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The Effects of Different Forms of Exercise on Short-Term Mental Health

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Abstract

The current study had two goals: (1) to investigate how acute exercise can improve short-term mental health in an ecologically valid setting and (2) to determine whether different forms of acute exercise (aerobic vs. anaerobic) affect mental health differently. To explore these questions, we recruited participants from various exercise classes at the UCSB Recreation Center and the Robertson Gym. Participants were given one survey before their exercise class and one after. Both surveys had indices that measured four aspects of mental health: perceived stress, anxiety, positive affect, and negative affect. To answer question one, we analyzed how these indices changed from pre- to post- exercise class across all participants. To answer question two, we analyzed whether or not there were greater improvements in the four indices depending on the exercise type (anaerobic or aerobic). Based on prior research, we predicted that perceived stress, anxiety, positive affect, and negative affect would improve from pre to posttest and that aerobic exercises would produce more improvements than anaerobic exercise. Consistent with our first hypothesis, we found statistically significant improvements from pre to posttest across all four measures. However, we did not find statistically significant differences between acute aerobic and anaerobic exercise in modulating improvements to mental health. Our results indicate that exercise is an effective way to improve short-term mental health. Further, either form of exercise (anaerobic or aerobic) can be performed to achieve a similar effect.

The Effects of Different Forms of Exercise on Short-Term Mental Health

The CDC recommends 150 minutes of moderate exercise each week to manage weight, reduce the risk of cardiovascular disease and diabetes, strengthen bones and muscles, and improve longevity (CDC, 2022). These physical benefits have been generally well known for decades now. Moreover, the role of exercise in improving mental health has been increasingly studied and is becoming more well known.

Exercise is profoundly beneficial for mental health in the long term (Stathopoulou et al., 2006). A recent cross-sectional study on a large population-based sample (1.2 million Americans over four years) found that individuals who regularly exercised experienced almost half as many days of poor mental health compared to those who did not (Chekroud et al., 2018). These results have been mirrored by studies exploring the effects of consistent exercise on individual components of mental health. For example, regular exercise has been shown to improve affect, or the “experience of feeling or emotion” (Szabo et al., 1998; VandenBos, 2015), decrease anxiety (Mochovitch et al., 2016), and augment mental well-being while decreasing stress (Starkweather, 2007). Further, regular exercise has been shown to help alleviate symptoms and aid in treatment for several forms of mental illness ranging from alcohol abuse to depression (Byrne & Byrne, 1993; Stathopoulou et al., 2006).

Much of the literature analyzing the link between exercise and mental health uses aerobic exercise as the independent variable to represent the broader category of “exercise.” Aerobic exercise is simply exercise that uses oxygen to produce energy in the body in the form of adenosine triphosphate (ATP). Anaerobic exercise, on the other hand, does not use oxygen to create ATP. Instead, during anaerobic exercise, energy is produced using a process called glycolysis in which ATP is formed from glucose. Aerobic exercise is sustained for longer periods of time and includes exercises like jogging, walking, and swimming. Anaerobic exercise, on the other hand, is typically characterized by shorter bursts of high intensity activity such as weightlifting or sprinting (Plowman & Smith, 2007).

There have been several studies comparing the effects of different exercise types (i.e., anaerobic vs. aerobic) on long-term mental health. Much of this literature explores whether or not one form of exercise does a better job than the other at reducing symptoms of psychopathology (e.g., depression, generalized anxiety). In this context, there is little evidence that there is a significant difference in mental health outcomes between the two exercise types (Byrne & Byrne, 1993; Kovach-Anta & Marguerite, 1998). In contrast, a study that compared the long-term mental health effects of aerobic and anaerobic exercise on a sample of non-athlete males found that anaerobic exercise was more effective in augmenting happiness and reducing stress and anxiety in the long-term (Kianian et al., 2018).

