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A Pilot Study: Self-reported anxiety and depression in regular exercisers

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By

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Abstract

Background: Current physical activity guidelines emphasize physical health outcomes and lack any mention of mental health outcomes. Physical activity guidelines need to be updated to reflect current research and include mental health outcomes. Unfortunately, the literature lacks discussion on the liminal period between the end of a physical activity intervention and the long-term follow up. Additionally, while low intensity (LI) physical activity and high intensity interval training are main topics of discussion in the literature, there is a lack of research on high intensity (HI) physical activity and its effect on mental health outcomes.

Purpose: To examine the efficacy of HI physical activity as a management tool for self-reported anxiety and depression in college age students who engage in regular physical activity.

Methods: A total of 27 participants (20 female, 7 male; mean age 20.59 ± 2.19 ; mean height 65.98 ± 3.65 inches; mean weight 143.44 ± 31.17 pounds) elected to partake in either LI or HI physical activity classes and completed 16 weeks of regular physical activity. The HI group consisted of 17 participants and the LI group consisted of 10 participants. Anxiety and depression scores were observed in the last 4 weeks of class using the PHQ-ADS questionnaire. A 2x4 factorial ANOVA was used to conduct within and between group comparisons.

Results: Anxiety and depression levels remained consistent in the LI and HI groups across four weeks of observation.

Conclusion: LI and HI physical activity can be considered effective at managing self-reported anxiety and depression in college-age students who engage in regular physical activity.

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Introduction

Current physical activity guidelines [Centers for Disease Control (CDC)] are focused on physical health outcomes associated with sedentary behaviors ([CDC], 2022). Unfortunately, the failure to describe benefits to mental health outcomes such as anxiety and depression using physical activity is apparent in the physical activity guidelines (Crone & Sellars, 2022; Teychenne et al., 2020). Research examining physical activity as it relates to mental health outcomes has increased in recent years (Bustamante et al., 2023). However, most studies focus on physical activity as an intervention for improving mental health outcomes in sedentary populations or previously sedentary populations.

Additionally, a large focus is placed on low intensity physical activity such as yoga or walking. Some researchers have observed a dose-response relationship between low intensity physical activity such as yoga and improved self-reported anxiety and depression (Bukar et al., 2019). In recent years, a greater emphasis has been placed on vigorous intensity exercise and physical activity as they relate to mental health outcomes. Furthermore, engaging in some moderate to vigorous physical activity improves symptoms of depression in adults of all ages, and better depression outcomes were associated with increases in weekly physical activity duration (Werneck et al., 2018). However, one study observed that engaging in 10 or more hours a week of occupation-related physical activity was associated with an increased prevalence of depression compared to depression observed in sedentary counterparts (McKercher et al., 2009).

Physical activity improves anxiety and depression symptoms in populations clinically diagnosed with mental illnesses. For example, combining kundalini yoga with

cognitive behavioral therapy (CBT) resulted in significant improvements in the depression and anxiety experienced by people diagnosed with generalized anxiety disorder (Khalsa et al., 2015). Similarly, walking at a moderate pace to vigorous pace for 12 weeks in accordance to physical activity guidelines significantly decreased anxiety severity in middle-aged and older adults (Yu et al., 2023). Based on the successes of previous researchers with low intensity physical activity promoting the mental and physical health of sedentary individuals, a health coaching intervention called Walk This Way was developed to promote sedentary persons' engagement in low intensity physical activity, to reduce the severity and prevalence of mental illnesses experienced in sedentary populations (Williams et al., 2016).

Conducting a meta-review, researchers noted that vigorous intensity interval training can reduce severity of depression symptoms and improves other mental health outcomes in people with various mental illnesses, including schizophrenia (Martland et al., 2020). Overall, studies examining the relationship between mental health outcomes and various physical activity intensities can vary in duration from short (2 weeks) as seen by Naveen et al., to long term (up to 12 weeks) interventions, as seen by Helgadóttir et al., with various follow-up periods relative to the duration of the intervention (Helgadóttir et al., 2017; Naveen et al., 2013). A meta-analysis is needed to evaluate current methods and population selection, as most researchers focus on sedentary populations pre- and post-intervention or comparing sedentary individuals to individuals who have maintained lifetime fitness.

