# Effects of Acute Exercise on Mood and Well-Being in Patients with Major Depressive Disorder

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**ABSTRACT**

BARTHOLOMEW, J. B., D. MORRISON, and J. T. CICCOLO. Effects of Acute Exercise on Mood and Well-Being in Patients with Major Depressive Disorder. *Med. Sci. Sports Exerc.*, Vol. 37, No. 12, pp. 2032–2037, 2005. **Purpose:** This study was designed to determine if a single bout of moderate-intensity aerobic exercise would improve mood and well-being in 40 (15 male, 25 female) individuals who were receiving treatment for major depressive disorder (MDD). **Methods:** All participants were randomly assigned to exercise at 60–70% of age-predicted maximal heart rate for 30 min or to a 30-min period of quiet rest. Participants completed both the Profile of Mood States (POMS) and Subjective Exercise Experiences Scale (SEES) as indicators of mood 5 min before, and 5, 30, and 60 min following their experimental condition. **Results:** Both groups reported similar reductions in measures of psychological distress, depression, confusion, fatigue, tension, and anger. Only the exercise group, however, reported a significant increase in positive well-being and vigor scores. **Conclusion:** Although 30 min of either moderate-intensity treadmill exercise or quiet rest is sufficient to improve the mood and well-being of patients with MDD, exercise appears to have a greater effect on the positively valenced states measured. **Key Words:** AEROBIC EXERCISE, AFFECT, PROFILE OF MOOD STATES (POMS), SUBJECTIVE EXERCISE EXPERIENCE SCALE (SEES), VIGOR

There is a growing recognition and acceptance of chronic exercise as a useful treatment modality for depression (8,12,30). Cross-sectional studies have reported more depressive symptoms in physically inactive individuals (20,33). A 16-wk exercise intervention found exercise to be as effective as antidepressants in treating older patients with depression (8). Regular exercise has also been shown to protect against relapse to previous levels of depression (6). A dose–response relationship between exercise and depression is plausible (12); for example, a moderate exercise dose has a therapeutic effect for patients with major depressive disorder (MDD), but a low exercise dose does not (13). The number of acute exercise bouts needed to produce a therapeutic effect is unknown; however, exercise training interventions have effected a substantial improvement in symptoms in only a few weeks (8,13). In a recent review, Dunn et al. (12) suggest that a dose–response relationship may exist between exercise and depression, with a positive association between the amount of exercise and the reduction in depression. A moderate exercise dose, therefore, appears to have a greater therapeutic effect for patients with MDD compared with a low exercise dose (13).

Although receiving little attention among clinicians, a single, an acute bout of exercise is sufficient to reduce transiently depressive symptoms and improve moods, according to numerous studies of nonclinical samples (30,35). Although less consistent following intense exercise (i.e., above lactate threshold (14)), mood has been shown to improve with moderate-intensity (50–70% $\dot{V}O_{2max}$) exercise (35), and at durations of at least 10–15 min (15). It may be that acute bouts of exercise will also serve as an intervention to aid daily mood regulation in patients with MDD. It is, however, more difficult to predict the influence of an acute bout of exercise in this population. The mood disorder that is associated with MDD, by definition, is less transitory than the mood disturbance scores found in healthy samples. It may be that the effect of MDD is simply too great to be overcome, even in the short term, with a single bout of exercise. Conversely, these effects appear to be moderated by preexercise scores (23). Thus, healthy participants with higher preexercise symptoms of depression report the greatest improvement in mood. Because few studies have tested the effects of acute exercise in conjunction with clinically diagnosed, mental health patients, however, it is not clear that these effects will generalize to a clinical sample.

