The effect of outdoor and indoor group exercise classes on psychological stress in college students

by

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Abstract

Background: Stress is a detrimental external stimulus that can lead to illnesses and disease. College students especially are negatively affected by high levels of psychological stress which is a crucial time for them having new responsibilities. Exercise can be a mechanism for reducing stress, with outdoor group exercise potentially being a more beneficial opportunity to improve mental health compared to individual or indoor exercise.

Purpose: This study tested the effects of outdoor compared to indoor group exercise classes on changes in perceived stress and outdoor physical activity in college students. The outdoor group was hypothesized to achieve more outdoor physical activity outside of the intervention and reduce their stress in a greater capacity compared to the indoor exercise group relative to baseline.

Methods: Participants were recruited via email, paper flyers, university newsletter and indicated informed consent prior to participation in a four-week exercise intervention. Participants were randomized into hour-long outdoor (n = 7) or indoor (n = 6) group exercise classes held twice per week. Data were collected in October and November 2021 as pre (baseline), mid (after 4 exercise sessions), and post (after 8 exercise sessions) intervention surveys. Measurements included demographics, anthropometrics, perceived stress, and current physical activity behaviors. Mixed ANOVAs with Tukey post hoc tests were used to determine differences in perceived stress and outdoor physical activity levels between the indoor and outdoor exercise groups.

Results: Participants (n = 13) were mostly aged 18-24 (76.9%), female (69.2%), and living off campus (69.2%). The largest group of particiapants were graduate students (38.5%) with the remainder spread evenly among grades (freshman, sohpmore, junior, senior). Adherence (attending at least 1 session) and measurement compliance (completing all time points) was low in the the outdoor group (n = 3 out of 7, 42.9%), while the indoor group was fairly high (n = 5 out

of 6, 83.3%). Statistically significant differences in perceived stress scores existed across time for the whole sample ($F(2, 12) = 48.359$, $p < 0.001$, Partial Eta squared = 0.890) and the interaction between time and condition ($F(2, 12) = 10.051$, $p = 0.003$, Partial Eta squared = 0.626). With the posthoc analysis, the outdoor group ($p < 0.001$) showed a greater reduction in perceived stress from pre to post compared to the indoor group ($p = 0.028$). No significant outdoor physical activity differences were found between the interaction of time and condition ($F(2, 12) = 0.948$, $p = 0.415$, Partial Eta squared = 0.136).

Conclusion: The first hypothesis was supported in that participants in the outdoor group significantly reduced their perceived stress more than the indoor group relative to baseline. However, the outdoor group did not engage in greater amounts of outdoor physical activity compared to the indoor group relative to baseline. University recreation facilities should work to establish reasonable outdoor space to facilitate outdoor group exercise classes. Future studies should look deeper into the elements of the outdoor environment that promote reductions in perceived stress and increase outdoor activity.

Table of Contents

List of Figures

List of Tables

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Chapter 1 - Introduction

Stress and Health

Stress is a problem for the general population and can lead to poor health outcomes and illness. Stress is referred to as an external stimulus that can cause mental or physical reactions leading to the development of a chronic illness (Kivimäki et al., 2002; Varghese et al., 2015). Initial signs of stress are cognitive impairment and an increased fight-or-flight response (Gelsema et al., 2006; O Donovan et al., 2013). Over time, these signs can lead to short-term symptoms, including headaches, muscle tension, indigestion, chest pain, reduced ability to fight infections, and poor sleep quality (Blaug et al., 2007). High stress is associated with unhealthy coping behaviors such as a poor diet, smoking, heavy drinking, lower levels of exercise, and obesity (O Donovan et al., 2013; Örtqvist & Wincent, 2006; Varghese et al., 2015). Chronic exposure to high stress levels may result in permanent changes to behavioral, emotional, and physical responses (Tice & Baumeister, 1997). While the impact of stress continues to be a problem for everyone, significant increases in college students' stress have been documented in the past ten years (American College Health Association, 2015; Charles et al., 2021; Son et al., 2020).

For the past decade, stress has been increasing in college students (American College Health Association, 2015; Charles et al., 2021; Son et al., 2020). In 2015, about 58.7% of college students experienced high stress levels (American College Health Association, 2015). In 2020, the worldwide COVID-19 pandemic increased psychological stress for everyone, including college students. College students reported significantly higher perceived stress levels at the beginning of the COVID-19 pandemic with around 71% of students indicating their stress levels had increased during the COVID-19 pandemic (Charles et al., 2021; Son et al., 2020). Consistent exposure to high stress levels may lower academic performance and student success (Pascoe et al., 2020; Tice

& Baumeister, 1997). College presents multiple potential stressors including changes in social activities, sleeping habits, eating habits, living environment, increased class workload, interaction with new people, financial changes, new responsibilities, work, and interpersonal relationships (Acharya et al., 2018; Darling et al., 2007). Ineffective stress management in students has been associated with feelings of increased worry, loneliness, nervousness, and sleep disruptions (Ross et al., 1999). Stress continues to rise among college students highlighting the importance of finding effective stress management strategies to prevent illness and short-term negative health outcomes.

Stress and Exercise

Exercise is considered to be a subset of physical activity that is planned, structured, and completed to maintain or improve physical fitness (Biddle & Mutrie, 2007). Exercise is one well-known coping mechanism that may reduce perceived stress in college students (Bennett, 2019; Bretland & Thorsteinsson, 2015; Edenfield & Blumenthal, 2011; Garber, 2017; Leininger et al., 2014). Students who choose exercise and maintain it during high academic stress periods buffer the adverse effects of stress and improve mental well-being and sleep quality (Wunsch et al., 2017). Exercise also improves other psychological aspects, including improved mood, self-esteem, and reduced symptoms of depression and anxiety (Lane & Lovejoy, 2001; Mikkelsen et al., 2017). The physiological benefits of exercise include improvements in cardiovascular fitness, lower blood pressure, weight loss, and prevention of chronic diseases such as cancer, diabetes, hypertension, obesity, osteoporosis, and Alzheimer's disease (Geirsdottir et al., 2012; Heyn et al., 2004; Warburton et al., 2006). Regular exercise lowers inflammation resulting from chronic diseases exacerbated by high amounts of stress (Mikkelsen et al., 2017). Establishing a regular exercise routine can help moderate the detrimental effects of high stress levels on college students' mental health.

Group exercise is a way to exercise that can help motivate individuals. Group exercise classes are available in various formats including Yoga, Barre, Pilates, indoor cycling, dance, functional training, core conditioning, aquatic activity, resistance exercise, fall prevention, boot camp to Step (Wing, 2014). Each of these group exercise classes has foundational benefits with additional benefits based on the class type. The health-related benefits of group exercise include improvements in aerobic fitness, body composition, resting metabolic rate, and resting blood pressure (Quindry et al., 2020). Group exercise classes have also been shown to improve cognitive and psychological functioning (Mutrie et al., 2007). Group exercise classes can provide a fun social environment that uses safely designed workouts that require no prior knowledge or experience in a consistent schedule (Wing, 2014). The participants of these classes can experience a stress-free environment by not needing to develop their own exercise plan for their workout. Students who attend weekly group exercise classes can reduce their stress levels and improve their emotional well-being and physical and emotional quality of life (Yorks et al., 2017).

