Short Communication

The effects of acute exercise on tobacco cravings and withdrawal symptoms in temporary abstinent pregnant smokers☆,⁎

Harry Prapavessis a,⁎, Stefanie De Jesus a, Therese Harper a, Anita Cramp a, Lyndsay Fitzgeorge a, Michelle F. Mottola a, Michael Ussher b, Guy Faulkner c, Peter Selby c

a University of Western Ontario, 1151 Richmond Street, London, ON N6A 5B9, Canada
b University College London, Cranmer Terrace, London SW17 ORE, UK

c University of Toronto, 55 Harbord Street, Toronto, ON M5S 2W6 Canada

HIGHLIGHTS

• Exercise reduces cravings in temporary abstinent pregnant smokers.
• A similar reduction pattern exists for tobacco withdrawal symptoms.
• Exercise is recommended during initial smoking cessation attempts during pregnancy.

abstract

Introduction: Smoking during pregnancy is common, and quitting at any point during pregnancy can yield benefits to both the fetus and mother. Smoking cessation is typically followed by withdrawal symptoms and a strong desire to smoke, both of which are likely to contribute to relapse. Research has shown that a bout of exercise minimizes cravings and tobacco withdrawal symptoms (TWS) after temporary abstinence in smokers, but these findings have not been replicated in pregnant smokers. This study examined the effect of 20 min of exercise on cravings (primary outcome) and TWS (secondary outcomes) among temporary abstinent, inactive pregnant smokers.

Methods: Thirty female smokers (Mean (M) age = 25.7 years, Standard Deviation (SD) = 5.5; M weeks pregnant = 18.2, SD = 5.3; Fagerstrom Test for Cigarette Dependence = 3.3, SD = 2.2; M 9.3 cigarettes/day, SD = 4.7; M hours abstained = 17.2, SD = 2.8) were randomized to 20 min of mild-to-moderate intensity exercise (EC; n = 14) or passive (PC; n = 16) condition. Cravings and TWS were assessed immediately before, during (at 10 min), immediately post, and at 10, 20, and 30 min post-condition.

Results: A 2 (condition) × 6 (time) repeated measures ANOVA revealed that the EC significantly (p < 0.05) reduced cravings (η² = 0.46) compared with the PC, across time. Non-significant, but nevertheless, large effects were evident favouring the EC over time for TWS restlessness (η² = 0.34), stress (η² = 0.24), irritability (η² = 0.21), tension (η² = 0.15), and depression (η² = 0.14).

Conclusions: Consistent with previous research, this study reveals that in pregnant smokers, a bout of exercise is associated with a reduction in cravings and similar patterns exist for TWS. Therefore, exercise may have the potential to assist in the initial stages of smoking cessation attempts during pregnancy.

Crown Copyright © 2013 Published by Elsevier Ltd. All rights reserved.
2. Methods

2.1. Participants

Participants consisted of 30 pregnant women who were recruited from London, Ontario (N = 23) and St. George's Hospital, South West London, England. There were no significant differences between the samples in the two locations in demographic or smoking characteristics. Individuals were eligible to participate if they were between 20 and 40 years of age, in their second trimester of pregnancy (13–24 weeks), smoked more than five cigarettes per day and at least 10 cigarettes per day prior to gravidity, were not receiving psychiatric treatment, did not present contraindications to exercise, and did not meet the physical activity guidelines for pregnancy (i.e., exercising less than three times per week for 30 minutes at a moderate intensity; Davies et al., 2003). Participants were also screened with the Physical Activity Readiness Medical Examination (Wolfe & Mottola, 2002) for pregnancy for contraindications to exercise.

2.2. Sample size

In a recent meta-analysis (Roberts et al., 2012), the average weighted reduction in desire to smoke was 1.9 points. Therefore, the authors selected a study (Janse Van Rensburg, Taylor, Hodgson, & Benattayallah, 2012) that reflected this change. Using calculated means and standard deviations for exercise (M = 3.6; SD = 1.0) and control (M = 5.3; SD = 1.0) post-condition for desire to smoke from Janse van Rensburg et al., it was estimated that for a between-group design, with a power of 0.99 and alpha at 0.05, a sample of 15 participants per group was needed to detect differences on this primary outcome variable (SamplePower Version 3, SPSS).

2.3. Primary outcome measure

Cigarette cravings were assessed using a seven-point scale (1 = not at all, 4 = somewhat, 7 = extremely) for the statement ‘How strong is your desire to smoke right now?’ (West et al., 1989).

