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Exploring the role of sedentary behavior and physical activity in depression and anxiety symptom severity among patients with substance use disorders

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ABSTRACT

Research has consistently shown that regular physical activity may protect against the development and maintenance of depression and anxiety, whereas sedentary behavior may exacerbate depression and anxiety. However, much of the past research in this area has focused on non-clinical populations. Therefore, the goal of this study was to examine the relations of physical activity and sedentary behavior to depression and anxiety symptom severity among an understudied patient population, patients in residential substance use disorder (SUD) treatment. This study also sought to determine the extent to which physical activity and sedentary behavior relate to depression and anxiety symptom severity above and beyond an established transdiagnostic risk factor for depression and anxiety, emotion dysregulation. A sample of 41 patients from a residential SUD treatment facility completed a variety of self-report measures focused on physical activity, sedentary behavior, emotion dysregulation, and depression and anxiety symptom severity. Physical activity, but not sedentary behavior, was found to significantly predict depression symptom severity above and beyond emotion dysregulation. Physical activity and sedentary behavior did not significantly predict anxiety symptom severity above and beyond emotion dysregulation. In addition to providing additional support for the relevance of emotion dysregulation to depression and anxiety symptom severity, results suggest that physical activity may be another factor to consider in evaluating risk for depression among patients with SUDs. Although additional research in this area is warranted, results also suggest the potential utility of targeting physical activity in reducing risk for depression among patients with SUDs.

1. Introduction

Increasing attention has been paid toward both the benefits of regular physical activity and the disadvantages of sedentary behavior for mental health. Research has generally shown that moderate to high levels of physical activity are associated with lower levels of depression, whereas no physical activity and sedentary behavior may exacerbate depression (Dunn, Trivedi, & O'Neal, 2001; Martinsen, 2008; Ströhle, 2009; Teychenne, Ball, & Salmon, 2008). Although the cross-sectional nature of most of the studies in this area precludes determination of the temporal direction of this relation, a recent review of studies examining the prospective relation between physical activity and depression (see Mammen & Faulkner, 2013) provided evidence that physical activity may prevent future depression (although not all studies included in this review demonstrated such a relation). Whereas similar findings have also been obtained for anxiety (e.g., Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991), less research has been conducted on the relation of physical activity to anxiety and, thus, conclusions regarding a dose-response relation between physical activity and anxiety severity are premature (Dunn et al., 2001; Ströhle, 2009).

Research indicates that the relations between physical activity and sedentary behavior and depression and anxiety are found within both clinical and nonclinical populations. For example, the relation between physical activity and depression has been studied among inpatient military veterans (Davidson, Babson, Bonn-Miller, Souter, & Vannoy, 2013) and inpatients and outpatients with mood and anxiety disorders (Harris, Cronkite, & Moos, 2006; Martinsen, Hoffart, & Solberg, 1989; Sexton, Maere, & Dahl, 1989). Yet, the majority of the research in this area has focused on non-clinical populations (Teychenne et al., 2008). Consequently, there is a need to examine these relations within clinical populations at particularly high risk for the experience of depression and anxiety, such as individuals with substance use disorders (SUD). Individuals with SUDs have been found to exhibit elevated levels of depression and anxiety relative to other clinical populations (Grant et al., 2004). Moreover, substance use has been linked to lower levels of physical activity and higher levels of sedentary behavior (Nelson &

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Gordon-Larsen, 2006; Pate, Heath, Dowda, & Trost, 1996). Notably, however, no studies to date have examined the relations between physical activity and sedentary behavior and depression and anxiety among individuals with SUDs. Such research has the potential to identify novel targets for interventions focused on reducing risk for depression and anxiety within this population.

In addition, although past studies have demonstrated relations of physical activity and sedentary behavior to both depression and anxiety, there is a need for research examining whether these relations exist above and beyond other established transdiagnostic risk factors for depression and anxiety. One such risk factor worth investigating in this regard is emotion dysregulation. Emotion regulation can be conceptualized as a multidimensional construct involving the awareness, understanding, and acceptance of emotions; ability to control impulsive behaviors and engage in goal-directed behaviors when experiencing negative emotions; flexible use of non-avoidant situationally appropriate strategies to modulate the intensity and duration of emotional responses in order to meet individual goals and situational demands; and willingness to experience negative emotions in pursuit of meaningful activities in life (Gratz & Roemer, 2004). Emotion dysregulation is characterized by the experience of difficulties in any of these areas.

