

The Effect of a Single Bout of Moderate vs. Vigorous Exercise on Mood in College
Students

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Abstract

The prevalence of depression is between 5-10% in adults and is the fourth most significant cause of disability in the world. It also is the second most common reported mental health disorder among college students, second to eating disorders. Research indicates that exercise is an effective intervention for depression (Blumenthal et al., 2007); however, few laboratory-based experimental studies have examined the effect of exercise on depression. The purpose of this research was to conduct an experimental study examining the effect of exercise intensity on depressed mood in college students. The study consists of undergraduate college students (n=25) self-reporting depressed mood. These students were randomly assigned to a vigorous exercise group, a moderate intensity exercise group, or a control. Depressed mood was examined before, immediately after, and 24 hours following a single bout of exercise using the Profile of Mood States (POMS). The hypothesis was that participants randomly assigned to vigorous intensity exercise would have greater mood changes (in the positive direction) than participants assigned to moderate intensity exercise or the control. Results indicated no differences between the groups on pre-test to post-test changes on mood as measured by the POMS at either timepoint. Future studies should use larger sample sizes in order to better detect significant differences. Also, it would be beneficial to use a population of clinically depressed students to better determine if exercise can be used and how it should be used in the treatment of depression.

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Introduction

Depression is characterized by several symptoms including decreased mood, loss of enjoyment and interest, and fatigue (Butler, Hatcher, Price, & Von Korff, 2007).

Depression is the fourth leading cause of disability worldwide, with a prevalence rate between five and ten percent in adults (Butler et al., 2007). The Global Burden of Disease projects that by the year 2020, depression will be the second leading cause of disease burden (Lopez & Murray, 1998). The incidence and prevalence of depression is higher among those suffering from chronic medical conditions and is associated with health-risk behaviors such as over-eating, smoking, and a low-activity lifestyle (Chapman, Perry, & Strine, 2005; Katon, 2003). When depression is associated with these illnesses, medical costs increase by approximately 50%.

In adolescents, depression is also associated with a greater risk of becoming obese (Goodman & Whitaker, 2002). People suffering from depression have been shown to have lower mental health and social functioning than those who suffer from chronic medical conditions like diabetes, heart, neurological, and lung problems as well as decreased physical functioning than some of these conditions (Wells & Sherbourne, 1998).

Individuals with depression have a lower utility, or greater preference for recovery, than those with chronic medical problems. Additionally, depression negatively impacts society as a whole in addition to the individual who is depressed. For example, depression is associated with being absent from work and decreased productivity while at work (Kessler, Foster, Saunders, & Stang, 2001). Depression has also been shown to

have a negative effect on educational attainment in high school and college students (Kessler et al., 1995). When considering a decrease in productivity, the overall cost of treatment, and increased comorbidities and mortality, depression places an economic burden on the US of over 50 billion dollars a year (Wang, Simon, & Kessler, 2003). Finding an intervention that is successful and cost-effective would be beneficial to both the individual and society as a whole.

Depression in College Students

Moving from high school to college can be a stressful time for many young adults. These high stress levels can play a role in the onset of mental health problems. A recent study found that over 50% of college students report having at least one of the following mental health disorders: depression, anxiety, eating disorder, self-injury, or suicidal ideation (Zivin, Eisenberg, Gollust, & Golberstein, 2009). Depression is the second most common mental disorder among this population, the first being eating disorders. According to the American College Health Association (ACHA, 2009), 78.8% of college students reported feeling sad at least one time in the past school year, 43% felt so depressed that it was difficult to function, and 9% seriously considered suicide at least once. An association between suicidal ideation and injury-related risk was shown to exist in college students ages 18-24 (Barrios, Everest, Simon, & Brener, 2000). Depression has the potential to affect academic performance, which could potentially lead to even more stress for the students. One study found that both depression and anxiety disorders were related to a decrease in academic performance in 16.1% of students (ACHA, 2009). There are several specific risk factors that appear to contribute to these high rates of

depression in college students, including grades, loneliness, financial concerns and relationship issues (Furr, Westefeld, McConnell, & Jenkins, 2001).

Interventions for Depression

Several treatments are being used to successfully treat depression, including therapies and medications. For example, cognitive behavioral therapy (CBT) and interpersonal psychotherapy have been shown to decrease symptoms of depression (Butler et al., 2007). The most common therapy is CBT and research indicates that when provided by an experienced therapist, it is just as effective as antidepressant medication (Leichsenring, Hiller, Weissberg, & Leibing, 2006; DeRubeis et al., 2005). Several different types of medications are used to treat depression including tricyclic antidepressants, selective serotonin reuptake inhibitors (SSRI), monoamine oxidase inhibitors, reboxetine, and venlafaxine (Barbui, Butler, Cipriani, Geddes, & Hatcher, 2007). No single medication has been shown to be more effective than the others in the short-term. Antidepressant monotherapy is the most widely used intervention for depression in that it is used in 84% of interventions (Lenderts & Kalali, 2009). However, combination therapies are becoming more common. A combination of therapy and medications may be more effective than either treatment alone (Butler et al., 2007). One study did find that combining CBT and fluoxetine was more effective than either treatment alone (TADS, 2004).

Exercise and Depression

Physical exercise has received a substantial amount of attention for its effects on mental health. It also is a safer treatment than antidepressants for some, since it does not

have any major negative side effects and has relatively low risks especially for the younger population (Larun, Nordheim, Ekeland, Hagen, & Heian, 2006). One advantage of exercise relative to medication is that exercise can be used in the long-term.

