

ABSTRACT

THE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING ON WELL-BEING AND BMI IN DOCTOR OF PHYSICAL THERAPY STUDENTS

Approximately 46.6 million adults suffer from a mental illness in the United States.^{1,2} Students have up to a 32% chance of developing a common psychiatric disorder, with graduate students having higher levels compared to undergraduates.^{3,4,5} Stress has negative effects on graduate students' psychological and physiological health. Exercise, specifically high intensity interval training (HIIT) has been supported to improve overall health. The purpose of this pilot study is to determine if providing a HIIT workout will have an effect on stress management in the doctoral students enrolled in the Doctor of Physical Therapy (DPT) program at Fresno State. The primary hypothesis is there will be a statistically significant improvement on well-being and body mass index (BMI) in doctoral students participating in a HIIT intervention compared to the control group. The null hypothesis is there will not be a statistically significant improvement. Thirty-nine healthy young individuals were recruited from the DPT program at Fresno State. The experimental group participated in HIIT, twice a week for 8 weeks. Results indicate that there are no significant improvements in well-being or BMI in those participating in a HIIT intervention compared to the control group. Due to the negative consequences of stress, clinical relevance is to determine if providing students enrolled in the DPT program at Fresno State with resources, such as HIIT, will improve overall well-being.

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May 2020

THE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING
ON WELL-BEING AND BMI IN DOCTOR OF PHYSICAL
THERAPY STUDENTS

by
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A project
submitted in partial
fulfillment of the requirements for the degree of
Doctor of Physical Therapy
in the Department of Physical Therapy
College of Health and Human Services
California State University, Fresno
May 2020

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ACKNOWLEDGMENTS

I would first and foremost like to thank my family for their love and support throughout the most challenging, yet rewarding 3 years of my life. Thank you for always believing in me and encouraging me to pursue my dream of becoming a physical therapist. Thank you to my dear friends Samantha Mendoza, Alyson Huber, Kari Turner, and Mason Rivera for the endless support, encouragement, and laughs throughout the entire 3 years. No matter how difficult the journey was, you made the process easier and so much more enjoyable. I am so blessed and grateful to have crossed paths with you and gain life-long friends. Thank you to my friend and colleague, Noelle Tarazona for being a great, reliable and hard-working research partner. It has been a pleasure sharing your ambition and partnership through this research project. Lastly, I would like to thank my research panel Dr. Jennifer Roos, PT, DPT, GCS, Dr. Jenna Sawdon-Bea PT, PhD, and Dr. Amy Brogan Ed.D. for pushing me to fullest potential and the constant support not only during this research project, but over the last 3 years. I will forever be grateful for your guidance, encouragement, and mentorship during my time at Fresno State.

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BACKGROUND

In 2017, the National Institute of Mental health reported that there were approximately 46.6 million adults over the age of 18, or 19%, of the entire population suffer from a mental illness in the United States.^{1,2} Of these individuals, the prevalence was higher amongst those between the ages of 18-25 years (22.2² Women (22.3%) were more likely to suffer from a mental illness compared to males (15.1%).² Due to the high prevalence of mental health disorders, \$100 billion dollars is spent annually in the healthcare expenditures and is projected to cost \$16.3 trillion dollars globally by the year 2030.⁶ Increased expense may be due to multi-factorial reasons such as increased awareness and diagnosis and providing individuals with treatments that are readily available. due to increased awareness and diagnosis and readily available treatment.⁷ Although mental health is widely discussed and services are provided to help manage and treat such disorders, the majority of the individuals do not seek assistance. Researchers have reported that 70% of individuals suffering from a mental disorder do not receive proper treatment, with males (34.8%) less likely to seek treatment compared to females (47.6%)^{2,8} It was found that females (47.6%) are more likely to seek assistance compared to males (34.8%).² Several factors influence lack of motivation to seek help to address their mental illness. Factors include prejudice against those who are diagnosed with mental illnesses, ignorance about the treatment, lack of knowledge when identifying features of mental illness, and lastly fear of being discriminated against due to having a mental disorder.⁸ In order to promote wellness throughout the entire population, it is important that individuals are aware of mental illnesses and how greatly it impacts an individual's life.

As defined by the World Health Organization (WHO), “Mental health is a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community.”⁹ Mental health and psychological well-being are essential for individuals to interact with one another, maintain relationships, study and think correctly, portray emotion, enjoy life, pursue interests, and make day to day decisions.⁹ Individuals who have poor mental health lack the ability to make appropriate choices and overall capability to properly function.⁹ Causes of poor mental health include neurological, mental and substance disorders comprising but not limited to stress, anxiety, depression, anorexia, schizophrenia, substance abuse, post-traumatic stress, attention deficit, borderline personality, disruptive mood, and obsessive-compulsive disorders.¹⁰ Risk factors that place individuals at a higher probability for developing illness include genetics, altered brain chemistry, personality, and exposure to different life events.¹¹ It is supported that individuals who have reduced mental health have decreased well-being and in turn, are predisposed to poor health, longevity, social relationships, economic and career success, and are less happy.¹² With the growing population and increasing demands to succeed in life, mental health is becoming increasingly prevalent in today’s society due to the importance to be mentally healthy.

Mental Health and Graduate Students

Poor well-being across the nation leads to instability, loss of productivity, and a less effective functioning society.¹² Although mental illnesses are a problem globally, it is becoming increasingly problematic in the graduate student population. Students are reported to have a 32% chance of developing a common

psychiatric disorder and are more than 6 times more likely to experience a mental illness than the general population.^{3,4} The high prevalence of mental illness in the student population is causing substantial economic and financial burdens. Postgraduate students have as high as a 50% drop-out rate in North America, Australia and the United Kingdom.⁴ Drop-out rates negatively affect universities incoming tuition and tax payers or financiers that invested money into grants and subsidies, that in turn go to waste.¹³ One of the most common sources of poor mental health and decreased well-being in the graduate student population is stress

Graduate Students and Psychological Stress

Psychological stress occurs when an individual perceives a task or the environment as demanding, taxing, or exceeding their adaptive capacity.¹⁴ Graduate students experience higher levels of stress compared to undergraduates due to the high level of difficulty and heavy loads of the academic material while maintaining a required minimum grade point average in order to stay in the program.⁵ Over the years, as the economy and professions continue to grow nationwide, required degree titles have continued to evolve.

Physical therapy programs have evolved nationally to a doctor of physical therapy.⁵ The length of the academic year or rather the weeks spent in the classroom have decreased over the years, but the average time the student spends in classroom has increased.⁵ These demands increase the challenge placed on the student, exposing them to increased stress.⁵ Seventy percent of graduate students will experience stress throughout the academic year.¹⁵ One specific graduate program that has been observed and found to have students with high levels of stress, is students who are enrolled in Doctorate of Physical Therapy (DPT) programs.¹⁶

Due to the increasing demands that the DPT program places on the students, determining stress perceptions across cohorts is growing concern to attempt to understand overall concerns and well-being.⁵ Frank et al. observed stress and anxiety of students within 3 professional DPT programs.⁵ This study supports that although no significant difference of perceived stress was found between the first and second year DPT students, second years were found to have significantly higher state anxiety scores.⁵ Because psychological distress and emotional exhaustion can negatively influence the graduate student's educational outcome, degree completion and overall well-being, it is important to determine the causes of stress to better understand how to assist the students.⁴

Causative factors of stress self-reported by graduate students include finances, career planning, family issues, teaching and assistantships, school work, exams, grades, heavy workloads, long hours of studying and lack of free time.^{5,15} Consequently, stress hinders a student's ability to complete academic work due to decreased concentration and motivation, procrastination, distraction, self-doubt and decreased confidence and ability to problem solve.⁴ In addition, stress causes students to feel lonely, sad, overwhelmed, and worried, decreasing well-being.⁴ Not only does stress have negative effects on student's psychological health, stress has a large impact on student's decreased physical health and well-being.

