Mental Health and Physical Activity 12 (2017) 37–43

Contents lists available at ScienceDirect

Mental Health and Physical Activity

journal homepage: www.elsevier.com/locate/menpa

The role of physical activity enjoyment on the acute mood experience of exercise among smokers with elevated depressive symptoms

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ARTICLE INFO

Article history:
Received 2 December 2016
Received in revised form
2 February 2017
Accepted 7 February 2017
Available online 10 February 2017

Keywords:
Aerobic exercise
Smoking cessation
Tobacco
Depression
Affect

ABSTRACT

Problem: Depressive symptoms are consistently shown to be related to poor smoking cessation outcomes. Aerobic exercise is a potential treatment augmentation that, given its antidepressant and mood enhancing effect, may bolster cessation outcomes for smokers with elevated depressive symptoms. Lower enjoyment of physical activity may inhibit the acute mood enhancing effects of aerobic exercise. The current study investigated the associations between depressive symptoms, physical activity enjoyment and the acute mood experience from exercise among low-active smokers with elevated depressive symptoms.

Method: Daily smokers with elevated depressive symptoms (N = 159; M_{age} = 45.1, SD = 10.79; 69.8% female) were recruited for a randomized controlled exercise-based smoking cessation trial. Participants self-reported levels of depressive symptoms, physical activity enjoyment, and rated their mood experience (assessed as “mood” and “anxiety”) before and after a standardized aerobic exercise test.

Results: Hierarchical regression analysis revealed that depressive symptom severity accounted for significant unique variance in physical activity enjoyment (R^2 = 0.041, t = −2.61, p = 0.010), beyond the non-significant effects of gender and level of tobacco dependence. Additionally, physical activity enjoyment was a significant mediator of the association between depressive symptom severity and acute mood experience (“mood” and “anxiety”) following the exercise test.

Conclusions: Physical activity enjoyment may explain, at least in part, how depressive symptom severity is linked to the acute mood experience following a bout of activity. Interventions that target increasing physical activity enjoyment may ultimately assist in enhancing the mood experience from exercise, and therefore improve smoking cessation likelihood, especially for smokers with elevated depressive symptoms.

1. Introduction

Tobacco use continues to be the leading cause of preventable morbidity and mortality in the United States (U S Department of Health and Human Services, 2014). Relapse following a quit attempt is common – e.g., 70–85% who attend treatment programs relapse within one year (Fiore et al., 2008). Smokers who are unable to quit are more likely to possess risk factors or characteristics that make it difficult to quit, such as psychiatric symptoms and disorders (Korhonen et al., 2011; Morrell, Cohen, & McChargue, 2010; Pratt & Brody, 2010; Trosclair & Dube, 2010). Robust evidence indicates that elevated depressive symptoms are related to the maintenance of smoking and cessation failure (Audrain-McGovern, Leventhal, & Strong, 2015; Mathew, Hogarth, Leventhal, Cook, & Hitsman, 2017). As a result, there has been growing interest in the development and testing of smoking cessation interventions that can effectively target depressive symptoms to help promote

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http://dx.doi.org/10.1016/j.mhpa.2017.02.001
1755-2966/

smoking cessation (Weinberger, Mazure, Morlett, & McKee, 2013).

One such intervention is aerobic exercise. Aerobic exercise interventions have been tested as an adjunctive smoking cessation strategy (Ussher, Taylor, & Faulkner, 2014), although the effect of exercise on long-term smoking cessation has been mixed, likely due to small sample sizes and insufficient intervention intensity (Ussher et al., 2014). However, bouts of aerobic exercise appear to consistently result in medium-to-large sized acute effects on reduced cigarette craving and enhanced mood (Haasova et al., 2013; Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012; Ussher et al., 2014). Indeed, it has been argued that exercise as a cessation aid, given its antidepressant and mood enhancing effect (Carek, Laibstain, & Carek, 2011; Cooney et al., 2013; Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005), may be particularly effective for smokers with elevated depressive symptoms (Bernard et al., 2013). Several preliminary studies with depressed smokers have found that aerobic exercise as an intervention may increase likelihood of smoking cessation outcomes (Bernard et al., 2012, 2015; Patten et al., 2017; Vickers et al., 2009). However, as is the case with the general population, adherence to exercise programs among smokers is low (Ussher et al., 2014). Understanding factors that influence adherence to exercise in smokers, particularly those who may be vulnerable to depression, is essential for increasing the efficacy of aerobic exercise as a smoking cessation strategy.

