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Exercise Interventions for Depressed Smokers: The Promise of Community Settings and Robots

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Abstract

Smokers have an increased risk of depressive symptoms and depressive disorders. Smokers reporting higher levels of depressive symptoms prior to cessation treatment have greater difficulty quitting smoking. However, few interventions have targeted depressed smokers, a tobacco use disparity group. There is preliminary evidence to support the use of supervised, vigorous intensity exercise interventions to help smokers with depression quit. This Mini-Review addresses the potential role of exercise interventions for this population. We cover: (1) tobacco cessation treatments that have targeted depressed smokers, (2) efficacy of supervised exercise interventions for depression and smoking cessation, (3) results from a pilot study of supervised, vigorous intensity exercise for depressed women delivered in a community setting, and (4) future directions including technologies to scale up delivery of exercise interventions and exercise maintenance strategies. Future studies are needed that broaden the characteristics of participants in trials to include racially diverse men and women with a range of depressive symptoms. Positioning exercise delivery within community settings enhances the possible reach of interventions to a more diverse population of smokers. Delivery of exercise coaching through robotic and other digital technologies could also increase intervention scalability and open new avenues to explore methods and strategies to promote exercise adherence/maintenance.

Introduction

In 2016, cigarette smoking prevalence among U.S. adults was 15.5%, with higher prevalence among men (17.5%) than women (13.5%)[1]. Cigarette smoking disparities persist as a function of sociodemographic characteristics: race, education, income, and insurance status[1,2]. Adults with severe psychological distress (anxiety and depressive symptoms) also report a higher smoking prevalence (35.8%) compared with adults without such distress (14.7%)[1]; these differences are accentuated among individuals with low income status and education levels[3]. Cigarette smoking reduces life expectancy by 10-15 years among individuals with depression and other serious mental illnesses[4].

Smokers have increased risk of depressive disorders and depressive symptoms[5]. In smoking cessation treatment samples, 34-50% report elevated depressive symptoms[6,7]. With few exceptions, elevated depressive symptoms and major depressive disorder (MDD) diagnosis prior to treatment predict reduced likelihood of quitting smoking[8]. Thus, designing effective smoking cessation interventions for currently depressed smokers, a tobacco-use disparity group, is a public health priority[9].

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This Mini-Review addresses the potential role of exercise interventions among depressed smokers. We cover: (1) treatments for depressed smokers, (2) supervised exercise interventions for depression and smoking cessation, (3) results from a pilot study of supervised, vigorous intensity exercise for depressed women delivered in a community setting, and (4) future directions.

Treatments for Depressed Smokers

Aside from exercise intervention studies described below[10-12], only four treatment studies have targeted smokers with current depressive symptoms[13-16]. These studies included fluoxetine[14], varenicline[13], and computerized motivational feedback combined with nicotine replacement therapy (NRT)[15]. A preliminary study of mildly depressed smokers indicated behavioral activation therapy increased smoking abstinence compared with standard cessation treatment[16], but was less effective for women and those with more severe depression. Cognitive-behavioral therapy (CBT) is effective for treating depression and has been studied extensively in smokers with a *past history* of MDD, and was only found to be effective for those with recurrent episodes[17,18]. Interestingly, mindfulness approaches to deescalate stress and negative emotions are effective for smoking cessation[19], but lack evaluation among depressed smokers, as well as combining cognitive approaches with exercise.

Supervised Exercise Interventions are Effective for Both Depression and Smoking Cessation

Exercise is an effective treatment for depression, with effects comparable to CBT or pharmacotherapy[20]. Most studies of exercise for depression used supervised, facility-based exercise[21]. Chalder et al[22] found that providing advice and encouragement to increase physical activity (no supervised exercise) was ineffective for promoting exercise adherence or reducing depressive symptoms. Similarly, in a randomized trial of men and women outpatients with MDD (1/3 smokers), our research team found that providing exercise counseling to encourage fitness center attendance (no supervised exercise) was not effective for promoting physical activity[23].

Among smokers, acute exercise reduces cigarette cravings and negative affect[24,25]. The most recent Cochrane review of 20 randomized trials among smokers without depression concluded there was little evidence that exercise was effective as a smoking cessation intervention[26]. However, the review suggested these interventions were limited by inadequate control groups, insufficient exercise intensity, and a lack of support provided to ensure exercise adherence.