It is important to note that any single bout of exercise would not be expected to provide a lasting reduction in the underlying clinical disorder of depression. The lasting application of any treatment, whether exercise, counseling, or medication, is more likely to have an enduring effect on MDD. Acute bouts of exercise, in contrast, would be ex-

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pected to provide a transient elevation of mood and well-being in clinical samples. This, however, does not minimize the potential mental health benefits of acute bouts of aerobic exercise. The use of alcohol, nicotine, or illegal drugs is a common practice among depressed patients (1). Although numerous motivations exist to use these substances, it has been suggested that these behaviors may, in part, be attempts to regulate mood outside of treatment (1,17). These forms of self-medication are common, even though they would not be expected to provide anything more than a temporary relief of depressive symptoms. In fact, the limited benefit of such efforts supports the need to provide alternative, healthy methods to regulate day-to-day variability in mood for these patients. Acute bouts of aerobic exercise offer a potentially healthy means of mood regulation for the MDD population.

This experiment was, therefore, designed to determine the impact of a single bout of aerobic exercise on the mood and well-being of individuals who are receiving treatment for MDD. Because previous investigations have found the effects of an acute bout of exercise to be similar to that of a quiet rest period (7,31), we used quiet rest as the comparison condition. As reported by several investigators (7,31), the positive effects of exercise on mood, although similar in magnitude, have been shown to persist significantly longer than that of quiet rest. We hypothesized, therefore, that 30 min of exercise would result in a longer duration improvement of mood and well-being.

## METHODS

**Participants.** Participants were 15 men and 25 women, 18–55 yr of age, diagnosed with MDD according to the DSM-IV (4) criteria. Future Search Trials, Inc. (FST) referred all participants to this study, which was completed within 2 wk of their diagnosis. Thus, participation in the study coincided with the onset of their treatment. Whereas this would be expected to confound the assessment of exercise training on MDD, it did not confound the effects of a single bout of exercise in this between-subjects design, because no treatment occurred between the pre- and posttest assessments. FST operates both a clinical psychology practice providing treatment for depression and other psychological disorders, as well as a clinical trials research company. All participants were diagnosed with MDD by a board-certified adult psychiatrist employed by FST. The mean age of the participants was 38.1 yr; 68% were white, 17% were Latino, 11% were African American, and the final 4% designated themselves as other. Exclusion criteria for this study were as follows: 1) participants who reported exercising regularly, as defined by more than twice per week, during the 1 month before screening; 2) participants intolerant or resistant to exercise; 3) participants with a principal psychiatric diagnosis other than MDD, or those with a comorbid disorder (e.g., panic disorder); and 4) participants currently taking antidepressant medication. None of the potential participants were excluded using these criteria. This study was approved by the institutional review board of the University of Texas at Austin, and each participant signed an informed consent before beginning the study.

**Procedure.** A psychiatrist referred all patients to the study once MDD was diagnosed. No participant had been diagnosed with MDD for longer than 2 wk at the time of participation. Once referred to the study, participants were then interviewed by one of the authors to determine eligibility. All individuals referred met inclusion or exclusion criteria, and each was assigned to either an aerobic exercise session or a quiet-rest control. None were told to refrain from coffee, smoking, or other mood-altering substances (e.g., supplements, energy drinks, chocolate) before testing. Pseudorandom assignment for 40 individuals was established before recruitment that placed 20 participants in each condition. Each participant was then assigned to the condition assigned to the individual's specific number (i.e., 1–40). Affective state was assessed 5 min before exercise or control, and three times after exercise or control: 5, 30, and 60 min after. Both the Profile of Mood States (POMS) and the Subjective Exercise Experiences Scale (SEES) were administered to ask the participants how they are feeling "right now, at this moment." Walking speed was adjusted to maintain heart rate at target levels, with heart rate continuously monitored but not recorded by the experimenter. Rating of perceived exertion (RPE) was monitored and recorded every 5 min during exercise. All participants were paid $100 upon completion of the study.

