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## An exploratory analysis of changes in mood, anxiety and craving from pre- to post-single sessions of exercise, over 12 weeks, among patients with alcohol dependence

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### Abstract

Aerobic exercise is currently being studied as a relapse prevention strategy for individuals with alcohol use disorders. Negative affect and cravings predict relapse. The acute effects of moderate-intensity exercise have been shown to improve mood and reduce craving. The current study examined the acute effects of exercise on changes in mood, anxiety, and craving from pre- to post-exercise at each week of a 12-week moderate intensity exercise intervention with sedentary alcohol dependent adults. Twenty-six participants in the exercise condition of a larger randomized clinical trial (Brown et al., 2014) exercised in small groups at moderate intensity for 20 to 40 minutes per session. Participants rated mood, anxiety, and cravings in the present moment before and after each exercise session over the course of the 12-week intervention. Data analyses focused on effect size and interval estimation. Joinpoint analysis was used to model longitudinal trends. Increases in mood and decreases in anxiety and craving were apparent at every session. Effect size estimates revealed that average change from pre- to post-exercise was in the small to medium range with some individual sessions reaching the large range. Joinpoint analyses revealed that the pre-post exercise changes in mood increased, anxiety remained stable, and craving diminished across the 12 weeks. This study provides provisional support for a change in mood, anxiety and alcohol cravings for the role of exercise in the early recovery period for alcohol dependence. Acute single bouts of moderate-intensity exercise may help individuals with alcohol dependence manage mood, anxiety, and craving thereby reducing relapse risk, but further research is needed with a more rigorous study design.

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Increasing attention has been given to the role of aerobic exercise as a relapse prevention strategy for individuals with alcohol dependence (A.M. Abrantes, Matsko, Wolfe, & Brown, 2013). For example, we recently completed a small, randomized clinical trial of a 12-week

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moderate-intensity aerobic exercise intervention and found promising drinking outcomes among alcohol dependent individuals in early recovery (Brown et al., 2014). Negative affect and alcohol urges have been identified as important predictors of alcohol relapse (Witkiewitz, Bowen, & Donovan, 2011) and it is possible that aerobic exercise may help reduce relapse risk through its acute effects on affect and urges.

The acute effects of exercise on mood and affect have been consistently demonstrated in both clinical and nonclinical populations, particularly with moderate-intensity exercise (Ekkekakis & Petruzzello, 1999; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991; Reed & Ones, 2006). Among individuals with addictive behaviors, a number of studies {e.g., (Elibero, Janse Van Rensburg, & Drobles, 2011; Taylor, Katomeri, & Ussher, 2005; M. Ussher, Nunziata, Cropley, & West, 2001; Williams et al., 2011)} have examined the acute effects of aerobic exercise on negative affect and urges to smoke among nicotine dependent individuals. In a recently completed meta-analysis of 15 studies, Haasova and colleagues (Haasova et al., 2013) found strong evidence for the acute effect of exercise on reducing smoking craving. Further, in the context of an 8-week exercise intervention, the magnitude of the acute effects of exercise on urges and affect did not change from week-to-week (Williams et al., 2011).

To our knowledge, only 2 studies have examined the acute effect of exercise on alcohol urges – one in a sample of recently detoxed alcohol dependent patients (M. Ussher, Sampuran, Doshi, West, & Drummond, 2004) and the other in currently abstaining heavy drinkers (Taylor, Oh, & Cullen, 2013). In both studies, significant decreases in urges to drink were observed after a single exercise session and when examined, accompanying acute changes in mood were not found with exercise (M. Ussher et al., 2004). However, the acute effects of exercise on mood and drinking urges have yet to be examined in the context of an exercise intervention in alcohol dependent patients. The purpose of this study is to examine the acute effect of exercise on changes in mood, anxiety, and urges to drink pre- and post-exercise sessions for each week of a 12-week moderate-intensity intervention and whether the magnitude of the acute effect is maintained throughout the program.

## Method

### 2.1 Participants

Forty-nine participants were recruited for a randomized controlled trial for a 12-week group aerobic exercise intervention for alcohol dependent, physically sedentary patients (Brown et al., 2014). For the current study, participants (n=26) who were randomized to moderate-intensity, group aerobic exercise (AE) (vs. a brief advice to exercise control condition), were selected for the analyses. The sample of 26 participants included 11 (48%) females with a mean age of 43.46 ( $SD = 11.50$ ) years. Participants were primarily Caucasian (n=24: 92.3%) and 17 participants (55.4%) had some college or more.

