



Published in final edited form as:

Addict Behav. 2018 February ; 77: 34–37. doi:10.1016/j.addbeh.2017.09.009.

Effect of brief exercise on urges to smoke in men and women smokers

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Abstract

Introduction: Although smoking urges have been demonstrated to vary by gender and also be influenced by exercise, it is unknown if exercise has a differential effect on smoking urges by gender. This study aimed to explore gender differences in the effect of an acute bout of exercise on cessation-related symptoms in smokers during acute abstinence.

Methods: We enrolled smokers (5 cigarettes/day) who were 18–40 years old for an ongoing study on exercise and smoking behavior. Participants abstained from smoking for at least three hours, prior to measurement of their maximal oxygen consumption tested, which was the acute bout of exercise. Prior to and after the exercise, participants completed the Questionnaire of Smoking Urges – Brief and the Minnesota Nicotine Withdrawal Scale.

Results: Participants (n=38; 61% women) were, on average, 30.0±0.9 years old and smoked 13.0±0.8 cigarettes/day. All measured aspects of craving and withdrawal significantly improved after the exercise in both men and women. Smoking urges differed by gender. In women there was a significant decline in anticipated relief from negative affect after the exercise (women: -0.45 ± 0.20 , $p=0.0322$ vs. men: -0.41 ± 0.26 , $p=0.1312$). Conversely, in men there was a significant decline in the intention to smoke after the exercise (men: -0.77 ± 0.23 , $p=0.0053$ vs. women: -0.66 ± 0.37 , $p=0.0909$).

Conclusions: While the effect of exercise on total smoking urges is similar in men and women, these data suggest that acute exercise may be reduce different aspects of smoking urges in men and women. Additional research is needed to explore the implication of these observations on cessation.

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Keywords

Exercise; Craving; Smoking Urges; Gender

1.0 INTRODUCTION

Gender differences in addiction generally showing that females are more likely to become addicted to drugs and tend to present with higher rates of relapse compared to males.¹ Among cigarette smokers, women, as compared to men, are more likely to relapse from a smoking cessation attempt and suffer from more smoking-related morbidity and mortality.²⁻⁴ Therefore, identifying smoking cessation interventions that are effective for women is of public health importance.

Exercise has been investigated as a behavioral intervention for smoking cessation. While the effects of exercise on smoking cessation outcomes have been inconclusive,⁵ the benefits of exercise on reduction of cravings, withdrawal and smoking urges have been documented.⁵⁻⁸ The results of a recent meta-analysis indicate there were no sex/gender differences in the effect of exercise on craving.⁹ However, these observations are limited by at least two factors. First, studies included in this meta-analysis used standardized exercise interventions, without regard to participant fitness level. It is possible that a more fit individual would receive less benefit from the same bout of exercise that a less fit individual would. Second, only craving (specifically, strength of desire and desire to smoke) was explored. Gender differences in the effect of exercise on other aspects of cessation-related symptoms (such as smoking urges) have yet to be explored. This is of interest given men tend to relapse in response to craving, whereas women tend to relapse in response to negative affect.^{10,11}

This study aims to evaluate whether an acute bout of exercise, that is tailored to a participant's fitness level, influences smoking urges (intention to smoke, anticipated relief from negative affect), as well as craving and withdrawal, differently in men and in women smokers. First, we assessed the effect of the acute bout of exercise (6–12 minutes, depending on fitness level) on cessation-related symptoms while participants were in an acute state of abstinence (>3 hours). Second, we explored this effect separately within each gender. We hypothesized that exercise would reduce smoking urges in women smokers more than their male counterparts. Understanding how exercise may influence smoking urges, in addition to craving and withdrawal, differently in men and women may lead to innovative smoking cessation exercise interventions that are more tailored to the needs of women and, therefore, more effective for smoking cessation.

2.0 METHODS

2.1. Study Sample.

This project is a secondary-data analysis from a larger study that examined the role of exercise on self-initiated quit attempts (results forthcoming). Potential participants completed a telephone interview followed by an in-person clinical examination to assess the following inclusion criteria: (1) current smokers (five cigarettes/day for six months),

(2) between the ages of 18 and 40 years old, (3) inactive (< two planned exercise sessions per week), (4) interest in increasing their exercise (7 out of ten-point Likert-type scale), (5) planning to quit smoking within the next six months, and (6) stable mental/physical health based on an examination conducted by a nurse practitioner. Exclusion criteria for the study included any contraindications to starting an exercise program (e.g., high blood pressure, recent history of heart attack or other cardiac event, unstable angina, and any other unstable pulmonary or cardiovascular condition).