Researchers have also examined the efficacy of exercise for treating depression. For example, a study done by Blumenthal et al. (1999) examined the effect of exercise on depression among older adults. Participants were randomly assigned to a 16-week aerobic exercise program, a combined program of exercise and medication, or antidepressants alone. Both groups showed an equal reduction in depression scores (Blumenthal et al., 1999).

A similar study was conducted randomizing participants into group exercise, home-based exercise, antidepressant medication or control for 4 months (Blumenthal et al., 2007). The participants had a mean age of 53 years. Results showed that both exercise groups and the medication group showed similar remission rates. Six months after the four month exercise treatment, the beneficial effects of exercise were maintained, with 64% of the exercise group continuing to exercise after treatment and 48% of medication group initiating an exercise program (Babyak et al., 2000). At 10 months, subjects in the exercise group also had a lower relapse rate than those in the medication group.

A study randomly assigning four different combinations of exercise frequency and energy expenditure to participants between the ages of 20 and 45 showed that when people exercise at the public health recommendation levels, it can be an effective treatment for depression (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2002; Dunn,

Trivedi, Kampert, Clark, & Chambliss, 2005). Exercising either three or five days a week showed similar reduction and remission in symptoms. Results have also shown that exercise is more likely to be maintained after experiencing a positive affective response (Williams et al., 2008). A randomized study looking at the withdrawal of exercise in people who engaged in regular exercise revealed that withdrawal was related to fatigue and an increase in depressive symptoms (Berlin, Kop, & Deuster, 2006).

Several cross-sectional studies have examined the effect of exercise on depression. For example, in a sample that included about 50% exercisers, a questionnaire reported that exercisers were less anxious and less depressed than the non-exercisers (De Moor, Beem, Stubbe, Boomsma, & DeGeus 2005). Because this was a cross-sectional study, we cannot infer causation. These same results were seen after conducting a multiple regression analysis to compare the prevalence of mental health disorders, specifically major depression and anxiety disorders, in people who did and did not exercise (Goodwin, 2003). In a study using daily diaries assessing physical activity and mood states, they found that on days those participants exercised, more positive mood states and less depressive symptoms were reported (Steptoe, Kimbell, & Basford, 1998). Research has linked higher steps per day and higher leisure-time physical activity to lower depression (McKercher et al et al., 2009). However, this same study reported that physical activity at work was related to higher levels of depression.

Exercise Intensity

Researchers have also examined how various types intensities, and durations of exercise and have led to psychological benefits. Martinsen, Reif, Klaiberg, & Braehler(1985) assessed maximal oxygen uptake and found that a small increase in maximum oxygen uptake delivered an antidepressant effect and that a moderate or large increase delivered even greater effects. When examining VO_{2max} , body fat percentage, and mood for both short-bout and long-bout exercise programs, statistically significant increases in VO_{2max} were seen in both groups. Long bouts were defined as being 30 minutes and short bouts were defined as three separate ten-minute bouts during the day. However, only the long-bout group showed an improvement in mood states (Osei-tutu & Campagna, 2005). Another study compared the results of different workloads and intensities of exercise by using different types of exercise, either biking or treadmill, and a self-selected workload (Rendi, Szabo, Szabo, Velenczei, & Kovacs, 2008). Results indicated that psychological improvements occurred independent of the workload or intensity of the exercise. Similar results were found in a study by Veale (1992). Both an aerobic group and a low-intensity exercise group showed improvements in depressive symptoms, however there were no significant differences between the groups.

Physical Activity and Depression in College Students

In addition to adults, researchers have examined the effect of exercise on depression among college students. For example, Taliaferro, Rienzo, Pigg, Miller, & Dodd (2008) examined the relationships between physical activity and hopelessness, depression, and suicide in college students. College students (n=43,499) between the

ages of 18-25 completed the 2005 National College Health Assessment. The students were considered physically active if they engaged in aerobic or strength exercises at least once a week. Results indicated that the students who participated in physical activity each week had a reduced risk of hopelessness and depression. This study did assess different types of physical activity, aerobic and strength training, indicating that different levels/types of activity are associated with reduced hopelessness and depression.

Another study examined the relationship between mental health and vigorous/moderate or strength training exercise in college women (Adams, Moore, & Dye, 2007). Female college students (n=22,073) completed a survey assessing health, depression, anxiety, suicidal ideation, and the frequency of physical activity. This cross-sectional study found that greater decreases in depression and anxiety were related to an increase in the frequency of physical activity. The results indicated that both types of exercise were inversely associated with depression. Additionally, strength training was inversely associated with anxiety and suicidal ideation.

Vigorous physical activity has been shown to be related to a lower frequency of depressive symptoms in both genders (Harbour, Behrens, Kim, & Kitchens, 2008). Utah college students (n=8,621) were asked to complete the Utah Higher Education Health Survey. The survey asked 123 questions focusing on high-risk behaviors, vigorous physical activity and depressive symptoms. Results indicated that students who reported meeting the vigorous physical activity recommendations (defined as meeting the ACSM recommendation of greater than or equal to 20 minutes on three or more days a week) also reported less frequent symptoms of depression.