Stress and Outdoor Exercise

The exercise environment predicts the quality of exercise benefits in that some environments can provide better benefits than others (Bodin & Hartig, 2003; Kondo et al., 2018; Lahart et al., 2019; Thompson Coon et al., 2011). Research shows that outdoor exercise may provide enhanced exercise benefits compared to exercising indoors (Byrka & Ryczko, 2018; Calogiuri et al., 2015; Deckbar et al., 2017; Lahart et al., 2019; Legrand et al., 2018; Niedermeier et al., 2017; Thompson Coon et al., 2011; Turner & Stevinson, 2017). Moreover, exercising outdoors improves psychological well-being through improvements in self-esteem and mood (Bodin & Hartig, 2003; Calogiuri et al., 2015; Niedermeier et al., 2017). Decreased feelings of anger, anxiety, depression, stress, and confusion are also related to outdoor exercise (Bodin &

Hartig, 2003). Exercising outdoors provides a calm environment making exercise more pleasant, improving mood (Calogiuri et al., 2015; Niedermeier et al., 2017), engagement (Byrka & Ryczko, 2018), and has greater stress-reducing effects (Hawkins et al., 2011; Klaperski et al., 2019) compared to indoor exercise. Reinforcing the enhanced benefits of outdoor exercise can increase physical activity participation in college students who want to be active.

Study Justification

College is a crucial time for students to establish healthy habits and has the potential to set them up for a healthy lifestyle for the remainder of their lives (Caspersen et al., 2000). The transitional time for students can negatively influence factors like diet, weight, and physical activity, which can also be affected by high levels of stress (Nelson et al., 2008). The detrimental impact of high stress levels on physical and mental health is well documented and continues to rise (American College Health Association, 2015; Charles et al., 2021; Son et al., 2020), emphasizing the need for practical coping skills. Outdoor exercise may be a better mechanism for coping with stress effectively compared to indoor exercise. Furthermore, outdoor exercise is associated with physiological, psychological, and social benefits (Bodin & Hartig, 2003).

Examination of research literature reveals several critical gaps. First, few articles compare the health effects of outdoor versus indoor exercise and sports (Klaperski et al., 2019) and the effects of strength training-based outdoor group exercise on perceived stress has not been studied. Second, a scarcity of research explores the feasibility of implementing outdoor group exercise classes in a real-world setting. This research attempts to close these gaps by understanding the effect of outdoor vs indoor exercise environments on psychological stress and outdoor physical activity in college students. This study is important because offering group exercise classes in an

outdoor environment is a potentially cost-effective intervention that could significantly decrease college students' stress levels.

This study is innovative because it explores the combined stress reduction benefits of spending time outdoors and exercising in college students. This study aims to examine perceived stress differences between outdoor versus indoor group exercise classes in college students relative to baseline. It was hypothesized that participants in the outdoor group exercise class would demonstrate more significant decreases in perceived stress levels than participants in indoor group exercise classes relative to baseline. A secondary hypothesis was that participants in the outdoor group exercise class would be more encouraged to spend time outdoors and increase their outdoor physical activity than those in the indoor group. This study hopes to advance knowledge on how outdoor group exercise can be utilized for stress reduction in college students.

Theoretical Framework

Social Ecological Models of physical activity and active living (Sallis et al., 2006) recognize the influence of the environment on physical activity behavior and related health outcomes. Outdoor spaces also have an influence on health behaviors and health outcomes. The proximity, type, and quality of outdoor spaces is significantly related to physical activity. Additionally, Lachowycz & Jones (2013) propose a framework for understanding the relationship between greenspace and health (Figure 1).

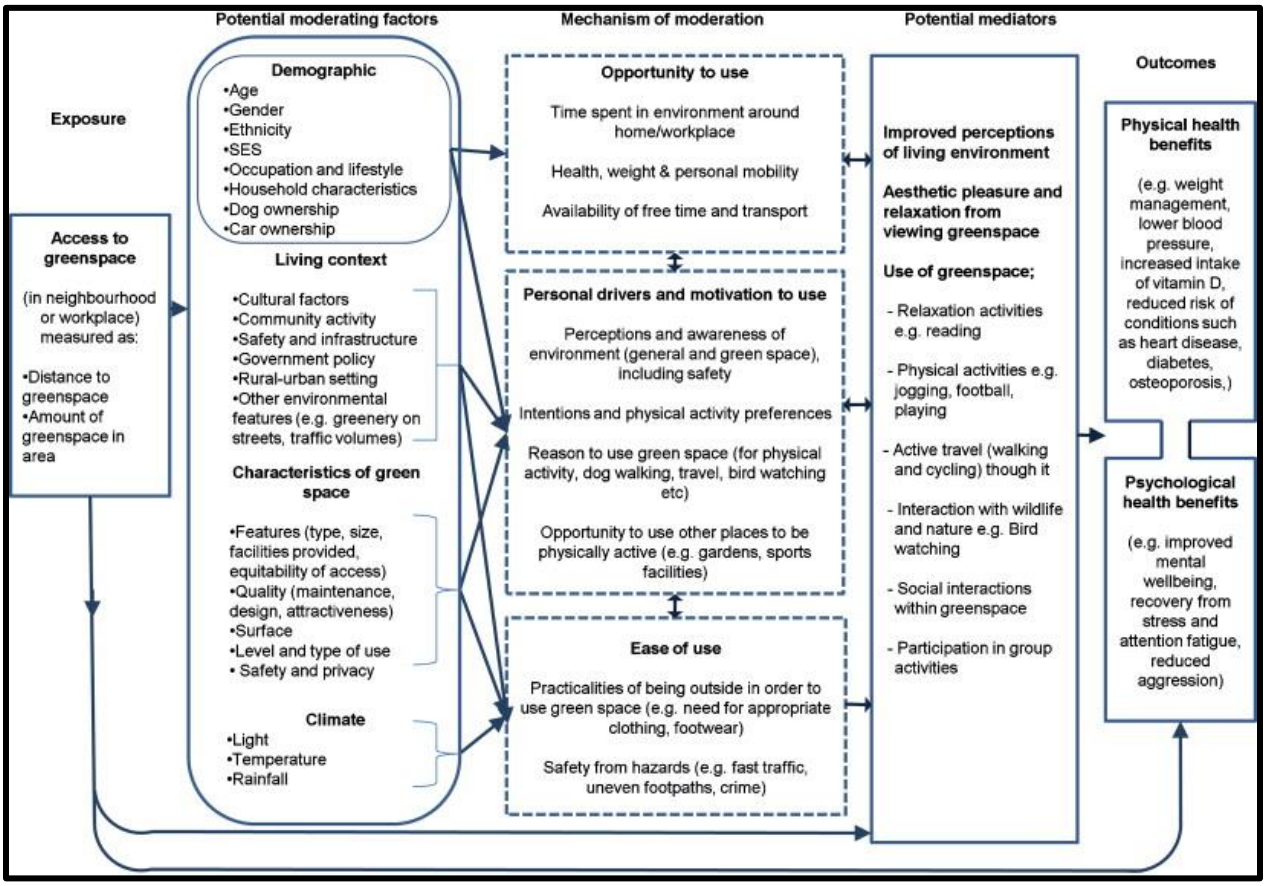

Figure 1. Greenspace and Health Framework

They speculate that access and exposure to greenspaces influences a variety of mechanisms that in turn influence health such as personal drivers and motivation to be active, intentions to be active, ease of conducting activities in those spaces, improved environmental perceptions, social

interactions, participation in group activities, and aesthetic pleasure and relaxation from spending time in green environments. Although Lachowycz and Jones suggest many mediating and moderating factors are at work in this relationship, the initial goal of this research project was to understand if a relationship between green/outdoor environments and perceived stress existed.

The conceptual framework for this study, informed by the Social Ecological Model and Lachowycz & Jones (2013), seeks to test if group-based exercise in natural outdoor environments (compared to indoor environments) could influence perceived stress and time spent in outdoor physical activity (McLeroy et al., 1988). Here, the combined effects of group exercise in outdoor or indoor environments are tested because evidence shows exercise on its own improves perceived stress and therefore, this design allows the direct effect of the environment to be tested (Bretland & Thorsteinsson, 2015; Leininger et al., 2014). Some research suggests the environment's indirect effect on health outcomes is shown through higher enjoyment and satisfaction in an outdoor environment, which can motivate people to be more active (Thompson Coon et al., 2011). On the other hand, lack of enjoyment of exercise can lead to lower levels of exercise adherence (Burgess et al., 2017). The direct effects of the environment will be further examined in this study.

