


Promotion of Smoking Cessation Using the Transtheoretical Model: Short-Term and Long-Term Effectiveness for Workers in Coastal Central Taiwan

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ABSTRACT

BACKGROUND: Smoking cessation reduces the risk of severe illnesses in the long run and contributes to improving health. This study evaluated the short-term and long-term effectiveness of workplace smoking cessation intervention implemented using the transtheoretical model.

METHODS: Participants were assessed at baseline before the intervention and after 6 months and 4 years of follow-ups. Data on changes in participants' perception of smoking prohibition in the workplace, knowledge of the hazards of smoking, attitude towards quitting smoking, and behavior related to tobacco harm prevention were collected.

RESULTS: Results showed the prevalence of smoking cessation was 31.5% (95% CI: 25.4-38.1%) after 6 months and 10.7% (95% CI: 6.9-15.6%) after 4 years. At the abovementioned time points, the prevalence of second-hand smoke exposure, and the proportion of people who demonstrated correct knowledge of smoke hazards initially decreased and then increased. The proportion of participants who had seen or received information about tobacco harm prevention provided in the workplace increased from 75.6% at baseline to 95.6% (increased by 20.0%) after 6 months and finally to 97.2% (increased by 21.6%) after 4 years ($P < .001$). However, the percentage of participants who hoped their workplace continued to provide smoking cessation services rose from 80.0% at baseline to 93.6% (increased by 13.6%) after 6 months and then fell to 78.0% (decreased by 2.0%) after 4 years ($P < .001$).

CONCLUSION: The short-term effectiveness of the transtheoretical model in promoting workplace smoking cessation is substantial, but in the long-term, effectiveness weakens.

KEYWORDS: Smoking cessation, short-term effectiveness, long-term effectiveness, workplace, transtheoretical model

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Introduction

Globally, concerning preventable diseases, smoking continues to generate an enormous burden. Data showed that smoking caused 7.69 million deaths worldwide in 2019 and contributed to 7.9% of disability-adjusted life years.¹ Smoking is bound to generate both direct and indirect impacts on medical expenditure, and the continually growing trend poses a significant threat to economic development.² In contrast, smoking cessation reduces the risk of severe illnesses in the long run and contributes to improving health. Therefore, smoking cessation

services are of significant need to smokers and, more so, to protect non-smokers from exposure to second-hand smoke.

Most people spend nearly a third of their time in the workplace, and successful implementation of tobacco harm reduction in workplaces certainly diminishes health threats.^{3,4} There is a global consensus to comply with smoke-free workplace regulations.³ Taiwan began promoting smoke-free workplaces in 2003. The prohibition of smoking in indoor workplaces was put into action in 2009.⁵ By 2017, 18,274 workplaces in Taiwan had passed the "Healthy Workplace Self-Certification." In Taiwan,



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the intervention measures for smoking cessation in workplaces generally include methods for quitting smoking, health education for all employees, and the formulation of a policy to reduce smoking. However, some employers in Taiwan use only simple voluntary smoking cessation strategies, such as posting smoking prohibition announcements in workplaces.⁶ As a result, the workplace smoking rate has been decreasing each year.⁵ From 2009 to 2017, the workplace smoking rate dropped from 18.2% to 11.5%, of which men dropped from 32.6% to 23.5%, and women remained from 2.5% to 2.6%.⁵ Nevertheless, cigarette smoking in the workforce remains prevalent. Therefore, smoking cessation in workplaces needs to be more proactively promulgated.

Most interventional studies on smoking cessation assessed only short-term effectiveness because long-term assessments are time-consuming and expensive. Furthermore, participants are prone to attrition, and the long-term effectiveness of interventions is not easy to sustain.⁷ A study analyzed the persistence of smoking cessation intervention by providing self-help manuals, group courses, media advocacy, and implementing non-smoking policies in European workplaces. For heavy smokers, this was shown to be effective in maintaining long-term smoking abstinence (6 months) and quitting after 14 months.⁸ However, 2 earlier large-scale studies conducted in the United States observed no significant improvement in combined disease prevention 6 months after the workplace intervention compared with workplaces without interventions.^{9,10} There is no doubt that more research is needed to determine the long-term effectiveness of smoking cessation programs in workplaces.

In order to design an effective smoking cessation intervention, the effectiveness of delivering smoking cessation recommendations is of concern. According to the transtheoretical model,^{11,12} individuals begin the process of change during the “pre-contemplation” stage. Subsequently, the individual enters and moves through the “contemplation,” “preparation,” and “action” stages before reaching the “maintenance” stage. This model reveals how interventions affect the process of behavioral change. The unique cyclical characteristics of the transtheoretical model focus not only on the contemplation of taking actions but also on changes moving in the opposite direction. Also, it well describes the hesitation and actions involved in quitting cigarette smoking. According to this model, each stage can be distinguished, and the time when a specific change in attitude, intent, and behavior occurs can be explained.^{11,12} However, its applicability to specific populations should be further verified.