2.2. Study Procedures.

All data for this paper were collected during the four-hour in-person screening visit. Prior to attending this visit, participants were instructed to abstain from cigarettes for at least three hours. Participants were also asked to abstain from strenuous exercise for two days, all types of exercise for twelve hours, all food for an hour and a half, and caffeine for an hour and a half. This was done for safety purposes, as well as to ensure maximal oxygen consumption testing accuracy and validity.

At the clinic visit, participants completed a maximal exercise test on a Precor 842i cycle ergometer. All exercise tests were monitored by a physician, with two to three additional study staff present for data collection and protocol implementation. Prior to the exercise test, participants underwent a 12-lead electrocardiogram (ECG; Quinton Q-Stress) in supine, sitting, and standing position. Upon normal ECG results, participants initiated the exercise test. During the test, heart rate and cardiac rhythm were continuously monitored by ECG. Blood pressure was measured immediately prior to testing, at two minute intervals during the test and for six minutes following recovery or until patient returned to baseline. Briefly, each participant was instructed to cycle at a rate of 50–70 rotations per minute (rpms); every two minutes the resistance was increased by an amount associated with a 1–2 metabolic equivalent (MET) increase in intensity with the goal of promoting volitional fatigue or reaching a predetermined maximal oxygen consumption (VO_2 Max) criteria for test termination within 6–12 minutes. Maximal oxygen consumption was assessed by the attainment of two of the following criteria: peak heart rate within 10 beats/minute of the age-predicted maximum heart rate ($220 - \text{age}$), peak respiratory exchange ratio (RER) ≥ 1.1 , and/or rating of perceived exertion (RPE) ≥ 18 . Participants wore a nose clip during the testing to ensure that all expired air was captured in a Mouthpiece Saliva Trap Type (Green). Respiratory gas was measured using breath by breath analysis averaged over 30 seconds to assess peak oxygen consumption (VO_2 peak), CO_2 production, and RER using a mass spectrometer MGA 1100 with BIPS software (Beck's Physiological Systems).

To measure study outcomes of cessation-related symptomatology, two validated questionnaires were administered approximately 30 minutes prior to the exercise test and approximately 15 minutes after the exercise test, by which time participants' blood pressure had returned to baseline. The first questionnaire was the Questionnaire of Smoking Urges (QSU) Brief.¹² This questionnaire yields two subscales – Factor 1 and Factor 2. Factor 1 assesses the strong desire and intention to smoke, with smoking perceived as rewarding. Factor 2 is the anticipation of relief from negative affect with an urgent desire to smoke. The second questionnaire was the Minnesota Nicotine Withdrawal Scale (MNWS).¹³ The

MNWS includes two subscales: craving and withdrawal, each resulting from eight items scored on a five-point Likert-type scale from 0 (no symptoms) to 4 (severe symptoms). Upon completion of the after-test questionnaires, participants were allowed to smoke. Participants were compensated with a \$30 Visa gift card at the end of the screening visit. All procedures were approved by the University of Minnesota's Human Research Protection Program.

2.3. Statistical Analysis.

Descriptive statistics (means and standard errors) were computed to describe the study sample. Fisher's exact tests and two-sample t-tests were used to assess differences in characteristics by gender. Paired t-tests were used to test for a change in the QSU and MNWS scores from before the exercise test to after the exercise test. Changes in QSU and MNWS were assessed for all participants, as well as separately by gender. P-values <0.05 were considered statistically significant. Due to the limited statistical power with a relatively small sample for this secondary analysis, the gender differences in outcomes were not statistically compared to each other; rather, the point estimates and their standard deviations were compared qualitatively. SAS v. 9.4 (SAS Institute Inc., Cary, NC) was used for analyses.