Not only does physical activity help with relieving depressive symptoms, it also can be a preventive factor. Researchers found that college women who participated in “athletic activities” reported significantly lower rates of depression in their life after college (Wyshak, 2001). Specifically, college female athletes and non-athletes (n=5,398) who graduated between 1925 and 1981 completed a questionnaire examining athletic history, current exercise, reproductive health, medical and psychiatric conditions. To be considered an athlete, participants must have participated in at least one year of a varsity sport. Former athletes were more likely to report exercising regularly and spending more time doing physical activity. Physician-diagnosed depression was significantly lower in the athletes than in the non-athletes.

In another study at a public college, Burris, Brechting, Salsman, & Carlson (2009) examined exercise and general psychological well-being. Participants (n=353) completed a questionnaire designed to identify individual and behavioral factors that exhibit strong associations with psychological health. These factors included optimism, health values, religion, psychological health, alcohol use, and sexual activity. Both optimism and health values were related to greater well-being, with health values including physical activity and abstinence from alcohol. The sample was restricted in that it was mostly Caucasian females, so the results cannot be generalized to males and ethnic minorities. Students who place a high value on their health and participate in physical activity have greater psychological well-being than those who do not (Burris et al., 2009)

Summary & Overview of Review of Literature

There are several studies examining the effect of exercise on depression; however, only a small portion of the research is specific to the college student population. Table 1 outlines five studies that reviewed and examined how exercise is related to depression in the college student population.

Table 1

Studies on Exercise and Depression in College Students

Study	Participants	Exercise & Assessment	Study Design	Findings
Taliaferro et al., 2008	43,499 college students (28,090 women, 15,409 men)	ACHA survey measuring hopelessness, depression, suicidal behavior, and physical activity	survey	Physical activity was related to reduced risk of hopelessness, depression, and suicidal behavior
Adams, Moore, & Dye, 2007	47,755 female college students from 77 different campuses	National College Health Assessment measuring depression, anxiety, suicidal ideation perceived health, and exercise frequency	survey	Both vigorous/moderate PA and strength training were modestly negatively associated with depression
Harbour et al., 2008	8621 college students from Utah universities	Utah Higher Education Health Behavior Survey specifically looking at relationships between vigorous PA and depressive symptoms	cross-sectional survey	Vigorous PA associated with a decrease in depressive symptoms
Burris et al., 2009	353 university students (61% female)	Questionnaire assessing health-as-a-value(alcohol avoidance and physical activity, optimism, spirituality, religiousness, alcohol use, sexual behavior, and psychological health)	self-report questionnaire	Psychological well-being positively associated with health values
Wyshak, 2001	3940 female college alumnae (college athletes and non-athletes)	Questionnaire assessing current physical activity and physician-diagnosed depression	self-administered questionnaire	College athletic activity was negatively associated with physician-diagnosed depression

College can be a stressful time in a person's life and given the high rate of suicide and depression within this population, it would be beneficial to focus more attention on how to decrease depression among this population (Zivin et al., 2009). Many studies have relied on self-report measures and surveys, associating depressive symptoms with exercise habits (Adams, Moore, & Dye, 2007; Harbour et al., 2008; Taliaferro et al., 2008), which can be problematic. Few studies have examined the direct effect of exercise on depression, which is important when examining if exercise is effective in reducing depressive symptoms. Experimental research is needed in this area to clarify the relationship between physical activity and mental health in this collegiate population. The proposed study relied on self-reporting of depressive symptoms; however it evaluated acute response instead of recalling previous mood states or feelings. Also, the effect of different intensities of exercise was examined and research in this area is mixed. Several studies found that there is no difference between vigorous and moderate exercise (Veale et al., 1992; Rendi et al., 2008) while one found that vigorous was more beneficial (Harbour et al., 2008). If future efforts are going to be made to utilize physical activity as a treatment for depression and to help alleviate the public health burden, the literature needs to be strengthened.

The current study was designed with the intent to understand how the intensity of exercise (vigorous or moderate) affects depressed mood states in college students. Research has shown that exercise is effective for treating depression, however little is known regarding why it is helpful (Blumenthal et al., 1999). It is unclear whether it is the

acute effect of exercise or rather the long-term effect of repeated bouts of exercise that is the mechanism for improved mood. The primary purpose of this study was to examine the direct effect of exercise on mood and to examine the effect of varying doses. One issue with using exercise in treating depression is that it may be difficult to actually get depressed people to exercise. The fatigue and loss of interest that depressed people suffer with may prevent them from exercising. Examining the effect of two different doses of exercise will help better understand which dose should be prescribed for depressed individuals. Also, by identifying the dose-response relationship between exercise and depression as well as how long the benefits of a single bout of exercise lasts will be helpful in prescribing exercise as a treatment for depressive symptoms in college students. Considering these findings, the current study hypothesized that participants randomly assigned to vigorous intensity exercise would have greater mood changes (in the positive direction) than participants assigned to moderate intensity exercise.

Methods

Overall Design

The proposed study examined the effect of the intensity of exercise (vigorous or moderate) on depressed mood in college students using a randomized design. The independent variable of intensity (vigorous or moderate) was used to see changes in the dependent variable (mood states), which was measured by the Profile of Mood States (POMS; Nyenhuis et al., 1999). Male and female undergraduate college students (n=25) between the ages of 18-24 were recruited. Recruitment occurred through undergraduate courses, with approximately 600 students being asked to participate. Some of the

students received extra credit depending on the class that they were recruited from.