There is extensive support for emotion dysregulation as a core and robust factor underlying the development and maintenance of both anxiety (Cisler, Olatunji, Feldner, & Forsyth, 2010) and depression (Clen, Mennin, & Fresco, 2011). Moreover, although findings that physical activity (in particular, aerobic exercise) may attenuate emotion dysregulation (Bernstein & McNally, 2017) suggest that physical activity may contribute to improvements in depression and anxiety through improvements in emotion regulation, further research examining the unique relations of physical activity and sedentary behavior to depression and anxiety is needed. Evidence that these relations are indirect through emotion dysregulation would suggest the utility of simply targeting emotion dysregulation in the treatment of depression and anxiety, especially given evidence that emotion dysregulation can be successfully modified through psychological interventions (Gratz, Tull, & Levy, 2014). However, research showing that physical activity and sedentary behavior account for additional, unique variance in depression and anxiety symptom severity above and beyond emotion dysregulation would highlight the potential utility of targeting physical activity and sedentary behavior directly, in addition to emotion dysregulation, in the treatment of depression and anxiety. Conversely, the absence of such unique relations would suggest that resources would be better spent targeting emotion dysregulation alone in interventions for depression and anxiety.

Therefore, the goal of the present study was to examine the relations of physical activity and sedentary behavior to depression and anxiety symptom severity within a sample of patients in residential SUD treatment. Providing a conservative test of incremental validity, this study also sought to determine the extent to which physical activity and sedentary behavior relate to depression and anxiety symptom severity above and beyond emotion dysregulation. We predicted that physical activity and sedentary behavior would demonstrate significant negative and positive associations, respectively, with depression and anxiety symptom severity. Moreover, we predicted that physical activity and sedentary behavior would both demonstrate significant associations with depression and anxiety above and beyond emotion dysregulation.

2. Method

2.1. Participants

Participants were 41 patients from a residential SUD treatment facility. Participants were predominately male (n = 27, 65.9%) and White (n = 36, 87.8%; African-American n = 5, 12.2%), with ages ranging from 18 to 49 years (M = 31.51, 8.67). Most participants were unmarried (n = 27, 67.9%), employed prior to entering residential treatment (n = 22, 53.7%), and had a high-school level of education or higher (n = 37, 90.2%). Clinical characteristics of participants and descriptive data for the primary variables of interest are presented in Table 1.

Table 1
Clinical characteristics of participants and descriptive data for main study variables.

	n or Median (% or Interquartile Range)
Major depressive disorder	14 (34.1%)
Obsessive compulsive disorder	9 (22%)
Social anxiety disorder	8 (19.5%)
Panic disorder	3 (7.3%)
Generalized anxiety disorder	15 (36.6%)
Posttraumatic stress disorder	18 (45%)
Alcohol use disorder	22 (55%)
Drug use disorder	41 (100%)
DASS-depression	8.00 (16.00)
DASS-anxiety	10 (12.00)
DERS-16	31.00 (14.00)
Sedentary time[a]	360.00 (390.00)
Physical activity[b]	428.57 (1162.5)

Note. DASS = Depression, Anxiety, Stress Scales – 21 item version; DERS-16 = Difficulties in Emotion Regulation Scale 16 item version.
[a] Minutes spent sitting per day.
[b] MET-minutes per day.