Chapter 2 - Literature Review

Stress and Health

Stress is associated with poor future health outcomes including obesity, cognitive impairment, increased symptoms of depression and anxiety, increased sickness frequency, and decreased reported health and bone mass (Turner & Stevinson, 2017). Stress is defined as an external stimulus that can cause mental or physical reactions leading to the development of a chronic illness (Kivimäki et al., 2002; Varghese et al., 2015). Stress adversely affects individuals' health, leading to an increased risk of long-term and short-term illnesses (Blaug et al., 2007; Kivimäki et al., 2002; O Donovan et al., 2013). For example, long-term stress is associated with cardiovascular and coronary heart disease (Kivimäki et al., 2002; Kivimäki & Steptoe, 2018). Kivimäki et al. (2002) examined if cardiovascular disease leading to mortality is caused by stress, while Kivimäki & Steptoe (2018) explored a similar relationship between stress and coronary heart disease risk. Researchers found that participants who indicated greater stress levels had a 2.2-fold increase in cardiovascular mortality risk and a 1.1 to 1.6-fold increase in coronary heart disease (Kivimäki et al., 2002; Kivimäki & Steptoe, 2018). While stress can intensify poor health outcomes in the future, it can also influence short-term health.

Stress increases the risk of diseases that shorten life expectancy, and it may also impair one's ability to accomplish daily tasks (Blaug et al., 2007; O Donovan et al., 2013). For instance, a review by Donovan et al. (2013) explored the effects of stress and found that stress can cause poor job performance, cognitive impairment, and lack of concentration leading to poor decision making, lower motivation levels, and increased anxiety. Similarly, Blaug et al. (2007) found that elevated stress causes chronic pressure and can lead to short-term physiological and psychological symptoms. Physiological symptoms of stress can include headaches, dry mouth, muscle tension or

pain, coughing, heartburn or indigestion, hypertension or chest pain, reduced ability to fight infections, and poor sleep quality (Blaug et al., 2007). Stress's psychological symptoms can include excessive worry, fatigue, loss of humor, low self-confidence, and anxiety and depression (Blaug et al., 2007). Stress can also influence behaviors like eating a poor diet, smoking, binge drinking, binge eating, and decreased exercise levels (O Donovan et al., 2013). College students experience elevated stress increasing exposure to the adverse long- and short-term effects of stress (Charles et al., 2021; Son et al., 2020). Although stress is a source of negative symptoms in college students, other external factors can also elevate stress levels.

College is a transitional time for students because they are introduced to new responsibilities. Students are now responsible for finances, time management, working, and a higher academic workload (Darling et al., 2007). Some students adjust to college life challenges well, while others are subject to high amounts of stress (Towbes & Cohen, 1996). The symptoms of stress in college students are wide-ranging and may have detrimental effects on their well-being (Charles et al., 2021; Son et al., 2020). College students specifically can experience negative psychological symptoms of high stress including hypertension, muscle tension, anxiety, depression, cognitive impairment, and reductions in sickness defenses of the immune system (Baghurst & Kelley, 2014). College students experience other symptoms from high stress levels including changing their behaviors to reflect more unhealthy choices like drinking soda and alcohol, substance abuse, consuming junk food, exercising less, and having poor sleep quality (Dalton & Hammen, 2018; Hudd et al., 2000). When stress is ineffectively managed, feelings of loneliness, nervousness, sleeplessness, and excessive worrying may arise (Ross et al., 1999). While stress causes many negative psychological symptoms in students' lives daily, it can also influence students' academic performance.

The idea that stress can impact academic performance is not new. Research by Tice & Baumeister (1997) evaluated procrastination and its relationship with performance, stress, and health. Two independent studies were conducted to examine procrastination among students with and without the addition of questions regarding their frequency of healthcare visits. The first study from Tice & Baumeister (1997) included students (n = 44) in a psychology course who had a term paper assigned with an automatic extension. The extension was added to examine whether students completed the paper by the original deadline, with the extension, or turned it in late. Students answered questions from the general procrastination scale, weekly measures of stress, work requirements, and how they felt after completing the paper. A high score on the general procrastination scale indicated being a 'procrastinator', while a lower score indicated that the student was a 'non-procrastinator'. Procrastinators had higher scores on the general procrastination scale and lower grades on the paper (r (42) = -0.29, p = 0.056), and higher stress levels (r (42) = -0.29, p = 0.056). The second study (Tice & Baumeister, 1997) examined the relationship between procrastination and illness in a new student sample (n = 60). The study used the same protocol but also included questions about their healthcare visits. Procrastinators experienced less stress early in the semester (r (56) = -0.31, p = 0.016), but later had increased stress levels (r (56) = 0.68, p < 0.001), more health-care visits (r (56) = 0.37, p = 0.004), and lower final scores on their paper compared to non-procrastinators (r (56) = -0.26, p = 0.045). These studies describe a clear relationship between procrastination and increased stress. Moreover, they show the impact of procrastination on grades and an increase in healthcare visits. Stress continues to negatively impact academic performance, but in recent years there have been new external factors elevating stress levels.

A marked rise in college students' stress in the past decade was recently accompanied by a worldwide pandemic that brought increased stress. Research demonstrates the pandemic's effects on stress in college students at a southeastern U.S. university (Charles et al., 2021). Longitudinal surveys before the pandemic in the spring of 2019 (n = 240) and during the beginning of the pandemic in the spring and fall of 2020 (n = 148, n = 352) measured changes in psychological symptoms, perceived stress, and alcohol use. College students reported significantly higher perceived stress levels (p = 0.03), more mood disorder symptoms, and higher alcohol use (p = 0.08) in spring 2020 compared to fall 2019 and fall 2020. Stress levels were considered low for fall 2019 and fall 2020 compared to spring 2020. The beginning of the pandemic seemed to have caused higher stress levels in students. Findings were likely due to unexpected challenges and disruptions in typical class styles that caused universities to switch to teaching online classes. Students also indicated that the pandemic negatively impacted their psychological well-being through increased depression (p = 0.02), anger (p < 0.001), and mania symptoms (p < 0.001) (Charles et al., 2021). Another study examining students' stress levels from a large public university (n = 195) found that around 71% of students indicated their stress levels had increased during the pandemic (Son et al., 2020). Students mentioned a majority of their stress came from fear and worry about their health (91%), concentration difficulties (89%), sleeping difficulties (86%), less social interactions (85%), and increased concerns regarding academic performance (82%). Due to the increased levels of stress in college students, finding a solution to reduce stress levels is crucial to prevent illnesses or poor health outcomes from high levels of stress.

Stress and Exercise

Exercise is a positive mechanism for reducing stress levels and improving health (Bennett, 2019; Bretland & Thorsteinsson, 2015; Leininger et al., 2014). Yoga is a great opportunity for

stress reduction (Della Valle et al., 2020). A meta-analysis reviewed six clinical trials looking at yoga interventions and calculated a moderate effect size of d = -0.67 for the effect of exercise on stress (Della Valle et al., 2020). Other forms of exercise like cardiovascular training, resistance training, group exercise, and walking have also been linked to stress reductions (Bennett, 2019; Bretland & Thorsteinsson, 2015; Leininger et al., 2014). However, evidence suggests that different forms of exercise may elicit different stress-reduction responses. For example, researchers designed an intervention with three groups: one group performed cardiovascular training, one group performed resistance training, and one group was instructed to not perform any exercise (Bretland & Thorsteinsson, 2015). The intervention goal was to see the effect of exercise type on well-being, personal accomplishment, psychological distress, perceived stress, and emotional exhaustion. Participants (n = 49) aged 19-68 completed their assigned exercise for 30 minutes, three times per week for four weeks. The control group in this study was put on a waitlist and did not perform any exercise. Participants in both exercise groups reported significant improvements in personal accomplishments ($p < 0.05$), improved well-being ($p < 0.001$), and lower levels of psychological distress ($p < 0.01$), perceived stress ($p < 0.01$), and emotional exhaustion ($p < 0.05$) compared to the control group. The cardiovascular exercise group demonstrated reduced psychological distress ($p < 0.01$), perceived stress ($p < 0.01$), and emotional exhaustion ($p = 0.053$), and increased well-being ($p < 0.001$) compared to the control group. The resistance training group had reductions in perceived stress ($p < 0.05$), while improving well-being ($p < 0.01$) and increasing personal accomplishment ($p < 0.01$) compared to the control group.

