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Research paper

Experimentally increasing sedentary behavior results in increased anxiety in an active young adult population

Meghan K. Edwards, Paul D. Loprinzi *

Department of Health, Exercise Science and Recreation Management, Physical Activity Epidemiology Laboratory, The University of Mississippi, MS, United States

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ABSTRACT

Introduction: Knowledge regarding the effects of sedentary behavior on anxiety has resulted mainly from observational studies. The purpose of this study was to examine the effects of a free-living, sedentary behavior-inducing randomized controlled intervention on anxiety symptoms.
Methods: Participants confirmed to be active (i.e., acquiring 150 min/week of physical activity) via self-report and accelerometry were randomly assigned into a sedentary behavior intervention group (n=26) or a control group (n=13). For one week, the intervention group eliminated exercise and minimized steps to $\leq$5000 steps/day whereas the control group continued their normal physical activity levels. Both groups completed the Overall Anxiety Severity Impairment Scale (OASIS) pre- and post-intervention, with higher OASIS scores indicating worse overall anxiety. The intervention group resumed normal physical activity levels for one week post-intervention and then completed the survey once more.
Results: A significant group x time interaction effect was observed ($F(1,37)=11.13$; $P=.002$), with post-hoc contrast tests indicating increased OASIS scores in the intervention group in Visit 2 compared with Visit 1. That is, we observed an increase in anxiety levels when participants increased their sedentary behavior. OASIS scores significantly decreased from Visit 2 to Visit 3 ($P=.001$) in the intervention group.
Conclusion: A one-week sedentary behavior-inducing intervention has deleterious effects on anxiety in an active, young adult population. To prevent elevated anxiety levels among active individuals, consistent regular physical activity may be necessary. Clinicians treating inactive patients who have anxiety may recommend a physical activity program in addition to any other prescribed treatment.

1. Introduction

Anxiety disorders (including panic disorders, generalized anxiety disorder, post traumatic stress disorder, phobias, and separation anxiety disorder) are the most common class of mental disorders present in the general population (Michael et al., 2007). Anxiety disorders have lifetime prevalence rates ranging between 13.6% and 28.8% and 12-month prevalence rates between 5.6% and 19.3% (in an American adult population) (Kessler et al., 2009), reflecting original observations by Cattell and Scheier (1961) that anxiety may be state-like (transient; reflecting a current emotional state) or trait-like (chronic; anxiety differences resulting from differing personality traits) (Cattell and Scheier (1961)). Generalized anxiety disorder (GAD) is the most common anxiety disorder seen in primary care. Approximately 6.8 million (3.1%) of United States adults suffer from generalized anxiety disorder, which is characterized by chronic, excessive, uncontrollable worry about a number of events or activities (Barlow, 1988). Generalized anxiety disorder has been associated with a number of somatic complaints, including chest pain and irritable bowel syndrome, and is believed to reduce effective problem solving confidence, lower senses of personal control, and inhibit ambiguous task performance Barlow (1988). Additionally, GAD has been associated with lower levels of daily life satisfaction and may detrimentally influence one's social, family, and occupational functioning (Hoffman et al., 2008).

Further emphasizing the importance of employing effective treatments to alleviate and prevent anxiety symptomology is the knowledge that comorbidity is more common among those with anxiety disorders. Approximately 75% of individuals with a lifetime anxiety disorder have at least one other mental disorder (Michael et al., 2007). For instance, according to reports from the National Comorbidity Study, GAD has a 91% rate of comorbidity

* Correspondence to: Physical Activity Epidemiology Laboratory, Department of Health, Exercise Science, and Recreation Management, The University of Mississippi, 229 Turner Center University, MS 38677, United States.
E-mail address: pdloprin@olemiss.edu (P.D. Loprinzi).

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(Kessler et al., 1997). Specifically, GAD has been shown to have strong associations with a number of affective (e.g., major depressive disorder and bipolar disorder) (Kessler et al., 2005). Also of notable importance, subthreshold levels of anxiety (e.g. subthreshold GAD or major depressive disorder) have been reported to be more prevalent than diagnosed anxiety of the same disorders and may elicit similar psychological distress and lower perceptions of health (compared to healthy individuals) as clinically diagnosed anxiety disorders (Rucci et al., 2003).