2.2. Measures

For descriptive purposes, psychiatric disorders were assessed using the *Diagnostic Interview for Anxiety, Mood, and OCD and Related Neuropsychiatric Disorders* (DIAMOND; Tolin et al., 2018). The DIAMOND is a structured clinical interview that was designed to assess current and lifetime DSM-5 psychiatric disorders. The DIAMOND demonstrates good test-retest and interrater reliability. Moreover, the diagnoses obtained using the DIAMOND have been found to be associated with corresponding diagnostic self-report measures (Tolin et al., 2018). Interviews were conducted by bachelors- or masters-level clinical assessors previously trained to reliability with the principal investigator (MTT). Detailed information on each disorder was collected by interviewers and reviewed by the principal investigator. In the case of diagnostic disagreements or interviewer uncertainty, all data were discussed by the principal investigator and interviewer until a consensus was reached.

Emotion dysregulation was assessed using the 16-item *Difficulties in Emotion Regulation Scale* (DERS-16; Bjureberg et al., 2015). The DERS-16 is a shortened version of the 36-item DERS (Gratz & Roemer, 2004) and was designed to assess individuals' typical levels of emotion dysregulation across five domains: nonacceptance of negative emotions, inability to engage in goal-directed behaviors when distressed, difficulties controlling impulsive behaviors when distressed, limited access to emotion regulation strategies perceived as effective, and lack of emotional clarity. The DERS-16 demonstrates good test-retest reliability and adequate convergent and discriminant validity (Bjureberg et al., 2015). Higher scores on the DERS-16 are indicative of greater emotion dysregulation. Internal consistency of the DERS-16 was acceptable (α = 0.93).

Depression and anxiety symptoms were assessed using the *Depression Anxiety Stress Scales-21* (DASS-21; Lovibond & Lovibond, 1995), a 21-item self-report questionnaire designed to differentiate between core symptoms of depression, anxiety, and stress experienced in the past week. The DASS-21 demonstrates adequate test-retest reliability and good construct and discriminant validity (Lovibond & Lovibond, 1995; Roemer, 2001). Internal consistencies of the depression (α = 0.86) and anxiety (α = 0.82) subscales were acceptable.

Physical activity and sedentary behaviors in the past 30 days were assessed using the *International Physical Activity Questionnaire – Short*

Form (IPAQ-SF; Craig et al., 2003). There is extensive evidence for the validity and reliability of the IPAQ-SF (Craig et al., 2003). The IPAQ-SF assesses time spent engaging in three intensities of physical activity including: vigorous activity (e.g., heavy lifting, aerobics, or fast bicycling), moderate activities (e.g., bicycling at a regular pace, carrying light loads), and walking for at least 10 min at a time. Physical activity duration was calculated by multiplying the average numbers of days per week during the past 30 days in which participants reported engaging in an activity by the average number of minutes of activity duration. Reported weekly activity duration for each activity was truncated at 180 min (IPAQ Research Committee, 2005). Weekly minutes of activity duration were multiplied by established multiples of resting metabolic rates (METs) for each level of activity intensity to generate MET-minutes per week (Ainsworth et al., 2000). Values for each activity type were summed and divided by seven to produce total MET-minutes per day. Sedentary behavior was assessed by participant's self-reported hours and minutes (converted to minutes) spent sitting each day.

2.3. Procedure

All procedures were reviewed and approved by applicable Institutional Review Boards. Data were collected as part of a larger study examining mechanisms underlying relapse risk. To be eligible for inclusion in the larger study, participants were required to: 1) have a Mini-Mental Status Exam (Folstein, Folstein, & McHugh, 1975) score of ≥24 (indicative of no significant cognitive impairment); and 2) have no current psychotic disorder (as determined by the DIAMOND). Eligible participants were recruited for this study no sooner than 72 h after entry into the facility to limit the possible interference of withdrawal symptoms on study engagement. Those who met inclusion criteria were provided with information about study procedures and associated risks, following which written informed consent was obtained. Following the provision of informed consent, participants completed a series of questionnaires including the measures described previously. Upon completion of this session, participants were reimbursed $25.

