



Smoking behaviour and sensations during the pre-quit period of an exercise-aided smoking cessation intervention

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HIGHLIGHTS

- Regular exercise during a pre-quit period is advantageous for quitting smoking.
- Exercise has harm reducing effects on smoking behavior prior to a quit attempt.
- Physical, cognitive and affective smoking sensations also decreased due to exercise.
- This novel study used a holistic approach, acceptable adherence and rigorous methods.

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ABSTRACT

Introduction: Previous research has shown reductions in cigarette consumption during the pre-quit period of exercise-aided smoking cessation interventions. Smoking topography and sensation patterns during this period is unknown and may provide valuable insight into compensation and cessation readiness.

Methods: Female smokers (N = 236, M age = 43, M cigarettes/day = 17.0) enrolled in an exercise-aided smoking cessation intervention self-reported daily cigarette use and cigarette sensory experiences. Breath carbon monoxide and smoking topography data were collected during the period leading up to the targeted quit date (i.e., baseline, week 1, and week 3), which was set for week 4.

Results: Repeated measures ANOVAs revealed that cigarette consumption ($p < 0.001$, $\eta^2 = 0.32$), carbon monoxide ($p < 0.001$, $\eta^2 = 0.14$), puff duration ($p = 0.01$, $\eta^2 = 0.05$), smoking satisfaction ($p < 0.001$, $\eta^2 = 0.34$), psychological reward ($p < 0.001$, $\eta^2 = 0.43$), enjoyment of respiratory tract sensations ($p < 0.001$, $\eta^2 = 0.29$), and craving ($p < 0.001$, $\eta^2 = 0.39$) decreased, whereas average puff flow ($p = 0.01$, $\eta^2 = 0.05$) increased.

Conclusions: This is the first study to establish that regular exercise during the pre-quit period served as a conduit for facilitating behavioral and sensory harm reduction with cigarettes. Furthermore, the pattern of change observed between cigarette consumption and smoking topography does not support compensation. These findings imply that female smokers who exercise prior to a quit attempt are in a favourable state to achieve cessation.

1. Introduction

A number of pharmacological and psychological individual-based smoking cessation methods exist. One novel adjunct to improve traditional therapies is physical activity, in the form of incidental or structured exercise. In a recent Cochrane review, Ussher, Taylor, and Faulkner (2014) sought to examine whether exercise-aided interventions either alone or in combination with a smoking cessation component were more effective than traditional smoking cessation interventions at improving quit rates. Of the 20 randomized controlled trials (RCTs) reviewed, four studies demonstrated significantly higher

abstinence for the exercise condition, compared to control, following treatment (Bock et al., 2012; Marcus et al., 1999; Marcus, Albrecht, Niaura, Abrams, & Thompson, 1991; Martin, Kalfas, & Patten, 1997) and one revealed the continued benefit of exercise versus control on quit rates at three and 12-month follow-up (Marcus et al., 1999). Three published studies not included in the Ussher et al. review (i.e., Abrantes et al., 2014; Maddison et al., 2014; Prapavessis et al., 2016) also found inconsistent evidence to support the exercise-based smoking cessation interventions for short and long-term abstinence. These findings may be attributable to exercise program adherence rates, which ranged from 60% to 88%, with some studies failing to report it altogether. Ussher

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and colleagues determined that among studies with stronger adherence rates, various cognitive-behavioral methods were implemented.

Aside from modest smoking cessation rates, other exercise-based smoking cessation programs have shown significant improvements in cardiovascular health, exercise performance, quality of life, and psychological well-being (e.g., stress, anxiety, coping ability), among others (Abrantes et al., 2014; Bloom et al., 2013; Korhonen, Goodwin, Miesmaa, Dupuis, & Kinnunen, 2011; Nielson et al., 2014; Stathopoulou, Power, Berry, Smits, & Otto, 2006; Steptoe, Edwards, Moses, & Matthews, 1989; Taylor, 2000; Taylor & Faulkner, 2008) among physically active individuals who have or are attempting to quit.

Nevertheless, the role of habitual exercise on smoking behaviour other than quitting is less known. A handful of studies have observed a decrease in the number of cigarettes smoked for the exercise treatment arm compared to the control arm (Leelarungrayub et al., 2010; Maddison et al., 2014; Taylor et al., 2014; Taylor, Houston-Miller, Haskell, & Debusk, 1988). In a single group community-based exercise program, there was also a significant decline in cigarette consumption (Whiteley et al., 2007). Recently, Thompson et al. (2015) showed that a smoking reduction intervention for economically disadvantaged smokers which focused on support to increase physical activity was more effective than standard care in reducing cigarette consumption. In fact, a meta-analysis by Lindson-Hawley, Aveyard, and Hughes (2012) concluded that tapering cigarette use was equally effective to the conventional abrupt approach to smoking cessation and hence, a viable alternative. Evidently, long-term exercise-aided interventions for smoking cessation may have a harm reduction effect on smoking behaviour.

