



## The effects of self-regulation strategies following moderate intensity exercise on ad libitum smoking



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### HIGHLIGHTS

- An acute bout of 20 min moderate intensity exercise delays smoking.
- Self-regulation strategies following exercise can prolong smoking delay.
- Goal setting is a powerful strategy in smoking delay.
- Self-regulation strategies can improve exercise-based smoking-cessation interventions.

### ARTICLE INFO

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Smoking cessation  
Physical activity  
Goal-setting  
Breathing  
Self-talk  
Heavy smokers

### ABSTRACT

**Introduction:** The purpose of the present study was to examine whether self-regulation strategies can further extend the effect of moderate intensity exercise on smoking delay.

**Method:** Participants were 40 adult smokers who were randomly assigned into two groups: control and self-regulation. A repeated measures design was adopted including a neutral condition (20 min video) and an exercise condition (20 min moderate intensity exercise).

**Results:** The results showed that smoking delay increased significantly for both groups; however, the increase for the self-regulation group was significantly larger than that of the control group.

**Conclusions:** The results support the anti-smoking effects of acute exercise; furthermore, they highlight the usefulness of self-regulation strategies, and in particular goal setting, in extending smoking delay. The present findings provide important evidence for the exercise and smoking literature and useful directions for the development of smoking cessation interventions.

### 1. Introduction

Considering the detrimental effects of smoking on health it is not surprising that the majority of smokers wish to quit smoking (Fiore et al., 2008; Robinson & Harris, 2011). Nevertheless, most, among whom smokers with life-threatening illnesses that may be attributable to smoking, are unable to cope with cigarette cravings and withdrawal symptoms (Stapleton, 1998), thus eventually relapsing early on following the quit attempt (Hughes, Keely, & Naud, 2004). Physical activity has been linked with lower smoking rates in cross sectional (Chiolero, Wietlisbach, Ruffieux, Paccaud, & Cornuz, 2006) and longitudinal studies (Laaksonen, Luoto, Helakorpi, & Uutela, 2002); in addition, it has been suggested as a protective factor in relapse following smoking cessation treatment (Abrantes et al., 2009), thus encouraging

health professionals to promote exercise as an alternative form of treatment for smoking cessation (Everson, Taylor, & Ussher, 2010). Nevertheless, the findings from interventions adopting exercise as a means to achieve smoking cessation have provided mixed results (for a review see Ussher, Taylor, & Faulkner, 2014); stressing in particular the limited support for the long-term effects of the treatment and the need to further improve interventions to decrease smoking relapse.

Towards this direction, experimental research testing the acute effects of exercise on smoking behavior has provided guidance for developing more effective interventions, through the examination of features that could potentially increase exercise adherence, such as recommended intensity of exercise (Kurti & Dallery, 2014; Oh & Taylor, 2014), or participants' sense of autonomy (e.g., Taylor, Katomeri, & Ussher, 2005; Zourbanos et al., 2016).

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In considering the acute effects of exercise on smoking, researchers have used a variety of smoking variables as outcome measures, such as urge to smoke and cigarette cravings (e.g., [Elibero, Van Rensburg, & Drobos, 2011](#); [Taylor et al., 2005](#)), withdrawal symptoms (e.g., [Williams et al., 2011](#)), and importantly, from an ecological perspective, ad libitum smoking (e.g., [Faulkner, Arbour-Nicotopoulos, & Hsin, 2010](#)). Overall, relevant reviews ([Haasova et al., 2014](#); [Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012](#); [Taylor, Ussher, & Faulkner, 2007](#)) have supported that cigarette cravings, withdrawal symptoms and negative affect decrease rapidly during exercise and remain reduced for up to 50 min following exercise, and that the effects on cigarette craving are greater for moderate and vigorous intensity exercise, compared to light or no exercise ([Haasova et al., 2014](#)). In particular, with regard to ad libitum smoking, [Taylor and Katomeri \(2007\)](#) identified the need for research to examine how exercise may influence smoking behavior, i.e., actual smoking rather than reports of cravings and withdrawal symptoms, which can strengthen the ecological validity of findings. [Faulkner et al. \(2010\)](#), using a within-subject design, examined the effect of a 10 min brisk walking task. They found that following the exercise condition time to first puff was significantly delayed compared to a passive condition. Similar results with varying delay times have been reported by [Taylor and Katomeri \(2007\)](#) following brisk-walking under stress inducing conditions, and by [Reeser \(1983\)](#) following stretch and isometric exercise in heavy smokers.