Participants were then randomized into a vigorous exercise group, a moderate exercise group, or a stretching group to control for contact time. Physical activity guidelines set by the ACSM were used to determine the exercise requirements for each group (Haskell et al., 2007). For moderate exercise, the participants were asked to use a treadmill for 20 minutes. The target heart rate during the 20 minutes was 55-70% of maximum intensity using their age-predicted heart rate. For vigorous exercise, the participants also used the treadmill for 20 minutes. The target heart rate for vigorous was 70-85% of their maximum intensity. Heart rate monitors were used to make sure participants were within the range for the intensity assigned. Participants in the stretching group were asked to do light stretches for 20 minutes while wearing heart monitors. The main dependent variable (POMS) was assessed immediately before and after the single bout of either vigorous or moderate intensity exercise. Another assessment using the POMS took place over the telephone 24 hours after the exercise bout.

Rationale for Design

Several studies indicate that exercise can decrease depressive symptoms (Dunn et al., 2001). There is evidence that a single bout of exercise has significant effects on depressed moods (Rendi et al., 2008). However, no experimental studies have examined the effects in college students utilizing a single bout of exercise. Additionally, no study has examined the effect of different intensities on depressed mood. The proposed study utilized self-report of mood. However, unlike previous studies on this population, mood was evaluated before and after an acute bout of exercise instead of recalling previous

exercise behaviors and mood states. Evidence for the effect of exercise intensity on depression is mixed and additional study is needed.

Participant Recruitment

College students between the ages of 18 and 24 were recruited from a large university. The main method of recruitment was through undergraduate classes. Those students who provided contact information were contacted by telephone to determine if they were willing to participate and if they were eligible.

Eligibility Requirements

Full-time college students (n=30) between the ages of 18 and 24 were recruited. Students needed to currently not meeting criteria to be considered active, which was defined as participating in physical activity three days a week or less for 30 minutes or less each day, or a total of 90 minutes or less a week. Both male and female students were recruited.

Specific exclusion criteria include: (1) current participation in exercise (>90 min/week) (2) currently enrolled in another exercise study (3) less than 18 years of age (4) unable to walk for 30 continuous minutes (5) congenital heart disease (6) exercise-induced asthma (7) diabetes (8) musculoskeletal problems; (9) any condition that would make exercise unsafe or unwise; and (10) currently receiving pharmacotherapy for a mood disorder.

Measures

One questionnaire was delivered to assess depressed mood. It is described below.

Primary Dependent Variable: Profile of Mood States (POMS)

The Profile of Mood States is a 65 item self-report inventory that measures 6 different mood states and their fluctuations. Items are rated on a 5-point Likert scale ranging from 0 (not at all) to 5 (extremely). The six different mood factors include tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. It has been shown to be a valid measure of mood states in the general population (Nyenhuis et al., 1999). It has also been shown to be reliable in detecting within-person change processes (Cranford et al., 2006). The POMS was delivered before and after the exercise bout in order to examine changes in depressive mood. Two subscales from the POMS were used for the results. The depression-dejection subscale was the primary outcome and the tension-anxiety subscale was a secondary outcome.

Other Measures: Demographic, Lifestyle, and other Variables

This measure addressed age, ethnicity, gender, socioeconomic status, amount of previous depressive episodes, family history of depression, antidepressants, and education. These questions were asked prior to the experiment.

Procedure

During recruitment, students were informed about the study and asked if they would be willing to be contacted for a phone screening to participate in the study. The phone screening assessed current physical activity levels, demographic variables, and history of depression. Prior to participation, participants were given a consent form and received information about the study. Once students were screened, they were randomized into one of three groups: vigorous exercise, moderate exercise, or control.

Excel was used to randomize the participants by assigning participants to Group 1, Group 2, or Group 3 and producing a string of numbers. Each participant was asked to complete the POMS within five minutes before their exercise bout. The exercise bout intensity and duration followed the ACSM guidelines for physical activity. Those in the vigorous exercise group were asked to walk for 20 minutes, at an intensity of 55-70% percent of their age-predicted max heart rate. The moderate exercise group was asked to walk for 20 minutes, at an intensity of 70-85% of their age-predicted max rate. Heart rate monitors were used to monitor intensity. The control group was asked to do light stretching for 20 minutes in the laboratory to control for any environmental factors and contact time. Each group was also asked to warm-up for two minutes and cool-down for two minutes. Within five minutes after completing the bout of exercise, the participants were asked to complete the POMS again. Another POMS assessment took place over the telephone approximately 24 hours after the initial bout of exercise. This was done in order to examine if the effects of a single bout of exercise have any lasting effects over the next day. In terms of compliance, participants were included in the results as long as at least 10 minutes of vigorous exercise or 20 minutes of moderate exercise was completed. Also, the exercise bout was considered successful if the participant was at their target heart rate for at least 10 minutes of the bout. Participants were asked to inform the researcher if at any time they wished to discontinue the exercise session. They were asked to inform the researcher if they were in pain, feeling nauseas, dizzy, or could not breathe. The participant was observed constantly during the entire session.

Data Analysis

To examine the effect of exercise intensity on depressed mood as measured by the Profile of Mood States (POMS- depression-dejection subscale) a series of between-subjects one-way ANOVA's were conducted. The ANOVA comparisons included vigorous vs. moderate, vigorous vs. control, and moderate vs. control effecting changes on the POMS. Change scores were calculated for both post-treatment (baseline POMS score was subtracted from the POMS score immediately following the acute exercise bout) and 24 hours after the session (baseline POMS score was subtracted from the 24-hour score). The same analysis was done using the POMS tension-anxiety subscale. For all comparisons, $p < .05$ was used to establish statistical significance.