By focusing on sedentary populations, improvements in mental health outcomes may be over-attributed to adaptations resulting from exercise as opposed to exercise being an effective tool for managing mental health outcomes. People who are not accustomed to engaging in regular physical activity are likely to experience reduced mood for a 25-minute period immediately after completing a physical activity session before returning to their normal mood (Hallgren et al., 2010). While there may be lifestyle changes associated with physical activity interventions, there exists little commentary on how the intervention may prompt lifestyle or behavior change that can affect long-term outcomes, which affects follow-up data.

Moreover, there is a lack of discussion of the role physical activity plays in managing mental health outcomes such as anxiety and depression in those who engage in regular physical activity. Most studies examining the relationship between mental health outcomes and engagement in regular physical activity often compare outcomes between sedentary and regularly active populations, such as Currier et al. (2020). Observation of mental health outcomes after adaptation to exercise or physical activity has occurred is necessary to better understand the role of physical activity as a management tool for self-reported mental health outcomes.

Background

The phenomena of anxiety and depression, while a universal human experience, is under great scrutiny in the college age student population. After conducting a meta-analysis and systematic review of global anxiety and depression prevalence in college

students, researchers found that depression symptoms occurred in 33.6% of the population, while anxiety symptoms occurred in 39% of the population (Li et al., 2022). Additionally, researchers determined that medical school students are highly likely to experience depression or anxiety (Li et al., 2022). Researchers in Iraq evaluated the prevalence and severity of anxiety and depression among pharmacy and medical students and nearly half of the students expressed symptoms of depression and over half of the students expressed symptoms of anxiety (Kathem et al., 2021).

Prior to the COVID-19 pandemic, there was a general increase in the amount of depression and anxiety experienced by college students in 2017 compared to 2012 (Peyer et al., 2020; Ramón-Arbués et al., 2020). During the pandemic, depression and anxiety continued to rise in college students (Wang et al., 2023). Currently, there is a lack of research on anxiety and depression prevalence in college students after the pandemic. However, it is necessary to conduct research to determine lingering effects of the elevated anxiety and depression experienced during the pandemic. Some researchers have observed a trend of decreasing physical activity as anxiety and depression increase; while the relationship is not causal, the correlation between physical activity and expression of anxiety and depression is noteworthy (Peyer et al., 2020).

Anxiety and depression are often examined simultaneously due to the common expression of both in college age students (Hoeflich et al., 2023). While not necessarily discussed as co-morbid, the relationship between depression and anxiety makes it difficult to isolate one versus the other in research examining the effectiveness of various treatments (Almeida et al., 2012). Therefore, most researchers will examine symptoms of

both anxiety and depression when evaluating the mental health of subjects undergoing different treatments or engaging in different lifestyle patterns.

Traditional treatments for anxiety and depression include but are not limited to conventional talk therapy and pharmaceutical interventions. Conventional talk therapy such as cognitive behavioral therapy is one of the most popular and effective methods to treat anxiety and depression, especially in college students (Hoeflich et al., 2023). With comparable effectiveness, pharmaceutical interventions can provide a reliable alternative for treating depression when using a symptom-oriented approach (Boschloo et al., 2019). Simultaneous use of talk therapy and pharmaceutical interventions is overall more effective than either method alone (Hollon et al., 2014; Jacquart et al., 2014). Regardless of treatment method, physical health remains a common element in research examining effectiveness of treatment methods for anxiety and depression.