There is growing recognition that physical activity enjoyment is related to adherence to physical activity programs (Williams, 2008). Consistent with hedonic theory (Kahneman, Diener, & Schwarz, 1999), people are more likely to do what they find pleasurable, while avoiding behaviors that they do not enjoy. Thus, greater physical activity enjoyment is posited to result in increased behavioral intentions to exercise, and in turn, sustained engagement in physical activity (Phillips, Chamberland, Hekler, Abrams, & Eisenberg, 2016).

Indeed, data non-specific to smokers indicate that self-reported physical activity enjoyment is cross-sectionally positively correlated with level of physical activity engagement (Cleland et al., 2010; Hagberg, Lindahl, Nyberg, & Hellénius, 2009; Rech, Reis, Hino, & Hallal, 2014; Salmon, Owen, Crawford, Bauman, & Sallis, 2003; Umeda, Marino, Less, & Hilliard, 2014) and prospectively associated with greater exercise program adherence and long-term maintenance of physical activity (Crain, Martinson, Sherwood, & O'Connor, 2010; Dishman, Jackson, & Bray, 2014; Herens, Bakker, Van Ophem, Wagemakers, & Koelen, 2016; Lewis, Williams, Frayeh, & Marcus, 2016; Williams et al., 2006). Self-report of physical activity enjoyment also predicts acute increases in positive mood and decreases in negative mood from pre-to post-exercise (Miller, Bartholomew, & Springer, 2005; Motl, Berger, & Leuschen, 2000) and mediates the exercise-mood relationship (Miller et al., 2005; Motl et al., 2000). For example, Motl et al. (2000) compared the acute mood effects of engaging in a rock-climbing exercise versus health education class among 95 male adults and found that the mood benefits associated with the exercise condition were mediated by physical activity enjoyment. However, results have not always consistently found an association between physical activity enjoyment and acute changes in mood following aerobic exercise (Berger, Darby, Zhang, Owen, & Tobar, 2016, 2010).

Depressive symptoms, such as inability to experience pleasure (i.e., anhedonia), lack of motivation, negative affect, and cognitive distortions (e.g., all-or-none thinking), may interfere with an individual's ability to experience enjoyment from exercise. The two studies of which we are aware that have examined the association between physical activity enjoyment and depressive symptoms, both non-specific to smoking, have yielded inconsistent results. Among adults with functional limitations, depressive symptoms and physical activity enjoyment were not significantly related (Murrock, Bekhet, & Zauszniewski, 2016). In contrast, among college students, physical activity enjoyment mediated the association between anhedonia and lower physical activity levels (Leventhal, 2012). Given this limited examination of the relationship between depressive symptoms and physical activity enjoyment, it is important to continue to evaluate the nature of these associations, particularly among smokers, for whom exercise adherence is critical for successful cessation outcomes (Ussher et al., 2014).

Thus, the current study aimed to examine the associations between depressive symptom severity over the past two weeks, physical activity enjoyment, and the acute mood-enhancing effects of a bout of exercise among a sample of low-active daily smokers with elevated depressive symptoms who were seeking treatment for smoking cessation. First, we hypothesized that depressive symptom severity would be significantly and inversely related to physical activity enjoyment, beyond the effects of tobacco dependence and gender. Second, physical activity enjoyment was hypothesized to be a mediator (indirect predictor) of the association between depressive symptom severity and the acute mood-enhancing effects of a bout of physical activity.