In addition to the significant personal burdens and barriers that may present themselves with presence of an anxiety disorder, anxiety disorders result in a high economic burden, costing the United States over 42 billion dollars a year (as reported in the 1990s) (Greenberg et al., 1999). Included within these costs are emergency room visits, specialist referrals, diagnostic tests, and prescribed medications (among others) (Barlow, 1988). Traditional treatments for anxiety disorders include various pharmacotherapy medications (e.g. antidepressants), as well as psychosocial treatment (e.g., cognitive behavioral therapy). Integrative acceptance and mindfulness-based models as well as physical activity programs have also been evaluated as alternative treatment options (Barlow, 1988, Kabat-Zinn et al., 1992, Miller et al., 1995). The multitude of global health-related benefits of physical activity (e.g., decreased risk for cardiovascular disease, heart attack, certain cancers, Type II diabetes and obesity as well as an increased overall quality of life) (Otto et al., 2007; Haennel and Lemire, 2002; Bernstein et al., 1994; Young-McCaughan and Sexton, 1991; Loprinzi, 2015; Loprinzi and Davis, 2016) coupled with the lack of negative physical side-effects that may result from pharmacotherapy options (e.g., withdrawal symptoms and dependency issues) (Julien, 2013) make physical activity a particularly appealing option for anxiety treatment and prevention. In addition to considerable epidemiological evidence of an inverse relationship between physical activity and anxiety, review papers and meta-analyses have highlighted numerous physical activity intervention studies that collectively demonstrate the anxiolytic effects of physical activity (Petruzzello et al., 1991, Strohle, 2009, Byrne and Byrne, 1993).

While it is important to understand how physical activity may influence one's anxiety levels, emerging research suggests that regardless of time spent being physically active, sedentary behavior is associated with a number of negative health outcomes (i.e., individuals who are more sedentary may have an increased risk of deleterious health consequences, including those who achieve the recommended levels of physical activity) (Proper et al., 2011, Loprinzi, 2016). Of particular relevance to our present study, a recent systematic review demonstrated a positive association between sedentary behavior and anxiety (Teychenne et al., 2015). This review summarized results from nine observational study designs (7 cross-sectional and 2 longitudinal studies) and found a moderately strong association between increased sitting time and increased risk for anxiety. The authors declared the need for future longitudinal and intervention study designs to further explore the topic (Teychenne et al., 2015). No published study (to our knowledge) has utilized an experimentally designed sedentary behavior intervention (where sedentary behavior is increased) to draw conclusions upon (with regards to the health outcome of anxiety).

The purpose of this study was to build upon current understandings of the sedentary behavior and anxiety relationship via a randomized, controlled sedentary behavior intervention. Among an "active" sample, we assessed anxiety to determine if a sedentary behavior intervention (i.e., minimizing physical activity and increasing sedentary behavior) had a significant effect on this outcome. We hypothesized active individuals whose sedentary behavior was increased for one week would report higher post-intervention anxiety levels. In addition, we hypothesized that anxiety levels would decline after normal activity was resumed (i.e. returned to baseline levels). This hypothesis is plausible because, as mentioned previously, observational-based research has demonstrated an inverse relationship between physical activity and anxiety (Strohle, 2009, Byrne and Byrne, 1993). Thus, it is reasonable to suggest that anxiety may worsen if sedentary behavior is increased. This approach may provide the strongest evidence of a potential cause-and-effect relationship between sedentary behavior and anxiety. Evaluating this within the younger adult population is of particular importance as this is a critical time period where physical activity often declines (Troiano et al., 2008) and anxiety has been shown to be prevalent (Lenze and Wetherell, 2011). For instance, our recent work suggests that the prevalence of anxiety disorder in a national sample of U. S. adults ages 20–39 years is 16% (Loprinzi and Codey, 2014). It has been suggested that the amount of physical, cognitive, and psychosocial changes young adults undergo increases their susceptibility to the development of anxiety disorders (Paus et al., 2008).

2. Methods

2.1. Recruitment

Participants were eligible for the study if they were between 18 and 35 years old, were confirmed to be active, spoke English, and provided informed consent. Participants were excluded from the study if they failed to obtain adequate levels of physical activity (described below) in the week of accelerometer data collection prior to the intervention. All participants provided written informed consent and the study procedures were approved by the authors' institutional review board.

The recruitment goal was 30–40 participants with at least n=22 in the intervention group; this was based of our recently published pilot data showing that changes in sedentary behavior were significantly associated with changes in various psychological-related parameters (Loprinzi and Sng, 2016). A student researcher at the authors' institution recruited participants using a non-probability convenience sampling approach (specifically, word of mouth was used to recruit co-workers as well as students from undergraduate classes within the authors' department). The final recruited sample size was N=39, and using a 2:1 sample size ratio for intervention and control participants (Dumville et al., 2006), 26 participants were randomly assigned into the sedentary behavior intervention group and 13 participants were randomly assigned into the control group.

2.2. Visit Details

Each participant completed either two (control group) or three (intervention group) visits, in addition to a pre-visit meeting. Hereafter, these visits are referred to as Baseline Visit (both groups), Visit 1 (both groups), Visit 2 (both groups), and Visit 3 (intervention group only), respectively. The visits were scheduled approximately one week apart and at roughly the same time of day. Fig. 1 contains a visual overview of the experimental design, with details explained in the narrative that follows.

At the Baseline Visit, the participant came in to our laboratory to confirm they met inclusion criteria for the study and, if deemed eligible to participate, to pick up their accelerometer. At this visit, the participant provided written informed consent of all of the study procedures. Next, they completed the International Physical Activity Questionnaire short form (IPAQ-SF) as a screening method to ensure that they were meeting the United States Department of Health and Human Services (USDHHS) guideline for American adults to accumulate at least 150 min/week of moderate-to-