This study collected data from subjects in workplaces. Changes in their perception of anti-smoking measures in the workplace, knowledge about the hazards of smoking, smoking cessation attitude, and behavior related to tobacco harm reduction were assessed, and their concentration of expired carbon monoxide (CO) and blood pressure were measured at 3 time points: baseline, 6 months, and 4 years. Data collected were analyzed to determine the short- and long-term effectiveness of

using the transtheoretical model to promote smoking cessation in the workplace.

Methods

Research design and study subjects

The current plan was an intervention study implemented upon approval from the Ethics Review Board of the associated institution (Tungs’ Taichung MetroHarbor Hospital, Institutional Review Board No. 105061). Participants’ baseline data were collected through simple physiological measurements and standardized questionnaires. After 6 months and 4 years, follow-up assessments were carried out at the workplaces.

This plan was carried out in coastal central Taiwan because the industrial areas are primarily located in the coastal area. After all, the coastal area was relatively poor in the past. Furthermore, the formulated plan required assistance from the executives and leaders of local organizations, social welfare and medical foundations, medical institutions, industrial parks, and companies promoting smoke-free workplaces. Research participants were recruited from workplaces starting in 2014, which included a construction plant, 3 fishery companies, seven manufacturing plants (food fertilizer, petrochemical, paper-making, plastics, electronics, and machinery manufacturing companies), 6 service industries (amusement park, an insurance company, catering, clean service, telecommunications service, and security service firms) and 3 public services. Four workplaces had more than 500 employees, and 896 workers were recruited to receive the intervention. The research team also trained workplace nurses to pass on tobacco harm prevention policies and help provide tobacco harm reduction knowledge.

Survey questionnaires

The research team combined health care services to provide smoking counseling to workers and health education using multimedia and lectures that focused on the disadvantages of smoking and the benefits of quitting smoking. Subjects attended a smoking cessation education course that lasted 2 hours during the intervention. Subsequently, the questionnaire surveys were conducted again after 6 months and 4 years to examine the intervention’s short- and long-term effectiveness. In total, 702 and 218 subjects were surveyed; the response rates were 78.3% and 24.3%, respectively. Two trained interviewers assisted each participant with the 20-minute survey questionnaire and asked the participants not to discuss the interview with colleagues who had not yet completed it. The survey questionnaire was self-filled, and the questions covered demographic characteristics, smoking status, perception of anti-smoking measures in the work environment, knowledge of smoking hazards, attitude towards quitting smoking, and behavior related to tobacco harm prevention. The perception of smoking prohibition measures in the workplace was assessed using 4 items. The knowledge scale was constructed also using 4

statements. Items on the attitude scale focused primarily on personal relevance, negative impacts on personal health and family, and resources for seeking to quit smoking; the 3 statements were used. To assess tobacco harm prevention-related behavior, only smokers were asked.

Inclusion and exclusion criteria

Before conducting the survey questionnaire, consent forms were obtained from all participants. There were 543 men and 353 women in the study cohort. Among them, 216 were smokers before the intervention. Like the US National Health Interview Survey,¹³ smokers at baseline were defined as people who continuously smoke and have smoked more than 100 cigarettes. Former smokers were defined as people who have smoked more than 100 cigarettes but have entirely quit. In the follow-ups, smoking quitters were people who had been smokers, accepted the intervention at baseline, and had not smoked 7 days prior to the follow-up visit, as described in a previous study.⁸ Moreover, the subjects were all of the same race and lived in the same geographical area, which reduced any response biases due to racial or lifestyle differences.

Intervention

This study uses the transtheoretical model to promote smoking cessation in the workplace, which involves the following stages and relevant actions detailed in Table 1.

- (1) Pre-contemplation stage: Subjects have no intention of quitting smoking in the foreseeable future; i.e., they will not make behavioral changes in the next 6 months. Subjects are potentially unaware of the impact smoking has on their health. In addition, some subjects indicated that they had tried to quit smoking but could not overcome the addiction or invitations from their colleagues. Therefore, health education at this stage emphasizes the negative impacts of smoking to heighten their awareness and encourage behavior change.
- (2) Contemplation stage: Subjects begin to realize their behavioral problems and consider quitting smoking within the next 6 months. Although preparative actions are not yet taken, thoughts and awareness of the benefits of smoking cessation have begun to grow, and they express the determination to quit smoking. Some subjects may remain in the contemplation stage for long periods and actively seek health-related information during the behavioral change process. Therefore, the research team complimented those who intended to quit smoking and concurrently provided them psychological support to overcome the smoking addiction. Moreover, the team clarified the values of personal

health, family prosperity, and work relationships to help eliminate difficulties and obstacles to smoking cessation, thus preventing them from regressing to the contemplation stage.