2. Method

2.1. Participants and procedure

Data analyzed were collected as part of an ongoing randomized controlled smoking cessation trial for community-recruited treatment-seeking smokers with elevated depressive symptoms (clinicaltrials.gov #:NCT02086149). Data included in this study were from smokers recruited from February 2014 to October 2016. The trial is examining the efficacy of standard telephone-based cognitive behavioral therapy (CBT) for smoking cessation and nicotine replacement therapy, with one of two adjunctive treatments: (a) 12-session, group aerobic exercise (AE) intervention or (b) 12-session, group health-education control (HEC) intervention. Interested participants were screened by telephone and invited for a baseline assessment on the basis of: being between the ages of 18–65 years, smoking $\geq$10 cigarettes per day, and having elevated depression symptoms as evidenced by a score $\geq$6 on the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). Callers were excluded from participation during the telephone screen based on the following primary criteria: engaged in more than 90 min of moderate-to-vigorous physical activity for the last 12 weeks, physical disabilities or medical problems contraindicating aerobic exercise, current pregnancy or intention to become pregnant in the next 3 months, and current use of pharmacotherapy for smoking cessation (e.g., nicotine replacement therapy). Potentially eligible participants were scheduled for a baseline Day 1 appointment, during which depression, physical activity enjoyment, and tobacco dependence were assessed. Participants who did not meet DSM-IV criteria for alcohol or drug abuse or dependence, bipolar disorder, eating disorder, psychotic disorder, current suicidality or homicidality during the baseline assessment (baseline day 1), and for whom medical clearance to exercise was obtained from their primary care physician, were asked to attend a second baseline assessment (baseline day 2; approximately one week after baseline day 1). At that visit, cardiorespiratory fitness was determined through a 1-mile walk test. Pre-and post-walk test ratings of mood were collected. After, participants were randomized to AE or HE and informed of their treatment condition. Only pre-randomization (baseline) data were utilized in the current investigation. Participants who completed self-report assessments at baseline day 1 and the walk test at baseline day 2 (n = 159, M_{age} = 45.1, SD = 10.79; 69.8% female) were included in data analysis.

2.2. Measures

The **Center for Epidemiologic Studies – Depression scale** (CES-D; Radloff, 1977) is a 20-item self-report measure of depression symptom severity over the previous two weeks. Items are rated on a Likert-like scale in terms of the frequency of experiencing various symptoms, with responses ranging from 0 ("*not at all or less than one day*") to 4 ("*nearly every day for two weeks*"), Responses are summed to derive a total score, with higher scores reflecting more severe depressive symptoms. The CES-D is a commonly used measure of depression severity in smokers (Brown et al., 2014, 2007) and is significantly associated with current smoking status and inability to quit smoking in the general population (Anda et al., 1990).

The **Fagerström Test for Nicotine Dependence** (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) is a 6-item self-report assessment of severity of tobacco dependence. Higher scores reflect greater physiological dependence on tobacco (possible range, 0–10). The **Smoking History Questionnaire** (Brown, Lejuez, Kahler, & Strong, 2002) and **Timeline Follow-Back** (Sobell & Sobell, 1992, pp. 41–72) were used to describe the sample in terms of smoking characteristics (e.g., age of smoking initiation, cigarettes per day).

The **Physical Activity Enjoyment Scale** (PACES; Kendzierski & DeCarlo, 1991) is a self-report measure used to assess enjoyment of physical activity. The PACES includes 18 items in which respondents are asked to rate "how you feel at the moment about the physical activity you have been doing" using a 7-point bipolar rating scale (e.g., "It's not at all stimulating/It's very stimulating" or "I feel bored/I feel interested"); higher scores reflect greater levels of exercise enjoyment. The PACES has strong psychometric properties across various populations, and is the most widely used measure of exercise enjoyment (Kendzierski & DeCarlo, 1991; Mullen et al., 2011).

Exercise testing was completed via the Rockport 1.0 mile treadmill walk test (Pober, Freedson, Kline, McInnis, & Rippe, 2002), in which participants were instructed to choose the fastest speed they could comfortably walk for one mile. Average speed on the treadmill was 2.8 miles per hour ($SD = 0.50$) and heart rate at completion of the walk test averaged 113.0 beats per minute ($SD = 14.23$).

Acute Mood Symptoms Self-Rating Scale. To assess changes in mood before and after exercise, the National Institute of Mental Health (NIMH) self-rating scale was used, as in previous studies (Abrantes et al., 2012). Participants were asked to rate 2 items, on a 10-point Likert scale, "mood" (0 = *Feel worst ever* to 10 = *Feel best ever*) and "anxiety" (0 = *No anxiety* to 10 = *Extreme anxiety*) just prior to and immediately following the walk test. Both these items reflect aspects of mood (e.g., higher scores on the "mood" item suggest more positive overall mood and higher scores on the "anxiety" item suggest more anxious mood, specifically). Therefore, for ease of interpretation of results, when the different types of mood are referred to (i.e., the 2 individual items), they will be in quotations ("") in order to distinguish them from references made to mood more generally.

