–1 points or 0–3 points given for each item. Total scores range from 0 to 10 points, and higher scores indicate higher nicotine dependence. The Cronbach's α for this study was .66 for the FTND.

Tobacco abstinence

Tobacco abstinence was measured using both self-reports and biochemical indicators (exhaled carbon monoxide concentration). Self-reports of tobacco abstinence rate is the percentage obtained by dividing the number of people who self-reported that they quit smoking by the total number of people in the intervention group. Exhaled carbon monoxide concentration was measured in ppm from the breath exhaled slowly by the participant after holding his or her breath for 15 seconds after inhaling deeply, using a carbon monoxide monitor (Micro CO; CareFusion, United Kingdom). According to the manual for the monitor, 0–6 ppm refers to nonsmoker, 7–10 ppm to light smoker, 11–20 ppm to smoker, and 20 ppm to heavy smoker.

Intervention

The workplace smoking cessation program has been developed in a systematic way derived from worksite smoking cessation interventions based on SDT. Deci and Ryan [14] stated that autonomous regulation and perceived competence are very important for the beginning and maintaining of health behavior change. Autonomous regulation and perceived competence as the key elements of SDT were applied into the smoking cessation program to help our participants quit smoking. First, the strategy for supporting autonomous regulation consists of eliciting the point of view and drawing out emotions from the participants (develop rapport and discuss the meaning of smoking and the reasons for quitting smoking); determining the participants' values about smoking cessation (relationship between setting goals in life and smoking, recognizing responsibility for smoking cessation behavior, and determining the meaning of lifelong smoking cessation in life); presenting the basis for information provided during counseling and training (scientific basis for smoking cessation method, principle of nicotine addiction, etc.); suggesting diverse options for smoking cessation (choose the start date of smoking cessation, smoking cessation method, times a participant wants to receive smoking cessation counseling and text messages, withdrawal symptom coping strategies appropriate for the participant, and strategies for avoiding temptation-causing situations for smoking); and supporting the participant to start to quit smoking on his or her own. Second, perceived competence–supporting strategies consisted of positive support for the success of participants' smoking cessation (creating a positive atmosphere with encouragement and empathy from acquaintances and smoking cessation supporters around), effective feedback, checking obstacles that are expected when implementing smoking cessation strategies, establishing coping strategies and strategies to avoid with a strong temptation to smoke, praise, and encouragement. Finally, the topics and contents of the SDT-based workplace smoking cessation program are presented: starting and motivating smoking cessation at Week 1, coping strategies for withdrawal symptoms at Week 2, motivation strengthening for smoking cessation at Week 3, coping behaviors with temptation-causing situations at Week 4, strengthening strategies for smoking cessation maintenance at Week 5, the importance of lifelong smoking cessation at Week 6, and maintaining successful smoking cessation at Week 7–12. The validity of the workplace smoking cessation program based on

SDT was verified by a panel of experts consisting of two nursing professors, one public health nurse working in a smoking cessation clinic, and two occupational health nurses from an oil refinery company. After the validation of the program by experts, a pilot testing was conducted on 10 workers in Building B of the oil refining company that did not participate in this intervention. After evaluating the pilot testing to ensure acceptability, feasibility, and useful content, the workplace smoking cessation program based on SDT was confirmed (Table 1).

Treatment/procedure

A researcher and another occupational health nurse with 10 years of working experiences carried out the smoking cessation program.

Table 1 *Contents of a Workplace Smoking Cessation Program based on Self-determination Theory Using Individual Counseling and Tailored Text Messaging.*