3.0 RESULTS

3.1. Study Sample.

Participants (n=38) included 23 women (60.5%) and 15 men (39.5%). The average age was 30.0±0.9 years old, with 68.4% identifying as white, and 60.5% reporting at least some college. The average cigarettes/day reported was 13.0±0.8.

There were no statistically significant differences in demographics or smoking behavior by gender (Table 1), but there were in exercise test outcomes. Specifically, men exhibited a significantly higher absolute VO₂ peak (28.7ml/min/kg ±1.3) and longer duration of test (9.7±0.2 minutes) compared to the women (VO₂ peak: 23.2±1.0ml/min/kg [p=0.0016] and test duration: 8.6±1.1 minutes [p=0.0005]). Baseline cessation-related symptomatology, as assessed prior to the exercise testing, did not differ by gender.

3.2. Overall Effect of Exercise on Cessation-Related Symptomatology.

Upon completion of the exercise test, all items of cessation-related symptomatology were significantly lower (Table 2). The effect ranged from a 14% decline in the intention to smoke (QSU Factor 1; Pre=4.95±0.28 vs. Post=4.24±0.32; p=0.0060) to a 38% decline in withdrawal (MNWS; Pre=0.89±0.11 vs. Post=0.55±0.08; p=0.0004).

3.3. Effect of Exercise on Cessation-Related Symptomatology by Gender.

When we explored the change in cessation-related symptomatology separately within each gender, we noted the following: First, after the exercise test, the intention to smoke (QSU Factor 1) declined significantly in men (-0.77±0.23, p=0.0053) and in women, but to a lesser non-significant extent (-0.66±0.37, p=0.0909). While the anticipated relief of negative affect (QSU Factor 2) declined by about the same amount in each gender after the exercise

test, there was a bit more variability in the change in men (women: -0.45 ± 0.20 , $p=0.0322$; men: -0.41 ± 0.26 , $p=0.1312$). No other gender differences were noted.

4.0 DISCUSSION

We observed that an acute bout of exercise, on average 8 to 10 minutes in duration, significantly reduced cessation-related symptomatology in adult daily cigarette smokers who were in a state of acute abstinence. These results replicate previous work which identified similar decreases in craving, withdrawal, and smoking urges after exercise.⁵⁻⁸ These data also extend the current literature by examining acute effects of exercise on smoking urges by gender. Women and men experienced a similar decline in the anticipated relief of negative affect, though there was greater variability in this decline in men. Further, after exercise, men experienced a stronger decline than women in urge to smoke.

Perhaps the most intriguing observation in this report is the difference in reduction of smoking urges by gender. Prior literature indicates that predictors of smoking relapse vary by gender. In men, craving is highly predictive of smoking relapse. Conversely one of the strongest predictors of smoking relapse in women is negative affect¹¹. Given our observations indicating that exercise reduces the urge to smoke more in men whereas exercise more consistently reduces the anticipated relief of negative affect in women. These data suggest that exercise may favorably alter strong predictors of relapse within each gender but also may reduce urges to smoke differently within men and women. However, it is worth noting that while there were differences in the statistical significance, the effect size was very similar between men and women. Despite the somewhat similar effect sizes, exploration into gender specific guidelines into exercise for smoking cessation is warranted. For instance, perhaps women would benefit more from a training program that encourages brief bouts of exercise in response to a heightened negative affect whereas men would benefit more from a training program that utilizes exercise to directly combat the intention to smoke.

Despite the novel exploration of gender differences in the effect of a tailored acute bout of exercise on smoking urges, this project is not without limitations. First and foremost, this study has a small sample. Our analyses were limited to within subject comparisons, which increases statistical power, hence we did not statistically test for gender differences (e.g., between subject comparisons). Second, our sample lacks diversity. Our sample was predominantly white young inactive adults. It is unknown how our observations apply to others. Third, although participants were asked to abstain from smoking for at least three hours prior to the session, we did not biochemically verify abstinence. However, because the exercise test was completed approximately two hours after arrival to the study visit, it was known that participants abstained for at least the duration of the study visit. Lastly, it is possible that the exercise test may have invoked anxiety or similar feelings as participants had to wear a mask and were under close observation. Therefore, the observations may not to apply to other types of exercise and/or exercise under different conditions

Overall, a short bout of tailored exercise significantly reduced cessation-related symptomatology in smokers during acute abstinence with some gender differences in the

reduction of urge to smoke. Future research on the implementation of short sessions of exercise with gender-specific instruction may yield improved cessation outcomes when exercise is used as an adjunctive to established smoking cessation interventions.