While physical health is often emphasized as an essential part of supporting and maintaining mental health, physical activity as a treatment method for anxiety and depression is relatively novel compared to conventional therapies. Symptomatic of a shift in the paradigm, researchers' interest in physical activity and its relationship to mental health has increased tremendously in recent years. When used concurrently with traditional methods such as talk therapy or pharmaceutical interventions, physical activity not only supports the benefits of traditional methods but can also prompt lifestyle change (Williams et al., 2016). Researchers concluded that physical activity is similarly effective to internet based cognitive therapy with long-term lifestyle changes that were present 12 months post-intervention (Hallgren et al., 2016). Additionally, researchers worldwide

speculate over a variety of different methods and interventions to utilize physical activity to ameliorate symptoms of anxiety and depression; a novel approach combines bouldering with psychotherapy (Kind et al., 2023). These interventions can differ in delivery method, type of physical activity, and intensity of physical activity. Most researchers examining the relationship between physical activity and anxiety and depression tend to observe the effects of low or vigorous intensity physical activity.

Physical activity intensity can be measured in a variety of ways, from heart rate monitors to Borg's rating of perceived exertion scale (RPE) (Scherr et al., 2013). While subjective, the RPE scale is based off an individual's unique experience, which can provide valuable insight in tailoring a physical activity program to best suit the individual's needs (Chowdhury et al., 2019; Scherr et al., 2013). Using Borg's rating of perceived exertion scale, low intensity physical activity can be understood as a score ranging from 11-13 (Chowdhury et al., 2019; Scherr et al., 2013). Moderate and vigorous physical activity can be understood as scores of 13-15 and 16+, respectively, when using Borg's rating of perceived exertion scale (Chowdhury et al., 2019; Scherr et al., 2013). However, for the purposes of providing general guidelines for public use, the CDC define moderate intensity physical activity as brisk walking and vigorous intensity physical activity as jogging or running (Centers of Disease Control [CDC], 2022). While the CDC does not define low intensity physical activity, some researchers have found that a comfortable walking pace is comparable to a score of 11-13 on Borg's RPE scale (Park et al., 2020). Another example of low intensity physical activity would include yoga (Ray et al., 2011).

Contemporary researchers also use Metabolic Equivalent Tasks (METs) as an objective standard to determine physical activity intensities (Ainsworth et al., 2011; Park et al., 2020). Using METs to quantify physical activity intensities allows for a standardized approach to physical activity programming. Low intensity, moderate intensity, and vigorous intensity physical activity would be defined as 1.6-2.9 METs, 3-5.9 METs, and ≥ 6 METs, respectively (Ainsworth et al., 2011). While yoga is typically considered a form of low intensity physical activity, more strenuous yoga poses can be correlated with increased METs typically reserved for moderate or vigorous intensity physical activity (Pullen et al., 2020).

Low intensity physical activity is a popular intensity for physical activity interventions targeted towards managing symptoms of anxiety and depression. Many researchers concur that self-selecting physical activity intensity is preferred for less active, also known as sedentary, populations (Parfitt et al., 2006). Furthermore, many studies examining physical activity as an intervention for mental health outcomes such as anxiety and depression focus on sedentary populations. Using METs, sedentary behavior can be quantified as 1.0-1.5 METs (Tremblay et al., 2017). Examples of sedentary behavior include reading, watching television, or using a computer (Jochem et al., 2019). Individuals who are sedentary are more likely to develop cardiovascular disease, hypertension, various forms of cancer, and lifestyle-related chronic illnesses such as type II diabetes (Dunstan et al., 2010; Katzmarzyk et al., 2009; Patterson et al., 2018). Currently, researchers are debating the long-term health implications of continuous

sedentary behavior versus intermittent sedentary behavior (sedentary periods interrupted by bouts of physical activity) (Diaz et al., 2019).

Individuals who maintain lifetime fitness are less likely to develop chronic illnesses and diseases commonly associated with sedentary lifestyles (Pearson, 2001). Additionally, in a retrospective study of adults, individuals who maintained lifetime fitness were less likely to experience anxiety and depression, as well as experiencing lessened severity of anxiety and depression (Currier et al., 2020). Perceptions toward physical activity and active lifestyles can be effectively improved for college students via education and courses on lifetime physical fitness (Quartiroli & Maeda, 2016).