Results

A total of 57 students were screened to participate in this study; 24 of them exercised more than 90 minutes a week, six had scheduling difficulties, two were currently taking antidepressants, and one was ruled out for other reasons. This left 25 participants to be randomized into the study. The three groups had similar demographic characteristics and no significant differences in baseline activity levels. The majority of participants were Caucasian and female ($n=17$), with a mean age of 19.8 years. Demographic data for the full sample and by group is summarized in Table 2. Three participants did not complete the 24 hours screening. No participants were excluded because of not meeting target heart rate criteria, all were within the desired range for the necessary amount of time.

Table 2

Demographic Characteristics by Group

		Vigorous	Moderate	Control
Age (mean)		20.7	5	20.4
Gender (% female)		70	62.5	71.4
Race (% Caucasian)		80	100	100
Ethnic Group (% non-hispanic)		100	87.5	85.7
Year in School (# of participants)				
	1 year	1	2	0
	2 years	3	4	4
	3 years	3	0	1
	4 years	3	2	2
Total Numbers		10	8	7

There were no significant differences between vigorous vs. moderate intensity, vigorous vs. control, or moderate vs. vigorous on the POMS depression-dejection subscale change scores for either timepoint (immediately following the acute bout of exercise or 24 hours after exercise). However, the effect of vigorous relative to the control group from baseline to post exercise on the POMS approached significance $f(1, 15) = 3.61, p, 0.077$, in that the vigorous group reported a more positive mood change than the control. These results are shown in Figure 1. Similarly, as can be seen in Figure 2, there was also no effect on the POMS tension-anxiety scores.