Week	Theme	Concept of SDT	Need of supportive behaviors from SDT	Contents
1	Start to quit smoking: Motivating to stop smoking	Autonomous regulation		Overview a workplace smoking cessation program based on SDT
			Elicit participant's perspectives & feelings	Building rapport
			Explore participant's values	Discuss the relationship between lifetime goals and quitting smoking - Writing down your reasons and motives for quitting smoking - Health benefits of quitting smoking
			Provide clear rationale for advice given	Provision of scientific information on how to quit smoking
			Provide effective options for behavior change	Assessment of preparedness to quit smoking - Individual selection of start date for quitting smoking - Decide participant's method to quit smoking: cold turkey or gradually - Selecting a favorite time to receive text messaging related to smoking cessation - Writing a pledge to quit smoking
		Competence	Be positive that the participant can succeed	Encouragement for success in quitting smoking
			Develop a plan that is appropriate	Developing a plan for behavioral changes to quit smoking
2	Developing coping strategies for handling withdrawal symptoms	Autonomous regulation	Provide clear rational for advice given	Provision of information on the principles of nicotine addiction
			Provide effective options for behavior change	Prepare for possible withdrawal symptoms - Writing your own plan for handling withdrawal symptoms - Selecting appropriate method to handle withdrawal symptoms
		Competence	Identify barriers to change	Identification of potential pitfalls to quit smoking
			Develop a plan that is appropriate	- Writing your own plan for dealing potential pitfalls
			Encourage skills building	Building skills for handing withdrawal symptoms
3	Facilitating motivation for smoking cessation	Autonomous regulation	Elicit participant's perspectives & feelings	Investigating reasons for smoking vs reasons for quitting smoking
			Explore participant's values	Recognizing the health responsibility to establish behavior to quit smoking
		Competence	Develop a plan that is appropriate	Establishing appropriate plan for continuing smoking cessation
			Provide accurate feedback	Providing effective & relevant feedback
			Be positive that the participant can succeed	Asking for help and support from those around you
4	Dealing with smoking temptations	Autonomous regulation	Provide clear rationale for advice given	Provision of scientific information on dealing with smoking temptations
			Provide effective options for behavior change	Writing your own plan and selecting appropriate coping strategies to avoid smoking temptations
		Competence	Identify barriers to change	Identification of specific smoking temptations
			Develop a plan that is appropriate	Developing appropriate plan to deal with smoking temptations
			Reframe failures as short success	Empathy and feedback for past experiences of smoking cessation
			Encourage skills building	Learning how you'll deal with temptations
5	Enhancing strategies for sticking on smoking cessation	Autonomous regulation	Support self-initiation for change	Identifying which of the strategies you established are being well and which are not
		Competence	Provide accurate feedback	Reinforcement of problem-solving strategies for quitting smoking
			Identify barriers to change	Reestablishing and encouraging strategies that are not being executed
6	Importance of lifetime smoking cessation	Autonomous regulation	Provide clear rational for advice given	Provision of information on the importance of lifetime smoking cessation
			Explore participant's values	Exploring the meaning of lifetime smoking cessation
		Competence	Provide accurate feedback	Discussion about changes after quitting smoking
7~12	Success in maintaining smoking cessation	Autonomous regulation	Support self-initiation for change	Discussion about free topics which participant chose to sticking on smoking cessation
		Competence	Be positive that the participant can succeed	Encouragement for maintaining successful smoking cessation - Developing empathy and encouragement for difficulties of quitting smoking - Compliments for maintaining successful smoking cessation

Note. SDT = self-determination theory.

Both of them have conducted various types of worksite health and wellness programs at a large-sized company for the past 10 years. The SDT-based smoking cessation program including brief counseling and tailored text messaging performed by a researcher was applied to the intervention group, and another occupational health nurse provided the conventional smoking cessation program to the control group.

Participants in the intervention group received a 34-page smoking cessation workbook, individual counseling for 10–15 minutes, and tailored text messages during the 12-week period. Weekly, 10–15 minutes of counseling was conducted by a researcher in the company's health office at times chosen by workers during the first 6 weeks, and phone counseling was provided for the remaining 6 weeks at times selected by workers who indicated a desire for phone counseling. Based on an individual counseling using the smoking cessation workbook, tailored text messages (for example, customized smoking cessation information, encouraging messages, coping strategies, smoking cessation maintenance strategies, exploring life goals without smoking, etc) were sent to workers during the 12-week period by a researcher. In addition, text messages were sent twice per day during the first two weeks, once per day from Weeks 3 to 6, and then once per week from Weeks 7 to 12. Workers could choose the times when they wanted to receive text messages. In case of the control group, participants received a smoking cessation leaflet as well as telephonic follow-up for 3 times. After data collection was entirely completed, participants in the control group were provided with smoking cessation workbook.

Blinding of data collectors and participants was used to ensure unbiased ascertainment of outcomes. Data were collected by a research assistant from August to November 2014. A research assistant as a data collector who had 5 years of nursing experience was hired to conduct the survey and to measure the exhaled carbon monoxide concentration before and after the program. Instructions for filling in the questionnaire and measuring exhaled carbon monoxide concentration were given to the research assistant. Data were measured immediately before the intervention as pretest, posttest at 6 weeks, and posttest at 12 weeks after the completion of the intervention.