Researchers seeking to better understand the relationship between physical activity and mental health outcomes such as anxiety and depression tend to follow one of two paths. The first is examining sedentary populations' anxiety and depression symptoms prior to, during, and immediately after a physical activity intervention. Some may follow up after the intervention is over to determine if the subjects have continued to enjoy the benefits first observed at the end of the intervention (Hallgren et al., 2016; Helgadóttir et al., 2017; Naveen et al., 2013). Due to the physical and mental health benefits associated with lifetime fitness, sedentary individuals are often compared to individuals who maintained lifetime fitness. Drawing comparisons between individuals who maintain lifetime fitness and those who are currently sedentary is the second path many researchers travel to improve their understanding of the long-term benefits physical activity can offer mental health. Unfortunately, until a meta-analysis of target populations

and methods in the research examining the intersection of physical activity and mental health is published, the meta commentary remains speculative.

Low intensity physical activity is a popular choice for physical activity, particularly with sedentary older adult populations (Espinel et al., 2015). Yoga is a popular form of low intensity physical activity that provides benefits to anxiety and depression (Bukar et al., 2019; Nanthakumar, 2020). Similarly, low intensity physical activity conducted on a regular schedule can greatly improve anxiety and depression symptoms in sedentary older adults (McDowell et al., 2020). Furthermore, yoga interventions combined with conventional talk therapy such as cognitive behavioral therapy can significantly improve anxiety and depression in college students (Khalsa et al., 2015). Due to the successes of previous researchers in utilizing physical activity as an effective tool, both alone and concurrently with other validated methods, interventions such as Walk This Way have been developed to promote physical activity engagement in sedentary populations, while simultaneously reduce the severity and occurrence of mental illnesses in sedentary populations (Williams et al., 2016). The popularity and success of low intensity physical activity as an intervention for sedentary populations may be related to maintenance of mood after a bout of physical activity. Some researchers concluded that individuals who are less accustomed to physical activity are likely to experience a decline in mood state for a period of 25 minutes after completing a bout of physical activity after which their mood returns to normal (Hallgren et al., 2010).

Another approach popular with researchers is vigorous intensity physical activity, including high intensity interval training (HIIT). Some researchers have concluded that

vigorous intensity physical activity can have a positive effect on anxiety and depression similar to low intensity physical activity (Yu et al., 2023). Additionally, vigorous intensity physical activity combined with conventional treatments can amplify the benefits of typical interventions for mental illnesses such as schizophrenia (Crone & Sellars, 2022; Martland et al., 2020). Interestingly, researchers attempting to discern the effectiveness of low, moderate, and vigorous intensity physical activity at managing symptoms of anxiety and depression concluded that low and vigorous intensity physical activity are both more effective at managing depression than moderate intensity physical activity (Helgadóttir et al., 2017). However, in middle aged and older adults there was no difference in depression scores between moderate and vigorous intensity physical activity groups after 12 weeks of regular physical activity (Yu et al., 2023). It is worth pondering whether moderate intensity physical activity is not challenging enough to provide benefits associated with vigorous intensity physical activity, while remaining too challenging for untrained populations to engage in for long periods of time. Even though moderate intensity physical activity may not be effective at managing anxiety and depression compared to low intensity or vigorous intensity physical activity, most researchers agree that sedentary populations stand to benefit from any type of physical activity, regardless of intensity (Hooda et al., 2024).

Currently, there exists some debate whether low intensity or vigorous intensity physical activity is better at ameliorating anxiety and depression. A meta-analysis and review would prove beneficial in determining contemporary researchers' opinion(s) on preferred physical activity intensity for mental health as well as provide an update to the current paradigm regarding physical activity intensity and mental health. Since many

researchers use different physical activity programs and tools to measure anxiety and depression, it would seem logical to assume that vigorous intensity physical activity is better overall for managing anxiety and depression. However, a meta-analysis is needed to examine the methods, program design, and target population(s) to conclude whether vigorous intensity physical activity is more effective than low intensity physical activity at managing anxiety and depression regardless of population.

