Journal of Affective Disorders 239 (2018) 258–268

Contents lists available at ScienceDirect

Journal of Affective Disorders

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

Research paper

Experimentally investigating the joint effects of physical activity and sedentary behavior on depression and anxiety: A randomized controlled trial

Jeremiah Blough, Paul D. Loprinzi*

Physical Activity Epidemiology Laboratory, Exercise Psychology Laboratory, Department of Health, Exercise Science and Recreation Management, The University of Mississippi, MS 38677, USA

ARTICLE INFO

Keywords:
Accelerometry
Exercise
Exercise cessation
Exercise withdrawal
Intervention
Interaction
Mental health

ABSTRACT

Objective: To experimentally examine whether increasing sedentary behavior, among a young adult active population, for one week is still associated with increased depression and anxiety symptomology even when allowing for a moderate engagement in physical activity (PA).

Methods: Participants were confirmed as active via self-report and accelerometry during baseline and randomly assigned to one of three experimental groups. The No Exercise Group (n = 19) was instructed to reduce steps to less than 5000/day and were not allowed to exercise for one-week; the Reduced MVPA (moderate-to-vigorous PA) Group (n = 18) was instructed to reduce steps to less than 5000/day but exercised for 50% of their previously reported vigorous PA for one-week; and the Control Group (n = 20) maintained normal activity for one-week. PA, depression, and anxiety levels were assessed at baseline, post-intervention, and after one week of resumed normal activity for the intervention groups.

Results: The experiment was successful in altering physical activity levels among the intervention groups and maintaining activity habits in the control group ($F_{Interaction}$ = 16.053, $P < 0.001$, η_p^2 = 0.391). Anxiety and depression symptomology remained constant across the two time periods in the control group. For both intervention groups (No Exercise Group and Reduced MVPA Group), depression statistically significantly increased during the inactive week and then resumed back to baseline levels after a week of resumed activity. However, there were no differential trends in anxiety ($F_{Interaction}$ = 0.073, P = 0.897, η_p^2 = 0.002) or depression ($F_{Interaction}$ = 0.276, P = 0.760, η_p^2 = 0.008) among these two intervention groups.

Conclusion: We provide experimental evidence that reducing habitual physical activity causes an increase in depression symptomology among young active adults. We did not, however, observe a joint effect of sedentary behavior and exercise on changes in anxiety and depression. At this point, it is still uncertain as to whether reduced MVPA or increased sedentary behavior were driving the observed changes in psychological function. Future research may help determine if these negative effects are from increased sedentary behavior or a reduction in MVPA.

1. Introduction

Approximately 25% of adults in the United States are affected by mental illness every year (Bagalman and Cornell, 2018). Anxiety and depression are two of the more prominent mental illnesses with lifetime prevalence rates ranging from 13.6 to 28.8% for anxiety (Michael et al., 2007) and 16.2% for depression (Kessler et al., 2003). These two disorders are often comorbid with one another, with 62% of adults with anxiety having at least one episode of depression (Judd et al., 1998). Depression can negatively impact many aspects of an individual's life (e.g., personal relationships, academic and work performance) (Bruffaerts et al., 2012) as can anxiety (e.g., life satisfaction, social, family and occupational functioning) (Hoffman et al., 2008).

The traditional methods for treating anxiety and depression are commonly through psychotherapy and pharmacotherapy. These methods have been shown to be effective forms of treatment (Cuijpers et al., 2008; Deacon and Abramowitz, 2004; Gartlehner et al., 2016; Baldwin et al., 2011). Notwithstanding, these methods are not always cost effective and medications can have unpleasant side effects (Coplan et al., 2015). However, evidence demonstrates that physical activity, which may have few sides effects and is cost-effective, has both preventative and treatment effects on these disorders (Mikkelsen et al., 2017; Rebar et al., 2015; Kvam et al., 2016; Schuch et al., 2016a, b; Mammen and Faulkner, 2013; Ströhle, 2009; Wegner et al., 2014).

There are many proposed mechanisms for the beneficial effects of physical activity, both psychologically and physiologically. A few

* Corresponding author.
E-mail address: pdloprin@olemiss.edu (P.D. Loprinzi).

https://doi.org/10.1016/j.jad.2018.07.019
Received 1 March 2018; Received in revised form 17 May 2018; Accepted 7 July 2018
Available online 10 July 2018
0165-0327/

possible psychological mechanisms for the anxiolytic and anti-depressive effect of physical activity include enhancing self-esteem or self-concept through, for example, social facilitation (Ekkekakis, 2013). Further, physical activity may serve as a distraction from an individual's anxiety and/or depression, and may boost an individual's self-efficacy allowing them to perceive more control over aspects of life leading to reduced anxiety and depression symptomology (Ekkekakis, 2013). There are several proposed biological mechanisms for the anxiolytic effect of physical activity, including an increase in serotonin sensitivity and release of endogenous opioids (Ekkekakis, 2013). Another possible physiological mechanism is that exercise increases brain-derived neurotrophic factor (BDNF), which is vital for synaptic plasticity (Ekkekakis, 2013), and thus, plays an important role in regulating the neural circuity of mood and cognitive function (Duman et al., 2016).