2.4. Secondary outcome measures

Six tobacco withdrawal symptoms (irritability, depression, tension, restlessness, difficulty concentrating, and stress), which have previously been shown to be sensitive to the effects of exercise (Taylor, Ussher, & Faulkner, 2007), were evaluated using the Mood and Physical Symptoms Scale (MPSS; West et al., 1989; West & Hajek, 2004; West & Russell, 1985). Each symptom was measured in the present state using a seven-point scale (1 = not at all, 4 = somewhat, 7 = extremely).

2.5. Exercise condition

The exercise condition entailed a single bout of treadmill walking at a mild-to-moderate intensity (25–55% of heart-rate reserve; Davenport, Mottola, McManus, & Gratton, 2008) for 20 min, which commenced upon reaching the lower limit of the heart-rate prescription. Approximately 2 min and 5 min were allocated for warm-up and cool down, respectively.

2.6. Passive control condition

The passive control condition required participants to view a neutral DVD (27 min in duration) about home gardening, in a quiet, isolated room in the laboratory. This control condition has been shown to be acceptable in previous studies (e.g., Ussher, Nunziata, Cropley, & West, 2001).

2.7. Design and procedure

Participants were assigned, according to a computer-generated randomization scheme, to a (i) mild-to-moderate exercise (n = 14) or (ii) passive control (n = 16) condition. Group allocation was concealed from participants, but not researchers. Prior to study involvement, participants were informed that the study was interested in measuring cravings and withdrawal symptoms following a temporary period of abstinence. Since all participants, irrespective of randomization, received this level of detail concerning the purpose of the study, the impact of blinding on the findings would be equivalent between groups and across time. This investigation received ethics approval from both institutions. The conduct of the trial followed the principles outlined in the Declaration of Helsinki and the World Health Organization 2002 Good Clinical Research Practice. All participants provided informed written consent. Study procedures, described below, were identical between sites.

Participants were required to attend a screening session (pre-abstinence) to complete questionnaires and confirm smoking status.
with an expired breath carbon monoxide level (CO; Micro Smokerlyzer®; Bedfont Scientific) greater than 10 ppm. Participants returned to the laboratory two days later after being asked to abstain from smoking for 18 h. Abstinence was confirmed by a reduction in expired CO levels (<10 ppm). Irrespective of condition, cigarette cravings and tobacco withdrawal symptoms were assessed immediately before the condition, during (at 10 min), immediately post-condition, and at 10, 20, and 30 min post-condition. For those in the exercise condition, heart rate (Polar RS100 Heart Rate monitor) was monitored to ensure adherence to the exercise prescription intensity. Interaction between all study participants and investigator was minimized.

2.8. Statistical analyses

To verify equivalence between the exercise and passive sitting conditions at baseline, independent-samples t-tests were used. If group differences at baseline were found for any variable, then a repeated measure analysis of covariance (ANCOVA) was conducted. However, ANCOVA assumes that the relationship between the dependent variable and each covariate is linear (Tabachnick & Fidell, 2001). Thus, if unequal variables at baseline are found not to be linearly correlated to either primary or secondary outcomes, then the assumption of linearity is being violated and ANCOVA is not recommended, as to do so would likely reduce the power (sensitivity) of the repeated measure ANOVA tests (Stevens, 1996). Statistical analyses were conducted using SPSS (Version 20). The level of significance was accepted at \( p < 0.05 \) for all statistical tests.

3. Results

3.1. Group equivalency

Participants’ demographic information and smoking characteristics (e.g., FTCD, Fagerstrom & Schneider, 1989) are presented in Table 1. Group equivalency was achieved between exercise and control conditions, with the exception of marital status, number of previous quit attempts, and hours abstained from smoking (Table 1). Controlling for the number of previous quit attempts and hours abstained from smoking for the main analysis was deemed unnecessary (see Section 2.8) as these variables were found to be unrelated to the primary outcome \( (r = 0.05, \ p = .927 \) and \( r = 0.01, \ p = .809 \), respectively) and either unrelated or mildly related to the secondary outcomes \( (r \ range = -0.00 \ to \ -0.32; \ p \ values range = .981 \ to \ .087) \). Group equivalency was evident for primary and secondary outcome measures pre-abstinence and post-abstinence (Table 1).

3.2. Fidelity inspection

Repeated-measures analysis of variance (ANOVA) showed a significant group (exercise vs. control) by time (immediately pre-treatment exercise Mean = 88.79, SD = 19.10 vs. control Mean = 82.80, SD = 12.41) and mid-condition 10 min (exercise Mean = 101.36, SD = 18.47 vs. control Mean 82.13, SD = 12.77) interaction effect in the expected direction for heart rate \( (F[1, 27] = 14.54, p = 0.001, \ f^2 = 0.35) \). Nine participants adhered to the prescribed mild-to-moderate intensity prescription for 20 min at 25–55% of their heart-rate reserve, while an additional participant was shy of this realization and exercised between 20 and 25% of their heart-rate reserve. The remainder of participants \( (N = 4) \) exercised below 20% of their heart-rate reserve.