Walking interventions have demonstrated similar improvements in stress reduction (Leininger et al., 2014). For example, a four-week team-based walking intervention with 39 participants decreased perceived stress post-intervention ($p = 0.012$). Measurements were taken

during two time points including one week prior and one week following the walking competition. Participants significantly increased the number of days they walked per week ($p < 0.001$) and increased their engagement in vigorous physical activity days ($p < 0.03$).

Another type of exercise with established stress-reduction benefits is group exercise. Group exercise can be beneficial by providing an inclusive environment to improve stress, quality of life, and well-being better than individual exercise. A study utilizing a POUND-style group-exercise class explored the effects of group exercise on perceived stress (Bennett, 2019). The POUND class is a type of group-exercise class that incorporates weighted drumsticks with choreographed movements to music. Women participants (n = 40) aged 18-60 partook in a one-hour POUND class two times per week for eight weeks (Bennett, 2019). It was found that over time, perceived stress levels were reduced with participation in the group exercise class.

Group exercise interventions have also been conducted with medical students measuring perceived stress and quality of life (Yorks et al., 2017). In this 12-week study, students (n = 69) participated in one of three groups: a 30-minute Les Mills group fitness class (n = 25), exercising alone regularly (n = 29), or a control group where students did not engage in regular exercise (n = 15). Participants in the fitness class group engaged in at least one class per week. Participants in the regular individual exercise group engaged in running, weight lifting or another individual exercise at least twice per week. The control group did not engage in regular exercise, but was able to use transportational physical activity such as walking or biking. Following the intervention, participants in the fitness class group had lower levels of stress, and improved physical and emotional quality of life compared to the regular exercise group and control group. These findings demonstrate group exercise as an effective mode for reducing perceived stress and improving quality of life compared to individual exercise. The evidence suggests that perceived stress levels

can be lowered through multiple types of exercise, however, the exercise environment one participates in needs to be considered.

Stress and Exercise Environment

Research exploring the relationship between exercise environment and stress has shown mixed results (Bodin & Hartig, 2003; Kondo et al., 2018). For example, in a running intervention, participants (n = 12) ran for one hour in two different outdoor environments: a park and an urban environment (Bodin & Hartig, 2003). The park environment was located in a nature reserve with a forest and open fields where participants ran on dirt and gravel paths. On the other hand, the urban environment had high vehicle traffic, minimal green space, and was near apartments and commercial buildings. Participants in the urban environment group ran on concrete sidewalks. Study outcome measures included self-reported depression and anxiety, and behavioral measures of attention and restoration. Findings suggest that running significantly improved feelings of anger (p = 0.002) and anxiety/depression (p = 0.002), though there were no significant differences between the park and urban environments in feelings of anger (p = 0.78) and anxiety/depression (p = 0.36). However, participating in exercise outdoors has been shown to result in lower levels of stress and a recent review confirms the differences in stress and the exercise environment (Kondo et al., 2018).

A newer review examined 43 studies that explored how outdoor environment exposure impacts physiological or psychological stress responses (Kondo et al., 2018). Heart rate, blood pressure, and self-report measures are commonly used tools to provide evidence about the relationship between outdoor exposure and stress. Moreover, these measures also help researchers understand the effects of outdoor exposure on health outcomes. Clinical measures of stress, like blood cortisol, were not included in this review, but are recognized physiological markers for

chronic stress and do not pertain to outdoor exposure acutely reducing stress (Kondo et al., 2018). This systematic review found mixed findings on outdoor exercise exposure improving stress responses more than indoor exercise, which demonstrates low generalization. However, the researchers justified multiple methods for furthering research regarding outdoor exposure. Future research should focus on what aspects of the outdoor environment led to the most reductions in stress. For instance, more interventions are needed to investigate the micro-environments effect on health outcomes, the dose-response relationship between the environment and health, or the relationship between proximity to natural spaces and stress, especially in neighborhoods that do not have proximity to natural resources (Kondo et al., 2018). More evidence is needed to determine if there is a difference in the effects of outdoor and indoor exercise on reducing stress.

The Importance of Exercise Environments

The impact of the exercise environment on stress and health-related outcomes is an emerging area of research with numerous verdicts. Two recent reviews found that outdoor or 'green' exercise has a greater positive effect on physical and mental well-being than physical activity indoors (Lahart et al., 2019; Thompson Coon et al., 2011). Thompson Coon's systematic review of 11 studies with mostly young student participants (Mean age = 25.22 years) revealed many benefits associated with outdoor exercise (Thompson Coon et al., 2011). The studies included in the review compared a single bout of walking or running in an indoor and outdoor environment. Outdoor exercise provided more enjoyment, revitalization, positive engagement, and energy, and lowered tension, anger, depression, and anxiety feelings when compared to indoor exercise. A more recent systematic review of 28 articles by (Lahart et al., 2019), investigated the benefits of exercise in 'green' environments compared to indoor exercise. Acute bouts of 'green' exercise resulted in higher enjoyment and affective valence than indoor exercise. However, the

authors noted that the risk of bias was high, suggesting a low quality of evidence. Furthermore, a few variables were negatively affected by 'green' exercise, including perceived exertion, exercise intensity, biological markers, and emotions. The mixed evidence presented by these two reviews suggests that more research is needed to understand further the benefits of 'green' exercise and how exposure to nature relates to physical and mental wellbeing.

Research comparing exercise in an indoor or outdoor environment often restricts participants to one exercise condition, limiting the generalizability of the findings. For example, some studies compared the effects of biking, strength training, and dancing in an indoor or outdoor environment, but required each participant to perform the exercise in only one environment (Byrka & Ryczko, 2018; Calogiuri et al., 2015). A workplace intervention to reduce stress split participants (n = 15) into two conditions: one indoors (a gym studio) and one outdoors (a park near the workplace) (Calogiuri et al., 2015). Both groups biked and performed strength training with bands in two 45-minute-long structured sessions. Blood pressure and cortisol were taken the morning following each exercise session. Self-reported measures of restoration and mood were collected pre and post-intervention. The outdoor group reported higher restoration ($p < 0.001$), mood ($p = 0.02$), and improved blood pressure ($p = 0.05$). However, cortisol levels did not change across groups following the exercise sessions. This intervention demonstrated that stress-related health outcomes can be enhanced through biking and strength training as well as differences in perception or mental responses to being outdoors vs. indoors.

Dancing is another type of exercise that has been studied in indoor and outdoor spaces. Salsa dancers (n = 64) completed five 40-minute sessions in a dance room or park to examine the differences between positive emotions, exhaustion, and physical activity engagement in each condition (Byrka & Ryczko, 2018). Self-reported feelings of positive emotions and exhaustion

were measured before and after each session, and engagement was measured during the session. Dancers in the park condition exhibited significantly greater levels of engagement ($p < 0.001$), positive emotions ($p < 0.01$), and greater levels of vigorous movements ($p < 0.01$) compared to the studio dancers (Byrka & Ryczko, 2018).