- (3) Preparation stage: Subjects indicate that behavioral change will be initiated soon but have not taken action. The team learned more about their previous attempts to quit smoking and analyzed those sporadic actions taken in the past and the plans of action. In particular, the team expressed approval to those with positive results and encouraged subjects to have confidence in their choice of methods, and in parallel, reviewed the causes of relapse.
- (4) Action stage: Subjects are encouraged to actively change their habits, such as going to bed early and getting up early, exercising more than 5 days a week and for more than 1 hour at a time, and gaining the ability to refuse a colleague's invitation to smoke skillfully.
- (5) Maintenance stage: At this stage, subjects should have quit smoking for more than 6 months. Although they have successfully quit smoking, they are still prone to smoking relapses. Therefore, the team encouraged them to seek support from those in their support system so that they would be less susceptible to temptations that eventually cause relapses.

Physiological assessments

Physiological assessments of participants, including expired CO concentration and blood pressure, were carried out. Expired CO concentration was measured using a calibrated CO detector (Micro Medical Spirometer; Williams Medical Supplies Ltd., Rhymney, UK). Those who used to smoke and expressed that they had quit smoking but had a CO value exceeding seven ppm were considered current smokers.¹⁴ Blood pressure was measured above the elbow using an electronic blood pressure monitor (Omron Healthcare Co. Ltd., Kyoto, Japan) after at least 15 minutes of rest with the participants sitting.¹⁵ Three measurements were made, and an average was taken. The immediate results of CO and blood pressure measurements were shown to the participants. In addition, an explanation of the data and health counseling was provided.

Statistical analysis

After performing the baseline assessment and implementing the intervention in the workplaces, 2 follow-ups were carried out after 6 months and 4 years to analyze the intervention's short- and long-term effectiveness. The prevalence of smoking cessation and the 95% confidence interval (CI) of the 2 follow-up time points were calculated. The denominator was the number

Table 1. Stages of change in promoting workplace smoking cessation using the transtheoretical model.

STAGE OF CHANGE	PROCESSES OF CHANGE	ACTIVITY
Pre-contemplation	Consciousness-raising: Encourage participants to increase their awareness, seek new information, and understand feedback on the issue.	Consciousness-raising: Ask participants to imagine the appearance and feeling of their lungs when they smoke.
	Environmental reevaluation: Encourage participants to assess the physical and social effects.	Environmental reevaluation: Use role reversal to role-play a person who feels uncomfortable when someone smokes and ask participants to show their reactions.
Contemplation	Consciousness-raising: Same as the pre-contemplation stage.	Consciousness-raising: Same as the pre-contemplation stage.
	Environmental reevaluation: Same as the pre-contemplation stage.	Environmental reevaluation: Same as the pre-contemplation stage.
	Self-reevaluation: Encourage participants to think about their feelings if they have smoking-related illnesses.	Self-reevaluation: Use value clarification to help participants recognize inconsistencies between values and behaviors.
Preparation	Self-reevaluation: Encourage participants to assess their feelings about uncontrolled smoking behaviors and express their viewpoints.	Self-reevaluation: At least 2 thoughts or beliefs about smoking are written down by the participant, and to identify all unreasonable statements. Use cognitive restructuring to help participants recognize irrationality and change irrational thoughts into rational statements.
	Self-liberation: Encourage participants to believe in their changes, the ability to change, and to choose and commit to their beliefs.	Self-liberation: Participants write a contract or announce publicly to family and friends his/her intention to engage in quitting smoking.
	Counter-conditioning: Encourage participants to choose healthier alternatives in situations that can cause health problems.	Counter-conditioning: Assist participants in identifying the conditions that cause breathing problems, teach participants to recognize the feeling of anxiety, shift focus, stay away from disturbing emotions, and stay focused for 10 seconds or more.
	Stimulus control: Encourage participants to find cues to remind them to increase positive behavior.	Stimulus control: Ask participants to expand cues from the rearranged environment and promote the use of smoking cessation services.
Action stage	Self-liberation: Same as the preparation stage.	Self-liberation: Same as the preparation stage.
	Counter-conditioning: Same as the preparation stage.	Counter-conditioning: Same as the preparation stage.
	Stimulation control: Same as the preparation stage.	Stimulus control: Same as the preparation stage.
	Contingency management: Encourage participants to acknowledge and reward positive behavioral change.	Contingency management: Identify specific rewards to be received when behavioral changes are made.
Maintenance	Counter-conditioning: Same as the action stage.	Counter-conditioning: Same as the action stage.
	Stimulus control: Same as the action stage.	Stimulus control: Same as the action stage.
	Contingency management: Same as the action stage.	Contingency management: Same as the action stage.
	Helping relationships: Encourage participants to take advantage of their support systems, such as family, friends, and health providers.	Helping relationships: Identify at least 1 person who cares about the participant and is committed to helping the participant change and providing support.

of smokers who received the smoking cessation intervention at baseline. In addition, participants with incomplete follow-up data were considered unsuccessful in quitting smoking. The participants' demographics, smoking characteristics, perceptions of anti-smoking measures in the work environments, knowledge of the hazards of smoking, smoking cessation attitudes, tobacco harm prevention-related behaviors, exhaled CO concentrations, and blood pressure assessed at different time points were compared. Continuous variables are displayed as mean \pm standard deviation and were analyzed using ANOVA. Categorical variables are denoted as the number of participants

(n, %) and were analyzed using the χ^2 -test. All *P*-values were calculated using a two-tailed test, and *P*-values less than .05 were considered statistically significant. Data were analyzed using SAS 9.4 (SAS Institute, Cary, NC, USA).