Participants assigned to the aerobic exercise session engaged in one session of brisk walking on a treadmill for 30 min. All participants assigned to the aerobic exercise session wore a heart rate monitor (Vantage XL; Polar Inc.) and walked at an intensity equal to 60–70% of their age-predicted maximal heart rate. This exercise protocol (i.e., intensity, duration, and mode) was selected because it met the American College of Sports Medicine's (ACSM) guidelines for accumulated, daily physical activity (3). No warm-up session was used; however, patients were instructed on how to walk on the treadmill before the exercise bout and were given instruction on walking, if needed, during exercise. The participants were also instructed on how to use the RPE scale, verbatim, as it is listed in ACSM guidelines (2). Participants assigned to the quiet rest control were given instructions to sit quietly for 30 min. These participants were provided with a comfortable, nonreclining chair, located in the same room as the treadmill. They were told not to sleep and they were not allowed to read. Neither the exercising nor the quiet rest participant experienced any other interactions during this period. At the end of the treadmill walking or quiet rest, participants were directed to a desk where they sat and completed the questionnaire at 5, 30, and 60 min. The same testing room was used for both conditions, and one experimenter was in the room throughout the entire experiment.

**Measures.** Because mood and well-being were the primary dependent variables, no attempt was made to use clinical measures to assess the degree of the ongoing depression. Instead, participants completed both the SEES

(26), and the short form, 30-item POMS (28). The SEES is a 12-item questionnaire that is scored on a 7-point Likert-type scale anchored with "Not at all" and "Very much so." The SEES provides three subscales that were used in the present study: 1) psychological well-being (great, positive, strong, terrific); 2) psychological distress (awful, crummy, discouraged, miserable); and 3) fatigue (drained, exhausted, fatigued, tired). The SEES has demonstrated adequate reliability, with Cronbach alphas ranging from 0.77 to 0.84 in the present experiment, and it has been used in studies involving exercise (26). The short form POMS is a 30-item questionnaire that is scored on a 5-point Likert-type scale anchored with "Not at all" and "Extremely." The POMS provides six subscales: 1) anger (e.g., grouchy, furious); 2) confusion (e.g., muddled, forgetful); 3) depression (e.g., sad, unworthy); 4) fatigue (e.g., tired, sluggish); 5) tension (e.g., nervous, anxious); and 6) vigor (e.g., lively, active). The POMS has demonstrated adequate reliability, with Cronbach alphas ranging from 0.93 to 0.95 in the present experiment, and it has been used in exercise studies with similar age and gender distributions (24). Exercise intensity was measured with Borg's RPE scale, with numerical ratings ranging from 6 to 20 with verbal anchors at 7 ("very, very light") and 19 ("very, very hard") (9).

**Power analysis.** Power analysis methodology represents a mixed factorial design, with two levels of the between-subject factor of group and four levels of the within-subjects factor of time. A repeated measures ANOVA power analysis was conducted using Power Analysis and Sample Size software (PASS) 2000 (21). The effect size for this calculation used the ratio of the standard deviation of the effects for a particular factor or interaction and the standard deviation of within-subject effects (21). In addition, each power calculation assumed a Geisser–Greenhouse corrected $F$ test with a 5% significance level. The power analysis was conducted for a single, two-group between-subjects factor, and a single within-subjects factor assessed over four time points. For this design, 40 participants (20/condition) achieves a power of 0.80 for the between-subjects main effect at an effect size of 0.45; a power of 0.93 for the within-subjects main effect at an effect size of 0.64; and a power of 0.79 for the interaction effect at an effect size of 0.64. The variation in effect size occurs because, in a repeated measures analysis, it is often assumed that the pattern of correlations between two observations will be higher when the observations are closer in time than the correlation for two observations that occur far apart in time (21). In sum, this design has sufficient power to detect moderate effects.

**Analysis.** These data were analyzed via a series of 2 (group) × 4 (time) ANOVA with repeated measures on the second factor. Significant interactions were decomposed into their simple effects of time within each level of group. If all interactions were significant, this would result in 54, experiment-wise *post hoc* comparisons. As a result, a standard alpha correction (e.g., Bonferoni or Scheffé) would be overly restrictive for the *post hoc* comparisons. Instead, experiment-wise alpha inflation was protected against by setting the alpha for all *post hoc* comparisons equal to 0.01. Given the predicted interactions, the groups are expected to report differences in the duration of these effects. As a result, change scores were used as the basis of the effect size estimates, (d), which will be presented as the mean difference in these change scores divided by their pooled standard deviation.