Effects of Stress on Physiological Health

In addition to psychological stress having a negative effect on graduate student's mental health and well-being, repetitive stress plays a large role in a student's physiological health. Chronic or repetitive stress increases the chance of development of cardiovascular diseases and hypertension.¹⁴ It is believed that the sympathetic nervous system plays a large role in the relationship between stress

and increased blood pressure.¹⁴ Sympathetic responses to acute stress include increased heart rate, cardiac output and blood pressure.¹⁴ Although it is not widely understood due to lack of evidence, it is believed that when an individual is repeatedly exposed to stress, the sympathetic nervous system is repeatedly activated, eventually leading to decreased ability for the blood pressure to return to prior resting levels.¹⁴ Furthermore, the body's ability to maintain homeostasis is damaged, leading to failure and consequently predisposing them to cardiovascular disease.¹⁴ In addition to cardiovascular health issues, repetitive stress can predispose an individual to reduced immune responses, headaches, depression, cancer, addiction, and obesity.^{5,17}

A significant correlation has been found between uncontrollable stressful events or chronic stress and body mass index (BMI), weight gain, and adiposity.^{18,19} Those who are exposed to repeated stress have an increased risk for obesity and are more vulnerable to stress-related food consumption and consequent weight gain.²⁰ Acute stress is found to significantly alter individuals eating patterns including bingeing, skipping meals or restraining intake.²¹ In addition, stress alters the individual's food preference and increases the likelihood to consume calorie dense and highly palatable foods, fast foods, and snacks.²²⁻²⁴ Wardle et al. notes that 73% of students report that they snack more frequently when stressed and 42% of students report increased intake of food.²³ Changes in individuals eating behaviors ultimately effects insulin sensitivity, carbohydrate metabolism, energy regulation and metabolism.²⁵ In addition to stress increasing the risk of poor eating habits, stress increases sedentary behavior.²⁵ Both objective and subjective measures of stress are found to cause reduced levels of physical activity which further leads to weight gain and increased BMI.²⁵ Beyond having

positive psychological effects, exercise also provides further benefits to address the aforementioned physiological health issues.²⁶

Stress Management

Common coping strategies graduate students use to manage academic stress include, but are not limited to eating, exercise, meditation, prescribed medication, sleep, use of alcohol and drugs, watching television, yoga, counseling/therapy, shopping, and talking with friends.²⁷ Although there are various avenues to manage academic stress, exercise has been amongst the top choice. In addition to managing stress, exercise improves anxiety, depression, self-esteem, self-efficacy, and self-concept making it an appropriate and healthy way to manage mental illnesses.²⁸

Recent studies indicate that all modes of aerobic exercise such as swimming, jogging, cycling, dancing, yoga, meditation, weight lifting and walking are beneficial in improving mental health and overall well-being.^{28,29} Exercise is a healthy, relatively inexpensive, and convenient treatment available to all students that provides an abundance of positive effects both physically and mentally.^{30,31} Regular participation in exercise has been shown to improve body composition, physical capacity and general health.³¹ Most importantly, exercise decreases stress, improve student cognition, academic performance and overall brain function.³¹ Incorporating physical activity into a student's daily regimen improves attention, concentration and increase student's ability to remain on task in and out of the classroom.³¹ Additionally, exercise is not associated with some of the higher risk for adverse effects compared to other coping strategies such as pharmaceuticals, substance or alcohol abuse, over eating, sleeping or binge watching TV.³⁰ Thus,

exercise has been established as a positive and safe form of treatment in decreasing student's stress and improving well-being.^{30,32}

Psychological Effects of Exercise

Animal based studies support that alterations in the human brain, including increased blood flow, oxygenation and metabolism occur with exercise.³³ It is believed that exercise regulates numerous neurotransmitters that affect mental health.³³ Exercise positively affects the uptake of dopamine and in turn, influences serotonin, which is involved in adjusting levels of anxiety.³³ Exercise also plays an important role in regulating catecholamine (epinephrine and norepinephrine) secretions.³³ Norepinephrine is responsible for several effects including, increasing an individual's level of alertness, heightening and stimulating the formation and recovery of memory, increasing alertness, and improving the ability to focus attention.^{33,34} If norepinephrine is not appropriately controlled, anxiety is more likely.

Epinephrine plays an important role in the implementation of long term memory, therefore it is significantly important during a stressful event.³³ Having the ability to recall a specific event allows an individual to respond appropriately or to prevent an individual from repeating similar dangerous acts in the future.^{33,34} For instance, if a child touches a hot burning stove, epinephrine is released to ensure the memory is reinforced regarding the painful experience.^{33,34} Once the memory is reinforced, it is unlikely the child would repeat the action because of the negative consequence that would be recalled.^{33,34} If epinephrine is increased, there may be a rise in negativity regarding a memory involving a fearful stimulus, thus making the individual anxious.^{33,34}

In addition to regulating catecholamine's, exercise promotes the release of endocannabinoids and opioids which stimulate a sense of well-being and euphoria and decreases sensitivity to pain and anxiolytic effects.³⁵ Likewise, neuromodulators such as the brain-derived neurotrophic factor (BDNF), glial cell line-derived neurotrophic factor (GDNF), nerve growth factor (NGF), and several others are stimulated during participation in exercise, which play an important role in determining an individual's overall behavior.³⁶ Not only does stress have a negative influence on one's mental health, exercise decreases an individual's chance of acquiring other health issues that are associated with mental health illnesses. In addition to providing psychological health benefits, exercise improves physiological health.

Effects of Exercise on Physiological Health

Exercise leads to various adaptations in the body, particularly influencing the musculoskeletal and cardiorespiratory systems, metabolism and body composition. Exercise, particularly endurance exercise, increases mitochondriogenesis which causes the shift from glycolytic to oxidative states, increasing oxidation of fatty acids.^{37,38} This in turn improves aerobic capacity, which is important to prevent obesity, cardiovascular diseases and type 2 diabetes.³⁸ Regular exercise also has an effect on enhancing lipoproteins by decreasing triglyceride and low-density lipoprotein levels and increasing high density lipoproteins.³⁹ In addition, individuals experience improved blood flow, glucose and insulin sensitivity, cardiorespiratory function and endothelial function.³⁹ Additionally, exercise reduces blood pressure, systemic inflammation and blood coagulation.³⁹ Exercise helps regulate weight and BMI by reducing abdominal adiposity and controlling weight.³⁹ Although any amount of exercise is

beneficial for improving overall health, in order for an individual to experience maximal effects, literature recommends participants adhere to general guidelines regarding appropriate exposure and intensity.^{26,40}

Physical Activity Guidelines for Americans

Piercy et al. notes that approximately 80% of the population does not participate in the appropriate amount of recommended exercise.⁴⁰ The 2018 Physical Activity Guidelines recommends that all adults, between the ages of 18 and 65 years of age should participate in moderate intensity exercise for a minimum of 150-300 minutes a week, or vigorous intensity exercise for 75 to 150 minutes a week or a combination of the two.^{26,40} In addition, it is recommended that adults perform endurance and muscular strength training 2 or more days a week.^{26,40} While these are the recommended guidelines, the majority of the population 18 years and older do not meet these requirements due to numerous reasons Sedentary behavior continues to increase over the years, with the highest prevalence amongst the college population .⁴¹ Due to the increasing rates of sedentary behavior observed in students, it is important to understand why there is a lack of participation In order to better promote adherence, and in turn promote improved well-being.