Results

Table 2 presents the demographics and smoking characteristics of the participants at all three-time points. As can be seen, participants' age increased after baseline measurement ($P < .001$, ANOVA). The proportion of men at the 3 time-points was

60.6%, 55.4%, and 63.3%, respectively, revealing a statistically significant decrease at six-month follow-up ($P = .04$, χ^2 -test). The proportion of participants with a college/university degree was 59.9% at baseline and 62.4% at six-month follow-up but decreased significantly to 36.7% at four-year follow-up ($P < .001$). Construction and fishery laborers had the most diminutive occupational proportions at all three-time points, 15.7%, 6.7%, and 18.3%, respectively, which also showed a significant decrease at six-month follow-up ($P < .001$). Additionally, service providers have the highest percentage of lost to follow-up after 4 years. The smoking prevalence decreased from 24.1% to 18.8% and then increased to 22.9%. The exposure to second-hand smoke decreased from 35.9% to 14.2% and then increased to 27.5%. Significant decrease in smoking rate ($P = .01$) and second-hand smoke exposure rate ($P < .001$) were observed at six-month follow-up compared with those at baseline. While the smoking rate showed no statistically significant difference between baseline and four-year follow-up, the second-hand smoke exposure rate was significantly lower at four-year follow-up than at baseline ($P = .02$).

Figure 1 shows participants' smoking status changes at all three-time points. At six-month follow-up, the point prevalence of smoking cessation among participants receiving intervention was 31.5% (95% CI: 25.4-38.1%), 34.9% among men (95% CI: 28.2-42.2%), and 20.0% among women (95%

CI: 2.5-55.6%). At four-year follow-up, the point prevalence of smoking cessation among participant receiving intervention was 10.7% (95% CI: 6.9-15.6%), 10.2% among men (95% CI: 6.5-15.2%) and 18.2% among women (95% CI: 2.3-51.8%). In contrast, of the 680 non-smokers at baseline, only 1 male employee became a smoker at 6 months, and another 3 male employees became smokers 4 years later.

At all 3 time points, the participants expressed their perceptions of the anti-smoking measures in the workplace, and the results are shown in Table 3. The proportion of people who knew that it was prohibited to smoke in indoor workplaces fell from 98.5% to 92.2% and then rose to 98.2%, indicating a significant difference ($P < .001$). The proportion of people who saw non-smoking signs posted in the workplace rose from 90.2% to 97.0% and then to 98.6% ($P < .001$). People who had seen or received tobacco hazard prevention information in the workplace increased most substantially, from 75.6% to 95.6% to 97.2% ($P < .001$). Finally, the proportion of people who would discuss the current anti-smoking measures in the workplace with their peers fell from 92.2% to 89.3% and then rose to 94.5%, also revealing a significant difference ($P = .03$).

Table 4 shows the assessment results on knowledge of tobacco harm, smoking cessation attitudes, and tobacco harm prevention-related behaviors at all three-time points. For knowledge of tobacco harm, the proportion of people who

Table 2. Demographic and smoking characteristics of participants at the three-time points.

VARIABLES	BASELINE n = 896	SIX-MONTH FOLLOW-UP n = 702	FOUR-YEAR FOLLOW-UP n = 218	P-VALUE
Age	40.4 ± 12.6	40.9 ± 11.3	49.8 ± 10.6	<.001
Gender				
Male	543 (60.6%)	389 (55.4%)	138 (63.3%)	.04
Female	353 (39.4%)	313 (44.6%)	80 (36.7%)	
Education				
Below middle school	142 (15.9%)	107 (15.2%)	61 (28.0%)	<.001
High school	217 (24.2%)	157 (22.4%)	77 (35.3%)	
College/university and above	537 (59.9%)	438 (62.4%)	80 (36.7%)	
Occupation				
Construction and fishery laborers	141 (15.7%)	47 (6.7%)	40 (18.3%)	<.001
Manufacturing laborers	345 (38.5%)	302 (43.0%)	112 (51.4%)	
Service workers	410 (45.8%)	353 (50.3%)	66 (30.3%)	
Smoking status				
Current smokers	216 (24.1%)	132 (18.8%)	50 (22.9%)	.03
Former smokers	77 (8.6%)	60 (8.5%)	27 (12.4%)	
Non-smokers	603 (67.3%)	510 (72.7%)	141 (64.7%)	
Second-hand exposure				
Yes	322 (35.9%)	100 (14.2%)	60 (27.5%)	<.001
No	574 (64.1%)	602 (85.8%)	158 (72.5%)	

Continuous variables were compared using ANOVA analysis, and categorical variables were compared using the χ^2 -test.