To understand the differences between exercising indoors and outdoors, some studies employ a cross-over design requiring participants to perform a type of exercise in both environments (Deckbar et al., 2017; Turner & Stevinson, 2017). Running was the exercise used for this design. For example, in one study, participants (n = 16) completed consecutive one-mile runs first in an indoor environment and then, after a one-day wash-out period, in an outdoor environment (Deckbar et al., 2017). Resting heart rate and blood pressure were measured before and after each run. Runners also rated their perceived exertion after each mile run. Runners ran faster in the indoor environment than outdoor environment ($p = 0.019$). However, the participants preferred to run outdoors over indoors though the outdoor run increased their rate of perceived exertion ($p = 0.042$). In a separate study by (Turner & Stevinson, 2017), runners (n = 22) aged 18-51 years completed a 6,000-meter (about 3.73 miles) run in both indoor (gym) and outdoor (woodland) environments. Randomization was used to determine which environment would be completed first. Affect valance, and perceived exertion was measured in both conditions before the run, at 3,000 m, 6,000 m, and post-run. Perceived exertion increased significantly while running ($p < 0.001$) and significantly decreased during a 10-minute post-run ($p < 0.001$). Interestingly, differences in perceived exertion and affect valence were not significantly different between conditions.

Research is limited in comparing the effect of exercise in three different environments including an indoor environment, an outdoor environment, and a control condition, requiring each

participant to perform the exercise in all three environments (Legrand et al., 2018; Niedermeier et al., 2017). Running, walking, and mountain biking are exercises that have been used for this type of study. For example, a running intervention tested the acute effects of exercise on energy and fatigue in participants (n = 18) with depressive symptoms (Legrand et al., 2018). Participants completed three different conditions for 20 minutes each. Running was completed for two conditions (@ 64-77% max heart rate) in two different environments including an indoor gym and an outdoor nature park. The last condition involved the participants being sedentary by watching a movie about sports, exercise, and health in a laboratory. Measurements for this study included depressive symptoms, energy levels, and fatigue. Energy levels improved significantly in both the outdoor ($p = 0.012$) and indoor exercise conditions ($p = 0.018$) (Legrand et al., 2018). However, there was no significant difference between the indoor and outdoor groups ($p = 0.758$) or overall feelings of fatigue.

Niedermeier et al. (2017) compared indoor and outdoor exercises to measure mood. Participants (n = 42) were asked to complete three different conditions in a randomized order. The conditions lasted about three hours each including a sedentary control, indoor treadmill walking, and outdoor mountain hiking. The mood measurements involved the Feeling Scale, Felt Arousal Scale, and a mood survey scale. Outdoor mountain hiking showed a significant increase in affective valence, activation ($p < 0.001$, d = 0.81), elation ($p < 0.001$, d = 1.07), and calmness ($p = 0.004$, d = 0.84) compared to the control condition. Those in the mountain hiking condition also showed significant decreases in fatigue ($p < 0.001$) and anxiety ($p = 0.005$). Those in the mountain hiking condition also improved fatigue (d = -0.57), affective valence, and activation (d = 0.54) compared to indoor walking. This indicates that the outdoor condition elicits greater positive

benefits of mood when compared to the indoor condition. These studies comparing indoor and outdoor exercise further recognize the greater benefits of outdoor exercise.

Perceived Stress

Research has studied the effect of indoor and outdoor exercise, but few studies have studied the main outcome of perceived stress (Hawkins et al., 2011). In a study exploring walking and gardening groups to reduce stress in older adults, researchers split participants (n = 94) into four conditions (Hawkins et al., 2011). These conditions included allotment gardeners, home gardeners, members of a local outdoor walking group, and lastly, members of a local indoor walking group. Blood pressure and perceived stress were measured before and after 30 minutes of their activity. Between the four conditions, there was a significant difference in perceived stress levels (p = 0.003). There was also a significant difference in perceived stress between the indoor exercisers and allotment gardeners ($p < 0.05$), showing the outdoor gardeners had lower perceived stress than indoor exercisers. These findings illustrate outdoor gardening as a beneficial exercise for reducing perceived stress in older adults.

Perceived Stress in College Students

To our knowledge, only one intervention compared differences in perceived stress of college students between indoor and outdoor exercise environments. College students (n = 140) participated in group-based sports activities for 1-2.5 hours in indoor and outdoor environments (Klaperski et al., 2019). Indoor sports included aerobics, aqua aerobics, basketball, fencing, swimming, and volleyball. Outdoor sports included mountain biking, running, and football. Mood, state-stress (perceived stress), and state-anxiety measurements were collected before and after each bout. Results indicated that perceived stress, mood, and state anxiety significantly improved after participating in any exercise group ($p < 0.001$). Indoor swimming (p = 0.004) and outdoor

mountain biking (p = 0.003) had a greater effect on stress reduction than other sports types. The outdoor environment was perceived as more calming (p = 0.000) and provided more stress-reducing (p = 0.000) and anxiety-reducing effects (p= 0.001) (Klaperski et al., 2019). These findings suggest that outdoor exercise is a beneficial outlet for students to achieve recommended amounts of exercise and reduce their stress levels, though indoor exercise via swimming was also effective for stress reduction.

Although a growing body of evidence suggests the benefits of exercise in outdoor environments, more research over a longer duration is needed to understand the complex relationship between exercise environment and stress in college students. Given that stress negatively affects students' health, it is crucial to understand how the environment augments benefits. The poor health outcomes from elevated levels of stress provide a crucial reason for conducting these studies on college students to prevent or alleviate the adverse outcomes. Health-related symptoms like depression, anger, anxiety, perceived stress, and well-being can be alleviated by participation in exercise regularly and group-based exercise (Bennett, 2019; Bodin & Hartig, 2003; Bretland & Thorsteinsson, 2015; Hawkins et al., 2011; Klaperski et al., 2019; Leininger et al., 2014). Little is known about the effects of combining structured group exercise and the outdoor environment to examine its effect on perceived stress, and this study hopes to close this gap in the literature.

Gaps in the Literature

Given the previous literature, several gaps still remain. These gaps include the comparisons of outdoor and indoor exercise environments with strength-based exercise or group exercise on perceived stress. This intervention attempts to close these gaps by comparing the effects of group exercise in outdoor versus indoor environments on perceived stress and outdoor physical activity

in college students. It was hypothesized that outdoor group exercise class participants would demonstrate more significant decreases in perceived stress levels than participants in indoor group exercise classes relative to baseline. A secondary hypothesis was that participants in the outdoor group exercise class be more physically active outdoors comparted to those in the indoor group. This study could inform future research and provide guidance for developing effective stress reduction interventions in college students.

Chapter 3 - Methodology

Study Setting and Study Design

The intervention took place in a midwestern state in October and November 2021. This four-week two-arm randomized controlled trial tested the effectiveness of outdoor (intervention) compared to indoor (control) group exercise classes for reducing psychological stress levels and increasing outdoor physical activity levels in college students (Figure 2). The intervention was organized by the researcher in cooperation with the administration of the university recreation center. All exercise sessions were led by the researcher who is a certified AFAA (Athletics and Fitness Association of America) Group Fitness Instructor.