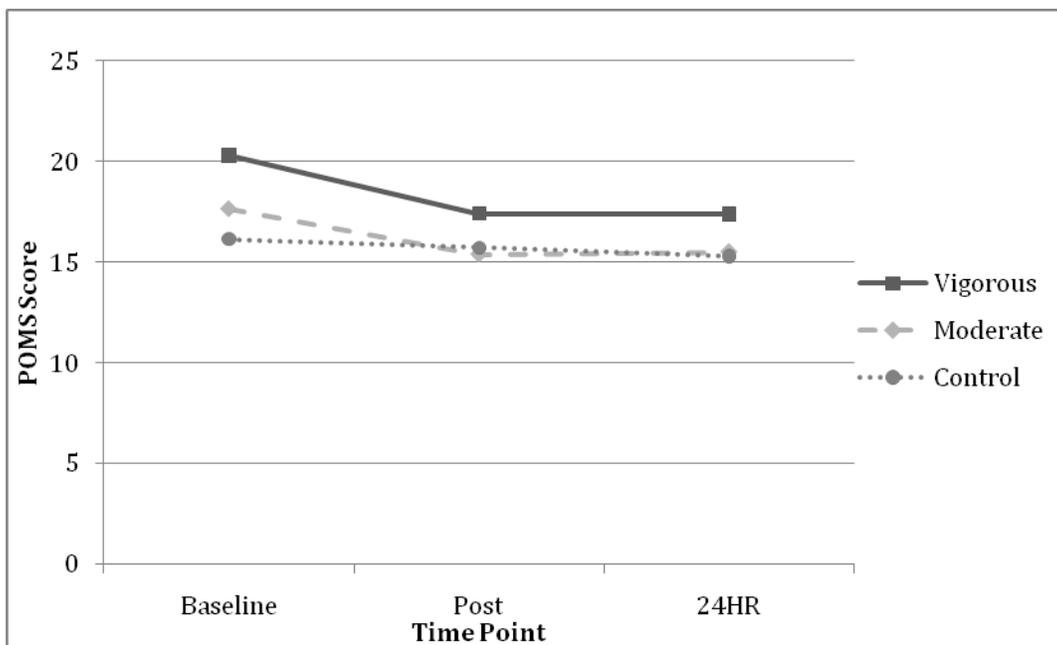


Figure 1. POMS depression-dejection subscale trends

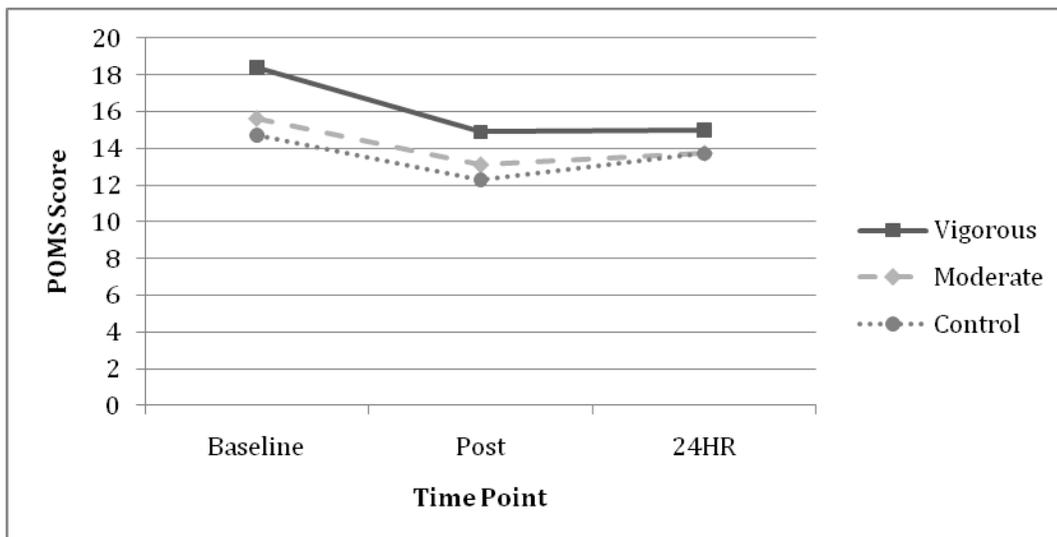


Figure 2. POMS tension-anxiety subscale trends

Discussion

Previous research has shown that exercise has been successful in reducing symptoms of depression (Blumenthal et al., 1999). A small number of these studies have focused on the college student population. A majority of these studies rely on retrospective self-report and surveys, with very little experimental research done looking at the direct effect of exercise on depression in college students (Adams, Moore, & Dye, 2007; Harbour et al., 2008; Taliaferro et al., 2008). Research also shows mixed results when looking at the effects of different intensities of exercise on depression (Veale, 1992; Rendi et al., 2008; Harbour et al., 2008). The purpose of the present study was to understand the effects of different exercise intensities (vigorous or moderate) on depressed mood in college students.

The results of this study did not show statistically significant findings in support of the hypothesis that participants randomly assigned to vigorous intensity exercise would have greater mood changes (in the positive direction) than participants assigned to moderate intensity exercise. However, the findings did indicate a trend towards vigorous intensity exercising having a better effect on depressed mood than no exercise. This supports previous findings that vigorous physical activity is related to a lower frequency of depressive symptoms (Harbour et al., 2008). This study used a general health survey to determine if recommended amounts of vigorous physical activity was related to less frequent depressive symptoms. Two previous studies (Veale, 1992; Rendi et al., 2008) found psychological improvements independent of exercise intensity. In the Veale study, aerobic exercise was compared to a control group as well as to a low intensity exercise

group. Both exercise groups showed psychological improvements, but there was no significant difference between the groups. Similar research was done in the Rendi study, where different workloads and intensities were compared. The results of the current study are consistent with these findings by observing no statistically significant differences between vigorous and moderate intensity exercise on depressed mood. However, the current study is lacking consistency with these previous studies since the moderate group was not found to be significantly different than the control group. The previous literature would have gained more support if both vigorous and moderate exercise showed significant differences in depressed mood changes from the control group. This lack of consistency in results may be due to the current study's small sample size.

The results also do not show any statistical significance when looking at exercise improving depressed mood in college students. Several previous studies have found significant results in support of this (Adams, Moore, & Dye, 2007; Harbour et al., 2008; Taliaferro et al., 2008). All of these studies relied on self-report surveys to determine if physical activity was related to a lower frequency of depressive symptoms, with this being supported by the results. The results of the current study are not consistent with these results, since there was no statistical significance supporting an improvement of depressive symptoms. However, the trends of the current study are moving in the direction to support this. The previous studies all relied on self-report measures and surveys. The current study still relied on self-report, but it was an experimental study

that would strengthen the literature if any statistical significance was found. However, with such a small sample size it is difficult to find any significant results.

Previous literature on depression and exercise in college students has shown that exercise is related to lower levels of depression. Most of this literature has the same general limitations including cross-sectional designs, self-report, and large female populations. Because these studies used self-report, there is a possibility that their recall of their activity levels were inaccurate. The use of cross-sectional designs also does not allow for causal relationships between the variables to be inferred. Similar to many previous studies, the current study has a much larger female population than male. This has been considered a limitation in several previous studies because it makes it hard to generalize the results to both genders. However, it may not necessarily be a limitation. Twice as many women are diagnosed with depression than men (Butler, 2006). Since women are affected more often, it may not be a limitation that studies usually have a larger female population. Also, men tend to exercise slightly more often than women, with 32.6 percent of men participating in regular exercise and 28.9 percent of women (Schoenborn & Adams, 2010). Men may be better responders to exercise, decreasing the occurrence of depressive symptoms.

Limitations

There are several limitations of this study that should be discussed further. First is the small sample size. As a pilot study, a small sample size was appropriate. However, a larger sample size would have given more power to see significant changes between groups and scores. Another limitation is the time of year that the study was

conducted. Specifically, college students were used in this study and a majority completed the study towards the end of the school year. It is possible that stress levels were high for the students due to finals. This created scheduling difficulties as well as difficulty reaching participants for the 24 hour follow-up POMS. These stress levels were potentially changing daily depending on when finals were taken and projects were due. This could have affected the changes in POMS scores from baseline to the 24 hour screening. Also, the use of age-predicted heart rate to determine vigorous and moderate exercise levels is not the most valid measure of heart rate and may have affected the results. It does not take into account differences in gender or the physical activity status of the participant.

A second limitation of the study is that during recruitment, all participants were accepted into the study regardless of how they scored on the POMS. This could have affected the results if the participant screened at the lowest depressive level possible on the POMS. It would then not be possible for the participant to screen lower for depressed mood on the post-exercise and the 24-hour POMS. Additionally, on the depression-dejection subscale, the vigorous group had a greater average score than the moderate group as well as the control group. This may have been the reason for the difference between the vigorous and control group from pre to post exercise. The difference may also have been due to regression to the mean. The vigorous groups' baseline score could be an extreme case and could have gone down to a more typical average score at post test and 24-hours.

The demographics of the study sample is another limitation. There was not an equal amount of males and females. Also, there was not a very large amount of minority students. However, depressive symptoms and depression are more common in women and this could be a population to target for further study and intervention. This does not make it easy to generalize the results to all populations.