2.3. Data analytic strategy

Zero order bivariate associations were examined between study variables. An initial hierarchical multiple regression model was constructed to examine the association between depression symptom severity and exercise enjoyment (PACES). Level of tobacco dependence (FTND) and participant gender (coded 0 = male, 1 = female) were entered as covarying factors in the first step of the regression model. Two regression-based mediation models were planned to examine the mediating role of PACES in the link between depressive symptom severity and acute mood experience after exercise. See Fig. 1 for an illustration of the conceptual model. Analyses were conducted using PROCESS, a conditional process modeling program that utilizes an ordinary least squares-based path analytical framework to test for both direct and indirect effects (Hayes, 2013). The statistical strategy utilized (Hayes, 2009; Preacher & Hayes, 2004) allows for estimation and significance testing of the indirect (mediation) effects through bootstrapping. Bootstrapping generates an empirical representation of the sampling distribution of the indirect effect, from which a confidence interval (CI) can be generated (Hayes, 2009). For all models, the 95-percentile CIs for coefficients were obtained analytically; the CIs for the indirect effects were estimated with bootstrap analyses (10,000 resamples), as recommended (Hayes, 2009; Preacher & Hayes, 2004). Participant gender, FTND, and corresponding pre-walk test "mood" and "anxiety" ratings were entered as covarying factors.

3. Results

3.1. Descriptive overview

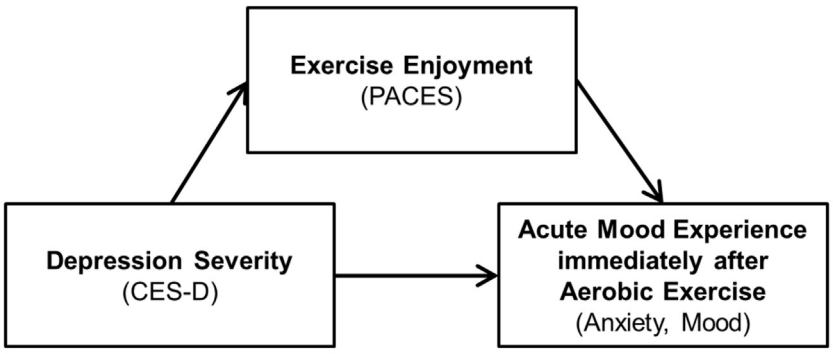
Participants (n = 159) primarily identified race as white (81.1%), were non-Hispanic (95.0%), and 66.5% completed at least part of college. The sample averaged moderate levels of tobacco dependence per the FTND ($M = 5.5$, $SD = 2.06$; range = 0–10) and moderate depressive symptom severity per the CES-D ($M = 15.3$, $SD = 11.34$; range = 0–52); 41.5% had CES-D scores ≥16, indicating probable major depression. The majority of the sample (74.2%) reported no physical activity engagement in the past 12 weeks. Of the remaining 25.8% of participants (n = 41), the average minutes/week of physical activity over the past 12 weeks was 64.2 min ($SD = 62.7$). There were no significant differences in CES-D or FTND scores for participants who completed baseline only versus those who completed baseline and the walk test session. Zero-order correlations between study variables were examined (see Table 1). Bivariate correlations revealed a significant negative association between CES-D and PACES scores ($r = -0.22$, $p = 0.004$; 5% shared variance). CES-D scores were negatively associated with pre-walk test "mood" ratings (i.e., lower positive mood; $r = -0.32$, $p < 0.0001$) and positively associated with pre-walk test "anxiety" ratings (i.e., higher anxiety; $r = 0.36$, $p < 0.0001$). The two mood rating scales shared a small amount of variance (approximately 10%).

3.2. Depression and exercise enjoyment

Hierarchical regression analysis revealed that CES-D scores accounted for significant variance in PACES scores ($F[3,155] = 3.02$, $p = 0.032$). Specifically, after adjusting for the non-significant effects of gender ($b = -4.42$, $se = 3.27$, $t = -1.35$, $p = 0.179$) and FTND ($b = -0.50$, $se = 0.73$, $t = -0.69$, $p = 0.494$), CES-D scores accounted for 4.1% of unique variance in PACES scores ($b = -0.35$, $se = 0.13$, $t = -2.61$, $p = 0.010$).