A dearth of literature focuses on sedentary populations' reactions to physical activity by comparing pre- and post-intervention anxiety and depression symptoms or compares sedentary individuals to individuals who have maintained lifetime fitness. However, there is a gap in the literature on the population of people who are not quite sedentary but have yet to achieve maintenance of fitness or lifetime fitness. What happens in the liminal period between sedentary and maintaining fitness?

Purpose Statement

The purpose of this study is to examine the efficacy of moderate to vigorous intensity physical activity as a management tool for self-reported anxiety and depression in college age students who engage in regular physical activity.

Hypothesis

It is hypothesized that: 1. Self-reported anxiety and depression symptom severity will remain constant or improve in both the low and vigorous intensity physical activity

groups; 2. Compared to the low intensity physical activity group, the vigorous intensity physical activity group will report similar or improved levels of self-reported anxiety and depression symptom severity.

Significance

The results of this study may provide new insight on the role physical activity plays in the ongoing management of self-reported anxiety and depression. Additionally, the results of this study may encourage the research and development of physical activity guidelines specific to mental health outcomes.

Methods

Participants

The participants for this study consist of 27 college age students (20 female, 7 male; mean age 20.59 ± 2.19 years; mean weight 143.44 ± 31.174 lbs; mean height 65.98 ± 3.66 inches) who attend the University of Nevada, Reno and enrolled in one of the following physical activity classes: PEX 169 (yoga) or PEX 176 (general physical fitness). A total of 5 classes were used for recruitment, 3 were general fitness and 2 were yoga. The physical activity classes conducted 50-minute sessions twice a week. Exclusion criteria is defined as anyone 30 years of age or older or anyone who is not cleared for physical activity by their physician. All participants who successfully completed the study were compensated with a \$10 Amazon gift card.

Location

All data was collected at the E.L. Wiegand Fitness center, as it is the location of the PEX 169 and PEX 176 classes.

Assessment

Self-reported anxiety and depression. The self-reported anxiety and depression severity for the low intensity and vigorous intensity physical activity groups were quantified using the PHQ-9 and GAD-7 combined assessment, called the Patient Health Questionnaire Anxiety-Depression Scale (PHQ-ADS). Previous research has verified the internal reliability, as well as the construct and convergent validity of the PHQ-ADS (Kroenke et al., 2016). Additionally, researchers noted that the PHQ-ADS has high internal consistency among university age students (Rahman et al., 2022).

Data Collection

A screening questionnaire was delivered during the week of October 30th, 2023, to determine participant demographic data. After completing the last physical activity class each week from November 6, 2023, to December 1, 2023, participants completed the PHQ-ADS questionnaire by scanning a QR code to complete an online version of the questionnaire hosted on Qualtrics.

Data Analysis

Data collected using the PHQ-ADS questionnaire was analyzed using SPSS v29.0 (IBM, Armonk, NY, USA). A 2x4 factorial ANOVA was conducted to compare the average weekly PHQ-ADS questionnaire results within and between the low intensity and vigorous intensity groups.

Results

Table 1.

	Age	Height (inches)	Weight (lbs)	Number of participants
Total	20.59 ± 2.19	65.98 ± 3.65	143.44 ± 31.17	27
Male	20.14 ± 1.68	70.14 ± 2.73	169.29 ± 37.96	7
Female	20.75 ± 2.36	64.53 ± 2.70	134.40 ± 23.29	20
Yoga	21.80 ± 2.74	65.00 ± 2.98	139.40 ± 26.00	10
General Fitness	19.88 ± 1.45	66.56 ± 3.97	145.82 ± 34.39	17

Demographic data of study participants depicting age, height, weight, and sex distribution.