Data analysis

Data were analyzed using the SAS 9.4 program (SAS Institute, Cary, NC, USA). First, a homogeneity test was performed using an independent t test or Chi-square with Fisher's exact test. A Chi-square with Fisher's exact test was used when the data were unequally distributed among the cells of the table or when the expected values in any of the cells of a contingency table were below 5. Moreover, an independent t test was used to test for the homogeneity of autonomous regulation, perceived competence, and nicotine dependence of the intervention and control groups before the program. Second, the effectiveness of the intervention on autonomous regulation, perceived competence, and nicotine dependence at 6 weeks and 12 weeks was examined using a repeated-measures analysis of variance and paired t tests. t tests or Chi-square tests were used to examine the effectiveness of the intervention on self-reported tobacco abstinence rate and exhaled carbon monoxide concentration.

Results

Homogeneity of general and smoking-related characteristics in participants

There were no significant differences between the intervention and control groups in any of the general characteristics, age, marital status, educational level, and occupation, indicating that the two groups were homogeneous. The homogeneity test of the participants' smoking-related characteristics indicated that there were no significant differences between the two groups in total years of smoking, cigarettes per day, experience of smoking cessation, and attempts to quit smoking. There were no significant differences in the dependent variables, autonomous regulation, perceived competence, and nicotine dependence as well, suggesting that the two groups were homogeneous (Table 2).

Effectiveness of a workplace smoking cessation program based on SDT

The effectiveness of the SDT-based workplace smoking cessation program on autonomous regulation, perceived competence, and nicotine dependence was shown. There were statistically significant differences in autonomous regulation, perceived competence, and nicotine dependence, with interactions between groups, between times, and between times and groups (all $p < .001$) (Table 3).

The effectiveness of the SDT-based workplace smoking cessation program on self-reported tobacco abstinence rate and exhaled carbon monoxide concentration was shown. There was a significant difference in the self-reported tobacco abstinence rate, indicating that the intervention group reported a tobacco abstinence rate of 100% and the control group reported a rate of 16.1% at 6 weeks. There was also a significant difference in the self-reported tobacco abstinence rate between the two groups at 12 weeks: 96.7% of the intervention group and 13.3% of the control group (all $p < .001$). Significant differences were shown in exhaled carbon monoxide concentration: The concentration of the intervention group was 0.53 ± 0.81 ppm, and that of the control group was 8.50 ± 4.60 ppm at 6 weeks; the exhaled carbon monoxide concentration of the intervention group was 0.30 ± 0.95 ppm, and that of the control group was 8.10 ± 3.81 ppm at 12 weeks (Table 4).

Discussion

This study provides valuable information that the workplace smoking cessation program based on an SDT is effective by

Table 2 *Homogeneity Test of General and Smoking-related Characteristics between Intervention and Control Groups (N = 60).*

Characteristics	Intervention group (n = 30)	Control group (n = 30)	t or χ^2 (p)
	n (%) or M ± SD	n (%) or M ± SD	
Age (yrs)	43.26 ± 11.19	40.66 ± 10.25	0.94 (.352)
Marital status			0.03 (.217)[a]
Married	24 (80.0)	22 (73.3)	
Single	4 (13.3)	8 (26.7)	
Others (divorced or widow)	2 (6.7)	0 (0.0)	
Educational level			3.06 (.079)
College	25 (83.3)	19 (63.3)	
High school	5 (16.7)	11 (36.7)	
Occupational class			3.06 (.079)
White-collar	25 (83.3)	19 (63.3)	
Blue-collar	5 (16.7)	11 (36.7)	
Total years of smoking	19.66 ± 10.48	18.76 ± 8.37	0.37 (.714)
Cigarettes per day	15.70 ± 5.75	14.51 ± 5.15	0.83 (.408)
Experience of smoking cessation			0.16 (.423)
Yes	28 (93.3)	25 (83.3)	
No	2 (6.6)	5 (16.7)	
Attempts to quit smoking (times)	3.20 ± 2.72	2.03 ± 2.00	1.89 (.064)
Autonomous regulation	3.51 ± 1.46	3.40 ± 1.32	0.29 (.771)
Perceived competence	4.01 ± 1.47	3.90 ± 1.56	0.28 (.783)
Nicotine dependence	3.63 ± 2.10	3.00 ± 2.31	1.11 (.273)

Note. M = mean; SD = standard deviation; yrs = years.
[a] χ^2 with Fishers' exact test.