Participants and Recruitment

Lahart et al. (2019) found a moderate effect size for outdoor exercise on health-related outcomes. An analysis was conducted to determine the number of participants needed for 80% power, an effect size of 0.80, and a 40% attrition rate. This analysis revealed a sample of 30 participants were needed for each group. Recruitment was conducted through flyers distributed by email, university newsletters, and on bulletin boards at the university health care center and university buildings. The flyer included a link for potential participants to determine if they met the study's inclusion criteria (See Flyer in Appendix A). Participants met the inclusion criteria if they were at least 18 years old and were full-time students. Participants were required to meet additional screening criteria from the ACSM Risk Screener to ensure their ability to fulfill the study's exercise requirements. The ACSM Risk Screener protocol is explained further below in the "Health Assessment" section in Measures. If a participant marked the over the ideal amount for the risk screener, they were required to obtain medical clearance prior to participation. Participants were excluded only if their physician did not give medical clearance. Participants were

given an informed consent form that included the purpose of the intervention, randomization, and the benefits and risks of participating in a research project. Randomization was conducted 1:1 by flipping a coin to determine which environment each participant would attend for the intervention. There was no determined minimum or maximum for each group. The informed consent was signed before participation in the intervention. Once all criteria were met including the inclusion criteria and the ACSM Risk Screener, participants scheduled baseline testing with the research coordinator. The study was approved by the Kansas State Institutional Review Board approval #10820. The researcher enforced all guidelines set forth by the University and Recreation Services regarding mask-wearing and social distancing. Inclusion criteria questions (Appendix B), the ACSM Risk Screener (Appendix C), and the informed consent (Appendix D) documents will be provided.

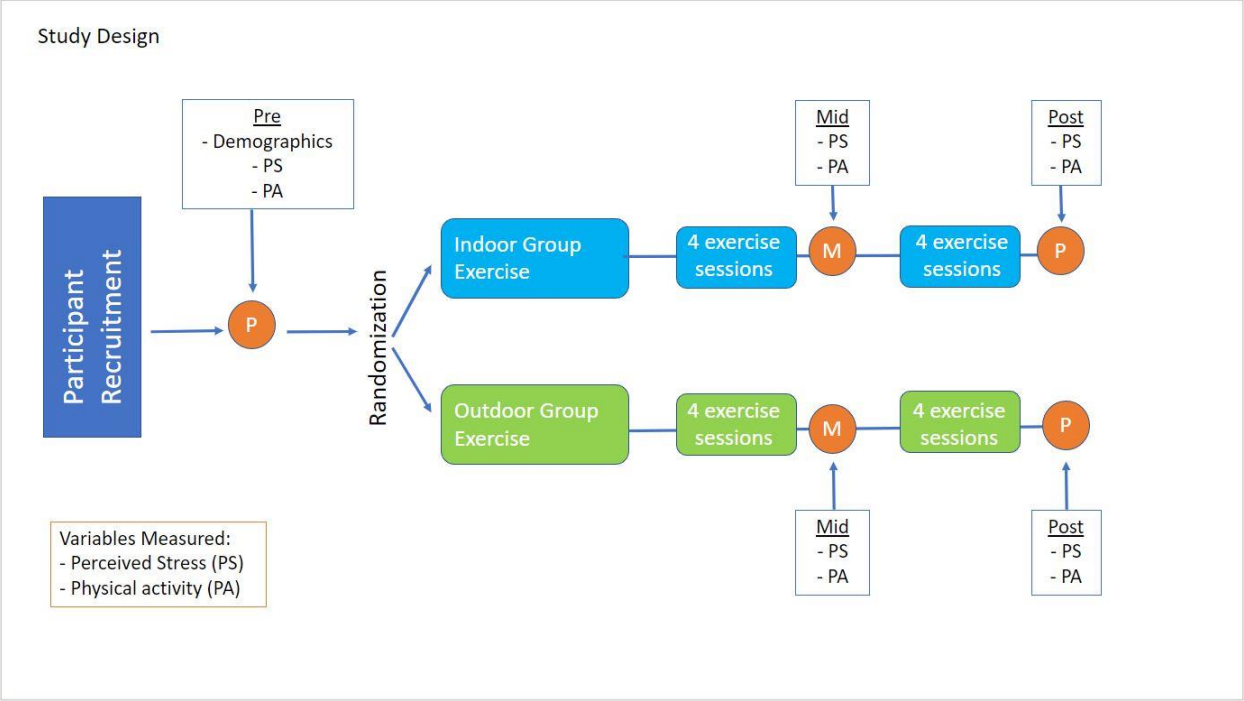

Figure 2. Study Design

Exercise Environment Description

The intervention included group exercise classes in two different environments: outdoor and indoor. The outdoor group exercise classes were conducted in a grassy baseball recreation field surrounded mostly by trees approximately 100 yards from the north side entrance of the university recreation center, while the indoor group exercise classes were conducted inside the university recreation center. Outdoor sessions began at 7 AM with visibility improving as the sun rose. Streetlights and car lights were utilized to provide adequate visibility and to maintain appropriate safety. One session took place at an alternative location: a park under a covered pavilion. The last two sessions in the outdoor environment were completely in the sun due to daylight savings time.

The indoor setting was a large dance studio room in the university recreation center. Visual contact with outdoors was limited to small windows which displayed a parking lot. A large wall-sized mirror covered the front and back wall of the studio. The studio had a ceiling fan and ballet bar that were utilized during sessions.

The weather conditions for outdoor sessions were mostly cloudy, chilly, and with moderate wind (5-20 mph); however, there were a couple of sunny days. Outdoor temperatures ranged from around 37 to 61 degrees F with an average temperature of 48.3 degrees Fahrenheit. The indoor sessions were kept at room temperature which was about 72 degrees Fahrenheit. The social interaction among environments was kept consistent. The group fitness instructor and research assistants interacted with participants in the same manner as in the outdoor and indoor classes to the best of their ability.

Group Exercise classes

All participants completed the same group exercise classes in the indoor (control) or outdoor (intervention) group. The researcher, a certified group fitness instructor through AFAA, led the group exercise classes. These classes were scheduled to begin at 7:00 AM and end at 8:00 AM. A total of eight classes were conducted two times per week for four weeks with the outdoor group meeting on Monday and Wednesday and indoor group meeting on Tuesday and Thursday. After finishing the four-week intervention, participants were given the option to attend additional sessions for two weeks to make up missed sessions. Make-up sessions were included in the data analysis for those participants who did not complete all eight during the four-week intervention.

Session workouts were replicated for each group to provide consistency. The exercise program used elastic resistance bands with handles, elastic resistance band loops, and fitness mats. Participants used resistance training and cardiovascular exercise in the form of walking, aligning with (Bretland & Thorsteinsson, 2015), due to their confirmed reduction of perceived stress over a four-week program in each type of exercise (Bretland & Thorsteinsson, 2015). Participants were encouraged to work through each activity during the session at an intensity they were comfortable with. Each session included 5 minutes for pre-session surveys, 5 minutes of a warm-up, 30 minutes of resistance training with bands, 10 minutes of walking, 5 minutes of a cool down, and 5 minutes for post-session surveys. The warm-up consisted of movements including jumping jacks, squats, high knees, and arm circles.

The first session of the week incorporated upper body movements utilizing the resistance bands with handles. Upper-body movements included the bicep curl, shoulder press, lateral raise, front raise, push-ups, and shoulder taps in plank. The second session of the week integrated lower body movements with the use of resistance band loops on a few exercises (ex. Lateral steps, donkey

kicks, fire hydrants, leg lifts, and leg pulses). Additional lower-body movements without incorporating the resistance band included squats, lunges, and bodyweight hinge movements. Weeks 3 and 4 repeated the upper and lower body exercises but increased reps and resistance. The program aimed to represent simple exercise sessions that could be done in conjunction with the participants' regular exercise routines or lack thereof. A light snack consisting of a granola bar was given upon completion of each session with water being available in the university recreation center.

Data Collection

The researcher and three research assistants conducted data collection. The research assistants took field notes during the group exercise classes to detail the weather in the outdoor condition and the level of engagement among participants in both environmental conditions. The researcher collected attendance data for each session. Primary and secondary outcome measurements were assessed through surveys one week prior to the intervention (pre-intervention), after 4 exercise sessions (mid-intervention), and after 8 exercise sessions (post-intervention). Participants that did not obtain 8 sessions after the four-week intervention were offered an additional week of sessions (2 sessions) and completed their post-intervention survey after completion of this week. The pre-intervention survey assessed perceived stress, current physical activity levels, and additional information (i.e. age, sex, major, year in school, marital status, location of residence, and stressors).