Participation in Exercise

Common barriers found to limit involvement in exercise include altered belief about his or her own mental and physical health, disorganization, lack of money, fatigue, increased shyness or feeling of embarrassment, low self-esteem, low confidence, and low self-efficacy, and the most common reason being lack of time.^{30,42} It is supported that individuals are more likely to participate in exercise programs that are of low cost, time efficient, provide them with both social and

professional support and overall improve positive beliefs about exercise.³⁰ In order to increase student adherence to exercise and achieve maximal mental and physical health benefits, it is important for the student to participate in an enjoyable exercise regimen that best fits his or her desires and busy lifestyle.

Evidence supports that students with increased social support by advisors, family, and peers are proven to report less stress, have less health and emotional problems and are overall more successful in their graduate program.⁴³ More importantly, it is found that academic colleagues can be more beneficial than family or advisor support due to the ability to provide both emotional and professional support. Therefore, participation in an exercise program that can be performed in a group setting with academic peers for support can have tremendous effects on student's mental health and well-being. One form of exercise that has been supported to have various health benefits is aerobic exercise.

Benefits of Aerobic Exercise

According to the American College of Sports Medicine (ACSM), aerobic exercise is defined as any activity that utilizes large muscle groups and can be maintained for longer durations of time.⁴⁴ Numerous activities that are considered aerobic exercise include walking, cycling, hiking, jogging, dancing and swimming.⁴⁴ Aerobic exercise has been supported to have multiple physiological and psychological benefits.⁴⁵ Studies support that aerobic exercise provides cardiovascular benefits by positively influencing blood lipid levels and blood pressure.⁴⁵ Additionally, aerobic exercise plays a large role in weight control by promoting fat loss.⁴⁵ Psychological benefits that have been observed are reduction of anxiety and depression, stress modulation, and positive changes in personality.⁴⁵ It is further supported that those who are aerobically fit have a reduced

psychological stress response compared to those who are less fit.⁴⁶ As discussed above, there are several aerobic exercises that an individual can perform, but one form of aerobic exercise that is becoming increasingly popular is high intensity interval training (HIIT). HIIT is a common form of exercise that encompasses graduate students requests of an admirable exercise intervention that can be performed in the presence of peers, in a time efficient manner, while positively influencing mental and physical health.

Benefits of High Intensity Exercise

High intensity interval training, is characterized by brief, intermittent bursts of vigorous exercise followed by periods of rest or low intensity exercise.⁴⁷ The active intervals range from 45 to 240 seconds followed with the intermittent rest periods depending on the chosen principle.⁴⁸ This form of exercise is supported to have large effects on both aerobic and anaerobic exercise capacities and therefore is of interest due to its ability to produce significant effects in limited time frames.⁴⁹ HIIT enhances both cardiovascular and skeletal muscle adaptations, improves mood, reduces anxiety, depression and stress and decreases fat in an efficient time frame.^{47,48,50} HIIT is an effective, easily accessible, low cost form of exercise that can be performed in almost any location and in the presence of student peers. Individuals record higher levels of enjoyment when participating in HIIT programs compared to other forms of exercise.⁵¹ It is believed that the high levels of enjoyment stems from both extrinsic factors such as observed changes in the body and intrinsic motivational factors such as mastery and pleasure.^{52,53} Studies also support that those who participated in HIIT had a greater adherence to the exercise program compared to other modes of exercise.⁴² With the ability to improve cardiorespiratory, muscular fitness and overall mood in a time efficient

manner, HIIT is an effective exercise intervention for the graduate student population.^{54,55}

Purpose and Hypothesis

The purpose of this pilot study is to determine if providing a free, convenient, timely, and group-setting HIIT workout will have an effect on stress management in the doctoral students enrolled in the Doctor of Physical Therapy program at California State University (CSU), Fresno.

The primary hypothesis is that there will be a statistically significant improvement on well-being and BMI in doctoral students participating in a HIIT intervention compared to the control group. The null hypothesis is that there will not be a statistically significant improvement on well-being and BMI in doctoral students participating in a HIIT intervention compared to the control group.

METHODS

Participants

Thirty-nine healthy young adults (28 females, 11 males) were recruited from CSU, Fresno's Department of Physical Therapy. All participants were Doctor of Physical Therapy (DPT) students enrolled Fresno State. Recruitment for participants included flyers, word of mouth, or electronic email providing enrolled student's information about the free exercise class provided by co-investigators. Exclusion criteria was to ensure that students did not have any existing medical conditions or injuries that would prevent safe participation in a group exercise class. Twenty-one subjects participated in the intervention (18 females, 3 males, mean age = 26.2), and 18 subjects were included in the control group (10 females, 8 males, mean age = 26.6). Participants reviewed and signed written informed consent prior to participation in the study. The study was approved by the Department of Physical Therapy IRB committee.

Data Collection

Data collection occurred prior to and following an 8-week HIIT group exercise class intervention. Pre-testing occurred on 1 day and included intake survey, height and weight measurements, an aerobic fitness test, and self-report mental health questionnaires. Following completion of an 8-week intervention, post-test measures and a satisfaction survey was completed. Pre-testing measures were performed 5 days prior to the start of the intervention phase and post-test measures were performed 5 days following completion. The study occurred between September and November 2019. Pre-testing started 3 weeks into the fall term and post-test occurred 5 weeks prior to end of fall term.

Intake Survey

Intake forms included questions about current physical activity levels, numbers of days per week and hours per day exercise performed, average exercise intensity, age, and year enrolled in the DPT program at Fresno State. See Appendix A.

Mental Health

A 5-item Likert scale, World Health Organization Five Well-Being Index (WHO-5), was completed by each participant.⁵⁶ The WHO-5 assesses subjective psychological well-being and is also used as a screening tool for depression.⁵⁶ The sum of each score provides the total score (max = 25), where the lower score indicates decreased well-being.⁵⁶ See Appendix B.

Physical Health

BMI was calculated based on participants height and weight with the following formula: $BMI = \text{Weight (kg)} / \text{Height (meters)}^2$ ⁵⁷. The same co-investigator measured height and weight. The participants weight was measured in pounds (lbs.) and converted to kilograms (kg) with the following equation: subjects weight in lbs./by 2.2 to obtain weight in kg.

Exercise Intervention

The 8-week HIIT exercise class was performed twice per week in the Fresno State Physical Therapy building. Sessions were scheduled on days and times most available for students across all 3 cohorts.

Each exercise session lasted a total of 25 minutes in duration. The workout began with a two-and-a-half-minute dynamic warm-up and immediately transitioned into a 20-minute period of high intensity training with a work to rest ratio of 45 seconds on to 15 seconds off. Please refer to Appendix C for the outline

of the intervention. The work intervals included various aerobic and strengthening exercises. Sessions ended with a 2.5-minute cool down period. Please refer to Table 1 for detailed warm up/cool down and exercises.

Exercise intensity for this study was established based on the modified Borg Scale at a range of 7-9 to encourage high intensity aerobic capacity. The participants' average and peak RPE levels for each session were recorded following the completion of the workout. Participants exercised to a set music playlist throughout the entire duration of the intervention. The sessions were supervised and instructed by co-investigators. See Appendix D for more details.

Control Group

The control group participated in pre and post data collection at the same time as the intervention group. The control group was asked to continue their normal activity throughout the duration of the 8 weeks.