Thus, the research clearly shows that engaging in any regular exercise is beneficial for mental health, but what are the mental health effects after a *single bout* of exercise? Studies have shown that acute exercise improves short-term mood (Yeung, 1996), stress, and anxiety (Szabo et al., 2012). Given that acute exercise enhances psychological well-being, researchers have explored the mechanisms through which these benefits occur. Consequently, some studies have directly examined the difference between acute anaerobic and aerobic exercise on mental health outcomes. One experimental study, for example, found a reduction of anxious symptoms in the aerobic group but no differences in the anaerobic group

(Raglin et al., 1993). In contrast, another experimental study found that both modes of exercise were effective in improving mood with no differences between the two groups (Chase & Hutchinson, 2015).

Though these experimental studies provide helpful information about the mental-health benefits of exercise, they do not give us the full picture. Specifically, much of the previous work was conducted in the lab and, thus, lacks a degree of ecological validity. That is, these studies are somewhat unrepresentative of how individuals actually exercise in their daily lives. Field studies address this methodological issue by studying people exercising in their typical setting. In one field study, for example, Rendi et al. (2008) collected data from individuals exercising at a gym and found that 20 minutes of treadmill or cycling exercise (both aerobic in nature) led to significant improvements in mood from baseline. However, most field studies analyzing exercise and mental health focus on the differences between indoor and outdoor exercise without directly comparing the effects of acute anaerobic and aerobic exercise. In one such study, Klaperski et al. (2019) found evidence supporting prior findings that exercise improves mood, anxiety, and stress. Further, outdoor exercise was reported to be more calming and seemed to be better at reducing stress. Due to these literary gaps, the current study will investigate the impact of different forms of exercise (aerobic vs. anaerobic) on important mental health indices in an ecologically valid setting. In sum, there are two goals for the proposed study: (1) to explore the effects of acute exercise on mental health in a naturalistic setting, and (2) to investigate whether different exercise types (aerobic vs. anaerobic) affect mental health differently. To assess mental well-being, we will measure perceived stress, anxiety, and affect (positive and negative) before and after exercise. We hypothesize that stress, anxiety, positive affect, and negative affect will improve from pre- to post-exercise class based on prior experimental work. Further, we predict that participants who engage in aerobic exercise will experience greater improvements in mental well-being compared to those who engage in anaerobic exercise. Given the lack of literature directly comparing the impact of the two forms of exercise on mental health outcomes, this prediction is primarily informed by the findings of Raglin et al. (1993) that suggests acute aerobic exercise may improve anxiety while anaerobic exercise does not.

Method

Design

This quasi-experimental field study utilized a 2 (time: before vs. after) × 2 (type of exercise: aerobic vs. anaerobic) mixed design. Dependent variables were self-reported measures of affect, perceived stress, and anxiety collected from individuals *before and after* they engaged in an exercise class (within-subjects component). To determine if there were differences in exercise types, participants were recruited from either aerobic (e.g., cycling) or anaerobic (e.g., weightlifting) classes (between-subjects component).

Participants

Individuals who signed up for fitness classes with the UCSB Department of Recreation during spring 2022 were eligible to participate in the study. Participants were recruited as they arrived for their

prescheduled fitness class at the UCSB Recreation Center (Rec Cen) or Robertson Gymnasium (Rob Gym). For five weeks during popular class times (Monday through Thursday in the afternoon/evening), the research team was stationed at either the outdoor lawn at the Rec Cen or inside the lobby of Rob Gym. Interested individuals were given flyers with information about the study as they passed our table if they were unable to participate at the time. Participants were compensated for their participation with snacks (chips, a granola bar, and a sports drink), a \$5 gift card, and entry into a raffle for the chance to win one of four \$50 gift cards.