The mid-intervention survey assessed perceived stress and current physical activity levels. The post-intervention survey assessed the same variables as the mid-survey but also included additional questions about why participants missed sessions, satisfaction with the intervention, and recommendations. If participants missed any exercise sessions, they were given these options to

explain their reasoning: Conflict, Sick/Injury, Parents, Weather, or didn't like their assigned group. Questions about intervention satisfaction and recommendations were open-ended. All participant intervention surveys (pre, mid, and post) are included in Appendix E.

Measures

Stress

The primary outcome of this study includes perceived psychological stress. This variable was measured by a four-item Perceived Stress Scale (PSS-4; Cohen et al., 1983). The original PSS-4 has an internal consistency of 0.74. (Vallejo et al., 2018). For this study, an adapted version of the four-item Perceived Stress Scale was utilized to measure acute perceived stress levels and demonstrate satisfactory internal consistencies (Cronbach's α before/after exercise= 0.75/0.79)(Klaperski et al., 2019). The adapted version of the PSS-4 uses the PSS-4 questions but is further adapted into statements, as described below.

Aligning with Klaperski et al., (2019), MacKay (2008) & Rogerson et al. (2016), the PSS questions were reworded from how participants felt during the last month to statements on how participants felt at the moment they fill out the survey. For example, the question asking, "In the last month, how often have you felt nervous and 'stressed'?" was altered to the statement "I feel nervous and 'stressed.'" The Likert scale was also reframed from a 5-point from 0 to 4 (0= never, 4= very often) to a 5-point scale from 1 to 5 (1= strongly disagree, 5= strongly agree) (MacKay, 2008). The adapted PSS-4 scoring procedure states that items 2 and 3 were reverse scored. The sum of scores for this measurement ranges from 4 to 20, with higher scores indicating greater levels of perceived stress. According to the study by (Anwer et al., 2020), the use of the Perceived Stress Scale (PSS-14) has adequate validity and internal consistency (Cronbach's alpha 0.78 and

0.71) for measuring perceived stress levels in college-aged students. These questions from the PSS-4 were used to validate the first hypothesis.

Physical Activity

The secondary outcome of this study was the engagement in physical activity outside the intervention. To measure physical activity, the International Physical Activity Questionnaire-Short Form (IPAQ- SF) was used to determine their light, moderate, and vigorous physical activity. This questionnaire in the shortened version is valid and reliable to assess college students' participation in physical activity (Dinger et al., 2006). Two additional questions were included to determine the amount of outdoor physical activity participants were engaging in outside of the intervention. These included: "During the last 7 days, how many days did you engage in outdoor physical activity?" and "How much time (minutes and hours) did you spend engaging in outdoor physical activity on one of those days?" These two additional questions were used to test the second hypothesis. Variables were calculated as weekly minutes of activity.

Health Assessments

Exploratory outcomes were measured with health assessments conducted during baseline and follow-up measurements. The health assessments included measurements of height, weight, body mass index (BMI), body fat %, fat mass, muscle mass, basal metabolic rate (BMR), blood pressure, resting heart rate, and blood oxygen content (SpO2). Height was measured using a Seca portable stadiometer. Weight, BMI, body fat %, fat mass, muscle mass, and BMR were measured using a Tanita scale Version C-110. Blood pressure was measured using an Omron automated blood pressure cuff. Resting heart rate and blood oxygen content were measured using a pulse oximeter. Taking these measurements is a standard protocol conducted before and after an exercise

intervention to determine if a person is physically able to participate in a new exercise program and if the intervention took part in changing these measurements (Rhoads & Petersen, 2016).

The American College of Sports Medicine (ACSM) Health Pre-participation Screening Questionnaire was used to determine health history and if medical clearance was required before participating in the intervention (Riebe et al., 2015). If one or more medical history section items were marked, the participant was required to obtain medical clearance from a physician before participating in exercise, and therefore the study (Riebe et al., 2015). Additionally, if two or more items in the cardiovascular risk factors section were marked, medical clearance from a physician was also required to participate in the study (Riebe et al., 2015). Those who required medical clearance were able to participate after their doctor indicated they could begin a new exercise protocol (Riebe et al., 2015). In this study. no participants needed to obtain medical clearance.

Data analysis

As noted above, the sample size (n=30 per condition) was calculated based on perceived stress using an effect size of 0.80, 80% power, and assumed a 40% attrition rate. SPSS version 27 was used for statistical analysis. Descriptive statistics were run on the data to obtain frequencies, means, and standard deviations. Data were checked for skewness and kurtosis as well as Levene's Test of test of equality of error variances and Mauchly's test of sphericity. A mixed analysis of variance (ANOVA) with the Tukey posthoc tested the effectiveness of group exercise in outdoor environments (compared to indoor) environments on perceived stress (hypothesis 1) and outdoor physical activity (hypothesis 2).

Chapter 4 - Results

Participant Characteristics

Of the seventeen participants interested in the intervention, thirteen people (76.5%) agreed to participate, signed an informed consent, and were randomized to either the indoor or outdoor group exercise environmental conditions if they were at least 18 and were full-time students. As shown in Table 1, participants (n = 13) were mostly female (69.2%), were 18-24 years old (76.9%), and lived off-campus (69.2%). Graduate students made up the largest group of students based on their year in school (38.5%). The majority of participants (61.5%) received the full dose of all eight exercise sessions (range 0-8 sessions). Participants in both groups were fairly active at baseline for combined moderate and vigorous activity (MVPA) per week (Indoor Mean = 296.67, Outdoor Mean = 274.29), however, there was no significant difference between MVPA/week between outdoor and indoor groups at baseline (Moderate: p = 0.967, Vigorous: p = 0.835). Participants who completed the intervention had higher levels of outdoor physical activity at baseline (mean = 207.50, SD = 196.74) compared to those who did not complete the intervention (Mean = 60.00, SD = 69.28) (p = 0.088). Perceived stress levels were not statistically different at baseline between completers (Mean = 11.00, SD = 1.77) and non-completers of the intervention (Mean = 10.00, SD = 2.45) (p = 0.502). A matrix showing attendance by session for each participant and condition is shown in Tables 2-4. When participants were unable to attend a session, they either had a conflict (n = 3, Indoor = 1, Outdoor = 2) or were sick/injury (n = 3, Indoor = 1, Outdoor = 2).

Table 1. Descriptive Table

	Total (n = 13)	1: Indoor (n = 6)	2: Outdoor (n = 7)
Gender	N (%)	N (%)	N (%)
Male	3 (23.1%)	3 (50.0%)	0
Female	9 (69.23%)	3 (50.0%)	6 (85.7%)
Non-binary	1 (7.7%)	0	1 (14.3%)
Age Range	N (%)	N (%)	N (%)
(18-24)	10 (76.9%)	4 (66.7%)	6 (85.7%)
(25-34)	2 (15.4%)	1 (16.7%)	1 (14.3%)
(35-44)	1 (7.7%)	1 (16.7%)	0
(45-54)	0	0	0
(55-64)	0	0	0
(65+)	0	0	0
Year in school	N (%)	N (%)	N (%)
Freshman	2 (15.4%)	0	2 (28.6%)
Sophomore	3 (23.1%)	2 (33.3%)	1 (14.3%)
Junior	2 (15.4%)	2 (33.3%)	0
Senior	1 (7.7%)	0	1 (14.3%)
5th Year	0	0	0
Graduate student	5 (38.5%)	2 (33.3%)	3 (42.9%)
Residence	N (%)	N (%)	N (%)
On campus	4 (30.8%)	1 (16.7%)	3 (42.9%)
Off campus	9 (69.2%)	5 (83.3%)	4 (57.1%)
Total sessions attended	N (%)	N (%)	N (%)
0	1 (7.7%)	0	1 (14.3%)
1	2 (15.4%)	0	2 (28.6%)
2	0	0	0
3	0	0	0
4	0	0	0
5	1 (7.7%)	0	1 (14.3%)
6	0	0	0
7	1 (7.7%)	0	1 (14.3%)
8	8 (61.5%)	6 (100.0%)	2 (28.6%)
Weekly Activity (minutes/week)		Mean (SD)	Mean (SD)
Sedentary		2065.00 (1220.29)	1920.00 (1384.67)
Walking		1360.00 (103.34)	542.14 (568.18)
Moderate		130.00 (103.34)	132.86 (136.22)
Vigorous		166.67 (154.88)	141.43 (262.94)