Statistical Analysis

Statistical analysis was completed using Microsoft Excel's Data Analysis with alpha levels set to 0.05. A per protocol analysis was conducted using only participants who attended 70% or greater of the intervention sessions. Independent t-tests were used to assess between group differences at baseline. A single factor ANOVA was used to evaluate the effects of the 8-week exercise intervention in comparison to the control group. Additionally, dependent t-tests were performed to assess significance within each group based on pre and post assessment measures. The primary outcome measure was the WHO Well-Being Index and the secondary outcome measures was BMI.

RESULTS

A per protocol analysis was conducted on 33 participants who attended 70% or greater of the intervention sessions. The intervention group (n=15) consisted of 60% first year cohort, 1% second year cohort, and 33% third year cohort. The control group (n=18) consisted of 22% first year cohort, 22% second year cohort, and 56% third year cohort. See Table 1 for more details.

Independent t-tests revealed no significant difference on any dependent variable between the experimental and control groups. A one-way ANOVA was used to determine significance by comparing the mean change in scores between pre and post-testing for the experimental and control groups on the following variables: well-being and BMI. See Table 2.

Mental Health

Table 3 displays the average change in pre and post intervention scores for the mental health variables, the WHO-5 Well-Being Index scores. WHO-5 Well-Being Index scores increased indicating improvement for the experimental group following the intervention and decreased for the control group, but the changes between the 2 groups were not significant ($p = 0.061$). Please see Table 2 for significance of intervention on BMI.

BMI

BMI increased for both the control and experimental groups. The change in BMI was not significant between the 2 groups ($p = 0.801$). Table 3 displays the average change in pre and post intervention scores for BMI. See Table 3 for the significance of intervention on BMI.

DISCUSSION

This research was conducted with hopes of determining DPT students at Fresno State perceived stress levels to target more effective ways to manage stress and ultimately improve overall mental and physical health. The purpose of this pilot study is to determine if providing a free, convenient, timely, and group-setting HIIT workout will have an effect on stress management in the doctoral students enrolled in the Doctor of Physical Therapy program at Fresno State.

The primary hypothesis is that there will be a statistically significant improvement on well-being and BMI in doctoral students participating in a HIIT intervention compared to the control group. The null hypothesis is that there will not be a statistically significant improvement on well-being and BMI in doctoral students participating in a HIIT intervention compared to the control group.

Summary of Results

WHO-5

The WHO-5 is a reliable and valid subjective measurement of individuals' general well-being. The scale has been used to assess the well-being and apathy of both the younger and older population.^{58,59} Most importantly, is supported that the WHO-5 is a reliable and valid measure of well-being in the college student population based on their experience with symptoms from mental illnesses.⁶⁰ The outcome measure was found to have an internal consistency of 0.86 and a test re-test reliability of 0.77.⁶⁰ It was also noted to have a sensitivity score of 96% and a specificity as high as 80%.⁶⁰ Due to its ability to reliably measure college student's well-being, general psychological distress, depression, and anxiety, the outcome measure has been widely used in various areas of research studies.⁶⁰ Such

areas include assessing individuals' well-being with various coping strategies, in the occupational health setting, the association between workplace stress and well-being, the association between psychosocial conditions and well-being and numerous additional stress related studies to measure distress and poor well-being.⁶¹⁻⁶⁶ In addition, the WHO-5 has been able to assess the effect of non-pharmacological and pharmacological interventions on the individuals' well-being such as exercise.⁶⁷⁻⁶⁹ A change of 3 on the WHO-5 is proven to be statistically significant and a change of 10 indicates the intervention is clinically significant.⁷⁰ As discussed, the WHO-5 is scored on a scale from 0-100, 0 being the complete absence of well-being and 100 is the highest level of well-being.⁷⁰ Studies support that the general population has a mean WHO-5 score of 70. A score of 48-50 is indicative of reduced well-being, further supporting that the individual should have further testing to determine mental health problems.^{56,60}

When comparing the DPT students in the HIIT workout research study to the general population, pre-test statistics support that the doctorate of physical therapy students at CSU, Fresno do in fact have reduced well-being. The mean pre-test WHO-5 score of the entire populace (n=39) including both the experimental and control group was 59.04. Although the DPT students demonstrated reduced WHO-5 scores pre and post intervention, exercise showed positive effects of exercise on improving overall well-being of those in the experimental group.

Well-Being Results

Regular exercise has been associated with happiness, increased quality of life, greater levels of life satisfaction and positive psychological well-being compared to those who do not exercise.⁷¹⁻⁷³ Stubbe et al. conducted a study

comparing well-being of individuals who participated in exercise opposed to those who do not.⁷² The study found that those who exercised are more satisfied with their lives and are happier than non-exercisers.⁷² Similarly, Penedo observed the health of exercisers compared to non-exercisers. The study confirmed that those that exercise show better health related outcomes, including general health- related quality of life, functional capacities, and mood states.⁷¹ Similar findings were found in our research study conducted on the DPT students at CSU, Fresno

When observing the 15 DPT students in the experimental group who had an attendance rate of 70% or greater, the average pre-intervention WHO-5 score was 57.6. The average post intervention WHO-5 score was 64.53 generating a positive mean change following the HIIT workout intervention of 6.90. Although the mean change of 7 is not considered statistically significant according to the abovementioned information, positive correlations were found supporting that exercise does have positive effects on student's well-being.

In comparison, the pre-intervention average WHO-5 score of the control group between pre and post assessment did not significantly change as demonstrated respectfully; 59.60 and a and 56.67. This supports that those who did not participate in the HIIT workout over the duration of the 8 weeks experienced no change in their well-being. In conclusion, although there was no significant improvement found with the implementation of a HIIT workout over the course of 8 weeks on well-being, the positive change of in WHO-5 scores of the experimental group demonstrates the benefits of providing students enrolled in the DPT program resources, such as an exercise intervention would be beneficial to implement in the curriculum in the future to improve student's health and to overall well-being. When researching supporting literature, there was a lack of evidence on the true effects of HIIT on individual's well-being. Therefore, the

search widened and further literature was conducted on the effects of high intensity aerobic exercise on well-being. Heggelund et al. supports that high aerobic exercise improves positive affect and well-being in healthy individuals and those with poor mental health.⁷⁴ Controversially, several studies found that well-being scores did not change over time with high intensity training and.^{42,75} One study reported that vigorous intensity activity actually had a negative impact on participant's well-being.⁷⁶ There are various plausible causes that the HIIT intervention did not significant improve the student's well-being in our study.

Considerations for Well-Being Results

One area that needs further consideration due to the possibility of effecting well-being results is data collection. The time which pre and post assessments took place can have a large effect on the patient's subjective reports on the WHO-5. Because the WHO-5 is a subjective report, it is highly possible that although the WHO-5 asks how the students have felt in the last 2 weeks, students' current emotions and feelings of how they feel at that specific moment can highly influence their answers. Edwards et al. found that emotional distress for medical students changed relative to exam times such that it was significantly higher before high exams compared to after.⁷⁷ The pre-assessment was given at the time the students were 3 weeks into the term. At this point in the semester, students had little experience with exams, practicum, or assignments. This may increase their perceived ability to manage stress or overall improve their well-being, resulting in higher baseline scores. In addition, the post assessment occurring 5 weeks before the semesters end, which is a highly stressful time of the semester with exams, assignments and practical's. Taking subjective measures at this time in the semester when they were stressed may have resulted in lower post-test scores.

These differences in pre and post assessment scores may alter the true effect of the exercise intervention. In addition to the assessments, the intensity and mode of our exercise intervention may not have been the most appropriate to achieve significant improvements in well-being.