Of the 79 total participants sampled, 61 were undergraduates, 15 were graduate students, and one was a community member of the Recreation Center (two others did not report). The sample consisted of 64 women, six men, two gender neutral/non-binary individuals, one individual who self-described as male as being assigned male at birth, and eight individuals who elected not to report their genders. Participants were primarily college aged ($M = 21.34$, $SD = 2.71$) but ranged in age from 18 to 31. Finally, 26 participants were white, 25 were Asian or Asian American, 11 were Latino, 11 were multiracial, one was Black or African American, one was Middle Eastern or North African, and four others did not report their race/ethnicity.

Participants engaged in a wide variety of different exercise classes. In total, 33 individuals participated in dance classes, 16 in cycling, 16 in yoga or Pilates, six in general fitness classes, five in martial arts, and three in swimming. These classes were then further categorized into anaerobic or aerobic based on the class name, class description, and how the exercises performed in each class are generally classified (Plowman & Smith, 2007). Classes that primarily utilized exercises with short-bursts of high intensity movements were classified as *anaerobic*, while classes with movements performed at low-to-moderate intensity for long durations were considered *aerobic*. Some classes engaged aspects of both aerobic and anaerobic exercise. For example, some martial arts classes employed aerobic exercises for conditioning and learning techniques, while others employed anaerobic exercises if participants were engaging in high-intensity sparring. These classes were categorized as either anaerobic or aerobic based on the self-reported exertion of the participant. If the exertion level was especially high (i.e., perceived exertion was reported as “hard” or higher on the scale) the participant’s class was classified as anaerobic; if the exertion level was moderate or low (i.e., perceived exertion was reported as “somewhat hard,” “light,” or lower on the scale), the class was classified as aerobic. This rationale was based on the fact that anaerobic exercise is associated with short bouts of high-intensity movements while aerobic exercise is typically longer in duration and less intense (Plowman & Smith, 2007). In total, 20 participants performed anaerobic exercise and 59 participants performed aerobic exercise.

Procedure

After providing informed consent, participants completed the first (pre-exercise) survey. In this first survey, they provided their demographic information as well as how they were currently feeling *before* they exercised. Specifically, participants responded to questions about their current stress levels, anxiety, and affect. The participants then engaged in their fitness class. After their class, they completed the post-exercise survey. They reported on specific characteristics of the fitness class they engaged in as

well as how they were feeling (current stress, anxiety, and affect) *after* they exercised. Finally, participants were thanked, and given a \$5 gift card, snacks, and a sports drink.

Measures

Perceived Stress

To measure participant stress, each survey contained a modified version of the 4-item Perceived Stress Scale (PSS-4) (Cohen et al., 1983). The original scale was designed to measure participant stress over a one-month period. To fit the parameters of this study, the questions were modified to represent participant stress at the time the survey was administered (before or after exercise), with higher scores indicating higher perceived stress. For example, the original question “In the last month, how often have you felt that things were going your way?” was modified to “Right now, to what extent do you feel that things are going your way?” Certain items (like the item above) needed to be reverse scored so they would appropriately indicate higher perceived stress (see Appendix A for the survey items). Participants responded on a 7-point Likert scale (1 = *not at all*, 7 = *extremely*) to what degree each of the seven items reflected their current perceived stress. Two perceived stress composites (before and after measures) were computed by averaging the four items together (pre-exercise $\alpha = .72$, postexercise $\alpha = .72$).

Anxiety

Participant anxiety was measured using a modified 6-item version of the State-Trait Anxiety Inventory (STAI-6; Marteau & Bekker, 1992). On a 7-point Likert scale (1 = *not at all*, 7 = *extremely*), participants reported the extent to which they felt each item at the current moment. Sample items included “comfortable” and “nervous” (see Appendix B for the survey items). To compute the before and after anxiety composites, we took the mean of the six items at each time point, with higher scores representing higher state anxiety. Some items were reverse scored to ensure a higher score represented higher state anxiety (pre-exercise $\alpha = .79$, postexercise $\alpha = .67$).