## RESULTS

The mean RPE for exercise participants was 13.2 (SD 1.8). Results for the other psychological variables are presented in Table 1. No significant main effects were noted for group: all $P$ values $> 0.15$. Significant main effects, however, were noted for time for all variables: $P$ values $< 0.01$, excluding SEES fatigue scores, which were $P > 0.15$. With regard to the specific hypotheses, a significant group × time interaction was seen for two of the nine variables used to indicate psychological state: psychological well-being as assessed by the SEES, F (3,114) = 5.32, $P < 0.01$; and vigor, as assessed by the POMS, $F <$ (3,114) = 5.55, $P <$ 0.01. Probing the interaction revealed that the exercise group reported significantly greater increases in positive well-being $F$ (3,17) = 6.61, $P < 0.01$, than did the quiet rest group, with significant differences occurring at 5 min, d = 1.13, and 30 min, d = 1.06, after exercise. The exercise group also reported significantly greater increases in vigor compared with the quiet rest group, $F$ (3,17) = 6.68, $P <$ 0.01, with significant differences at 5 min, d = 1.02, and 30 min, d = 0.73 after exercise. Because the vigor subscale includes the item "active," which may be misinterpreted to refer to physical activity rather than psychological vigor, the item was deleted for a second analysis. This deletion did not adversely affect the reliability of the resulting subscale, with a Cronbach alpha equal to 0.80. Results indicated no difference from the initial analysis. The group × time interaction remained significant for the modified vigor subscale, $F$ (3,114) = 5.94, $P < 0.01$; with a pattern of results (d = 1.17 at 5 min; and 0.76 at 30 min) similar to the full subscale. One participant reported a high RPE of 18, suggesting that individual's exercise was of high intensity. The analysis was rerun after deletion of factors related to this participant. The deleted factors had no effect on the pattern of results, with psychological well-being, F (3,111) = 6.36, $P < 0.01$; and vigor, $F <$ (3,111) = 5.23, $P < 0.01$, remaining as the only significant group × time interactions.

## DISCUSSION

This experiment was designed to examine the effect of a single bout of exercise on mood and well-being in individuals who were diagnosed with MDD. Exercise had additional benefits over quiet rest for two of the nine subscales assessed: 1) psychological well-being (SEES), and 2) vigor (POMS). With the exception of the fatigue subscale (SEES), which remained unchanged, participants in both conditions reported similar improvements on the remaining subscales

TABLE 1. Affective measures means and standard deviations.