### 2.2 Procedure

Participants were recruited from an intensive alcohol treatment program and from the community. After obtaining informed consent, all participants completed assessments and

interviews at baseline, 12-week (end of treatment), and 6-month follow-ups (though we focus only on the 12-week intervention for the purposes of the current study). The study procedure, inclusion criteria and intervention are described in detail elsewhere [cf., (Brown et al., 2014)]. Because participants were randomized to the 12-week exercise intervention or to a single session of brief advice (BA), we were unable to collect any weekly pre- to post changes due to a control intervention in those assigned to the BA condition.

**Group Aerobic Exercise (AE)**—The 12 weekly aerobic exercise group sessions took place at the study fitness facility on the grounds of Butler Hospital. Participants joined the exercise group on a rolling basis, with group sizes ranging from 2 to 5 participants. Participants exercised at moderate-intensity (a rate that achieved 55 – 69% of age-predicted maximal heart rate), using a treadmill, elliptical machine or recumbent bicycle at each group session under the supervision of a masters level exercise physiologist. Exercise sessions started at 20 minutes per session and gradually increased to 40 minutes per session by week 12.

**Adherence to AE intervention**—On average, participants attended 8.44 ( $SD = 4.12$ ) AE sessions (70.3%: out of 12 sessions). A total of 16 of the 26 participants (62%) attended 8 or more of the exercise sessions and 9 participants (35%) completed all 12 sessions at the fitness facility.

## 2.2. Measures

Participants were asked to rate their mood and anxiety at the present moment with single item 11-point Likert scales (mood: 0=“worst” to 10=“best” and anxiety: 0=“none at all” to 10=“extremely”). These items have been used in other studies of the acute effects of exercise {e.g., (A. M. Abrantes et al., 2009)}. Additionally, we created a similar craving item rated on a Likert scale (0=“none at all” to 10=“extremely”) to ask participants to rate the extent to which they were experiencing urges to drink at the present moment.

## Data analysis plan

The current study follows recommendations by Cumming (Cumming, 2013, 2014) and supported by Eich (Eich, 2014) to develop hypotheses and analyze data using strategies that do not rely on null hypothesis significance testing (NHST). Cumming argues (Cumming, 2013, 2014) that there are a number of advantages to analyzing data using effect sizes (ESs), confidence intervals (CIs), and accumulation of evidence instead of relying on NHST to draw conclusions from data. These advantages include (a) presenting increased information about the magnitude of the effect and about the precision of estimates presented, (b) exchanging dichotomous decision making for a focus on estimation, (c) avoiding the limitations of relying p-values, e.g., Type I and Type II errors, and (d) ease of integrating findings with other research using meta-analytic strategies.

We examined the acute effects of exercise on mood, anxiety, and craving in three ways. First, we calculated the pre- to post-exercise changes in mood, anxiety, and craving and calculated the CIs around each difference score as well as the average change across 12-sessions, pooling our data using repeated measures calculations (see Figure 1). Second, we

used Joinpoint analysis (JPA) to assess the stability of the changes across time. JPA is designed to identify inflection points in longitudinal data (Kim, Fay, Feuer, & Midthune, 2000). If no inflection points are identified, an intercept and slope for the longitudinal data will be provided. Slopes equivalent to zero provide us with evidence for consistency of effects. An advantage to JPA when analyzing data from small samples is that trends are modeled from the means and standard errors for each time point. This allows for the inclusion of cases with some missing data. Third, we calculated the difference between the within session (pre- to post-exercise) change and 0 and calculated unbiased Cohen's  $d^1$  values for each session and the average effect size across the 12-week study period (see Figure 2). The unbiased estimate of Cohen's  $d$  was used due to the relatively small sample size and to allow us to compare our effect size estimates with Cohen's (Cohen, 1988) recommended cutoffs of .2, .5 and .8 for small, medium and large effects, respectively (see Cumming, 2013, p. 294).

## Results

Comparing the dotted black (pre-exercise) with solid black (post-exercise) lines in Figure 1, increases in mood ratings and decreases in anxiety and craving ratings at every session were apparent. As depicted in Figure 1, the average changes from pre- to post-exercise for mood and anxiety ratings were greater than one point on an 11-point scale and was two-thirds of a point for craving ratings. Zero was not included in the confidence intervals for the average changes across these three items.

On the session level, zero was never included in the CIs for mood or anxiety changes; however, zero was included in the CIs for 5 out of 12 session ratings for craving changes. This provides consistent evidence for mood and anxiety improvements following exercise at each session, but suggests that from pre- to post-exercise session, no change is a plausible result for change in craving. It is also apparent from Figure 1 that there are wider CIs found in craving, which suggest greater variability across subjects in changes in craving following exercise compared to mood and anxiety on the session level.