A lack of research was found on the effects of both HIIT and aerobic exercise on participants' well-being when measured with the WHO-5. Therefore, literature review was expanded and the effects of various forms of exercise on a variety of well-being outcome measures was assessed in order to determine the most appropriate intervention. Elkington et al. conducted a systematic review on the psychological responses to acute aerobic, resistance, or combined exercise in healthy and overweight individuals.⁷⁸ The review was comprised of 42 studies and a total of 2,187 participants, both male and females between the ages of 18 and 64 years were included.⁷⁸ The results of 37 aerobic, 2 resistance, and 1 combination of aerobic and resistance exercise studies were evaluated.⁷⁸ The study supports that acute aerobic exercise improves positive well-being, however due to the limited number of studies, it is still unclear which form of exercise yields superior psychological benefits.⁷⁸ Therefore, future research in this area is warranted to determine what the most appropriate form of aerobic exercise and duration would be in order to improve the well-being of DPT students at Fresno State.

BMI and General Health

The WHO created general categories to classify an individual's BMI based on his or her height and weight. The classifications are as follows: underweight (15-19.9), normal (20-24.9), overweight (25-29.9) and obese (30 or greater).⁵⁷

Because BMI is easily attainable, it has been widely used in various studies in order to determine individuals general health and well-being.⁵⁷

A rising trend has been observed in BMI and years spent at a University. Although first year college students are likely to gain 15 pounds, students BMI do not significantly change throughout the 4 years of college.^{79,80} However, it is supported there is a significant increase in BMI at the 5th year and beyond.⁸⁰ Mazurek et al. studied the health among graduate students in the first year of their health-related degree.⁸¹ Relationships were found in this study among mental health and healthy lifestyles by assessing several different components including self-reported behaviors of exercise, diet and sleep and biometric screening including BMI.^{81,82} Approximately 40% of the student population were found to be overweight with a BMI of 25-29.9 (25%) and obese with a BMI of 30 and greater (12%).^{81,82} In addition, it was also reported that only 44% of the participants in the study met the recommend amount of exercise of 30 minutes a day, 5 days a week.^{81,82} Mazurek et al. support that mental health negatively correlated with healthy lifestyle beliefs and behaviors, noting that as mental illness symptoms increased, the students health behaviors and beliefs decreased.⁸¹

When comparing our recent study on DPT students at CSU, Fresno, similar and contrasting results were found between BMI and participation in exercise. Similarly, when observing the entire population including both the control and experimental group, 40% of the individuals were found to be overweight (33.33%) and obese (5.13%). Although the percentage of overweight and obese BMIs between the 2 studies were found to be similar, the average BMI for all participants in both groups was 24.55. Furthermore, the subjective report of participation in physical activity differed between the 2 studies. In the DPT student research study, the pre-test activity level was significantly different than

the results from Mazurek et al. in which all individuals in both the experimental and control group subjectively reported that they met the recommended exercise guidelines. This higher participation in exercise from both groups and being involved in a career that promotes healthy lifestyle may explain why the students in the DPT HIIT study had an average BMI was normal compared to other studies.

BMI Results

Deng et al. support that exercise has an inverse relationship with BMI.⁸⁰ Individuals who were in the desired BMI range participated in at least 3 days of moderate and vigorous intensity exercise per week.⁸⁰ The obese individuals were found to be those who participated in less.⁸⁰ Additional studies suggest that exercise alone cannot maintain BMI and body fat percent, but it can reduce individuals the risk of becoming overweight and having high body fat percentages.⁸³ Kesavachandran et al. observed the effect of exercise on BMI.⁸³ A higher percentage of those who participated in exercise were found to have normal BMI levels opposed to those who did not perform physical activity. In addition, less individuals in the exercise group were categorized as overweight compared to those in the non-exercise group.⁸³ According to ACSM, an individual must exercise 225 minutes per week in order to see clinically significant weight loss, which our participants were not held accountable to perform.⁸⁴ Although our study suggests that there was no significant change in the students BMI with participation in exercise, our findings reflects what other studies have supported, which is that participation in regular exercise alone may not significantly decrease BMI, but rather help maintain it.⁸⁵

When observing our findings, the mean BMI for the experimental group (n=15) whom attended 70% of the HIIT workouts pre-intervention was 24.66 and

post intervention of 24.69, placing the group in the normal BMI category. Of these individuals, 20% were considered overweight and 6.7% was considered obese. Furthermore, our results indicate that both groups did not have a significant change in their BMI whether they were participating in the HIIT workout or not. I believe that it is understandable that no significant changes were seen in BMI because both groups were already had a normal or desirable BMI. There are many variables that were presented in this study that must be taken into considerations when observing the effects of HIIT on BMI.

Considerations for BMI Results

It is important to take into consideration that there may not have been significant improvements in BMI in the experimental group because they were compared to an active control group. The study did not exclude those in the control group who exercise on a regular basis or require complete absence of exercise within the control group, therefore, those in the control group continued exercising as desired. Data collected from the pre-assessment intake forms in this study indicates by subjective report that both groups were exercising more than ACSMs recommended activity guidelines of 150 minutes per week of moderate to vigorous exercise. The control group was found to be exercising more per week than the experimental group with 319.20 mins per week compared to 381.10 minutes per week, respectively. Implementation of a HIIT workout twice a week for 25 minutes in duration would only add an additional 50 minutes of exercise per week to the experimental group. If participants were exercising as they were prior in addition to the HIIT intervention, they would be exercising 369.20 minutes per week, which increases the similarity between the 2 groups. Because both groups are performing relatively the same amount of exercise per week, which is

frequently and more than the recommended amount, it is understandable that there would be no significant difference in BMI.

Engagement in exercise has been supported to have an inverse relationship with chronically stressed individuals. Furthermore, it is supported that there is a direct correlation of low levels of exercise performed by medical school students.^{20,25,86,87} Although the majority of the evidence supported that exercise decreases with increased stress, other studies found that exercise was positively influenced by stress. It was supported that individuals who already engaged in exercise regularly, increased his or her participation when feeling more stressed in order to utilize it as a coping mechanism.^{17,22,25} It is highly probable that the high levels of participation in exercise in the control group is due to the fact that the control group was predominantly third year students. By the third year in the DPT program, it is likely that the students have found an appropriate way to cope with stress, such as exercise. In addition, third year students are most likely to have better time management skills, and therefore are able to participate in exercise as desired.

Physical therapy students are health care professionals whom promote participation in exercise, therefore it is likely that the students in both groups participate in exercise on a regularly basis as well as use it as a coping mechanism to manage stress compared to the general population. These results may not be seen throughout all graduate students or in the general population. For instance, students undergoing his or her psychology or nursing degree may not participate in exercise as regularly as DPT students. Therefore, participation in a HIIT workout would be a significant change in the amount of exercise they perform each week, most likely making it more probable that there would be significant differences in health and well-being with the implementation of exercise in their weekly routine.

In addition to an active control group, the intensity that the participants were exercising at must be taken into consideration.

Exercise Intensity

The modified Borg scale was used to determine the participants exercise intensity following the daily HIIT workouts. Based on the modified Borg scale, it is determined that an RPE less than 5 is low intensity, an RPE of 5-6 is moderate intensity and an RPE greater than or equal to 7 is high intensity.^{88,89} Therefore, the participants in this study were asked to maintain an RPE level equal to or greater than 7. The participants' average and peak RPE performed each day was recorded. Statistics from this data collection supports that some participants were below the recommended RPE of 7, while others were slightly above. The average RPE throughout the 8 weeks was 6.44, which demonstrates that the participants were exercising more at a moderate intensity opposed to a high intensity. This inconsistency and the participants' inability to maintain the desired RPE and exercise intensity may contribute to the HIIT workout not having a significant difference. In supplement to the participants intensity having a possibility on the lack of significant findings, it is important to consider if there is a more desirable mode of exercise and more appropriate length of intervention in order to see significant improvements in BMI.