3.3. Cravings and tobacco withdrawal symptoms

Cigarette cravings and tobacco withdrawal symptoms data were analyzed using a 2 (condition: exercise vs. control) × 6 (time) repeated-measures ANOVA (see Fig. 1). The Mauchly’s test for sphericity was significant \( (p < .001) \) indicating the assumption of sphericity was violated. Hence the multivariate statistic is reported. For cravings, there was a substantial group by time interaction effect \( (\text{Wilks’ Lambda} = .540, (F[5, 24] = 4.094, p = 0.008, \ f^2 = 0.46) \). Planned post-hoc t-tests showed cravings were significantly lower following baseline in the exercise compared with the control condition immediately after exercise \( (p = 0.044, \ f^2 = 0.12) \) and 10 min post exercise \( (p = 0.018, \ f^2 = 0.16) \). Although in the expected direction, only a trend effect was seen during exercise \( (p = 0.061, \ f^2 = 0.10) \) and no significant differences were found 20 \( (p = 0.128, \ f^2 = 0.07) \) and 30 min \( (p = 0.128, \ f^2 = 0.01) \) post exercise (see Fig. 1).

For tobacco withdrawal symptoms, a group by time interaction trend effect was evident for restlessness \( (\text{Wilks’ Lambda} = .661, (F[5, 23] = 2.363, p = 0.072, \ f^2 = 0.34) \). Differences between groups over time for stress \( (\text{Wilks’ Lambda} = .753, (F[5, 24] = 1.576, p = 0.205, \ f^2 = 0.24) \), irritability \( (\text{Wilks’ Lambda} = .790, (F[5, 24] = 1.274, p = 0.307, \ f^2 = 0.21) \), tension \( (\text{Wilks’ Lambda} = .860, (F[5, 24] = 10.143, p = 0.001, \ f^2 = 0.10) \) and difficulty concentrating \( (F[5, 24] = 3.4, p = 0.024, \ f^2 = 0.19) \) showed a significant \( (p < 0.05) \) interaction effect with condition \( (F[5, 24] = 3.078, p = 0.028, \ f^2 = 0.19) \) indicating the assumption of sphericity was violated. These variables were repeated-measures analyzed with condition as the between-subjects factor and time as the within-subjects factor. No significant differences were found for difficulty concentrating \( (F[5, 24] = 1.274, p = 0.307, \ f^2 = 0.21) \) and tension \( (F[5, 24] = 0.73, p = 0.578, \ f^2 = 0.03) \) for stress.
Average reductions for each symptom was as follows: irritability 1.64 to 2 (i.e., 23% to 29%); depression .78 to .92 (i.e., 11% to 13%); tension 1.5 to 1.85 (21% to 26%); restlessness 1 to 1.78 (i.e., 14% to 25%); difficulty concentrating .15 to .43 (i.e., 2% to 6%) and stress 1.5 to 2.07 (i.e., 21% to 30%).

Although our fidelity check showed differences in heart rate between those who exercised and those who did not, it also showed that 5 out of our 14 exercisers failed to reach their prescribed intensity (25–55% of heart rate reserve). The finding raises two questions: Why did we not achieve a higher adherence rate to the exercise prescription? And, what level of exercise intensity is needed to attenuate cravings and withdrawal symptoms? With respect to the first question, this study recruited pregnant smokers who did not meet the physical activity guidelines for pregnancy. For some sedentary pregnant smokers, exercising at 25–55% of heart rate reserve for 20 continuous minutes may be challenging, uncomfortable, or produce adverse symptoms that participants would rather avoid. Considering that it is unethical to ask a compromised population to exercise beyond their perceived limits, exercising below 25% of heart rate reserve may be more tolerable and sustainable for some sedentary pregnant smokers, as revealed by the adherence rate to the exercise prescription.

With respect to the second question, this study demonstrates that low-to-moderate intensity movement significantly reduces cravings, compared to passive sitting. This is comparable to similar research studies in non-pregnant smokers that evaluated exercise of very low intensity. Specifically, significant reductions in cravings have been shown in light-intensity yoga (Elberio, Jane Van Rensburg, & Drobes, 2011) and isometric exercise (Ussher, Cropely, Playle, Mohidin, & West, 2009), when compared with a passive control group. The latter study showed an average reduction of 1.79 points in strength of desire to smoke from baseline to post-isometric exercise, which is equivalent to the results in this pregnant population. Nevertheless, the small sample size made it impossible to explore whether the intensity of exercise moderates craving reductions—an important issue to pursue in future work. It should be pointed out that the American College of Sports Medicine suggests that the minimum intensity of exercise required to achieve aerobic benefit in previously sedentary women is equivalent to 20–39% VO2 reserve, which corresponds to approximately 13–33% heart rate reserve (Davenport, Sopper, Charlesworth, Vanderspank, & Mottola, 2008). Hence, all pregnant smokers were exercising at an appropriate intensity to achieve potential health benefits.