2.4. Data analysis plan

Continuous variables were assessed for outlying data points (Hoaglin & Iglewicz, 1987). Two extreme values were identified within the distributions of the DERS-16 and sedentary time (sitting minutes/day). These values were subsequently Winsorized (Tukey, 1962). Each univariate distribution was positively skewed. Consequently, all statistical analyses were performed using non-parametric tests which do not assume normal variable distributions. The median and interquartile range were calculated for each study variable. Spearman's rank-order correlation was used to examine the bivariate associations of both physical activity (Total MET-minutes per day) and sedentary time (sitting minutes per day) with the DERS-16, DASS-depression, and DASS-anxiety. Separate two-step hierarchical linear regression models were then conducted to examine the unique relations of physical activity and sedentary time to DASS-depression and DASS-anxiety scores, controlling for the variance associated with DERS-16 scores. Bootstrapping with 5000 resamples was used to generate bias-corrected and accelerated 95% confidence intervals (95% CI) for all regression coefficients. Variance Inflation Factors (range: 1.09 to 1.19) were not indicative of multicollinearity. Analyses were performed using SPSS 23.0 (IBM Corp, 2015). All tests of statistical significance were two-tailed with alpha set at 0.05.

3. Results

3.1. Bivariate associations

DERS-16 scores were positively correlated with DASS-depression ($r = 0.45$, $p = .003$) and anxiety ($r = 0.44$, $p = .004$) scores, but were not significantly associated with sedentary time ($r = 0.14$, $p = .387$) or physical activity ($r = -0.23$, $p = .147$). DASS-depression scores were significantly associated with greater sedentary time ($r = 0.41$, $p = .008$) and lower physical activity ($r = 0.41$, $p = .004$). DASS-anxiety scores were significantly associated with lower physical activity ($r = 0.32$, $p = .044$), but were not significantly associated with sedentary time ($r = 0.14$, $p = .383$). DASS-anxiety and depression scales were positively correlated ($r = 0.65$, $p < .001$). There was a significant negative correlation between physical activity and sedentary time, $r = -0.40$, $p = .010$.

Table 2
Emotion dysregulation, physical activity, and sedentary time predicting depression and anxiety symptom severity (N = 41).

	DASS Depression				DASS Anxiety			
	B	95%CI	*p*	ΔR^2	*B*	95%CI	*p*	ΔR^2
Step 1			–	.182			–	.239
DERS-16	.327	.145, .572	.003		.299	.092, .549	.003	
Step 2			.031	.140			.374	.039
DERS-16	.242	.031, .543	.034		.285	.049, .529	.006	
Sedentary time[a]	.006	-.003, .020	.157		-.003	-.012, .010	.445	
Physical activity[b]	-.003	-.006, −.001	.032		-.002	-.005, .001	.171	

Note. 95% confidence intervals and *p* values for individual variables calculated using bias corrected and accelerated bootstrapped standard errors.
[a] Minutes spent sitting per day.
[b] MET-minutes per day.

3.2. Hierarchical models

DERS-16 scores were significantly associated with higher DASS-depression scores in the first step of the model (see Table 2). Sedentary time and physical activity, added in the second step, yielded a significant 14.3 percent increase in explained DASS-depression score variance. Physical activity, but not sedentary time, was significantly associated with lower DASS-depression scores when controlling for DERS-16 scores.

DERS-16 scores were significantly associated with DASS-anxiety scores in the first step of the second hierarchical regression model. The second step, which included sedentary time and physical activity, did not account for a significant increase in DASS-anxiety score variance, and neither physical activity nor sedentary time was significantly associated with DASS-anxiety.

4. Discussion

The primary goal of the present study was to provide an initial examination of the relations of physical activity and sedentary behavior to depression and anxiety symptom severity among patients receiving residential SUD treatment. Specifically, this study examined the extent to which physical activity and sedentary behavior were uniquely associated with depression and anxiety symptom severity above and beyond an established transdiagnostic risk factor for these symptoms, emotion dysregulation. Results indicate that physical activity was inversely associated with depression severity among individuals with SUDs, even when accounting for emotion dysregulation. This finding highlights the importance of assessing an individual's level of physical activity (in addition to other established risk factors such as emotion dysregulation) when evaluating risk for depression among individuals with SUDs, as well as the potential utility of targeting physical activity in treatments for depression within this population. Although this

finding is consistent with extant literature on the relation between physical inactivity and depression (e.g., Dunn et al., 2001), some novel results were found.