A meta-analysis conducted by Batacan Jr. et al. observed the effects of HIIT on cardio metabolic health markers in both females and males between the ages of 18 and 35.⁹⁰ Sixty-five articles which were published between 1981 and October 2015 were included in this study. Both short term (<12 weeks) and long term (>12 weeks) HIIT interventions were included.⁹⁰ The participants in the study were divided into 2 groups based off their BMI values, including the normal

weight (18.5-24.99 kg.m²) population and the overweight (≥ 25 -29.99 kg.m²) and obese (≥ 30 kg.m²) population.⁹⁰ Due to the large variety of HIIT intervention protocols, studies ranged from acute single sessions to longer term multiple sessions and included a variety of aerobic modalities such as treadmill running, swimming, and cycling.⁹⁰ Results indicated that short term HIIT, as similar to our study, has no effect on body mass, BMI, and percent body fat in both the normal and overweight/obese populations.⁹⁰ Short term HIIT did however have positive effects on reducing waist circumference in the overweight/obese population.⁹⁰ When observing the effects of long term HIIT on cardio metabolic health in the normal weight population, insufficient studies were available to examine the effects on body composition.⁹⁰ Therefore, further research in this area would be beneficial to determine if a long term HIIT protocol can significantly reduce students BMI.⁹⁰ It was however found that long term HIIT does have significant effects on body fat percentage and waist circumference in overweight and obese individuals.⁹⁰ Due to the findings of this meta-analysis, it is important to consider other modes of exercise and possibly longer duration interventions in order to see significant effects on BMI.

Mode and Duration of Intervention

Because it was supported in the meta-analysis by Batacan Jr. et al. that both short term and long term HIIT do not have significant effects on BMI in both the normal and overweight/obese populations, further research was conducted to determine the possibility of a more appropriate intervention.⁹⁰ Chiu et al. supports that participation in 60 minutes per day of high intensity aerobic exercise on a treadmill for 3 days over a 12-week period can significantly reduce body weight, body fat, and BMI.⁹¹ Although the use of treadmills may not be appropriate to

implement in our future studies due to cost and availability, it may be beneficial to look into further interventions that mimic this intervention that would be applicable for the DPT student population at Fresno State. In addition to aerobic exercise, other modes of exercise have been found to be beneficial in improving participant's BMI.

Resistance training leads to improved mental health by reducing individual's symptoms of depression, anxiety, and fatigue and improving cognitive function and self-esteem.⁹² When combining resistance training with aerobic exercise, individuals have significant improvements in total mood disturbance, tranquility, revitalization, depression, physical self-concept positive engagement and tension.⁹³⁻⁹⁵ In addition to mental health benefits, resistance training positively influences individual's BMI. Resistance training has been proven to be important in the management of metabolic disorders and obesity.⁹⁶ Westcott et al. performed a study including individuals between 20 and 80 years of age.⁹⁷ All included participated in a combined aerobic and resistance program with once, twice or 3 times per week.⁹⁷ Results demonstrated that although those who participated 3 days per week had the greatest change in BMI, all 3 groups experienced a decrease in body fat and fat weight and an increase in lean weight.⁹⁷ It is important to consider if implementation of strength training with resistance bands, free weights or weight machines in addition to the HIIT aerobic workout would produce greater significant results in improving student's stress management and well-being. Not only is it important to consider an intervention that will improve both mental and physical health, it is important that the participants are satisfied and enjoy the chosen form of exercise.

Participant Satisfaction

Although the HIIT workout intervention did not significantly effect DPT students stress management and well-being, the study was highly accepted from those involved. Following the study, DPT students in the experimental group were asked how satisfied they were with different aspects of the research study using a 5 point Likert scale. When asked how satisfied they were with the overall program, 85.7% reported they were satisfied a great deal while the additional 14.3% of the students noted they were very much satisfied. All individuals reported that they were likely to enroll in the program if offered again. Additionally, all DPT students noted that they were very likely to refer their peers to participate in the program. It is important to consider that although significant results were not found within this research study, students subjectively reported that it is worth the time to take out of their demanding schedule to participate in like exercise programs.

Limitations

There are a number of limitations that took place in this research study including lack of research, sample size, sampling methods, subject criteria, design of the intervention, implementation of data collection and lack of resources.

Completion of a doctorate of physical therapy program has just recently become a requirement for PT licensure in the last several years. Due to it being such a recent requirement, it was difficult to access literature or find supporting data on the studies that included both the targeted population as well as the intervention. Because of the lack of previous studies and evidence, it made it difficult to truly understand the significant levels of stress that doctor or physical therapy students have. In addition, little research has been conducted on different

interventions to improve DPT students stress management, BMI and well-being. An additional limitation was the way the participants were recruited.

The doctoral of physical therapy students were opportunistically and conveniently recruited due to time constraints. Due to the fact that the study was only performed with DPT students at Fresno State, a small sample size was obtained. The participants were not randomized into either the experimental or control group, which decreases statistical power and portrays an internal validity threat. Furthermore, participants were not blinded in this study. Participants chose whether or not they wanted to partake in the experimental or control group. This may form a bias in which individuals who are already active or enjoy participating in exercise, may be more likely to participate in the intervention. Therefore, the intervention group may have been populated with individuals that were already exercising on a regular basis and continued to exercise outside of the study, making it difficult to determine the true results of the intervention. In hindsight, those that chose to be in the control group may be more likely to not enjoy exercise or alternatively, already participate in exercise, therefore did not want to participate in the intervention group due to prior engagements. In addition, the study had an unequal representation of participants.

The experimental group was dominated by the first-year cohort (60%) and the control group was primarily made up of third year students (56%). In addition, there were more females (n=23) than males (n=10) who participated in the study. Therefore, the findings are not essentially generalizable to the entire DPT population at Fresno State. Additional limitations presented in this study that may affect overall results are confounding factors. Such factors include relationships, work, finances, nutrition and diet, sleep, and extracurricular activities.

Future Research

Due to the vigorous curriculum of the physical therapy program, it was difficult to find an exercise time that accommodated all 3 cohorts schedule. The intervention was offered twice a week in the afternoons and due to the limited availability in the DPT student's schedules, various second years were unable to attend because of time conflicts with class. This may have caused a bias in this research study and negatively affecting the ability to see true results of a HIIT workout on stress management and well-being throughout the entire DPT student population. Although William et al. supports that second years are found to be the most depressed, anxious, and stressed when compared to first year DPT students, only 17% (n=7) of the second-year cohort participated in the study.¹⁶ Greater participation from the second-year cohort would have been valuable to better understand activity levels and their mental and physical health to further determine if implementation of an exercise program in the curriculum would be beneficial for stress management and improving well-being. If an exercise program would continue to be offered to the DPT students, it would be beneficial to determine a schedule that would fit all 3 DPT cohorts. If it is not attainable, it would be beneficial to offer numerous workouts throughout the week for the students to attend as able to increase participation rates and overall attendance. Future studies should require appropriate recruitment strategies to gain a more accurate representation of the entire DPT population of all 3 cohorts. It would be beneficial to obtain a similar sample size from all 3 cohorts and equally between both genders. In order to promote improved participation and obtain results that would be representative of the entire DPT population, it would be important to find a schedule that better fits all 3 cohorts. If it is difficult to do so, I believe providing more opportunities by adding additional days or times during the week would help improve participation availability. Although data

analysis supported that the experimental and control groups were comparable at baseline, future research should randomize the study to obtain a better representation of the entire population and most importantly, decrease validity threat.