In contrast to these beneficial effects of physical activity, sedentary behavior has been shown to have deleterious effects on psychological wellbeing, independent of physical activity levels (Proper et al., 2011). Sedentary behavior is linked with increases in depression and anxiety symptomology (Teychenne et al., 2015; Zhai et al., 2015; Loprinzi and Sng, 2016). The majority of the research examining the association of sedentary behavior and psychological health is from an observational point of view. Few studies on this topic have investigated sedentary behavior experimentally.

To gain more experimental evidence on sedentary behavior, we recently recruited physically active individuals (≥150 min/week of moderate-to-vigorous physical activity [MVPA]) to participate in a one week sedentary-inducing intervention trial (Edwards and Loprinzi, 2016a, b). We found that both depression and anxiety levels increased when transitioning from an active state to a sedentary state (Edwards and Loprinzi, 2016a, b). We also demonstrated that the depression and anxiety scores returned back to baseline after one week of resuming normal physical activity levels (Edwards and Loprinzi, 2016a, b).

The purpose of this study was to extend our previous work by experimentally examining whether increasing sedentary behavior is still associated with increased depression and anxiety symptomology even when allowing for a moderate degree of engagement in physical activity (i.e., 50% of their baseline habitual levels). This potential experimental interaction effect of physical activity and sedentary behavior on health aligns with recent observational research from our group as well as others (Ekelund et al., 2016; Loprinzi et al., 2016a, b). However, such a potential interaction effect has not been examined experimentally, which was the primary purpose of the present experiment. We hypothesized that, as noted previously (Edwards and Loprinzi, 2016a, b), an induction of sedentary behavior would cause an increase in anxiety and depression symptomology, but this increase would be attenuated by a moderate degree of exercise engagement.

2. Methodology

2.1. Study design

A randomized controlled trial was employed, consisting of 3 interventions arms, including a No Exercise Group (Group 1; sedentary intervention group), a Reduced MVPA Group (Group 2), and a Control Group (Group 3). Procedures adhered to the 2010 CONSORT guidelines except for #24 (prospective registration of the trial). All study procedures were approved by the authors' institutional review board and consent was obtained from all participants prior to data collection.

2.2. Eligibility criteria

Participants were eligible for participation if they were aged 18–35 years, sufficiently active by meeting physical activity guidelines (defined hereafter), did not report severe depression (i.e., PHQ-9 > 20), and had not been diagnosed with a psychological disorder within the past 6 months of the baseline assessment.

2.3. Participants

The sample involved 57 participants in total with 19 in Group 1, 18 in Group 2, and 20 in Group 3. The sample size was selected as it was similar to our previous experimental research (employing an *a-priori* power analysis) on this paradigm (Edwards and Loprinzi, 2016a, b). See Appendix A for a flow diagram of the participant enrollment.

2.4. Recruitment

The participants were students recruited by a convenience-based sampling approach (e.g., classroom announcement at the authors' University). Recruitment began in February of 2017 and ended in November of 2017.

2.5. Study procedures

The intervention groups (Group1 and Group 2) participated in 4 visits and the control (Group 3) completed 3 visits, with all visits occurring 1 week apart and at approximately the same time of day. All visits were conducted in the Exercise Psychology Laboratory at the University of Mississippi. See Appendix B for a schematic of the temporal procedures of the present experiment. These temporal procedures are also detailed in the narrative that follows.

2.6. Baseline physical activity eligibility assessment

At the first visit (Baseline), physical activity was subjectively assessed via the two-item PAVS (Physical Activity Vital Sign) questionnaire (described below). Participants were eligible for participation if they were initially sufficiently active (based on self-report), defined as ≥150 min of MPA (Moderate Physical Activity) and/or ≥75 min of VPA (Vigorous Physical Activity). If eligible based on self-report, an accelerometer was given to be worn (at the midaxillary line on the right hip at the level of the iliac crest) until the next visit one week later. For the following visit (Visit 1), the accelerometer data was analyzed, and the participant continued in the study if he/she was deemed active (≥150 min of MVPA) per the accelerometry data (details on accelerometer data reduction are noted below).

2.7. Pre-Intervention assessment

After the one-week of accelerometry assessment to confirm that participants were sufficiently active, they re-completed the PAVS questionnaire as well as depression (PHQ-9) and anxiety (OASIS) questionnaires. After these assessments, participants were given an accelerometer (again) and a pedometer and randomly assigned to a group via a computer-generated random sequence algorithm. Allocation of the grouping sequence was concealed and the participants were blinded to their group assignment until the end of the first visit. If assigned to the No Exercise Group (Group 1), the instructions for the following week were to not exercise whatsoever and to reduce daily steps to less than 5000, hence the pedometer. Participants were only included in the Reduced MVPA Group (Group 2) if 75 min or more of VPA was reported via the PAVS at Visit 1. If assigned to Group 2, the instructions for the intervention week were to only exercise at 50% of his/her reported VPA from the PAVS at Visit 1 (e.g., 90 min VPA