| | Baseline | | Postexercise: 5 min | | Postexercise: 30 min | | Postexercise: 60 min | |
|---|---|---|---|---|---|---|---|---|
| POMS | M | SD | M | SD | M | SD | M | SD |
| Tension | | | | | | | | |
| Exercise | 7.95$^{a}$ | 4.37 | 5.75$^{a,b}$ | 4.72 | 5.25$^{b}$ | 4.53 | 3.65$^{c}$ | 4.58 |
| Quiet rest | 8.25$^{a}$ | 4.84 | 5.55$^{b}$ | 4.68 | 5.65$^{b}$ | 4.86 | 5.55$^{a,b}$ | 5.24 |
| Depression | | | | | | | | |
| Exercise | 11.00$^{a}$ | 4.19 | 6.80$^{b}$ | 5.29 | 6.70$^{b}$ | 5.38 | 6.55$^{b}$ | 5.86 |
| Quiet rest | 9.95$^{a}$ | 5.12 | 8.30$^{a,b}$ | 5.81 | 7.65$^{b}$ | 6.33 | 6.60$^{a,b}$ | 5.74 |
| Anger | | | | | | | | |
| Exercise | 6.25$^{a}$ | 5.22 | 3.55$^{b}$ | 5.10 | 3.05$^{b}$ | 5.01 | 2.95$^{b}$ | 5.31 |
| Quiet rest | 7.40$^{a}$ | 5.02 | 4.10$^{b}$ | 4.54 | 3.65$^{c}$ | 4.92 | 3.20$^{d}$ | 4.94 |
| Vigor | | | | | | | | |
| Exercise | 4.20$^{a}$ | 2.54 | 7.75$^{b}$ | 4.84 | 6.10$^{b,c}$ | 3.46 | 5.15$^{a,c}$ | 3.45 |
| Quiet rest | 4.85$^{a}$ | 3.57 | 4.60$^{a}$ | 4.11 | 4.40$^{a}$ | 4.21 | 5.00$^{a}$ | 4.41 |
| Fatigue | | | | | | | | |
| Exercise | 11.11$^{a}$ | 5.11 | 8.35$^{b}$ | 4.91 | 7.95$^{b}$ | 5.61 | 7.65$^{a,b}$ | 5.50 |
| Quiet rest | 11.15$^{a}$ | 5.19 | 8.75$^{a,b}$ | 5.80 | 9.20$^{a,b}$ | 5.96 | 8.35$^{b}$ | 6.11 |
| Confusion | | | | | | | | |
| Exercise | 8.85$^{a}$ | 3.17 | 6.30$^{b}$ | 4.27 | 7.05$^{b}$ | 4.31 | 6.70$^{b}$ | 4.62 |
| Quiet rest | 9.20$^{a}$ | 3.71 | 7.95$^{a,b}$ | 3.68 | 7.45$^{a,b}$ | 3.69 | 6.80$^{b}$ | 3.82 |
| (SEES) | | | | | | | | |
| Well-being | | | | | | | | |
| Exercise | 11.05$^{a}$ | 2.54 | 15.50$^{b}$ | 4.51 | 14.65$^{b}$ | 4.88 | 13.85$^{a,b}$ | 4.88 |
| Quiet rest | 13.40$^{a}$ | 5.14 | 12.70$^{a}$ | 4.03 | 12.60$^{a}$ | 5.21 | 12.60$^{a}$ | 4.64 |
| Distress | | | | | | | | |
| Exercise | 12.80$^{a}$ | 6.12 | 9.05$^{b}$ | 5.28 | 8.80$^{b}$ | 5.83 | 6.90$^{c}$ | 4.80 |
| Quiet rest | 14.55$^{a}$ | 6.60 | 13.20$^{a}$ | 6.82 | 11.20$^{a,b}$ | 6.47 | 8.40$^{c}$ | 5.21 |
| Fatigue | | | | | | | | |
| Exercise | 14.00$^{a}$ | 6.84 | 13.90$^{a}$ | 5.86 | 12.00$^{a}$ | 5.93 | 12.20$^{a}$ | 5.92 |
| Quiet rest | 16.85$^{a}$ | 6.01 | 15.90$^{a}$ | 7.33 | 15.50$^{a}$ | 7.45 | 14.30$^{a}$ | 8.09 |

POMS, profile of mood states; SEES, subjective exercise experiences scale; M, mean; SD, standard deviation.
Note: Differences in superscripts within each group represent mean differences between time points with $P < 0.01$.

throughout the 60 min of postintervention assessment. Thus, both a period of rest in a quiet, comfortable environment and a period of brisk treadmill walking appear to be sufficient to improve the mood of patients with MDD. This result replicates data from healthy samples that demonstrate exercise to be no better than quiet rest in reducing state anxiety (7) and no better than other forms of mood enhancement in reducing depressive moods (30). It is well known that mood is improved for healthy samples following periods of rest or relaxation (7,16), and exercise (7,35). It appears that this benefit applies to patients with MDD.