Future research should focus on implementing additional ways to collect objective data. Objective data is a way to collect information in a standardized way, improving validity and reliability. Using heart rate monitors to measure the participants exercise intensity should be taken into consideration for future research. As discussed, by allowing the subjects to report exercise intensity subjectively using the modified Borg RPE scale allows the participant to report any intensity even if he or she was not participating at that level. Additionally, subjective measures often times are misinterpreted. By implementing heart rate monitors, validity and reliability of the pre and post-test measures would improve, overall improving the ability to see the true effects of the research study. In addition, use of HR monitors is likely to hold the participant accountable to exercise in the desired intensity range by giving immediate visual feedback. Additionally, it is important to consider alternate objective measures to determine the student's general health and well-being. Instead of assessing the student's health and well-being by measuring BMI with the weight to height ratio, it may be more appropriate to consider different measures. Several studies utilized waist circumference, waist-to-height ratio, body fat percentage, bone mineral content and fat mass measured by tape measures and a whole-body dual-energy X-ray absorptiometry to determine the effects of a HIIT intervention on body composition.⁹⁸ Future research should also consider the use of an additional subjective outcome measures to better quantify the DPT student population's well-being.

Although the WHO-5 has been supported to be a reliable and valid outcome measure to assess individual's well-being, other outcome measures have been found to be reliable in assessing well-being globally and in the student population.⁹⁹ It is important to consider if additional outcome measures should have been used to better assess the DPT students at Fresno State's well-being. As discussed, depression anxiety and stress are significantly prevalent in DPT students and play a large role in the student's overall well-being. One outcome measure that has been widely used both globally and specifically in the student population to assess 3 common negative symptoms of psychological distress in order to determine the student's mental health and overall well-being is the Depression, Anxiety, and Stress Scale – 21 (DASS-21).

The DASS-21 is a self-reported instrument that measures the severity of the psychological distress by assessing the 3 different domains separately.¹⁰⁰ Subjects indicate how much a negative emotion has applied to them over the last week on a 0-3 rating scale (0= "Did not apply to me at all over the past week"; 3 = Applied to me very much or most of the time over the past week."¹⁰⁰ The score of the 7 subscale is summed and doubled in order to getting a severity rating.¹⁰⁰ The higher the score indicates the greater psychological distress. Please see table in appendix for breakdown of severity ratings.¹⁰⁰ Although there is not specific minimal detectable change (MDC) values for the graduate student population, studies have supported that the MDC for the adults referred to psychotherapy with symptoms of depression include: depression subscale = 5, stress subscale = 7, and total score = 10.12.¹⁰¹ Additionally, although there is lack of evidence for graduate student's normative data, numerous studies support normative values in the undergraduate student population. Edmond et al. found that the normative values for undergraduate students are as follows: Depression subscale = 8.62, anxiety

subscale = 7.76, stress subscale = 13.88.¹⁰² However, in a study performed by Williams et al., graduate students in a Doctor of Physical Therapy Program were found to have higher average scores on the DASS-21: Depression = 14.67, Anxiety = 17.42, Stress = 44.72.¹⁶ Brown et al notes that the DASS- 21 is a reliable outcome measure with an excellent test- retest reliability ranging from 0.71 to 0.81.¹⁰³ Furthermore, the DASS-21 has been found to have excellent internal consistency or a Cronbach alpha value in the undergraduate population, ranging from 0.82 to 0.97.¹⁰⁴ Because the DASS-21 looks at 3 different psychological domains that are highly prevalent in the student population, I believe it would be a more appropriate outcome measure to use in future studies opposed to the WHO-5 to determine DPT student's mental health and overall well-being. Although outcome measures are important to observe effects of the intervention, it is important that consider that the experimental group is not being compared to a control group that may be performing similar activities to the intervention in order to see true effects.

Due to the lack of exclusion criteria for participation in exercise outside of the study for both the experimental and control group, a bias may have been formed. By not excluding those who are participating in exercise makes it difficult to determine what results are strictly from the intervention alone or rather from extracurricular activities. In addition, it is difficult to determine if implementation of exercise for 8 weeks has an effect when the control group may be just as active throughout the 8 weeks. As discussed, both groups had similar baseline measures in all areas including BMI and activity participation. Therefore, the study is comparing a relatively active control group with the experimental group. If all individuals are participating in exercise throughout the duration of the study, both groups are receiving the health benefits and in turn will not significantly differ

from one another following the intervention. It would be more beneficial to require complete absence of exercise in the control group and extracurricular activities in the experimental group outside of the HIIT workout to have a better representation of the true effects of the intervention on stress. In addition, future research may consider comparing the effects of an exercise intervention on a less active and healthy graduate school cohort. This will allow better understanding of how a HIIT workout would benefit stress, BMI and well-being. Future research should consider altering the environment that the exercise intervention is performed.

Future research should consider that the setting of the HIIT intervention may have played an important impact on the findings within the research study. Although the location of the HIIT workout was easily accessible and convenient for the DPT students as it was in the PT building, exercising in other locations may be more beneficial in providing greater health benefits.¹⁰⁵ It is supported that exercising outdoors opposed to indoors increased physical activity levels, decreased perceived exertion, and improved physiological functioning by reducing stress, improving mood and self-esteem, and restoring mental fatigue.¹⁰⁵ In addition, it is found that exercising outdoors is more enjoyable and in turn, improves participants behavior and adherence with exercise.¹⁰⁵ Because students already spend the majority their day inside studying, and more specifically in the same rooms and building as the intervention, it would be beneficial to consider if implementing an exercise program outdoors would have an a significant stress on improving DPT students stress management and well-being. I believe that students would find exercising more enjoyable and improve motivation, attendance and well-being. In addition to the environment of the exercise intervention, providing a

larger variety of music or allowing the students to choose the music may have improved levels of intensity and overall enjoyment.

Music is found to be beneficial in increasing work output, regulating or altering mood, triggering emotions, heightening arousal, encouraging rhythmic movement and improving attention.¹⁰⁶ Most importantly, music is supported to improve overall exercise performance by delaying fatigue and increasing the participants endurance, power and strength.¹⁰⁶ Evidence supports that utilization of music has the ability to increase total exercise duration, maximal heart rate, improving the participant's endurance. Furthermore, utilization of self-selected music during exercise exerts a distractive effect while improving performance in which it allows individuals to dissociate or change their focus away from unpleasant feelings of fatigue and pain experienced with exercise.^{106,107} Therefore, motivation by music leads to increase in duration of exercise performed, which is a stress alleviator by medical students.¹⁰⁶ Although a consistent playlist was utilized during the HIIT workout in this research study, it may be more beneficial for students to self-select the music to best fit his or her personality and improve motivation, intensity, duration and distraction in order to improve overall exercise performance. Students from the research study reported that they were somewhat (2.9%) to a great deal (52%) satisfied with the music. Several individuals left additional comments noting that they would have liked a greater of music over the duration of the HIIT workout. All abovementioned limitations should be taken into consideration in future research due to their impact on stress-management, BMI and well-being.

Additionally, it would be beneficial to determine if a different mode of exercise such as steady state continuous or aerobic with resistance would better reduce BMI and improve well-being. Additionally, future research should

determine if implementation of an exercise program with a mindfulness based stress reduction (MBSR) intervention would lead to greater results. MBSR is a self-administered effective based intervention that has been proven to reduce stress in the graduate student population.¹⁰⁸⁻¹¹⁰ In addition to feeling less stressed, students report with the use of mindfulness based training, they are more aware of their thoughts, feelings and actions, felt calmer and better able to cope with stress, accepted themselves more, improved sleep quality and learned how to use meditation to calm themselves.¹⁰⁹ Because both exercise and mindfulness based intervention have been supported to have positive effects on stress management and well-being, it is believed that combining and exposing students in the curriculum to the 2 interventions would produce significant effects. Future research in these abovementioned areas would assist future researchers in designing a more appropriate intervention to provide significant improvements in stress management and in turn improved mental and physical health of the DPT students at Fresno State.