Positive and Negative Affect

Finally, participant affect was measured using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Participants reported how well each of 18 emotions (nine positive and nine negative) aligned with their current affect on a 7-point Likert scale (1 = *not at all*, 7 = *extremely*.) Sample positive affect items included “interested” and “enthusiastic”; sample negative affect items included “distressed” and “downhearted” (see Appendix C for the survey items). Positive affect was computed by averaging the nine positive items (pre-exercise $\alpha = .92$, postexercise $\alpha = .89$), and negative affect was computed by averaging the nine negative affect items (pre-exercise $\alpha = .61$, postexercise $\alpha = .88$). Higher scores for each composite reflect higher positive or negative affect, respectively.

Perceived Exertion

Additionally, an item was added to measure the perceived exertion participants felt during their exercise classes. Participants responded to the question, “How strenuous was the class you just took?” on a 15 point Likert scale (6 = *no exertion*, 20 = *maximal exertion*)(see Appendix D for the survey items).

Results

Effect of Acute Exercise on Short-Term Mental Health

To explore our first research question, we conducted four paired sample *t*-tests to analyze the differences in the four mental health indices from pre- to post-exercise class. Group means, *t*-tests, and effect sizes (Cohen’s *d*) are reported in Table 1. Perceived stress, anxiety, positive affect, and negative affect all improved significantly from pre to posttest indicating that acute exercise plays a role in improving short-term mental health. That is, as shown in Figure 1, stress, anxiety, and negative affect decreased while positive affect increased from pre- to post-exercise class (see Figure 1). Positive affect improved the most from pre to posttest while the effect on anxiety and perceived stress was moderate. The effect on negative affect was relatively low.