Table 2.

		Variable	p-values
Standard Univariate Assumption		Week	0.804
		Physical activity type	0.468
		Interaction	0.768
Main Effect Comparison	Week	Week 1 Week 2	0.787
		Week 1 Week 3	0.241
		Week 1 Week 4	0.587
		Week 2 Week 3	0.413
		Week 2 Week 4	0.726
		Week 3 Week 4	0.863
	Physical Activity Type	0.468	
Simple Main Effect Comparison		Yoga 1 Gen 1	0.340
		Yoga 2 Gen 2	0.898
		Yoga 3 Gen 3	0.599
		Yoga 4 Gen 4	0.809

Statistical results and respective p-values.

A two-way repeated measures ANOVA is used to examine how time and type of physical activity affect anxiety and depression scores. The null hypothesis for the statistical analysis states that there is no significant difference in anxiety and depression scores between the two physical activity groups or across the four weeks of data collection, within or between groups. The data is organized using two variables, 'week' and 'patype.' The independent variable 'week' represents time, with four levels, week 1 (w1), week 2 (w2), week 3 (w3), and week 4 (w4). Additionally, 'week' is the repeated measures factor. The second independent variable, 'patype,' represents the physical intensity of the groups, with two levels, low intensity (yoga) and vigorous intensity

(general physical fitness). The dependent variable for the study is the anxiety and depression scores of the participants.

Using Mauchly's test, sphericity is assumed for the 'week' variable since the conditions for sphericity were not violated (Mauchly's $W = 0.460$, $X^2 = 2.888$, $df = 5$, $p = 0.726$). Additionally, the conditions for sphericity are not violated for the interaction between physical activity type and time (Mauchly's $W = 0.691$, $X^2 = 1.378$, $df = 5$, $p = 0.929$). Since sphericity is assumed in both uses of Mauchly's test, the results will be interpreted using the standard univariate assumptions. There were no significant results in the within-subjects effects for 'week' ($p = 0.468$), 'patype' ($p = 0.804$), or the interaction between 'week' and 'patype' ($p = 0.768$). The lack of significance in the standard univariate assumptions mean there is a failure to reject the null hypothesis.

Looking at the main effect for each factor, pairwise comparisons for 'week,' yielded no significant results week to week. Comparing anxiety and depression scores from week 1 to weeks 2, 3, and 4, yielded p-values of 0.787, 0.241, and 0.587, respectively. Comparison of anxiety and depression scores between week 2 and weeks 3 and 4 yielded p-values of 0.413 and 0.726, respectively. Finally, comparison of anxiety and depression scores from weeks 3 and 4 yielded a p-value of 0.863. Additionally, the pairwise comparison for physical activity type yielded no significant results ($p = 0.468$).

Observing the simple main effect comparison of physical activity types across the four weeks, Holm's Bonferroni correction was used to account for alpha slippage across tests. Arranging the p-values from best to worst, are the comparison between the low intensity and vigorous intensity physical activity groups each week; week 1 low vs.

vigorous ($p = 0.340$), week 3 low vs. vigorous ($p = 0.599$), week 4 low vs. vigorous ($p = 0.809$), and week 2 low vs. vigorous ($p = 0.898$). Since there are four levels, the alpha levels for the physical activity and week interaction effect are 0.0125 ($0.05/4 = 0.0125$), 0.0167 ($0.05/3 = 0.0167$), 0.025 ($0.05/2 = 0.025$), and 0.05 ($0.05/1 = 0.05$). There were no significant results and therefore no significant difference between physical activity groups across the four weeks.