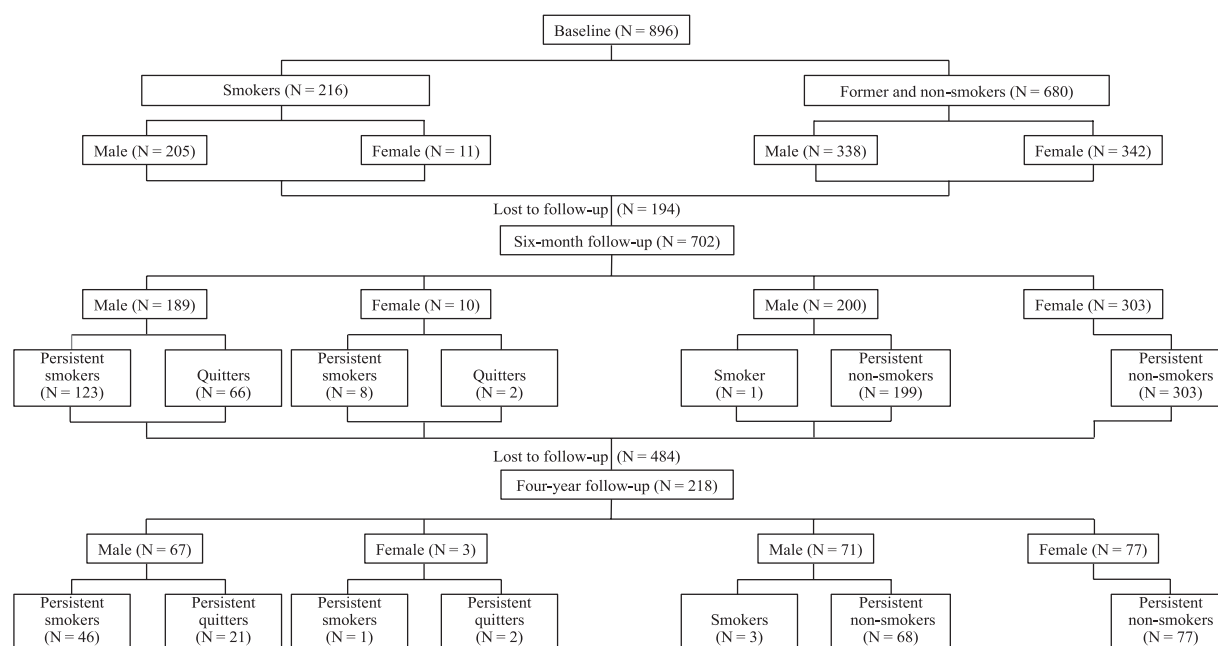


Figure 1. Participants' changes in smoking status at the 3 time points.

Table 3. Participants' perceptions of anti-smoking measures in the work environment.

VARIABLES	BASELINE	SIX-MONTH FOLLOW-UP	FOUR-YEAR FOLLOW-UP	P-VALUE
	n = 896	n = 702	n = 218	
Know that indoor workplaces must be completely smoke-free	88 (98.5%)	64 (92.2%)	214 (98.2%)	<.001
Have seen no-smoking signs in the workplace	808 (90.2%)	681 (97.0%)	215 (98.6%)	<.001
Have seen or received information about tobacco prevention and control provided by the workplace	677 (75.6%)	671 (95.6%)	212 (97.2%)	<.001
Have discussed with peers the current state of smoking prohibition in the workplace	82 (92.2%)	627 (89.3%)	206 (94.5%)	.03

Compared using the χ^2 -test.

correctly perceived “smoking as harmful to human health” fell from 99.3% to 95.9% and then rose to 100.0%. The proportion of people who correctly recognized that “second-hand smoke is more harmful to health than first-hand smoke” fell from 97.5% to 85.3% and then rose to 98.6%. Similarly, the proportion of people who correctly perceived “smoking in public places will be penalized” fell from 99.3% to 87.2% and then rose to 96.8%. The proportion of people who correctly recognized that “there are designated smoking areas in the workplace” decreased from 82.1% to 80.8% and then rose to 88.1%. The above findings on the 4 knowledge items all showed statistically significant variations in their perception among the three-time points (all $P < .05$, χ^2 -tests).

The participants strongly supported a smoke-free work environment regarding attitudes toward quitting smoking without statistically significant differences at all three-time points ($P = .27$). They also agreed that quitting smoking was

beneficial to their health and their families' health ($P = .47$). However, the response to the desire for the workplace to continue providing smoking cessation services rose from 80.0% to 93.6% and then fell to 78.0%, revealing a significant difference ($P < .001$). In addition, the proportion of smokers who would not smoke in the non-smoking areas of the workplace showed no significant difference at any of the 3 time points ($P = .48$). In particular, the proportion of participants seeking assistance in preventing tobacco harm in the workplace increased from 50.9% to 65.2% and then increased significantly to 92.0% ($P < .001$).