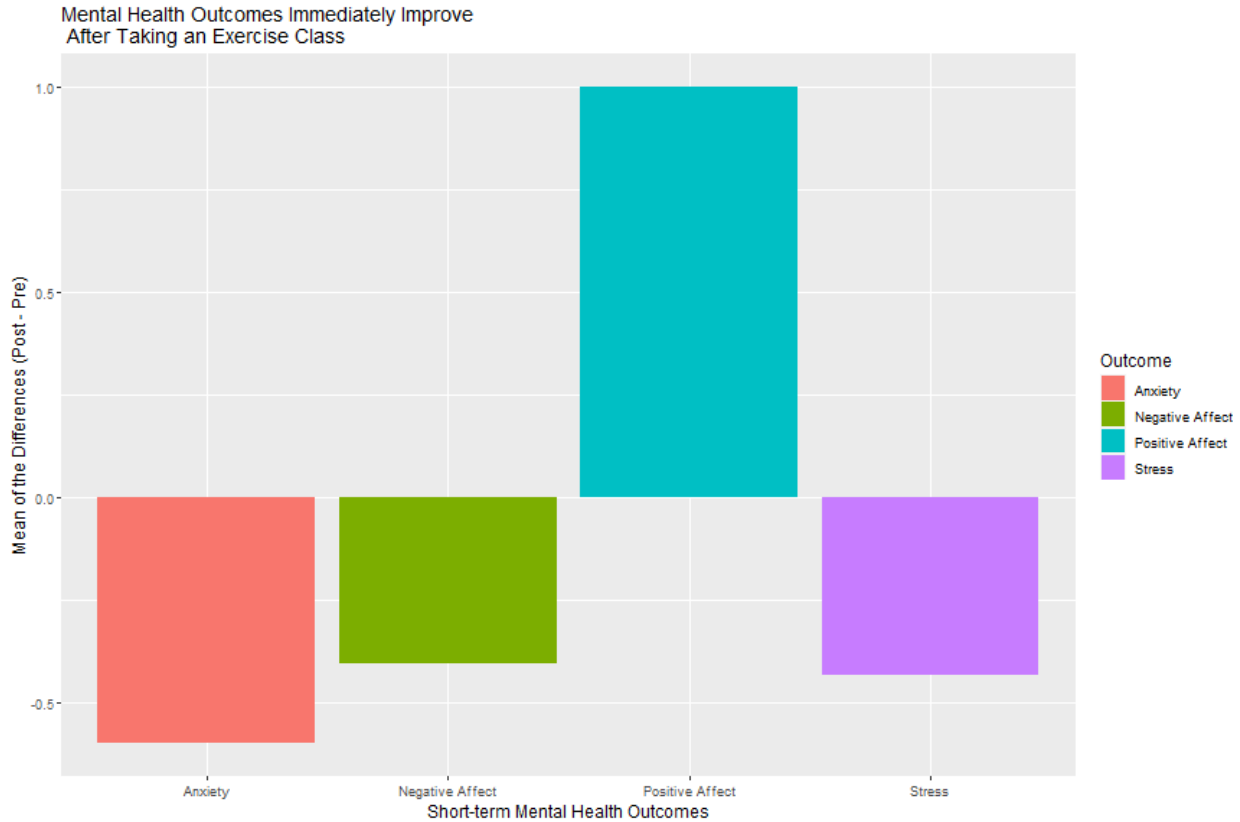
Table 1

Differences in Measures of Mental Health from Pre- to Post-Exercise Class

Measure	Pre-Class Descriptives	Post-Class Descriptives	<i>t</i>	<i>p</i> -value	Cohen's <i>d</i> 95% CI for <i>d</i>
Perceived stress	<i>M</i> = 3.29 <i>SD</i> = 1.97	<i>M</i> = 2.87 <i>SD</i> = 1.00	<i>t</i> (77) = -5.91	<i>p</i> < .001***	<i>d</i> = -0.67 CI [-0.92, -0.42]
Anxiety	<i>M</i> = 3.16 <i>SD</i> = 1.06	<i>M</i> = 2.54 <i>SD</i> = 0.91	<i>t</i> (75) = -4.92	<i>p</i> < .001***	<i>d</i> = -0.56 CI [-0.81, -0.32]
Positive Affect	<i>M</i> = 3.70 <i>SD</i> = 1.23	<i>M</i> = 4.68 <i>SD</i> = 1.23	<i>t</i> (75) = 7.92	<i>p</i> < .001***	<i>d</i> = 0.91 CI [0.64, 1.18]
Negative Affect	<i>M</i> = 2.16 <i>SD</i> = 0.99	<i>M</i> = 1.79 <i>SD</i> = 0.91	<i>t</i> (75) = -3.21	<i>p</i> < .01**	<i>d</i> = -0.37 CI [-0.60, -0.14]

Figure 1

Change in Mental Health Outcomes from Pre- to Post- Exercise Class



Anaerobic vs. Aerobic Exercise

To answer our second research question, four two-way mixed ANOVAs were conducted to determine if the type of exercise (anaerobic vs. aerobic) modulated improvements in mental health from before to after the exercise (see Table 2). For each analysis, time was entered as the within-subjects variable and exercise type was entered as the between-subjects variable. Each mental health index was the dependent variable.

First, we examined how the type of exercise (aerobic vs. anaerobic) and time of the survey (before vs. after class) contributed to perceived stress. Consistent with the paired t -tests reported above and as expected, there was a significant main effect of time, $F(1,76) = 26.49, p < .001, \eta^2_p = .033$. However, there was not a main effect of exercise type, $F(1,76) = 0.12, p = .73, \eta^2_p = .001$, and there was no significant interaction, $F(1,76) = 0.02, p = .96, \eta^2_p < .001$.

Next, we analyzed how the type of exercise and time of the survey impacted anxiety. Again, there was a significant main effect of time, $F(1,74) = 17.05, p < .001, \eta^2_p = .06$. There was no significant main effect of exercise type, $F(1,74) = 1.03, p = .31, \eta^2_p = .009$, and no significant interaction, $F(1,74) = 0.04, p = .83, \eta^2_p < .001$.