Conclusions

More research in this area is needed. This was a pilot study with a very small sample size and more comprehensive research would be beneficial. In particular, research with a larger sample size is needed. Research would also be strengthened by using students that are currently clinically depressed. However, one issue with using exercise in treating depression is that it may be difficult to actually get depressed people to exercise. The fatigue and loss of interest that depressed people suffer with may prevent them from exercising.

The current study focuses on depressed mood, however if future studies used clinically depressed students it would be more beneficial in determining the effects of exercise on depression. Changes cannot be detected when students show no depressive symptoms to begin with. Future research would also benefit by using a stricter requirement for sedentary students. This study accepted students that exercised up to 90 minutes a week. By using students that did not exercise as much, larger depressed mood score changes may be seen. By continuing research in this area, ways to alleviate any burden from depression in college students could be found. If exercise is found to be

beneficial for students facing any depressive symptoms, it would be a very available and cost-effective option for students to gain relief without relying on medications or counseling.

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Appendix B

Profile of Mood States

ID # _____

Date _____

Directions: Describe HOW YOU FEEL RIGHT NOW by checking one space after each of the words listed below:

FEELING	Not at all	A little	Mod.	Quite a bit	Extremely
Friendly	1	2	3	4	5
Tense	1	2	3	4	5
Angry	1	2	3	4	5
Worn Out	1	2	3	4	5
Unhappy	1	2	3	4	5
Clear-headed	1	2	3	4	5
Lively	1	2	3	4	5
Confused	1	2	3	4	5
Sorry for things done	1	2	3	4	5
Shaky	1	2	3	4	5
Listless	1	2	3	4	5
Peeved	1	2	3	4	5
Considerate	1	2	3	4	5
Sad	1	2	3	4	5
Active	1	2	3	4	5
On edge	1	2	3	4	5
Grouchy	1	2	3	4	5
Blue	1	2	3	4	5
Energetic	1	2	3	4	5
Panicky	1	2	3	4	5
Hopeless	1	2	3	4	5
Relaxed	1	2	3	4	5
Unworthy	1	2	3	4	5
Spiteful	1	2	3	4	5
Sympathetic	1	2	3	4	5
Uneasy	1	2	3	4	5
Restless	1	2	3	4	5
Unable to concentrate	1	2	3	4	5
Fatigued	1	2	3	4	5
Helpful	1	2	3	4	5
Annoyed	1	2	3	4	5
Discouraged	1	2	3	4	5
Resentful	1	2	3	4	5
Nervous	1	2	3	4	5
Lonely	1	2	3	4	5

Miserable	1	2	3	4	5
Muddled	1	2	3	4	5
Cheerful	1	2	3	4	5
Bitter	1	2	3	4	5
Exhausted	1	2	3	4	5
Anxious	1	2	3	4	5
Ready to fight	1	2	3	4	5
Good-natured	1	2	3	4	5
Gloomy	1	2	3	4	5
Desperate	1	2	3	4	5
Sluggish	1	2	3	4	5
Rebellious	1	2	3	4	5
Helpless	1	2	3	4	5
Weary	1	2	3	4	5
Bewildered	1	2	3	4	5
Alert	1	2	3	4	5
Deceived	1	2	3	4	5
Furious	1	2	3	4	5
Effacious	1	2	3	4	5
Trusting	1	2	3	4	5
Full of pep	1	2	3	4	5
Bad-tempered	1	2	3	4	5
Worthless	1	2	3	4	5
Forgetful	1	2	3	4	5
Carefree	1	2	3	4	5
Terrified	1	2	3	4	5
Guilty	1	2	3	4	5
Vigorous	1	2	3	4	5
Uncertain about things	1	2	3	4	5
Bushed	1	2	3	4	5

Appendix C

ID # _____

Consent Form

Effects of Exercise on Depression in College Students

You are invited to be in a research study looking at the effects of exercise on depressive mood states in college students. You were selected as a possible participant because you are an undergraduate student. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Betsy Kennedy, a graduate student in the department of Kinesiology.

Background Information

The purpose of this study is to attempt to answer how a single bout of exercise (vigorous or moderate) affects depressive mood states in college students. Exclusion criteria include: (1) current participation in exercise (>60 min/week) (2) currently enrolled in another exercise study (3) less than 18 years of age (4) unable to walk for 30 continuous minutes (5) congenital heart disease (6) exercise-induced asthma (7) diabetes (8) musculoskeletal problems and (9) any condition that would make exercise unsafe or unwise (10) currently receiving pharmacotherapy for a mood disorder.

Procedures:

If you agree to be in this study, we would ask you to do the following things: You will be randomly assigned to one of three groups: a vigorous exercise group, a moderate exercise group, or a stretching group. Each group will be asked to complete a single bout of exercise. A stationary bike will be used for the exercise bouts. Your heart rate will be monitored during the bout of exercise. Immediately before and after the session, you will be asked to complete a questionnaire. The questionnaire will ask you to simply rate how intensely you are feeling a certain word at that time. Another questionnaire will be delivered over the phone 24 hours after the exercise session is completed.

Risks and Benefits of being in the Study

Regarding risks of the study, there are risks associated with exercise including orthopedic injuries or exacerbation of a pre-existing medical condition. If an injury occurs or if exercise becomes unsafe, you will be asked to discontinue the exercise session.

There are no direct benefits for participation in this study.

Research Related Injury

In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company. If you think that you have suffered a research related injury, let the study physicians know right away.