Lastly, Table 5 lists the measurements of the participants' expired CO concentration and blood pressure. At the three-time points, both expired CO concentrations and the proportion of participants with expired CO concentrations exceeding seven ppm decreased significantly. The same trend was observed in smokers and non-smokers ($P < .001$). However,

Table 4. Participants' knowledge of tobacco harm, attitudes towards quitting smoking, and behaviors related to tobacco harm prevention.

VARIABLES	BASELINE	SIX-MONTH FOLLOW-UP	FOUR-YEAR FOLLOW-UP	P-VALUE
	n = 896	n = 702	n = 218	
Knowledge of tobacco hazards				
Smoking is harmful to human health	890 (99.3%)	673 (95.9%)	218 (100.0%)	<.001
Second-hand smoke is more harmful than first-hand smoke	874 (97.5%)	599 (85.3%)	215 (98.6%)	<.001
Smoking in public places will be penalized	890 (99.3%)	612 (87.2%)	211 (96.8%)	<.001
There are designated smoking areas in the workplace	741 (82.1%)	567 (80.8%)	192 (88.1%)	.045
Smoking cessation attitude				
Support for smoke-free work environments	856 (95.5%)	668 (95.2%)	213 (97.7%)	.27
Quitting smoking is beneficial to your own and your families' health	883 (98.5%)	682 (97.2%)	216 (99.1%)	.47
Hope that the workplace will continue to provide smoking cessation services	717 (80.0%)	657 (93.6%)	170 (78.0%)	<.001
Smoke hazard prevention-related behavior^a				
Do not smoke in non-smoking areas of the workplace	191 (88.4%)	122 (92.4%)	45 (90.0%)	.48
Seek assistance in preventing tobacco harm in the workplace	110 (50.9%)	86 (65.2%)	46 (92.0%)	<.001

^aOnly smokers were asked.

^bCompared to using the χ^2 -test.

average systolic blood pressure dropped from 125.6 mmHg to 124.5 mmHg and then increased significantly to 131.7 mmHg ($P < .001$, ANOVA). Similarly, the proportion of abnormal blood pressure dropped from 45.1% to 43.7% and then increased significantly to 56.0% ($P = .005$). In contrast, average diastolic pressure showed no significant differences among the 3 time points. The trend for changes in blood pressure was the same for both smokers and non-smokers.

Discussion

This study examined the effectiveness of smoking cessation promoted in workplaces using the transtheoretical model. Upon intervention, the prevalence of smoking and second-hand smoke exposure and the proportion of people who demonstrated correct knowledge of smoke hazards first decreased and then increased, while the concentration of expired CO decreased significantly over time.

Most interventional studies on smoking cessation assessed only short-term effectiveness. Indeed, the long-term effectiveness of interventions is not easy to sustain.⁷ As an effective strategy for promoting smoking cessation in the workplace, its long-term effectiveness merits investigation. The present results showed that the point prevalence of smoking cessation for those receiving intervention was 31.5% after 6 months and 10.7% after 4 years. Contrarily, compared with that at the baseline, smoking prevalence was significantly lower after 6 months, while there was no significant difference at four-year follow-up. In the Netherlands, an early study assessing short- and long-term effectiveness of continuous workplace interventions showed a 20% smoking cessation rate after 4 months and 16%

after 14 months.⁸ Another recent study on the effectiveness of workplace smoking cessation promoted through offering educational courses and financial assistance found a decrease in cessation rates from 46% after 6 months to 41% after 12 months of intervention.¹⁶ In Switzerland, a study observed a 45% cessation rate among smokers in the general population after 6 months of intervention using financial assistance.¹⁷ However, it decreased to 18% after 18 months of intervention.¹⁷ In line with previous studies, our findings revealed more pronounced smoking cessation effectiveness in the short run but decreased long-term effectiveness.

In the current study, smokers were asked one of three questions to assess the smoking cessation stage. The first question set whether participants considered quitting smoking within the next 6 months - the contemplation stage. The second assessed whether the participant is considering withdrawing within the next 30 days - the preparation stage. If smokers were not considering quitting, they were classified into the pre-contemplation stage. The third question assessed the time of the last quit attempt. If participants plan to quit within the next 30 days but have not attempted quitting within the past year, they will be reclassified into the contemplation stage. Smokers who quit within the past 6 months were classified into the action stage, while those who quit for more than 6 months were in the maintenance stage.

In the process of smoking cessation, the focus for those in both pre-contemplation and contemplation stages is to enhance awareness. Smokers in the pre-contemplation stage are often described as resistant or unmotivated and tend to avoid information, discussion, or idea about the targeted health behavior.¹⁸ Smokers in the contemplation stage are also often seen

Table 5. Concentration of expired carbon monoxide (CO) and blood pressure at the 3 time points.