We then explored the effect of these two factors on positive affect. Consistent with the previous two measures, there was a significant main effect of time, $F(1,74) = 45.54, p < .001, \eta^2_p = .11$. Also consistent,

there was no significant main effect of exercise type, $F(1,74) = .01, p = .92 \eta^2_p < .001$, and no significant interaction, $F(1,74) = 0.16, p = .69 \eta^2_p < .001$.

Finally, we examined how exercise type and time of the survey impacted negative affect. We again found a significant main effect of time, $F(1,74) = 5.39, p = .02 \eta^2_p = .02$, did not find a main effect of exercise type, $F(1,74) = .19, p = .66 \eta^2_p = .002$, and found no interaction, $F(1,74) = .83, p = .36 \eta^2_p = .004$.

In summary, we found no evidence to support that the type of exercise played any role in moderating how exercise affects perceived stress, anxiety, positive affect, or negative affect.

Table 2

Differences in Mental Health Outcomes from Pre- to Post-exercise for Anaerobic vs. Aerobic Classes

Measure	Type of Exercise	Time	M (SD)
Perceived Stress	Anaerobic	Pre-exercise	3.22 (0.96)
		Post-exercise	2.78 (1.04)
	Aerobic	Pre-exercise	3.31 (1.11)
		Post-exercise	2.88 (0.99)
Anxiety	Anaerobic	Pre-exercise	2.93 (1.17)
		Post-exercise	2.34 (0.99)
	Aerobic	Pre-exercise	3.18 (1.03)
		Post-exercise	2.56 (0.88)
Positive Affect	Anaerobic	Pre-exercise	3.77 (0.78)
		Post-exercise	4.68 (1.17)
	Aerobic	Pre-exercise	3.69 (1.36)
		Post-exercise	4.71 (1.26)

Negative Affect	Anaerobic	Pre-exercise	2.13 (0.82)
		Post-exercise	1.93 (0.97)
	Aerobic	Pre-exercise	2.18 (1.04)
		Post-exercise	1.71 (0.90)

Discussion

The two goals of this project were to (1) explore how exercise affects short-term mental health in an ecologically valid setting and (2) compare the efficacy of acute aerobic and anaerobic exercise at augmenting short-term mental health. Participants were recruited before they engaged in their regular exercise classes. Their mental health was assessed using measures that quantified their levels of perceived stress, anxiety, positive affect, and negative affect. We predicted that individuals who engaged in either type of exercise would experience subjective improvement across all four measures. Moreover, we hypothesized that individuals who performed acute aerobic exercise would experience greater improvements to their short-term mental health than individuals who performed acute anaerobic exercise.

Consistent with our first hypothesis, there were significant improvements from pre- to post-exercise class in self-reported perceived stress, anxiety, positive affect, and negative affect. By demonstrating the effect in an ecologically valid setting, these findings support prior research suggesting that acute exercise can improve short-term mental health. Moreover, while the effect of exercise for all four measures were notable, our analyses showed that acute exercise seems to have the greatest impact on improving short-term positive affect.

We did not find support for our second hypothesis that acute aerobic vs. anaerobic exercise leads to greater improvements in short-term mental health. Instead, our analyses showed little to no difference between anaerobic and aerobic exercise with regard to improving mental health. This suggests that both exercise types are essentially the same at providing positive short-term mental health outcomes. Our results primarily support the findings of Chase and Hutchinson (2015), who found no difference between acute anaerobic and aerobic exercise at improving mood. Moreover, our results indicate that not only are anaerobic and aerobic exercise similar at improving mood, but other components of overall mental health (i.e. anxiety and perceived stress). Our results are in contrast with Raglin et al. (1993), who found that only acute aerobic exercise improved anxiety immediately after exercise. These differences may have been, in part, due to the relative lack of statistical power afforded for the between-subjects analyses that came from the small sample size of the anaerobic group.