One of the few trials to show a long-term effect on smoking abstinence targeted women using 12 weeks of thrice weekly (i.e., 36 sessions) supervised, research-facility-based, vigorous intensity exercise[27]. When this treatment was streamlined to only four supervised exercise sessions (versus 36), it was not effective for smoking cessation and there was poor adherence to home exercise[28]. Moreover, two studies encouraging home-based exercise counseling among depressed female smokers, including one study by our research lab, revealed that such methods were not effective for promoting exercise adherence or smoking cessation compared with a health education contact control group, presumably due to the lack of supervision and support[10,12].

Though not directly targeting depressed smokers, Abrantes et al[29] piloted a 12-week supervised exercise intervention of moderate intensity (1 session/week), with CBT components to reinforce home-based exercise. No statistically significant differences were detected on smoking abstinence for the intervention versus health education control but higher levels of moderate-to-vigorous exercise were associated with lower depression severity during treatment.

Smits and colleagues[30] observed that a supervised exercise protocol similar to Marcus et al[27] was effective for smoking cessation among adults with high symptoms of anxiety sensitivity, a cognitive factor that may amplify the subjective experience of exertion (effort) during exercise, resulting in lower adherence with physical activity[31]. Therefore, rigorously designed studies suggest that a supervised exercise program could benefit smokers with psychological distress, including depressed smokers, by providing reinforcement, guidance, and support for exercise, thus improving adherence[26].

Efficacy of Supervised, Vigorous Intensity Exercise for Depressed Women Smokers

Our research team explored if the same effective intervention tested among women smokers[27] could also be efficacious for female smokers with depression[11]. In addition to the positive results obtained for women smokers[27], vigorous exercise was used because of potential benefits of greater intensity exercise[32,33] and increased cardiorespiratory fitness[34] on depressive symptoms. Unlike the Marcus study[27], the intervention was delivered in a community YMCA setting, instead of a research facility, enhancing its dissemination potential.

To adapt the intervention to depressed smokers, we incorporated language in the coaching manual from our team's prior study of consumer preferences for exercise interventions conducted among 464 depressed men and women[35]. Advice and feedback from a community sample of 12 depressed women smokers also informed adaptations to the treatment protocol. For the pilot trial[11], 30 adult women smokers with moderate-severe depressive symptoms were randomly assigned to 12 weeks of thrice weekly, in-person

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sessions of supervised, vigorous intensity, YMCA-based exercise (EX; n=15), or to a HE contact control condition (n=15). Participants received behavioral smoking cessation counseling and NRT. Treatment adherence was high for both groups (72% EX, 66% HE, p=0.55). All EX participants engaged in some vigorous exercise at every session, and at the final session attended, participants averaged 25 minutes (SD=6, range 123-30) of vigorous exercise (of 30 minutes recommended by week 12), suggesting the exercise protocol is feasible. The biochemically verified smoking abstinence rate was higher for EX than HE at week 12 (11/15 [73%] vs. 5/15 [33%], p=0.028), but not at week 26 (27% vs. 40%, p=0.439), even after adjusting analyses for depression score and antidepressant medication use (week 12, p=0.035; week 26, p=0.48. Cardiorespiratory fitness levels at week 12 increased significantly (p=0.002) more from baseline among EX than HE participants.

From this pilot study[11] we concluded that supervised, vigorous intensity exercise is feasible, and our data suggest exercise enhances short-term smoking cessation among depressed female smokers. The lack of treatment condition differences at 6 months suggests the need to incorporate exercise maintenance strategies.

Our pilot study[11] was limited by sample characteristics: women only, 90% White, with moderate-severe depressive symptoms. Exercise interventions for smoking cessation need to be adapted for suitability to a racially diverse sample of men and women with a range of depressive symptoms. Within smoking cessation intervention trials generally, a recent literature review on sex differences found that of 126 trials conducted, only two observed that women were significantly more likely to quit smoking than men, compared to 59 that found women were significantly less likely to quit smoking than men. The remaining 65 studies reported no sex differences[36].