3.3. Acute effects of aerobic exercise on mood

Pre-walk and post-walk "mood" were moderately correlated ($r = 0.56$, $p < 0.001$); pre-walk and post-walk anxiety were also moderately correlated ($r = 0.68$, $p < 0.001$). A paired sample *t*-test revealed that change in anxiety scores from pre to post walk test was significant ($M_{change} = 1.26$, $SD = 1.96$, $t(158) = 8.11$, $p < 0.0001$), reflecting a reduction in anxiety ($M_{post} = 1.5$, $SD = 2.19$; Cohen's $d = 0.65$). Similarly, change in "mood" scores from pre to post walk



Note: CES-D = Center for Epidemiologic Studies – Depression scale); PACES = Physical Activity Enjoyment Scale

Fig. 1. Conceptual model.

test was significant ($M_{change} = -0.68$, $SD = 1.46$, $t(158) = -5.89$, $p < 0.0001$), reflecting an improvement in "mood" ($M_{post} = 7.7$, $SD = 1.60$; Cohen's $d = -0.47$).

See Table 2 for mediation results. With regard to the acute change in mood, the total effects model predicting post-walk "mood" was significant [$F(4,154) = 19.096$, $p < 0.001$), driven by the significant effect of pre-walk test "mood" ($b = 0.632$, se = 0.076, $t = 8.309$, $p < 0.001$), but not CES-D scores. The effects of FTND and gender on post-walk mood were significant. CES-D scores were significantly negatively related to PACES scores. The model with PACES predicting acute change in "mood" was significant ($F(5,153) = 20.341$, $p < 0.001$). Specifically, PACES was positively associated with "mood" post-walk test and accounted for an additional 6.8% of variance in "mood" post-walk test. In the test of the indirect (mediation) effect, PACES emerged as a significant mediator of the association between CES-D and "mood" post-walk test.

Regarding acute changes in anxiety, the total effects model predicting post-walk test anxiety was significant ($F(4,154) = 35.842$, $p < 0.001$), driven by the significant effect of pre-walk test anxiety ($b = 0.544$, se = 0.052, $t = 10.495$, $p < 0.001$), but not CES-D scores. The effects of FTND and gender were significant. CES-D scores were significantly negatively related to PACES scores. The model with PACES predicting acute change in anxiety was significant ($F(5,153) = 30.639$, $p < 0.001$). Specifically, PACES was negatively associated with anxiety post-walk test and accounted for an additional 1.8% of variance in anxiety post-walk test. In the test of the indirect (mediation) effect, PACES emerged as a significant mediator of the association between CES-D and anxiety post-walk test.

4. Discussion

In this study, we examined the relationship between depressive symptoms and physical activity enjoyment, and the role of physical activity enjoyment in the acute mood effects of aerobic exercise among smokers with elevated depressive symptoms. Consistent with our hypothesis, we found that depressive symptoms were significantly and negatively correlated with self-reported levels of physical activity enjoyment. This effect was incremental beyond the effects of gender and tobacco dependence. In addition, physical activity enjoyment was positively associated with acute mood response following a single bout of exercise (i.e., a 1-mile walk test). Further, depressive symptoms did not directly influence the mood response following a bout of exercise. It is well-documented that a statistical indirect effect can exist in the absence of a total or direct effect or bivariate-level correlations (Hayes, 2013), thus we tested the indirect effect of physical activity enjoyment. Findings indicated that depressive symptoms were *indirectly* related to the acute mood response following a bout of exercise, through the influence of physical activity enjoyment. That is, physical activity enjoyment may explain, at least in part, how depressive symptom severity is linked to the mood-enhancing effects following a bout of activity. Notably, physical activity enjoyment accounted for unique variance in the acute mood response following a bout of exercise (between 1.8% and 6.8%), which is small to medium sized effect (Cohen's d's = 0.27–0.54), suggesting that physical activity enjoyment is likely only one of a number factors that contributes to the acute mood experience after exercise. This set of findings has implications for exercise adherence, given that both physical activity enjoyment and the affective experience after exercise are robust

Table 1
Descriptive characteristics and bivariate associations between study variables.