Limitations and Future Directions

The current study contributed to existing literature on exercise and mental health in two major ways. First, it further explored the relationship between exercise and mental health in a setting that was externally valid to the way in which individuals exercise in their day-to-day lives. Second, it specifically analyzed the differences between the efficacy of acute aerobic and anaerobic exercise at improving short-term mental health. One other important strength of the current study was our repeated measures design, which increased the statistical power of our results. That being said, there are several limitations in the current study that future work should account for.

First, to further maximize ecological validity, future research should sample participants that are not exercising in fitness classes. We are aware that many individuals do not participate in exercise classes as their means of regular exercise, which limits our ability to generalize our results. Further, many of the classes individuals participated in were fun activities that may have helped improve participant mental health independent of the exercise being performed. For example, individuals in dance classes may have had improvements across the four measures because they enjoy dancing, not just because they were exercising. Finally, one could argue that some of the exercise classes that were sampled had elements of both anaerobic and aerobic exercise. With that being said, classes were carefully sorted into each category based on the description of the course and perceived exertion of the participant to ensure that they fit into our analyses correctly. Despite this, future replications should perform a more controlled experimental comparison of the two exercise types to control for these potentially confounding factors.

Though ecological validity and experimental control should be independently maximized in future replications, our method provided us a bit of both. For example, sampling from classes gave us some control over other, potentially confounding, factors that are present when sampling individuals in an ecologically valid setting. For example, participants exercising outside of a class may be working out with friends (or alone) which would introduce a social (or nonsocial) element that would have to be considered during analysis. By sampling people from exercise classes, the social setting was relatively similar for everyone. Further, when sampling individuals performing their own workouts, there may be differences in exertion from participant-to-participant depending on the specific workout they decide to do. Sampling from individuals in exercise classes ensured that all the participants in that class were performing the same routine. To this end, future research analyzing participants performing their own workouts should utilize exercise monitors to control for some of these interpersonal differences in exertion. Future research should also sample individuals from a wider range of ages. We sampled almost exclusively college-aged females. This greatly reduced the generalizability of our results and should be a priority of future work.

Conclusion

In sum, our results provided support for prior research suggesting that acute exercise can improve short-term mental health. We found no difference between aerobic and anaerobic exercise at improving mental health. This is important as it demonstrates that any form of exercise can provide significant improvements to short-term mental health for individuals who are seeking improvement. Finally, the

current study provides reason for future research to look more into the effects of anaerobic exercise on mental health as the literature is currently relatively sparse.

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Appendix A
Modified PSS-4

To what extent do you feel each of the following emotions right now?

1-----2-----3-----4-----5-----6-----7

Not at all

Moderately

Extremely

_____ that you are *unable* to control the important things in your life?

_____ confident in your ability to handle your personal problems?

_____ that things are going your way?

_____ that difficulties are piling up so high that you *cannot* overcome them?

Appendix B
Modified STAI-6

To what extent do you feel each of the following emotions right now?

1-----2-----3-----4-----5-----6-----7

Not at all

Moderately

Extremely

_____ Comfortable

_____ At ease

_____ Nervous

_____ Concerned

_____ Good

Appendix C

Modified PANAS

To what extent do you feel each of the following emotions right now?

1-----2-----3-----4-----5-----6-----7

Not at all

Moderately

Extremely

_____ Interested

_____ Angry at myself

_____ Blameworthy/ Ashamed

_____ Happy

_____ Determined

_____ Sad / Blue

_____ Upset

_____ Proud

_____ Confident

_____ Enthusiastic

_____ Worried

_____ Sluggish

_____ Distressed

_____ Strong

_____ Irritable

_____ Lonely

_____ Inspired

_____ Dissatisfied with myself

_____ Energetic

Appendix D

Perceived Exertion

How strenuous was the class you just took? Please circle the number to rate your *perception of your physical exertion during the class*.

6-----7-----8-----9-----10-----11-----12-----13-----14-----15-----16-----17-----18-----19-----20

No	Extremely	Very	Light	Somewhat	Hard	Very	Extremely	Maximal
exertion	light	light		hard		hard	hard	exertion