VARIABLES	BASELINE	SIX-MONTH FOLLOW-UP	FOUR-YEAR FOLLOW-UP	P-VALUE ^c
	n = 896	n = 702	n = 218	
Expired CO concentration (ppm)	6.2 ± 7.4	4.8 ± 5.6	2.9 ± 4.3	<.001
Smokers ^a	14.5 ± 10.0	11.6 ± 8.6	6.7 ± 5.4	<.001
Non-smokers ^a	3.5 ± 3.3	3.2 ± 2.9	1.7 ± 3.2	<.001
Expired CO concentration > 7 ppm (%)	252 (28.1%)	135 (19.2%)	32 (14.7%)	<.001
Smokers	172 (79.6%)	94 (71.2%)	25 (50.0%)	<.001
Non-smokers	80 (11.8%)	41 (7.2%)	7 (4.2%)	.001
Systolic blood pressure (mmHg)	125.6 ± 18.7	124.5 ± 19.3	131.7 ± 16.8	<.001
Smokers	128.7 ± 17.6	127.6 ± 17.7	134.8 ± 15.1	<.001
Non-smokers	124.7 ± 19.0	123.8 ± 19.6	130.8 ± 17.2	<.001
Diastolic blood pressure (mmHg)	78.8 ± 13.0	78.6 ± 13.5	80.0 ± 11.7	.38
Smokers	81.9 ± 13.4	80.9 ± 14.2	82.2 ± 11.4	.26
Non-smokers	77.9 ± 12.7	78.0 ± 13.3	79.2 ± 11.7	.39
Abnormal blood pressure ^b (%)	404 (45.1%)	307 (43.7%)	122 (56.0%)	.005
Smokers	114 (52.8%)	55 (41.7%)	32 (64.0%)	<.001
Non-smokers	290 (42.6%)	252 (44.2%)	90 (53.6%)	.04

^aThere were 216, 132, and 50 smokers and 680, 570, and 168 non-smokers at baseline, six-month, and four-year follow-ups.

^bSystolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg.

^cContinuous variables were compared using ANOVA, and categorical variables were compared using the χ^2 -test.

as ambivalent about changing or as procrastinators.¹⁹ Therefore, the greater the awareness of the health risks of smoking, the more active the attitude is towards quitting smoking.²⁰ Simultaneously, participants were encouraged to reassess their environment. The contemplation stage helps them self-reevaluate and strengthen their awareness, making them realize inconsistencies between values and behavior. Furthermore, the preparation stage is viewed as a transition stage, with individuals intending to progress to the action stage.²¹ In addition to self-evaluation, participants in the preparation stage were encouraged to believe in changes occurring in them and choose and commit to act with this belief. At the same time, they were facilitated to cope with anxiety, learn to focus, and stay away from worries, urging them to use smoking cessation services. Individuals in the action stage are thought to be able to make significant, perceptible lifestyle changes within 6 months.²² For participants during the action stage, their activities from the preparation stage were continued with completion and rewards for behavioral change determined. Lastly, besides activities from the action stage, participants were assured of continual care and support for smoking cessation in the maintenance stage in that they report the highest levels of self-efficacy and are less frequently tempted to relapse.¹⁹ There has been sufficient evidence supporting the effectiveness of promoting smoking cessation using the transtheoretical model.^{11,12}

A workplace intervention study conducted in Turkey on promoting smoking cessation with the transtheoretical model observed that the proportion of smokers in the pre-contemplation stage shifted significantly to the preparation stage after 6 months. However, the proportion of participants who successfully quit smoking did not increase after 6 months.²³ This result reflected that workers who intended to quit smoking were more likely to enter the preparation or action stage of the transtheoretical model but were less likely to remain in the maintenance stage and even more likely to return to the contemplation or preparation stage.²⁴ Of note is the variation in the distribution of demographic characteristics of our participants across the three-time points. The average age of participants at baseline was 40 years old, while that after 4 years was 50 years old. The number of participants lost to follow-up was higher among the younger and highly educated, especially those in the service industry. Whether they no longer participated in the study because they started to smoke again remained unknown. In contrast, older, less-educated workers or current smokers maintained their presence in the pre-contemplation stage and were less likely to quit smoking.²⁵⁻²⁸ In this study, the weakened long-term effectiveness of the intervention may be explained by the higher percentage of participants with lower educational levels at four-year follow-up. Therefore, a strengthening scheme should improve long-term smoking cessation effectiveness. For

example, the smoking cessation plan could be reviewed 6 months after a participant quits smoking. In particular, greater importance should be attached to the follow-up by contacting participants and providing counseling. Moreover, incentives could be continuously provided.