Variable	1.	2.	3.	4.	5.	6.
1. Gender	–	0.182*	-0.060	-0.104	-0.167*	0.128
2. CES-D		–	0.117	-0.224**	-0.361**	0.355**
3. FTND			–	-0.048	-0.062	0.026
4. PACES				–	0.148	-0.055
5. Mood (Pre Walk Test)					–	-0.315**
6. Anxiety (Pre Walk Test)						–
Mean/n	111	15.3	5.5	84.6	7.1	2.8
SD/%	69.8%	11.34	2.06	18.92	1.50	2.63

Note: Gender (coded 0 = male, 1 = female); CES-D = Center for Epidemiologic Studies – Depression scale); FTND = Fagerström Test for Nicotine Dependence; PACES = Physical Activity Enjoyment Scale; *p < 0.05, **p < 0.01.

Table 2
Mediation results.

CES-D → MOOD						
Regression Paths	R^2	*b*	*se*	*t*	*p*	$CI_{95\%}$ LL, UL
CES-D → Post-walk mood (path c)	0.332	0.015	0.010	1.514	0.132	-0.005, 0.035
CES-D → PACES (path a)	0.059	-0.296	0.142	−2.08	0.039	-0.577, -0.016
PACES → Post-walk mood (Path b)	0.399	0.023	0.006	4.154	<0.001	0.012, 0.034
CES-D → Post-walk mood (Path c')		0.022	0.010	2.258	0.025	0.003, 0.041
CES-D → PACES → Post-walk mood (a×b)		-0.007	0.004	–	–	-0.016, -0.001
CES-D →Anxiety						
Regression Paths	R^2	*b*	*se*	***t***	*p*	$CI_{95\%}$ LL, UL
CES-D → Post-walk anxiety (path c)	0.482	0.021	0.012	1.770	0.079	-0.003, 0.045
CES-D → PACES (path a)	0.055	-0.347	0.142	−2.451	0.015	-0.626, -0.067
PACES → Post-walk anxiety (Path b)	0.500	-0.016	0.007	−2.360	0.020	-0.030, -0.003
CES-D → Post-walk anxiety (Path c')		0.016	0.012	1.305	0.194	-0.008, 0.040
CES-D → PACES → Post-walk anxiety (a×b)		0.006	0.003	–	–	0.001, 0.014

Note: Exercise enjoyment (PACES) is the mediator in all analyses. Path a = effect of X (i.e., CES-D) on M (i.e, PACES); Path b = effect of M on Y (i.e., post-exercise mood or anxiety); Path c = effect of X on Y; Path c' = effect of X on Y controlling for M; Indirect effect = a×b coefficient (mediation).

predictors of physical activity behavior (Lewis et al., 2016; Williams, 2008). Specifically for smokers, depressive symptoms may increase risk for poor adherence to an exercise intervention due to lower exercise enjoyment.

Of note, level of tobacco dependence was not related to physical activity enjoyment in this sample. This finding is somewhat surprising given that smokers subjectively experience moderate-intensity exercise as more strenuous than objectively measured intensity (Ussher et al., 2014) and that higher levels of cigarette consumption (smoking rate) are associated with lower physical activity enjoyment (Verkooijen, Nielsen, & Kremers, 2009). Theoretically, the effects of smoking on the respiratory (e.g., reduced lung functioning, breathlessness) and cardiovascular systems (e.g., elevated blood pressure and heart rate) may contribute to and/or potentiate the physically distressing experience of aerobic exercise, which would likely decrease the pleasurable experience of exercise. It is possible that a direct measurement of smoking-related cardiorespiratory impairment (e.g., spirometry, functional capacity), in contrast to a self-report measure of tobacco dependence, would reflect differences in physical activity enjoyment. Also, it is important to further consider the extent to which the observed associations with depressive symptoms and physical activity enjoyment are specific to cigarette smokers, or are more broadly observed across physically inactive individuals.