Examination of the interaction effect comparison among the four weeks requires Holm's Bonferroni correction to account for error rate across tests. Arrangement of the p -values from best to worst compare the difference of differences between physical activity groups across weeks; week 1 low vs. vigorous and week 2 low vs. vigorous ($p = 0.233$), week 2 low vs. vigorous and week 4 low vs. vigorous ($p = 0.541$), week 2 low vs. vigorous and week 3 low vs. vigorous ($p = 0.573$), week 1 low vs. vigorous and week 3 low vs. vigorous ($p = 0.820$), week 1 low vs. vigorous and week 4 low vs. vigorous ($p = 0.846$), week 3 low vs. vigorous and week 4 low vs. vigorous ($p = 0.922$). Since there are six levels, the alpha levels for the interaction comparison are 0.0083 ($0.05/6 = 0.0083$), 0.01 ($0.05/5 = 0.01$), 0.0125 ($0.05/4 = 0.0125$), 0.0167 ($0.05/3 = 0.0167$), 0.025 ($0.05/2 = 0.025$), and 0.05 ($0.05/1 = 0.05$). There were no significant results and therefore no significant interactions between physical activity groups each week across the four weeks. Finally, observation of the polynomial contrast results yielded no significant results and no linear trend ($p = 0.457$) across the four weeks.

The results support the conclusion that there is no significant difference in anxiety and depression regardless of physical activity intensity from weeks 12 to 16 of regular physical activity.

Discussion

After 12 weeks of regular physical activity, self-reported anxiety and depression levels were maintained through 16 weeks. There was no significant difference observed in self-reported anxiety and depression scores between ($p > 0.05$) or within ($p > 0.05$) groups across the four weeks of observation. The results of this study may oppose previous researchers' conclusions that low intensity physical activity is more effective at managing anxiety and depression compared to vigorous intensity physical activity (Helgadóttir et al., 2017). There are several possibilities for the differences in results. Firstly, this study was a quasi-experimental study, with no control group, while the previous literature was a randomized control trial with a "treatment as usual" group serving as the control group. Additionally, the previous study included a moderate intensity group. Furthermore, the intervention and measurement of depression symptoms lasted 12 weeks in total, while this study observed participants from weeks 12 through 16. Another difference is the age group of participants; in this study only ages 18-29 were included, however in the previous study the participants' ages ranged from 18-67. Finally, the use of different measurement tools for symptoms of anxiety and depression could be responsible for the difference in results. However, the results of this study remain

promising for viewing and utilizing physical activity as a method for managing anxiety and depression beyond immediate short-term interventions.

Unfortunately, this study is rife with limitations and confounds. Six participants were eliminated due to incomplete surveys, one participant was eliminated due to age. Additionally, the study had a small sample size with an unequal distribution of the sex of participants, with 20 female participants and 7 male participants for a total of 27 participants. Furthermore, the uneven group size between the low and vigorous intensity groups is another confounding factor, with 10 and 17 participants, respectively in each group.

A severe limiting factor of the study is the inconsistent survey completion by participants on a weekly basis. Not all participants completed all four surveys; if participants completed less than two surveys, their data was excluded. Additionally, week 3 of data collection occurred during Thanksgiving week, and many participants were not present that week, so their data could not be collected. Also, if participants skipped any physical activity sessions, it was not possible to collect their data for that week.

Another severe limiting factor of this study is the lack of a true baseline by collecting anxiety and depression scores at week 1 of physical activity. While the results can be indicative of maintenance of anxiety and depression scores, it is impossible to determine changes in anxiety and depression scores in the first 12 weeks of physical activity. The final limiting factor for this study is the self-selection of physical activity groups by the participants prior to the commencement of the study. Participants may have

chosen a specific type of physical activity with the expectation that it would help their mental health, which further confounds the data and results.

Conclusion

Physical activity, regardless of intensity, has an entire host of benefits to both physical and mental health. Consistency and maintenance of a regular physical activity routine are an essential in maintaining physical and mental health. The results of this study should encourage other researchers to continue to examine the period between the end of a physical activity intervention and long-term lifestyle and behavioral change. Recommendations for future research include observing non-sedentary and non-lifetime fitness populations, as well as examining anxiety and depression in those who are maintaining fitness in conjunction with contemporary conventional treatments such as talk therapy and pharmaceuticals.

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