Results from the JPA did not identify any discrete change points in the slopes for mood, anxiety, or craving pre- to post-exercise changes, suggesting that a linear trend best represents the longitudinal data. There was a stable reduction in anxiety in response to acute exercise across all 12-weeks (Intercept =  $-1.32$  (SE = .05), 95% CI [ $-1.42, -1.22$ ],  $Z = -26.06$ ; Slope =  $-.01$  (SE = .01), 95% CI [ $-.03, .01$ ],  $Z = -1.36$ ). The CI for the slope of changes in anxiety included zero, suggesting that the reduction in anxiety following exercise did not change (neither increased nor decreased) over time. In contrast, the changes from pre- to post-exercise in mood increased and changes in craving decreased across the 12-weeks (Mood: Intercept =  $-.01$  (SE = .07), 95% CI [ $-.14, .12$ ],  $Z = -.12$ ; Slope =  $.04$  (SE = .01), 95% CI [ $.02, .06$ ],  $Z = 3.38$ ; Craving: Intercept =  $-.78$  (SE = .07), 95% CI [ $-.91, -.65$ ],  $Z = -10.89$ ; Slope =  $.02$  (SE = .01), 95% CI [ $.00^2, .04$ ],  $Z = 2.32$ ). Specifically, neither the CI for the slope of changes in mood or the slope for craving included zero.

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$$^1 d_{unbiased} = d * \left(1 - \frac{3}{4df - 1}\right)$$

Results of the effect size calculations revealed unbiased Cohen's *d* estimates in the small to medium range, with some individual session effects reaching the large range. Figure 2 presents the magnitude of the pre- to post-exercise change in mood, anxiety, and craving compared to no change for each session and averaged across the 12 sessions. The results mirror the results presented in Figure 1, but add a standardized index of the magnitude of the effects. On average, changes in mood and anxiety were in the medium range and changes in craving were in the small to medium range.

## Discussion

The current study utilized a rigorous statistical approach that does not rely on NHST but rather focuses on interpretation of effect sizes and confidence intervals to examine the magnitude and stability of the acute effects of exercise on mood, anxiety, and drinking urges among an alcohol dependent sample in early recovery. The average pre-to-post-exercise changes and their confidence intervals provided evidence of improvements in mood and decreases in anxiety and urges to drink. These findings are consistent with prior work on the acute effects of exercise on decreasing negative affect and improving mood. In addition, the current findings contribute to the growing body of evidence on the acute effect of exercise on reducing craving in individuals with addictive behaviors that has focused primarily on nicotine dependence (Haasova et al., 2013), but now also includes alcohol (Taylor et al., 2013; M. Ussher et al., 2004) and opiate dependence (Bailey, Hall, & Fareed, 2011).

Interestingly, while we found evidence for improvements in mood, Ussher and colleagues (M. Ussher et al., 2004) did not observe an acute effect of mood in their study of recently detoxed alcohol dependent patients. However, in their study, exercise consisted of an acute bout of 10 minutes of moderate-intensity cycling while participants in the current study exercised for much longer durations on various types of exercise equipment. Future studies will be necessary to determine the amount and type of exercise necessary to exert an acute effect on mood in alcohol dependent patients.

While the extent to which the acute effects of exercise on mood and cravings changes over the course of an exercise training program has been relatively unexplored, Williams and colleagues (Williams et al., 2011) found no changes in the magnitude of acute effects of exercise on affect and craving over 8 weeks of exercise. However, in the current study, the acute effects on mood increased and cravings diminished over the course of the 12-week intervention while acute changes in anxiety remained stable. It is possible that the additive effect of repeated exercise sessions in combination with longer duration of alcohol abstinence contributed toward improved pre-exercise mood and lower pre-exercise cravings toward the later weeks of the intervention.

The current study should be interpreted with consideration of its limitations. Given that this is a pilot study with a modest sample and without a control condition, we are unable to make causal inferences about the effects of exercise on mood, anxiety, or craving. There are a

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<sup>2</sup>Note that the lower bound of the CI for craving was rounded down to zero to be consistent with the number of decimal places reported.

number of factors that could have contributed to the findings that require additional exploration in future studies, including the impact of exercise intensity and duration, the impact of being observed (i.e., Hawthorne Effect), and currently levels of cardiorespiratory fitness. In addition, the single item assessments of mood, anxiety, and craving have not been validated. However, the mood and anxiety items have been used in previous research {e.g., (A. M. Abrantes et al., 2009)}. Future controlled studies with larger samples and an appropriate control group are needed to replicate and extend our finding supporting the cumulative benefit of repeated experiences of the acute effects of exercise on drinking and mood.