It is interesting to note that exercise was associated with a greater effect than quiet rest for two subscales. Both psychological well-being (SEES) and vigor (POMS) were improved following exercise, with no change in these variables following quiet rest. Of the nine constructs assessed in this experiment, these are the only subscales used to indicate positively valenced states. All other subscales are negatively valenced and revealed no difference between conditions. The pattern of effects following exercise was not surprising. It has long been recognized that exercise is sufficient to improve both positive and negative states (27), with a meta-analysis of older adults finding nearly identical effects sizes for exercise on positive and negative affect (5). The different pattern of effects for exercise and control conditions also mirrors the results found in healthy participants (19,25). For example, one study indicated that exercise and quiet rest resulted in similar changes in depression, but only the exercise conditions were followed with increased vigor (19). Although replication is required, it appears that, for both patients with MDD and healthy populations, exercise might have an effect on positively valenced states that is unique from the effect of quiet rest. Although the increase in positively valenced states was short lived, returning to baseline within 60 min of recovery, the effect was sizable, ranging from an effect size of $d = 0.73$ to 1.13. In fact, the exercise participants reported an increase in vigor to within 1/2 SD ($d = -0.47$) of published norms (28).

Although this would not be expected to have an impact on the underlying mental disorder, a single bout of exercise does appear to be a useful method for patients with MDD to regulate their mood in the short term, with a particular effect on positive moods. Given the debilitating symptoms of depression, a respite such as this is potentially invaluable to those who suffer with MDD. This is especially true because the time course of pharmacologic treatments require at least 2–4 wk and can exceed 6–8 wk before providing significant relief of depression (29). Other acute interventions exist (e.g., sleep deprivation), which have been shown to provide a greater benefit than was demonstrated in this study, but these other interventions also have only transient effects (18). Future research, therefore, should be designed to compare the effectiveness of acute interventions and to test potential mechanisms and any potentially adverse effects for these protocols. Such designs will provide the clearest direction to clinicians and patients in their search for a positive means to regulate mood disturbances associated with depression.

It may be that these effects were impacted by limitations in the survey instruments (e.g., the wording, variability of baseline scores, and instruments used). Although it can be argued that the item "active" within the vigor subscale artificially influenced postexercise responses (32), a secondary analysis deleted this item with no change in the pattern of effects. In addition, the low variability in baseline scores for the well-being subscale might have had an impact on the statistical significance for the change reported by the exercise group. The prepost change score standard deviations, however, were relatively homogeneous (4.07 and 4.81) for the exercise and control conditions, respectively. Finally, exercise was shown to reduce fatigue for the POMS subscale, with no change in fatigue for the SEES subscale. Although higher intensity exercise has been shown to increase fatigue (11), the reduction for the POMS subscale was consistent with another study of moderate-intensity aerobic exercise (19). The failure to find an effect for the fatigue subscale of the SEES, therefore, was surprising. There does not appear, however, to be a consistent finding for this subscale in conjunction with aerobic exercise. Various investigators have found no change in fatigue (22), an increase in fatigue (34), and a reduction in fatigue (10), all of which may be owing to the use of an exercise-specific scale, which has been criticized for providing inaccurate baseline scores (14).

Additional reasons exits to interpret and apply these findings with caution because the results may not generalize to the clinical population for several reasons. For instance, we only included patients diagnosed with clinical depression without comorbid diagnoses. Individuals with comorbid diagnoses have additional concerns and may respond differently to this method of treatment. Additionally, this study is limited by the failure to assess levels of ongoing clinical depression, which prevented a test of this as a possible moderating factor. It should be noted, however, that the average baseline score for the depression subscale of the POMS was 11.00 for the exercise condition and 9.95 for the quiet rest condition. Although this used the "at this moment" instructions, they are significantly greater (d = 1.98 and 1.52, respectively) than the adult norms for the short form of the POMS using the "how you have been feeling, during the past week, including today" instructions (28). Thus, although we are unable to examine the level of clinical depression as a possible moderating factor, it does appear that these participants were experiencing a high degree of depressive symptoms at the pretest.

Despite these limitations, this remains the first experiment to examine the impact of a single bout of exercise on the postexercise mood states of clinically depressed patients. The positive results are encouraging and suggest that future research be conducted to determine the limits of acute exercise to provide this short-term benefit.

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