Table 3 *Comparison of Autonomous Regulation, Perceived Competence, and Nicotine Dependence between Intervention and Control Group (N = 60).*

Variables	Intervention group (n = 30)	Control group (n = 30)	Sources	F	p
	M ± SD	M ± SD			
Autonomous regulation					
Pretest	3.51 ± 1.46	3.40 ± 1.32	Group	212.33	<.001**
Posttest 1 at Week 6	6.27 ± 0.58	3.16 ± 1.55	Time	34.85	<.001**
Posttest 2 at Week 12	6.47 ± 0.43	3.18 ± 1.51	Group × time	48.16	<.001**
Perceived competence					
Pretest	4.01 ± 1.47	3.90 ± 1.56	Group	40.49	<.001**
Posttest 1 at Week 6	6.35 ± 0.78	3.88 ± 1.76	Time	26.79	<.001**
Posttest 2 at Week 12	6.57 ± 0.55	3.70 ± 1.67	Group × Time	32.29	<.001**
Nicotine dependence					
Pretest	3.63 ± 2.10	3.00 ± 2.31	Group	15.11	<.001**
Posttest 1 at Week 6	0.00	2.93 ± 2.59	Time	57.46	<.001**
Posttest 2 at Week 12	0.03 ± 0.18	2.86 ± 2.37	Group × Time	51.47	<.001**

Note. M = mean; SD = standard deviation. **$p < .01$.

encouraging autonomous regulation and competence for workers. Moreover, this study offers meaningful results because SDT-based smoking cessation program using individual counseling and tailored text messages led to 96.7% smoking cessation rate among workers. Given that the prevalence of smoking in workers is higher than the smoking rate of adults and that combining tobacco use with occupational hazards could enhance the possibility of smoking-related occupational disease [11], development and implementation of the tailored smoking cessation program for workers is very important.

Our findings indicated that autonomous regulation of the intervention group significantly increased at 6 weeks and increasing autonomous regulation maintained at 12 weeks, whereas there were no significant differences in the control group before as well as at 6 weeks and 12 weeks. This is in line with findings from other studies of SDT-based smoking cessation program [16–18]. The higher level of autonomous regulation in smokers is important because it predicts long-term smoking cessation and also yields greater feelings of competence for quitting [24,26]. The reason for a significant increase of autonomous regulation in this study is that our program includes a variety of strategies for supporting autonomous regulation that allowed workers to choose effective smoking cessation options to enhance autonomy. For example, workers are asked to identify several important life goals and indicate how smoking may hinder these aspirations. Our intervention is intended to help workers how quitting tobacco fits into their life and how best to make this change. Through such exploration of values between participants and occupational health nurses, autonomous regulation could be facilitated.

Table 4 *Comparison of Tobacco Abstinence Rate and CO Levels between Intervention and Control Groups (N = 60).*

Variables	Intervention group (n = 30)	Control group (n = 30)	χ^2 or t	p
	n (%) or M ± SD	n (%) or M ± SD		
Tobacco abstinence rate				
Posttest 1 at Week 6				
Yes	30 (100.0)	5 (16.1)	42.85	<.001**
No	0 (0.0)	25 (83.9)		
Posttest 2 at Week 12				
Yes	29 (96.7)	4 (13.3)	42.08	<.001**
No	1 (3.3)	26 (86.7)		
CO levels (ppm)				
Posttest 1 at Week 6	0.53 ± 0.81	8.50 ± 4.60	−9.33	<.001**
Posttest 2 at Week 12	0.30 ± 0.95	8.10 ± 3.81	−10.86	<.001**

Note. CO = carbon monoxide; M = mean; SD = standard deviation.
**$p < 0.01$

An encouraging finding was that the perceived competence of the intervention group significantly increased at 6 weeks and was still maintained at 12 weeks in this study, contrary to results about no differences in that of the control group. This result is consistent with those of previous studies that the intervention group's perceived competence has been significantly higher than that of the control group [16–18]. The reason why perceived competence increased in this study is that several components of the interventions are designed to support competence of quitting smoking. The Smoker's Health Project has shown that ways to support competence include helping to establish a behavior change plan and offering relevant feedback [27]. For example, workers in our study voluntarily established coping strategies for a strong temptation to smoke using their workbook, and tailored text messages were sent to them during 12 weeks. The study by Williams et al [27] has shown that the most important factor affecting the competence of quitting smoking is the ability to cope with situations causing smoking. To overcome smoking temptations, tailored messages are more likely to be remembered and perceived as more personally relevant than nontailored messages [13]. Moreover, we supported the ability of the participants to quit smoking by providing tailored feedback on how to continue a smoke-free status and gave positive encouragements. Before the beginning of the program, we identified who would be the happiest if the worker succeeded in quitting smoking, and letters or video clips from smoking cessation supporters were obtained to give positive support and encouragement to the workers by delivering the letters or video clips to the workers in the middle stage of the program. Through these diverse perceived competence support strategies, workers could feel confident that they could succeed in quitting smoking, and this, in turn, increased their perceived competence.