It is quite possible that the effects of exercise as an adjunctive quit smoking therapy on cigarette consumption is further evidence of the incompatibility of these two behaviors. Cross-sectional research has suggested that physically active smokers are more confident that they can refrain from smoking (King, Marcus, Pinto, Emmons, & Abrams, 1996), less nicotine dependent (deRuiter, Faulkner, Cairney, & Veldhuizen, 2008), make more cessation attempts (deRuiter et al., 2008), and are more successful at quitting smoking (Marcus et al., 1991) than physically inactive smokers. As such, most well-designed exercise-aided smoking cessation trials introduce exercise to participants prior to the quit attempt. In light of previous findings, this sequential approach is considered more advantageous than introducing exercise and cessation concurrently or cessation prior to exercise. The concurrent approach may be taxing as participants are enduring multiple behaviour change; while exercise is considered a gateway behaviour to cessation, cessation is not considered a gateway behaviour to exercise. This is underscored by the aforementioned trials (Leelarungrayub et al., 2010; Maddison et al., 2014; Prapavessis et al., 2007; Taylor et al., 2014) which did not provide a reduction intervention and yet smokers who exercised leading up to the targeted quit date (usually 3–4 weeks away) curbed their cigarette consumption. Against this background, exercise and smoking are not compatible behaviors and exercise may indeed be the conduit to smoking reduction.

With tobacco use, individuals may consciously or unconsciously adjust their smoking behaviour, or compensate, to achieve a desired effect. Two such forms of nicotine titration are changing the number of cigarettes smoked per day and smoking topography which can be evaluated from exhaled carbon monoxide and smoking topography. It has been suggested that smoking topography is the likely means of compensational smoking, over altering cigarette consumption and vent blocking (Cinciripini et al., 1989; Hammond, Fong, Cummings, & Hyland, 2005; Karanci, 1985; Scherer, 1999). What remains to be elucidated is whether smoking topography compensation occurs in light of cigarette reduction during the pre-quit period of an exercise-aided smoking cessation program.

There is limited evidence on whether regular exercise has any impact on the reinforcing, subjective sensations that individuals experience when smoking during the pre-quit period. These reinforcing

sensory experiences include smoking satisfaction, psychological reward, enjoyment of respiratory tract sensations, aversion, and craving reduction. Only one previous study has examined changes in cigarette-related sensations with respect to physical activity. Using a pilot RCT that involved an 8-week physical activity and smoking reduction counselling intervention for disadvantaged smokers, Taylor et al. (2014) learned that the previously mentioned sensory experiences decreased with increased physical activity levels.

In addressing cigarette consumption, smoking topography and smoking sensations together, investigators and healthcare professionals alike will gain deeper insight into a smoker's profile as they approach their quit date. In particular, if topography and sensations associated with smoking intensify ahead of the quit date, despite a reduction in cigarette consumption, complete abstinence may be more difficult to achieve, putting smokers at a disadvantage compared to quitting abruptly. On the other hand, it is conceivable that if harm reduction behaviour and psyche (i.e., diminished or no change in smoking intensity and sensory experiences) followed cigarette reduction, smokers may be better positioned to achieve smoking cessation and do so with greater ease. With this knowledge, stakeholders can tailor interventions and circumstances surrounding the quit attempt to optimize success, which would enhance the proportion of individuals in pursuit of and realize cessation.

Therefore, the purpose of this study was to examine the temporal changes of cigarette consumption, expired carbon monoxide levels, smoking topography, and cigarette-related sensations during the first three-weeks (i.e., pre-quit period) of a supervised, laboratory-based exercise-aided smoking cessation program. The targeted quit date was set for the beginning of week 4. It was hypothesized that cigarette consumption and carbon monoxide would decrease during the pre-quit period. Smoking topography and sensory factors would either positively change (i.e., reduction in puff duration, inter puff interval, and puff count as well as less satisfaction and reward associated with smoking) or remain unchanged during the pre-quit period.

2. Methods

2.1. Design

The current study was part of a large-scale study (Getting Physical on Cigarettes) wherein the effect of an exercise-aided smoking cessation intervention on post-intervention cessation rates compared to contact controls was examined (Jung, Fitzgeorge, Prapavessis, Faulkner, & Maddison, 2010; Prapavessis et al., 2016). Data for the current study were collected prior to the start (i.e., baseline) and during the first three weeks of the exercise intervention. The targeted quit date was set for the beginning of week 4, at which point, participants concurrently followed the exercise and Nicoderm® three step, 10-week program.

2.2. Participants

The Getting Physical on Cigarettes trial recruited approximately 420 participants (over seven cohorts, approximately 60 participants in each) from local businesses, health care and academic institutions, organizations, and through advertisements placed in newspapers, radio stations, and public transit in London, Ontario. Only subjects involved with the last four cohorts were invited to participate in this study.

To be eligible to participate in Getting Physical on Cigarettes, women were required to be between the ages of 18 and 65, smoke 10 cigarettes or more per day for the last two years, wish to quit smoking, engage in two or fewer 30-minute bouts of moderate-to-vigorous intensity exercise per week over the past six months, fluent in English, and have access to a telephone or e-mail account for communication purposes. Women were excluded from participating if they were pregnant or were intending to become pregnant during the next year, had other substance dependency issues (e.g., alcohol), prescribed

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