A potentially valuable feature of smoking cessation programs may be the use of self-regulation strategies ([Mann, de Ridder, & Fujita, 2013](#)). Self-regulation is a process where individuals assume the responsibility of learning, by self-monitoring their progress and using strategies that will lead to self-improvement and personal goals ([Zimmerman, 2000](#)). People with greater self-regulation ability are committed to healthier behaviors and are more successful in becoming more physically active ([de Bruin et al., 2012](#)). The development of self-regulation strategies within exercise-based smoking cessation interventions could potentially help improving the long-term effects of exercise programs on smoking cessation. A number of self-regulation strategies have been used in several smoking cessation programs to help smokers cope with smoking issues, among others, goal setting, self-talk, self-control, self-efficacy, anxiety control, breathing techniques, body-image exposure, etc. ([Hassandra, Goudas, & Theodorakis, 2015](#); [Nair, Collins, & Napolitano, 2013](#); [Ussher et al., 2014](#)). Goal setting is a psychological strategy that has been applied successfully to domains such as sport and health promotion for enhancing motivation ([Locke & Latham, 2013](#)). Concerning breathing techniques, research has been shown that conscious breathing, that is paying attention to breathing and learning how to handle it, is one of the most effective ways to improve mood and reduce stress ([Ma et al., 2017](#)). [Cropley, Ussher, and Charitou \(2007\)](#) reported that a guided body-scan relaxation routine including deep breathing and concentration, significantly reduced withdrawal symptoms including cigarette craving and negative emotion. Self-talk, described as self-instructional training has been a central component of cognitive behavior therapy ([Meichenbaum, 1977](#)). Self-talk is considered a key factor to establish cognitive control that could be used as a self-regulatory strategy in all aspects of behavior ([Vygotsky, 1962](#)). In the contemporary literature, self-talk strategies have attracted important attention within physical activity context and there is evidence suggesting that self-talk can serve to increase concentration, enhance self-confidence, and regulate mood ([Theodorakis, Hatzigeorgiadis, & Chroni, 2008](#)). In addition to these strategies, certain behavioral strategies, such as taking brief walks, which has been shown to delay smoking ([Thayer, Peters, Takahashi, & Birkhead-Flight, 1993](#)), and taking sips of water are among the recommendations of the American Cancer Society for enhancing self-regulation for smoking abstinence ([American Cancer Society, 2016](#)). In sum, the above evidence encourages the use of self-regulation strategies in combination with exercise as a means to empower the effects of exercise on smoking behavior.

In a relevant study, [Hatzigeorgiadis et al. \(2016\)](#) tested, using a within-subject design, the acute effects of moderate intensity exercise in combination with self-regulation strategies with references to exercising, on smoking delay in physically inactive smokers. Their results showed that smoking delay was significantly larger in both the exercise and the exercise plus self-regulation conditions; in addition, it was shown that the use of goal-setting, breathing exercises, and self-talk in relation to their exercise significantly prolonged smoking delay by approximately 10%, compared to the plain exercise condition. Acknowledging the limitations of their study, the authors identified the possibility of carryover effect and suggested that the adoption of between-subject or mixed designs would further enhance the confidence in the findings. Finally, they suggested that future research should explore the effects of smoking-related, rather than exercise-related, self-regulation strategies on smoking behavior. To address these recommendations, the present study aimed at exploring the potential additive effect of cognitive and behavioral self-regulation strategies targeting smoking delay following exercise. A randomized control trial design was adopted with two groups, control and self-regulation, to assess time to first smoke in two conditions, neutral and exercise.

## 2. Method

### 2.1. Participants

Power analysis (software G\*Power 3.1.9.2) was calculated to identify the minimum number of participants required to achieve reasonable power. The analysis regarding the exercise effect showed that for an effect size of 1 (averaged effect identified by [Taylor et al., 2007](#) for studies using the smoking ad libitum paradigm), 11 participants would be sufficient to achieve a power of 0.80. The analysis regarding the self-regulation strategies additional effect based on the findings by [Hatzigeorgiadis et al. \(2016\)](#), showed that for an effect size of 0.15, 38 participants would be sufficient to achieve a power of 0.80. Participants were 40 adults (12 males and 28 females), with a mean age of 42.00 ( $SD = 10.93$ ) years. Participants were physically inactive (as assessed by the International Physical Activity Questionnaire-short form; [Craig et al., 2003](#)), adult smokers, who reported smoking on average 22.00 ( $SD = 7.55$ ) cigarettes per day. The mean score on the Fagerström test for nicotine dependence ([Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991](#)) was 6.18 ( $SD = 1.92$ ).

### 2.2. Procedure

Ethical approval for the current study was granted by the Ethics Review Committee of the institution. Participants were recruited through public advertisement before the onset of the study. Upon recruitment, participants were informed that they should attend two morning sessions, that would last approximately two hours each, a week apart from each other. They were told that for both occasions they would have to abstain from smoking overnight, and that smoking abstinence would be evaluated through a breath test. These instructions were repeated one day before the first session when participants were contacted by phone to confirm the appointment.

Participants, who were blind to the treatment, were randomly assigned into control ( $n = 20$ , 15 females) and self-regulation groups ( $n = 20$ , 13 females). Participants of both groups were tested in two conditions one week apart at the same week-day and day-time; for both groups the two sessions were conducted in a consistent order: first, the neutral condition where time to smoke was assessed following a video session; second, the exercise condition where time to smoke was assessed following a moderate intensity exercise session. Upon arrival to the laboratory for the first session participants signed consent forms regarding participation requirements and withdrawal rights. One researcher trained in previous experiments and through extensive pilot trials implemented the intervention to all participants, with an assistant

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