As these limitations exemplify, a major challenge is to discover innovative and cost-effective strategies to bolster long-term exercise adherence among diverse populations, including those living in rural and impoverished communities, while considering that supervised exercise is associated with better outcomes in studies of both depression[37] and smoking cessation (see also Ussher et al[26] for review)[38,39]. Because at least a third of all smokers in the U.S. have elevated symptoms of depression, identification of highly scalable solutions for cessation is a public health imperative.

Future Directions

Scalable interventions

Our research team is exploring a novel application of technology for delivering exercise coaching, without losing necessary supervision, using a robotic interface. Coaching is done in real time via an iPad tablet placed atop a mobile robotic wheel base, controlled remotely using an iOS device or computer. The current intervention prototype interacts in real time and thus bridges the gap between human and embodied support[40,41]. The robotic interface can move around the participant, not only to examine how the participant performs an exercise, but also to facially interact with him/her. A robotic-assisted coach could thus achieve similar functions as an in-person coach including: supervision, interaction, instruction and correction of exercise form, accountability, support, and reinforcement. The technology is different than web assisted video- or skype phone-conferencing because the robotic interface accompanies and moves with and around the participant during exercise while the participant remains hands-free.

We gathered preliminary data on acceptability of the robotic interface among 100 adult men and women recruited from two local community settings serving populations with low-income status, the YMCA and Rochester Public Library[42]. Participants watched a brief demonstration of the robot-delivered exercise coaching and then completed a survey. Respondents were 40% female, 41% racial minority, 56% unemployed, 38% current smoker, 58% had a history of depression, and 66% were sedentary. The mean Technology Acceptance Scale score was 34.0 (SD=5.5, range 16-40) of a possible score of 40, indicating very good overall receptivity to the robot. Racial minorities and unemployed participants reported greater technology acceptance than White (p=0.015) and employed (p<0.001) respondents; suggesting the potential utility of this technology for diverse populations. No associations were detected between TAS score and smoking status, sedentariness, depression history, sex, or age. Qualitative feedback indicated the robot was perceived as a novel, motivating way to prompt exercise, increase accessibility of interventions, and was the "wave of the future." We concluded that robotic technology has potential applicability for exercise coaching in diverse populations, including depressed smokers, but that formative research is needed to assess consumer uptake and feasibility.

Additional options to increase intervention scalability include digital health coaching delivered through the web or mobile phones (e.g., texting, applications) as substantial research has documented the efficacy of such treatment delivery platforms for smoking cessation and physical activity[43]. In depression treatment, support provided by a virtual coach (i.e., embodied conversational agent) can facilitate participant engagement and self-disclosure due to its greater perceived anonymity and non-judgmental nature[44]. One drawback is that these technologies emulate, but do not include, the support and empathy of a live coach[45]. For example, a recent study utilizing a fully automated robot for motivational interviewing to increase

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physical activity found that while participants appreciated the novelty and non-judgmental nature of the technology, their experience was limited by the lack of individualized responses or social interactions with the robot[46]. As internet and Wi-Fi access improves in the future[47], robotic-assisted and other digital technologies could have applications for several health behavior change interventions.

Exercise maintenance

Maintenance of physical activity or of any health behavior change is a challenge for community settings[48,49]. One option is holding booster sessions, though little evidence provides efficacy for maintenance of physical activity or smoking cessation[50]. For physical activity maintenance, the literature suggests strategies to enhance social translucence (accountability) and social support for exercise[48,49]. Thus, future work might consider embedding the intervention within existing community settings, such as a YMCA or community health center. For example, YMCA desk staff or fitness center attendants could check-in individuals for their exercise program and document and verbally reinforce their attendance to provide accountability and social support. YMCAs also implement substantially reduced membership fees based on income and award points for facilities use, which could be useful for both initiating and extending memberships. Technology options discussed above could also be evaluated for providing social support.

Summary

This Mini-Review highlights the importance of focusing on depressed smokers as a tobacco-use disparity group. We identify several directions for research, most notably, broadening the characteristics of participants in trials to include racially diverse men and women with a range of depressive symptoms. Positioning exercise delivery within community settings enhances the possible reach of interventions to a more diverse population of smokers. In addition, delivery of exercise coaching through digital technologies could increase intervention scalability and open new avenues to explore methods and strategies to promote exercise adherence/maintenance and smoking cessation.

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