Importantly, participation in exercise interventions is related to *increased* physical activity enjoyment (Hagberg et al., 2009; Ivanova, Yaakoba-Zohar, Jensen, Cassoff, & Knäuper, 2016), including among individuals with depression (Schneider et al., 2016). Physical activity enjoyment is often considered an intrinsic motivator for exercise (Phillips et al., 2016). Consistent with Self-Determination Theory (Ryan & Deci, 2000), intrinsic motivation is a key factor for long-term maintenance of exercise behaviors (Ryan, Fredrick, Lepes, Rubio, & Sheldon, 1997). Therefore, low active smokers with elevated depressive symptoms could initially benefit from external contingencies that increase motivation for exercise adherence (e.g., financial incentives) or adjunctive treatment to bolster the pleasurable mood experience of exercise. For example, prior studies have examined approaches to increasing physical activity enjoyment, including use of music (Jones, Karageorghis, & Ekkekakis, 2014) and mental imagery (Stanley & Cumming, 2010), or use of preferred (choice) exercise intensity program versus prescribed intensity (Oliveira, Deslandes, Yuzo, Viana, & Santos, 2015; Parfitt, Rose, & Markland, 2000). Other studies have integrated acceptance and commitment-based strategies to increase physical activity enjoyment and exercise tolerance among sedentary women (Ivanova et al., 2016). Further, having positive expectations about exercise can lead to greater physical activity enjoyment (Mothes et al., 2016), although inactive individuals generally underestimate how much they will enjoy physical activity (Loehr & Baldwin, 2014; Ruby, Dunn, Perrino, Gillis, & Viel, 2011). Strategies that focus on correcting negative expectancies about exercise may help to increase physical activity enjoyment. With repeated engagement in exercise, smokers with elevated depressive symptoms may experience an increase in physical activity enjoyment that will help them sustain activity, thereby enhancing the potency of aerobic exercise as a mood management and smoking cessation intervention.

Several limitations are worth noting. First, the acute bout of physical activity in this study was in the context of a laboratory setting where the participants were aware that the researchers were examining their cardiorespiratory fitness level. The perception of being evaluated could have influenced mood and anxiety ratings. Second, we relied on self-report measurement of depressive symptom severity. Future work would benefit from use of clinician-administered depression severity assessment, which would bolster the comprehensive measurement of depression symptoms. Additionally, while the CES-D is commonly used to assess depression severity among smokers, future work could consider use of alternative self-report measures (e.g., Beck Depression Inventory-II; Beck, Steer, & Brown, 1996; Patient Health Questionaire-9; Spitzer, Kroenke, & Williams, 1999). Third, the current study exclusively relied on self-reported measurement, thus we cannot rule out the possibility of measurement error. Fourth, measurements of depressive symptoms and physical activity enjoyment were assessed cross-sectionally and one week before the walk test. Future studies should employ a prospective design. Also, while we have utilized these mood and anxiety ratings in prior studies (Abrantes et al., 2009; Brown, Prince, Minami, & Abrantes, 2016) to examine acute changes due to a bout of exercise, more commonly employed measures of mood/affect (Lox, Jackson, Tuholski, Wasley, & Treasure, 2000) could result in different findings. Lastly, our sample lacked racial and ethnic heterogeneity, was primarily female, and all participants were interested in an exercise study for smoking cessation. Thus this sample may not necessarily generalize to more racially and ethnically smokers and those who are non-treatment seeking. Despite these limitations, the findings from this work contribute toward the literature on developing and testing exercise intervention for smoking cessation.

It has been suggested that the limited efficacy of aerobic exercise

for smoking cessation could be due, at least in part, to low adherence to the prescribed regimen. Physical activity enjoyment is a malleable factor, which, if enhanced, could bolster adherence to physical activity interventions, and in turn increase the efficacy of aerobic exercise as a smoking cessation strategy. Increasing engagement in pleasurable activities generally is also a core component of the psychosocial treatment of depression (e.g., behavioral activation; Kanter et al., 2010), so the mental health benefits of increasing physical activity enjoyment may also be robust for individuals with elevated depressive symptoms. Future work in the area of aerobic exercise and smoking cessation should consider the role of physical activity enjoyment, particularly among smokers with psychiatric vulnerabilities (e.g., elevated depressive symptoms), as it may be an important contributor to lower adherence to exercise interventions.

Acknowledgments

This work was supported by a grant (R01CA173551) funded by the National Cancer Institute. The second author is supported by a grant (T32HL076134-11) funded by the National Heart, Lung, and Blood Institute. The authors declare that there is no conflict of interest.

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