Acknowledgements

We extend our thanks to Kimberly Nagel, Emily Lekah, Angela Tipp, and Jane Schulz, for their participation in recruitment and data collection, as well as Dr. Otto Sanchez, Mary Whipple, Ericka Tripp and Dereck Salisbury for their assistance with implementation of the exercise test. We also thank Scott Bischoff for his editorial assistance.

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Table 1.

Study Sample (n=38)

	All (n=38)	Women (n=23)	Men (n=15)	p-value ¹
Demographics				
Age ²	30.0±0.9	28.6±1.3	31.8±1.3	0.1621
Race ³				0.8783
African American or Black	4 (10.5%)	2 (8.7%)	2 (13.3%)	
American Indian or Alaskan Native	3 (7.9 %)	2 (8.7%)	1 (6.7%)	
Other/Mixed Race	5 (13.2%)	4 (17.4%)	1 (6.7%)	
White	26 (68.4%)	15 (65.2%)	11 (73.3%)	
Education ³				0.2699
High school graduate or equivalent	8 (21.0%)	3 (13.0%)	5 (33.33%)	
Some college or 2yr degree	23 (60.5%)	16 (69.6%)	7 (46.7%)	
College graduate or 4yr degree	7(18.0%)	4 (17.4%)	3 (20.0%)	
Smoking Behavior				
Cigarettes/Day ²	13.0±0.8	12.4±1.1	14.1 ±1.3	0.2127
First Morning Cigarette Smoked <30 minutes ³	22 (57.9%)	15 (65.2%)	7 (46.7%)	0.3235
Exercise Test Results				
Test Duration (minutes) ²	9.0±0.2	8.6±1.1	9.7±0.2	0.0005
Absolute VO ₂ Peak (ml/min/kg) ^{2,4}	25.4±0.9	23.2±1.0	28.7±1.3	0.0016

¹ p-values from Fisher's exact tests or two-sample t-tests² reported as mean± standard error³ reported as n (%)⁴ missing data from one participant due to equipment failure during testing

Table 2.

Cessation-Related Symptoms in Relation to Exercise Test by Gender (n=38)

	Pre-VO2 ¹	Post-VO2 ¹	Difference (post – pre) ¹	p-value ²
Withdrawal ³				
All (n=38)	0.89±0.11	0.55±0.08	-0.34±0.09	0.0004
Men (n=15)	0.75±0.14	0.43±0.09	-0.32±0.10	0.0080
Women (n=23)	0.99±0.16	0.63±0.12	-0.35±0.13	0.0128
Craving ³				
All (n=38)	2.71±0.16	2.08±0.20	-0.63±0.17	0.0009
Men (n=15)	2.40±0.25	1.80±0.34	-0.60±0.21	0.0140
Women (n=23)	2.91±0.19	2.26±0.25	-0.65±0.26	0.0184
Total Smoking Urges ⁴				
All (n=38)	3.58±0.24	3.01±0.25	-0.57±0.18	0.0032
Men (n=15)	3.19±0.32	2.59±0.38	-0.59±0.23	0.0198
Women (n=23)	3.83±0.33	3.27±0.33	-0.56±0.26	0.0470
Intention to Smoke ⁴				
All (n=38)	4.95±0.28	4.24±0.32	-0.71±0.24	0.0060
Men (n=15)	4.47±0.42	3.69±0.50	-0.77±0.23	0.0053
Women (n=23)	5.26±0.36	4.60±0.41	-0.66±0.37	0.0909
Anticipated Relief from Negative Affect ⁴				
All (n=38)	2.21±0.24	1.77±0.22	-0.44±0.15	0.0077
Men (n=15)	1.91±0.33	1.49±0.33	-0.41±0.26	0.1312
Women (n=23)	2.40±0.34	1.95±0.30	-0.45±0.20	0.0322

¹Values are mean ± standard error²p-values are from paired t-tests³Minnesota Nicotine Withdrawal Scale¹³⁴Questionnaire of Smoking Urges – Brief¹²