When nicotine dependence, self-reported tobacco abstinence, and exhaled carbon monoxide concentration to evaluate whether or not the participant succeeded in quitting smoking were measured, this study has demonstrated that the nicotine dependence, self-reported tobacco abstinence, and exhaled carbon monoxide concentration of the intervention group were similar to those of nonsmokers at 6 weeks and 12 weeks, whereas there were no significant differences for the control group in nicotine dependence before and after 6 weeks and 12 weeks. A systematic literature review on verifying the effectiveness of workplace smoking cessation programs reported that smoking cessation rates measured at 12 months ranging from 15.4% to 43.7% was not high [12]. The large variation in the success rate of smoking cessation programs underlines that it is necessary to develop an

effective smoking cessation program to fit workers' characteristics and to facilitate the smoking cessation of workers. Considering the previous studies, the tobacco abstinence rate in this study is considerably high. High rate of smoking abstinence in this study was explained by two concepts such as high level of autonomous regulation and competence. For example, workers could continue their smoke-free status due to improvement of autonomous regulation, in which workers perceive that they are the main agents of smoking cessation behavior and choose diverse methods to continue smoke-free status or behavior on their own. Moreover, text messages continuously have been sent to workers to motivate them to maintain smoking cessation status, when the workers had the highest craving to smoke, based on the content of individual face-to-face and phone counseling.

The strength of this present study is that the workplace smoking cessation program for oil refining workers could be a sound investment to both workers and employers. Given that SDT-based smoking cessation program resulted in 96.7% smoking cessation rate of workers, it would provide an attractive and cost-effective intervention to increase smoking abstinence rates of smokers in various workplaces. Furthermore, additional motivational strategies such as tailored text messaging and individual counseling are highly effective to quit smoking in workers. Thus, SDT-based smoking cessation program using tailored text messaging and individual counseling is possible to be disseminated across workplaces. Another strength of this study is that the dropout rate is low and attrition does not appear to introduce a bias.

Despite the significance of this research, some limitations should be considered. Owing to a small sample of a relatively homogenous group of workers from one oil refining company, findings of main outcomes may not be generalizable to all types of workers with tobacco use. Another limitation is that there may have been a selection bias as participation were voluntary and participants were more likely to be motivated to quit tobacco use. In addition, assessing only the short-term effects of the workplace smoking cessation program is another limitation. Owing to the durability of our successful findings being unclear, long-term follow-up should be considered. Finally, it should be noted that our results may not be generalizable to both higher and lower socioeconomic status smokers because blue-collar workers are more likely to smoke and have less success in quitting than white-collar workers, which might increase their smoking-related health risks [28].

Conclusion

In the SDT-based smoking cessation program, individual counseling and tailored text messaging to workers had positive effects on autonomous regulation, perceived competence, nicotine dependence, self-reported tobacco abstinence rate, and exhaled carbon monoxide concentration at 6 weeks and 12 weeks. The findings indicate that the provision of SDT-based smoking cessation program is effective and feasible in a workplace setting.

The results suggest several implications. First, future studies aimed at smokers working in a variety of different sized companies would be conducted to confirm the effectiveness of SDT-based smoking cessation program. Compared to large-sized companies, small- and medium-sized companies are less likely to adopt smoking cessation programs because smaller workplaces have fewer earnings and may lack the resources needed to implement smoking cessation programs [29]. Second, this study evaluated smoking cessation behavior for 12 weeks, but as smoking cessation is a behavior in which individuals need to control and overcome a lifetime of temptation-causing situations, we need to conduct a long-term observational follow-up study to determine how long the effect of an SDT-based smoking cessation program lasts. Third, the workplace smoking cessation program should be conducted for blue-collar workers because the prevalence of smoking in blue-collar workers is higher than that in white-collar workers and blue-collar workers are more likely to be exposed to hazards on the job, which might increase their smoking-related health risks [28].

Conflicts of interest

No conflict of interest has been declared by the authors.

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