We observed promising outcomes in terms of mood improvement and anxiety and urge reductions over the 12 weeks (i.e., pre-to post-exercise”). In conclusion, these findings complement existing work on the acute benefit of exercise for individuals with addictive behaviors {e.g., (Taylor et al., 2005; Taylor et al., 2013; M. Ussher et al., 2004; M. H. Ussher, Taylor, & Faulkner, 2014)} and extend it to individuals engaged in an exercise intervention and who were in early recovery from alcohol dependence. If future studies support our current findings, acute, single bouts of moderate-intensity exercise may be incorporated as treatment strategies to help individuals with alcohol dependence to reduce anxiety and craving symptoms as well as to improve mood potentially decreasing their overall risk for relapse.

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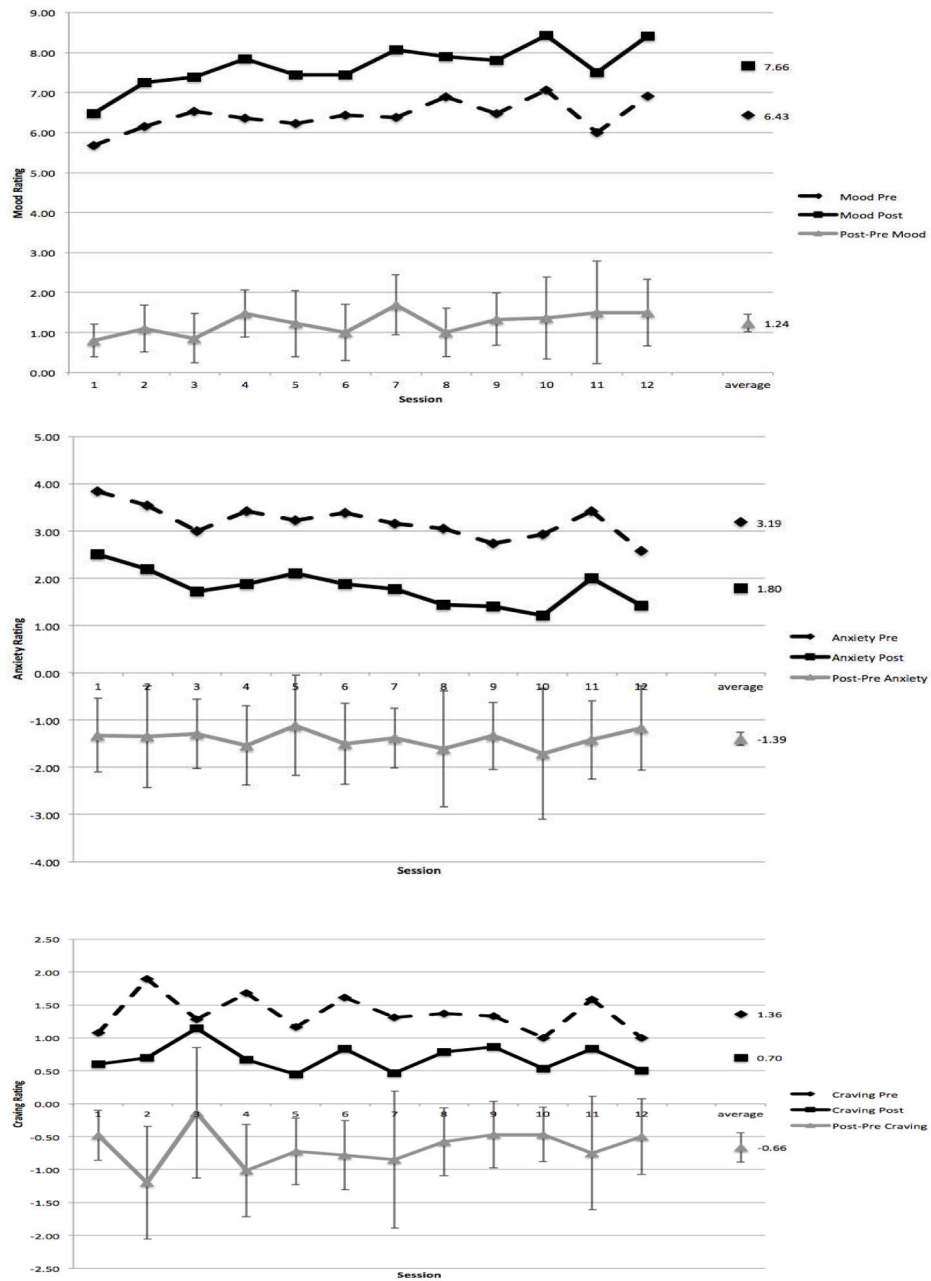
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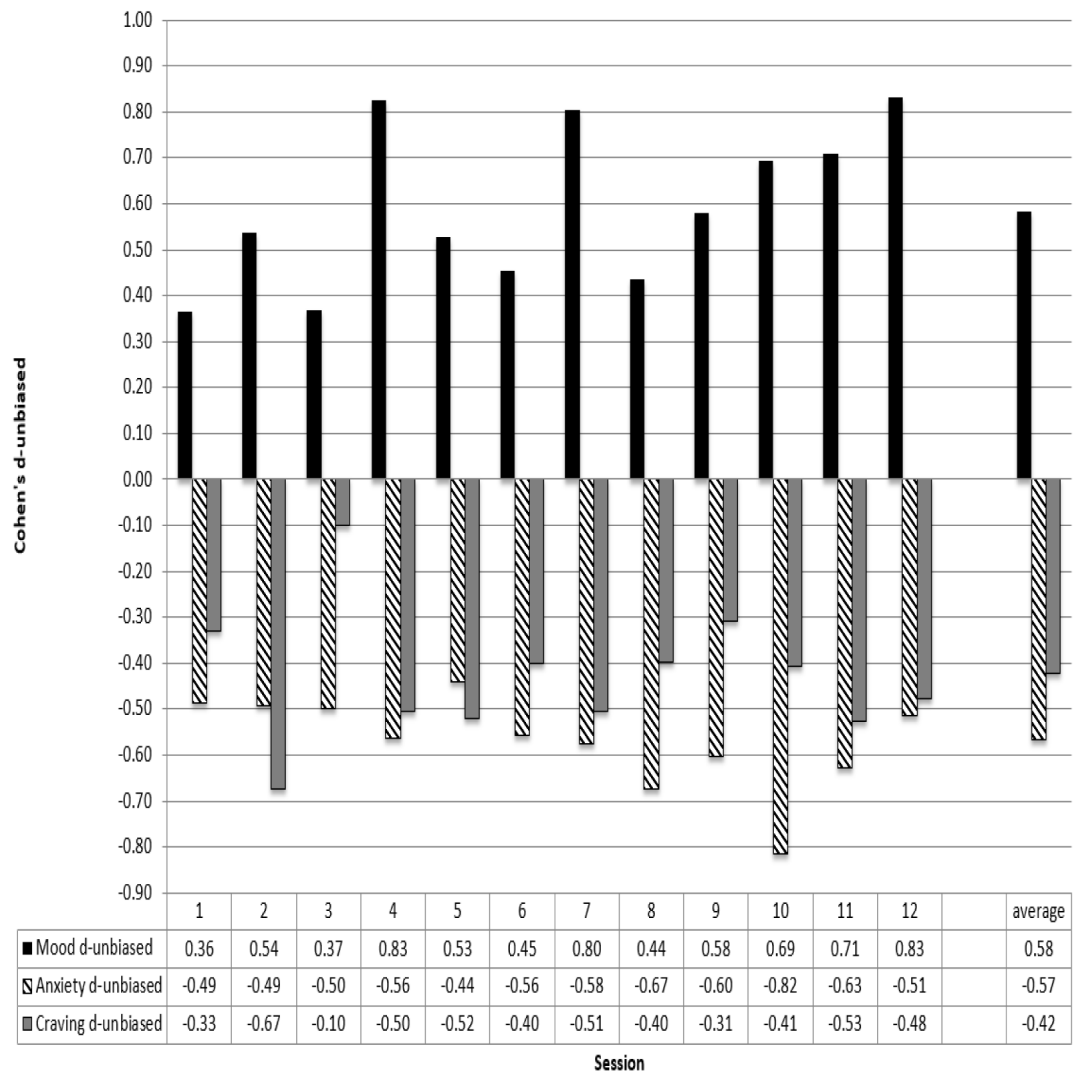
### Highlights

- Acute effects of exercise have been shown to improve mood and reduce craving
- Acute effects of exercise were examined in alcohol dependent adults over 12 weeks
- Effect size estimates pre to post exercise were mostly in the small to medium range
- Single bouts of exercise may help alcohol dependent persons manage mood and craving





**Figure 1.** Pre- and post-exercise ratings and pre-, post-exercise change in mood, affect, and craving alcohol by session and overall.



**Figure 2.**  
The magnitude of pre- to post-exercise change in mood, anxiety and craving compared to no change by session and overall.