The present study is not without limitations. Specifically, recruitment of participants that were interested in participating and met inclusion criteria (e.g., adequate cigarette consumption) was challenging. The complexity surrounding recruitment of pregnant smokers and recommendations has been documented (Pollak et al., 2006). Despite showing significant differences in cravings, the study was underpowered for the secondary outcome TWS variables. Although participants endured a temporary period of smoking abstinence, cravings and withdrawal symptoms may not be as severe as engaging in an actual quit attempt. In addition, as women progress with pregnancy, physical limitations and fatigue might prevent adherence to exercise as a means to cope with cravings. Similarly, requesting that pregnant smokers abstain from smoking and any nicotine products for 18 h seemed to be a challenging task for some participants (i.e., the mean period of abstinence was 15.5 h for the exercise group, compared to 18.9 h for the passive control group). Although mean hours abstained was significantly different between groups, this variable was completely unrelated to cravings the primary outcome variable (r = 0.01, p = .809).

Furthermore, pre-treatment cravings scores were comparable between groups (see Fig. 1). Taken together, this suggests that lower abstinence periods should be considered in future work that allows all participants to meet study protocol requirements without jeopardizing craving scores. Finally, findings cannot be generalized to pregnant smokers younger and older than the current sample.
This study provides preliminary evidence that exercise moderates cravings, and to a lesser extent, tobacco withdrawal symptoms, in temporarily abstinent pregnant smokers. Considering that high relapse rates are due to cravings and withdrawal symptoms, our findings support the role of a brief bout of exercise in initial cessation attempts and symptom management. With respect to cessation, there is insufficient evidence regarding the safety and effectiveness of nicotine replacement therapy for pregnant smokers (Coleman, Chamberlain, Davey, Cooper, & Leonardi-Bee, 2012) and behavioural interventions alone have had limited success (Lumley, Oliver, Chamberlain, & Oakley, 2009). Hence, large randomised trials of exercise as an aid to smoking cessation during pregnancy are now needed and one such trial is ongoing (Ussher, Aveyard, et al., 2012; Ussher, Etter, et al., 2012). In the meantime, the benefits of exercise outweigh the risks and should be recommended to pregnant smokers who want to improve their general health and increase their ability to manage cravings and withdrawal.

Author disclosure for addictive behaviors

Title: The effects of acute exercise on tobacco cravings and withdrawal symptoms in temporary abstinent pregnant smokers

Fig. 2. Mean (SE) of tobacco withdrawal symptoms over time (T1 Before, T2 During, T3 After, T4 10 min After, T5 20 min After, T6 30 min After) for exercise (closed circles) and passive control (empty circles) conditions. Descriptive statistics can be obtained from the corresponding author upon request.

Please cite this article as: Prapavessis, H., et al., The effects of acute exercise on tobacco cravings and withdrawal symptoms in temporary abstinent pregnant smokers, Addictive Behaviors (2013), http://dx.doi.org/10.1016/j.addbeh.2013.10.034
Role of funding sources

This study was supported by a Canadian Institutes for Health (Canadian Tobacco Control Research Initiative (CTCRI)) grant awarded to HP, principal investigator, MFT, CS, and PS. The Exercise and Health Psychology Laboratory, where the work was conducted, is supported by a Canadian Foundation Innovation infrastructure grant awarded to Dr. Harry Prapavessis. The aforementioned funding sponsors did not have any role in study design, collection, analysis, or interpretation of data, writing the manuscript, and the decision to submit the manuscript for publication.

Contributors

HP, GF, PS, MM, and MU conceived the study. SJ, DC, TH, and IF recruited participants and conducted the study in London, ON. MU recruited participants and collected the study in London, England. HP and SJD ran the statistical analyses and prepared the first draft of the manuscript, which were jointly interpreted and edited by the authors, respectively. All authors contributed to and approved the final version of the manuscript.

Conflict of interest

My coauthors and I do not have any personal or financial conflicts of interest related to the research, nor do the authors have other relationships with other people or organizations within three years of beginning the submitted work that could appropriately influence, or be perceived to influence, this work.

References