Clinical Relevance

DPT students have higher rates of mental illnesses than the general population due to the busy curriculum, time constraints, pressure to succeed on tests and in class, pressure to maintain a GPA to remain in the program, and the desire to participate in extracurricular and maintain relationships with family and friends. Therefore, due to the cumulative effect, DPT programs are highly stressful for the graduate student. Williams et al. studied 163 first and second-year physical therapy students and noted that the student's depression, anxiety, and stress levels significantly increased over the course of the semester. In addition, the study found burnout and academic fatigue also increased throughout the semester and

years, while coping strategies decreased.¹⁶ The 2 most common coping strategies reported by the DPT students included exercise and visiting with friends and family. The study noted as the students experienced increased levels of distress and burnout, the engagement in these activities were decreased.¹⁶ In addition to increased levels of stress being found within the DPT student population, Physical Therapists in the workplace are also faced with high levels of mental illness.

Physical therapists experience work stress due to the excessive workloads and a lack of resources available.¹¹¹ Experiencing stress on the job leads to many negative consequences including burnout, sickness absence, work-related musculoskeletal disorders and turnover.¹¹¹ In addition, stress in the work place has been associated with increasing the PTs chance to obtain a medical or psychiatric conditions such as depression and cardiac disease.¹¹¹ Job stress is not only negatively effecting the therapist alone, but the patients as well. Increased levels of stress has been correlated with reduced quality of patient care.¹¹¹ In addition, Anderson et al. performed a cross-sectional survey on 1,366 Physical Therapists who were members of the APTA.¹¹² The study found that 29% of PTs are experiencing high emotional exhaustion and 13% have burnout. In addition, 15% of PTs have high-perceived stress due to experiencing emotional exhaustion and burnout.¹¹² Because of the various negative consequences of stress in the workplace, it is important that students possess the ability to manage their personal stress before they are faced with having to deal with the pressures of being a licensed PT. It is imperative to develop strong coping strategies to reduce and manage stress for future healthcare providers.¹¹³ Furthermore, by having effective coping mechanisms to manage stress, students and health care providers will have reduced likelihood of obtaining mental and physical health disorders, undergoing exhaustion and fatigue, and burnout.¹¹³ An important note is that individuals who

manage their mental health have improved academic performance, quality of patient care, and improved overall health and well-being.³¹

Conclusion

Our study did not demonstrate change in well-being after participation in a 12-week HIIT exercise class. A positive trend was noted in well-being by participants that completed the intervention. The WHO-5 does not have reliability data for graduate students however when compared to the general population the results of all participants were significantly lower when compared to normative data.³¹ Future studies should identify an outcome measure to more accurately analyze stress and anxiety who perform HIIT exercise classes while enrolled in the DPT program at Fresno State.

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TABLES

Table 1. Demographic Information of Experimental and Control Group

Variable	Experimental Group (n=15)			Control Group (n=18)			
	n (%)	Mean	SD	n (%)	Mean	SD	
Age		26.90	5.972		26.60	1.516	
Gender	Male	2(13.33)		7(38.89)			
	Female	13(86.70)		11(61.11)			
Cohort	1 st year	9(60.0)		4(22.22)			
	2 nd year	1(6.67)		4(22.2)			
	3 rd year	5(33.33)		10(55.56)			
Average current	Hours per day		1.40	0.455		1.36	0.495
Physical activity level	Days per week		3.80	1.166		4.67	0.882
	Intensity of exercise		5.40	1.093		5.78	0.853

Table 2. Descriptive Statistics of Well-Being and BMI in Experimental and Control Groups

Index	Test	Experimental Group		Control Group	
		Mean	SD	Mean	SD
Well-Being	Pre-test	57.60	11.39	59.56	16.65
	Post-test	64.53	18.87	56.66	16.12
BMI	Pre-test	24.66	3.50	24.73	3.31
	Post-test	24.69	3.42	24.78	3.26

Table 3. Results of One-Way ANOVA of HIIT on Well-Being and BMI

Index	F	P-value
Well-Being	3.780	0.061
BMI	0.065	0.800

APPENDICES

APPENDIX A: STUDENT INTAKE FORM

**California State University, Fresno Department of
Physical Therapy
Research Study - HIIT Exercise Pilot Study fall 2019**

Student Information:

1. Name: _____
2. Email: _____
3. Age: _____
4. Height _____
5. Weight: _____ lbs
6. Gender: F / M
7. Year in DPT program: 1 / 2 / 3
8. Current hours of physical activity per week:
 - a. Number of days per week:
9. How would you rate the intensity of your daily/weekly physical activity
(circle):

1 Effortless
2 Almost no effort
3 Very Light
4 Light
5 Moderate
6 Vigorous
7 Hard
8 Very Hard
9 Extremely Hard
10 Maximum Effort

APPENDIX B: WHO -5 WELL-BEING INDEX

WHO – 5 Well-being Index

WHO-5 Well-being Index

Please respond to each item by marking one box per row , regarding how you felt in the last two weeks.		All of the time	Most of the time	More than half the time	Less than half the time	Some of the time	At no time
WHO ₁	I have felt cheerful in good spirits.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
WHO ₂	I have felt calm and relaxed.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
WHO ₃	I have felt active and vigorous.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
WHO ₄	I woke up feeling fresh and rested.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0
WHO ₅	My daily life has been filled with things that interest me.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1	<input type="checkbox"/> 0

APPENDIX C: EXERCISE INTERVENTION

	Monday	Wednesday
Warm up 2:30 minutes	Dynamic warm up 2:30 minutes - 30 seconds each 1. Knee to chest 2. Piriformis 3. Quad stretch 4. Side lunge 5. Mummy walks	
Intervention 45 sec on/15 sec off = 20 minutes	1. Butt Kicks 2. Forward lunges 3. Jumping jacks 4. Sumo squats 5. Up downs 6. SL RDL 7. High knees 8. Tricep dips 9. SL glute bridge 10. Leg lowers 11. Front plank 12. Russian Twist 13. Fake Jump Rope 14. Side lying leg lifts (switch) 15. Jumping lunges 16. Fire hydrants 17. Mountain climbers 18. BW squats 19. Standing lateral crunches 20. Tuck jumps	1. Forward/back skaters 2. Reverse lunges 3. Burpees 4. Straight leg kicks 5. Toe touch jumps 6. Flutter kicks 7. Push ups 8. Stars 9. Side plank alt 10. Criss cross jacks 11. Alt toe taps 12. Static squat with reach 13. Star plank 14. Quick forward straight leg kicks 15. Lunge in place 16. Spiderman mountain climbers 17. Calf raises 18. Skater hops lateral 19. Standing oblique crunches 20. Jump squats
Cool Down 2:30 minutes	1. Walk in place for 30 seconds 2. Static quad - 30 sec both sides 3. Hamstring - 30 sec both sides	
	Warm up = 2:30 mins HIIT workout = 20 minutes Cool down = 2:30 minutes Total workout = 25 minutes	

APPENDIX D: MODIFIED BORG SCALE

0	None
0,5	Very, very light
1	Very light
2	Light
3	Moderate
4	A little intense
5	Intense
6	
7	Very intense
8	
9	Very, very intense
10	Maximum