Compensation:

You may receive payment: extra credit may be given in the class from which you were recruited.

Confidentiality:

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Betsy Kennedy. You may ask any questions you have now. If you have questions later, you are encouraged to contact them by phone at 612-723-7100, or by e-mail at kenn0341@umn.edu. You may also contact advisor Beth Lewis at blewis@umn.edu and 612-625-0756.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: _____

Date: _____

Signature of parent or guardian: _____

Date: _____

(If minors are involved)

Signature of Investigator: _____

Date: _____

Appendix D

ID # _____

Consent Form**Effects of Exercise on Depression in College Students**

You are invited to be in a research study looking at the effects of exercise on depressive mood states in college students. You were selected as a possible participant because you are an undergraduate student. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Betsy Kennedy, a graduate student in the department of Kinesiology.

Background Information

The purpose of this study is to attempt to answer how a single bout of exercise (vigorous or moderate) affects depressive mood states in college students. This consent form is solely for a survey that measures mood. The questionnaire will ask you to simply rate how intensely you are feeling a certain word at that time. This survey will determine your eligibility for the study.

Procedures:

If you agree to be in this study, we would ask you to do the following things: You will be asked to complete a short survey that assesses your current mood including levels of moods such as happiness, sadness, and anger in order to determine your eligibility for this study.

Risks and Benefits of being in the Study

There are no risks of being in this study.

There are no direct benefits for participation in this study.

Compensation:

You will receive payment: extra credit will be given in the class if you are eligible for the

study.

Confidentiality:

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Betsy Kennedy. You may ask any questions you have now. If you have questions later, you are encouraged to contact them by phone at 612-723-7100, or by e-mail at kenn0341@umn.edu. You may also contact advisor Beth Lewis at blewis@umn.edu and 612-625-0756.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study. I also consent to being contacted later.

Phone number: _____

E-mail: _____

Preferred method of contact: _____

Signature: _____

Date: _____

Signature of parent or guardian: _____

Date: _____

(If minors are involved)

Signature of Investigator: _____

Date: _____

Appendix E

ID # _____

Depression in College Students Telephone Screening

Date of Contact: / /
(mm /dd /yy)

Status at phone screen

- Eligible
- Ineligible
- Not interested
- Thinking about study

If ineligible, check reason for being ineligible:

- Too much exercise (number of minutes) _____
- Health related (please list reason _____)
- Scheduling difficulties
- Currently enrolled in another exercise-related study
- Other _____

Scheduled time for exercise bout: _____

Hello, this is Betsy from the exercise and depression in college students study. You completed a depression survey in class. Just as a reminder, the study is looking at the effects of exercise on depression in college students. You will be randomly assigned to one of three groups: a vigorous exercise group, a moderate exercise group, or a stretching group. Each group will be asked to complete a single bout of exercise. Your heart rate will be monitored during the bout of exercise. Immediately before and after the session,

you will be asked to complete a questionnaire. Another questionnaire will be delivered over the phone 24 hours after the exercise session is completed. I am calling because your score on the PHQ-9 makes you eligible to participate in this study. There are a few more eligibility questions that I need to ask before having you come in for the session. Are you interested in being in this study?

YES NO

Do I have your permission to keep the information I ask you during this interview? The information will remain confidential and will be kept without your name attached.

YES NO

Please answer the following questions.

- 7) What is your Date of Birth _____. (MM/DD/YYYY)
(If less than 18 years of age, explain to them that the study is for individuals 18 and older)
- 8) What is your gender? **Male Female**
- 9) How many years of undergraduate have you completed?
 - (1) One
 - (2) two
 - (3) three
 - (4) four
 - (5) five or more
- 10) a) Which of the following do you consider to be your racial group?
 - (1) American Indian/Alaskan Native
 - (2) Asian
 - (3) Native Hawaiian or Other Pacific Islander
 - (4) Black or African American
 - (5) White
 - (6) Other (describe) : _____.
 - (88) Don't know/refuse

b) Which of the following do you consider to be your ethnic group?

(1) Hispanic or Latino

(2) Not Hispanic or Latino

11) Have you been diagnosed with depression? **YES NO**

12) Are you currently on antidepressants? **YES NO**

13) Do you exercise regularly? **YES NO**

a. What activities did you do? _____

b. How many times per week? _____

c. For how many minutes each time? _____

14) Are you able to walk for 30 continuous minutes? **YES NO**

15) Are you currently enrolled in another study on health or
physical activity? **YES NO**

16) Do you have congenital heart disease? **YES NO**

17) Do you have exercise-induced asthma? **YES NO**

18) Do you have diabetes? **YES NO**

19) Do you currently have any muscular skeletal problems such as arthritis, gout, osteoporosis, or back, hip or knee pain that may interfere with being physically active?
YES NO

20) Is there any other health related issue that would make exercise unsafe or unwise?

YES NO

Explain: _____

A. Eligible

26. What is your full name?

27. What is your (check preferred method of contact):

28a. Home phone number () _____

28b. Work phone number () _____

28c. Cell phone/beeper (if applicable) () _____

28d. Email address (if applicable) _____

29. Can we leave message at:

29a. Home **YES NO**

29b. Work **YES NO**

29c. Cell **YES NO**

30. Exercise bout day/time _____

B. Not eligible

I'm sorry, but you are not eligible for the study. If we have studies in the future that you might be eligible for based on the information you told me, could we contact you again?

Thank you for your time and interest.

YES NO