First, physical activity level did not contribute to anxiety symptom severity above and beyond emotion dysregulation. Although physical activity level did demonstrate a significant zero-order association with anxiety symptom severity, this association did not remain significant when accounting for emotion dysregulation. Such a finding may highlight the particular relevance of emotion dysregulation to anxiety symptom severity. Indeed, there is considerable evidence that emotion dysregulation is a strong predictor of anxiety-related pathology (Cisler et al., 2010). Second, despite a significant zero-order association between sedentary behavior and depression symptoms, sedentary behavior did not evidence a unique relation with depression or anxiety symptom severity when controlling for emotion dysregulation and physical activity levels. Although this discrepancy may suggest the relative importance of physical activity versus sedentary behavior to depression symptoms, it may also be explained by the relatively small sample size (and, thus, low power) and/or shared variance between our measures of sedentary behavior and physical activity. Future research with larger samples is needed to further elucidate the extent to which sedentary behavior contributes to symptoms of depression and anxiety above and beyond physical activity levels and other transdiagnostic risk factors.

Although findings contribute to the extant literature on physical activity and depression, results of this study must be interpreted in the context of limitations present. First and foremost, the cross-sectional and correlational nature of the data preclude conclusions regarding the directional nature of the observed associations. It is likely that there are bi-directional relations among emotion dysregulation, physical activity, and depression symptom severity, with symptoms of depression increasing emotion dysregulation and reducing motivation to engage in physical activity. Consequently, prospective studies are needed to clarify the nature of the relations examined within this study. In particular, future research is needed to examine the direct relation of increases in physical activity to reductions in depression symptom severity, as well as the extent to which increases in physical activity contribute to reductions in depression symptom severity indirectly through improvements in emotion dysregulation (see Bernstein & McNally, 2017). Second, our sample was small, reducing power to find significant differences. Before any conclusions can be made about the relevance of physical activity to depression symptom severity among SUD patients, replication of these findings using larger samples of patients with SUDs is needed. Moreover, it warrants mention that all participants met criteria for a current drug use disorder. Thus, it is not clear if findings would generalize to patients with only an alcohol use disorder or other psychiatric disorders in the absence of a drug use disorder.

We also assessed physical activity and sedentary behavior through self-report. Given that participants in this study may have been abusing substances or struggling with other psychological symptoms during the period in which physical activity and sedentary behavior were assessed, participants may not have been able to provide an accurate assessment of their physical activity levels and sedentary behavior during that time. In addition, although our measure of physical activity provided participants with a definition of the different levels of physical activity, participants may still have answered questions according to their own beliefs on what constitutes vigorous, moderate, or low intensity physical activity. Moreover, our measure of physical activity and sedentary behavior was designed for population-level surveillance, and, thus, may not be appropriate for small-scale studies (Bauman et al., 2009). Future studies would benefit from the use of self-report measures of physical activity and sedentary behavior specifically designed for more focused and smaller-scale studies such as the one described here, as well objective measures of physical activity (e.g., accelerometers, physiological assessment) to more precisely quantify the intensity of participants' average daily physical activity and sedentary behavior. Finally, our measure of physical activity did not ask participants about the specific activities in which they engaged. Although studies have not found differences between aerobic and anaerobic exercise in depression attenuation (see Dunn et al., 2001; Martinsen, 2008), other factors may influence the impact of physical activity on depression. For example, future studies examining the relation between physical activity and depression should consider the context of physical activity (e.g., physical activity conducted alone or with others, physical activity engaged in as part of one's occupation or as a leisure activity) and whether personal meaning was attached to the physical activity (Harris et al., 2006). Despite limitations, results highlight the importance of considering physical activity levels when evaluating factors that may contribute to the severity of depression symptoms among patients with SUDs. Results also suggest that there may be utility in developing, implementing, and evaluating physical activity interventions for patients with SUDs to reduce depression risk. Such interventions may also have utility in reducing risk for a variety of physical health problems common within this population (e.g., Barry & Petry, 2009; Wells, Golding, & Burnam, 1989).

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