In this study, the prevalence of second-hand smoke exposure was lower at both follow-ups than at baseline. In addition, only 4 men who did not smoke at baseline became smokers. These results revealed the existence of smoking prohibition in the workplace. In the current study, nearly all participants knew of the smoking prohibition regulations at baseline, including policies and signs. Therefore, the intervention implemented in this study could not further enhance workers' perceptions of smoking prohibition in workplaces or even allow for a small number of participants to reverse and ignore the smoking prohibition for a short period. The phenomenon also reflected changes in the proportion of peers discussing the status of smoking cessation in the workplace. These showed that workers did receive smoking cessation information prior to the current study, and some of them had even entered the contemplation and preparation stage from the pre-contemplation stage. Also, it is worth mentioning that the proportion of participants who had seen or received information on tobacco harm prevention provided by the workplace increased by 20% from baseline to the six-month follow-up, suggesting the tobacco hazard prevention information previously provided in the workplace was not well-received.

Furthermore, the research participants showed a significant increase in knowledge of tobacco hazards after receiving the intervention. However, 11.9% of the participants still did not understand or ignored the presence of designated smoking areas. The results are consistent with the responses at all three-time points that nearly 90% of smokers stated that they would not smoke in non-smoking areas in the workplace. Therefore, between establishing smoking barriers and protecting workers' smoking rights, workers who do not understand the establishment of designated smoking areas may confuse, especially among non-smokers. Moreover, smokers with misconceptions may be trapped in the contemplation stage of the transtheoretical model. In terms of attitude towards quitting smoking, participants continuously expressed strong support for a smoke-free working environment and agreed that quitting smoking was beneficial to their health and that of their families. Such positive attitudes have been established before intervention and are not easy to change. In other words, most participants had entered at least the pre-contemplation stage of the transtheoretical model before intervention. They had also received information on the hazards of tobacco and understood the relevant problems. However, 80.0% of the participants at baseline wanted the workplace to continue providing smoking cessation services. The proportion of participants increased to 93.6% at the six-month follow-up but dropped significantly to 78.0% at the four-year follow-up. Paradoxically, the proportion of smokers seeking assistance for tobacco prevention in the

workplace after receiving intervention increased significantly. The research team used a combination of health care services in the industry to provide smoking counseling to employees in the long run. However, the results mentioned above reflected the dissatisfaction of some non-smokers with the long-term dedication of health service resources to smoking cessation. Therefore, it is essential to take note of the emotions of specific groups that may affect the effectiveness of smoking cessation in the workplace and the allocation of health service resources in the workplace.

In smoking cessation studies, expired CO concentration has been used to verify participants' responses.^{16,20,29} This study used the participants' expired CO concentration and blood pressure to verify the effectiveness of smoking cessation and observed a significant decrease in expired CO concentration of smokers over time, indicating a change in the smoking behavior of the intervention group. The concentration of expired CO among non-smokers also decreased significantly over time, demonstrating that non-smokers were less exposed to tobacco hazards in the workplace. However, regardless of whether participants were smokers or non-smokers, the average systolic blood pressure and the proportion of abnormal blood pressure first decreased and then increased. The average diastolic blood pressure did not change over time. It was possibly due to the increase in age. As mentioned earlier, most of the participants lost to follow-up were younger and highly educated. Therefore, their proportion of abnormal blood pressure should be lower than that of older people.³⁰ However, this study did not assess the smoking levels of the participants at baseline. In particular, some heavy smokers had quit smoking during the short-term follow-up but relapsed over more extended periods and became mild smokers. Therefore, future research is required to compare smokers' short- and long-term effectiveness with different levels in quitting smoking in the workplace in response to an intervention.

This study was still impacted by job movements, how busy participants were, and other reasons, resulting in the omission of follow-ups for some participants. All participants were voluntarily recruited for the study and were thus more motivated to accept the smoking cessation intervention program. In contrast, participants who were disappointed in the smoking cessation services or not motivated to quit smoking were more likely to withdraw from the intervention program. Nevertheless, this study has limitations that must be considered. Research participants were recruited from 20 workplaces, and the sample should be larger to show sufficient statistical power. However, the overall results may not apply to specific workplaces with different worker demographics or job characteristics.

From a public health perspective, promoting mutually supportive smoking cessation intervention programs in workplaces may be more effective than requesting workplaces to implement their smoking cessation measures, as not all workplaces have sufficient resources. In order to promote a smoke-free workplace, future studies can seek assistance from

leaders of local organizations and institutions. For example, establish a platform for workplace health to communicate the determination to promote and build consensus for a smoke-free workplace, take action, and share resources, hoping that each department would formulate public policies to promote smoking cessation. In addition, tobacco harm counseling, in conjunction with the industry's health care services, will facilitate follow-up on participants. Also, future studies can assess why workers smoke again after quitting and propose an improved public smoking cessation program. Many smokers experience stress at work or in their lives.^{31,32} Smoking cessation interventions should thus take the socio-economic status of smokers into account, aim to understand the sources of stress, and provide appropriate counseling so that practical assistance can be provided. Finally, the gradual integration of smoking cessation interventions into health promotion activities of all employees should be considered so that care and encouragement of healthy behavior among colleagues can be strengthened.

Conclusion

This study used the transtheoretical model to promote a workplace smoking cessation intervention. The present findings showed significant short-term effectiveness but decreased effectiveness in the long run.

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