Table 2. Attendance Matrix (Sessions 1-4)

	Session 1		Session 2		Session 3		Session 4	
ID #:	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
2	X		X		X		X	
3			X		X		X	
5	X		X		X			
6	X		X		X		X	
7			X		X		X	
13			X		X			
Indoor Totals	3		6		6		4	
1		X		X		X		X
4				X				
8		X		X				
9		X				X		X
10								
11				X				
12		X		X		X		X
Outdoor Totals	4		5		3		3	
Field Notes:	57 F, sunny	48 F, sunny	37 F, sunny	61 F, sunny	48 F, overcast	46 F, foggy	52 F, partly sunny	57 F, light rain, fog, moved to second location

Table 3. Attendance Matrix (Sessions 5-8)

	Session 5		Session 6		Session 7		Session 8	
ID #:	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
2	X		X		X		X	
3			X		X		X	
5	X		X		X			
6	X		X				X	
7	X		X		X		X	
13	X		X		X		X	
Indoor Totals	5		6		5		5	
1		X		X		X		X
4								
8		X						
9						X		X
10								
11								
12		X		X		X		X
Outdoor Totals	3		2		3		3	
Field Notes:	34 F, overcast	43 F, windy and cold	45 F, overcast	37 F, cloud cover	46 F, sunny	48 F, clear and sunny with few clouds	39 F, sunny	52 F, cloudy

Table 4. Attendance Matrix (Make-up Sessions)

	Session 9		Session 10	
ID #:	Indoor	Outdoor	Indoor	Outdoor
2	N/A		N/A	
3	X		X	
5	X		X	
6				
7	X			
13	X		X	
Indoor Totals	4		3	
1		N/A		N/A
4				
8		X		X
9		X		X
10				
11				
12				
Outdoor Totals	2		2	
Field Notes:	37 F, sunny	46 F, slight breeze	21 F, sunny	45 F, very windy

Data Analysis Criteria

Four participants in the outdoor group and one participant in the indoor group were excluded from the data analysis because they did not complete the study due to lack of attendance or lack of survey compliance (did not attend at least one exercise session or complete all three surveys for the intervention). Therefore, five indoor group participants and three outdoor group participants met inclusion criteria and completed the study protocol (n = 8). An intent-to-treat analysis was not used since this analysis method uses all participants that are randomized in the intervention no matter what condition they actually receive ("once randomized, always analyzed") and is used to reduce confounding from non-random dropout or non-compliance among participants (Gupta, 2011). However, this method reduces the ability to see a real effect of the explored intervention by comparing two different groups (Gupta, 2011). Another method for analyzing data that accounts for compliance and dropout issues among participants is the per-protocol analysis. A per-protocol analysis removes all participants who violate the protocol

including not adhering to the assigned treatment, not completing all measurements, and switching treatment groups (Matilde Sanchez & Chen, 2006). By using this analysis, the data are better able to detect differences between treatments groups (Matilde Sanchez & Chen, 2006). A per-protocol analysis was used because the purpose of the intervention was to test the effect of the condition (group exercise in outdoor versus indoor environments) on stress and outdoor physical activity. It was a valid protocol to exclude one participant from the data analysis who failed to attend any sessions and four participants failing to comply with the three measurement time points. Including those participants in the data analysis would make it more difficult to demonstrate the condition's effects on perceived stress and outdoor physical activity. Given the small sample size, participants (n = 8, Indoor = 5, Outdoor = 3) were analyzed if they completed at least one session and all three measurement time points (Figure 3).

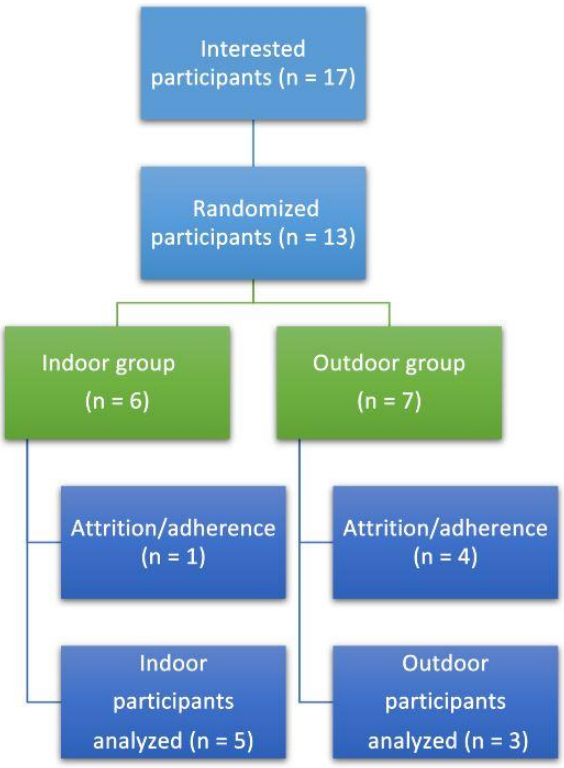

Figure 3. Data Analysis Protocol

Changes in Perceived Stress and Outdoor Physical Activity

The data were normally distributed according to the skewness and kurtosis guidelines for normality. These guidelines state that the data range for skewness (-1 to +1) and kurtosis (-2 to +2) are considered normal (George & Mallery, 2010). The assumptions for a mixed ANOVA were met including Mauchly's test of sphericity and Levene's test of equality of error variances. Significance was determined at a $p < 0.05$ level. Descriptives for perceived stress and outdoor physical activity is shown (Table 5).

Perceived Stress

A mixed ANOVA was performed to analyze the effects of group exercise in indoor and outdoor environmental conditions on perceived stress across three time points (pre, mid, and post) (Table 6). The mixed ANOVA revealed that there was a significant main effect of group exercise on perceived stress scores over time for the whole sample, ($F(2, 12) = 48.359$, $p = 0.000$, Partial Eta squared = 0.890). Perceived stress scores decreased pre to post-intervention (See Figure 4). The posthoc analysis revealed that across time there was a significant decrease in perceived stress scores of the whole sample from both pre to post ($p = 0.000$) and mid to post ($p = 0.001$). The main effect of the environmental condition (indoor or outdoor) was non-significant, (overall $F(1,6) = 0.040$, $p = 0.847$, Partial Eta squared = 0.007). This shows the perceived stress scores were not significantly different between groups. There was a significant interaction between time and environmental condition, ($F(2, 12) = 10.051$, $p = 0.003$, Partial Eta squared = 0.626), demonstrating the effect of the group exercise on perceived stress scores was significantly different between the indoor and outdoor groups. The indoor group's perceived stress scores from pre to post were significantly reduced from 10.4 to 8.6 ($p = 0.028$). The indoor group's perceived stress scores mid to post were significantly reduced from 11.4 to 8.6 ($p = 0.017$). The outdoor group's

perceived stress scores pre to post were significantly reduced from 12.0 to 6.0 (p = 0.000) and significantly reduced mid to post from 11.7 to 6.0 *(p* = 0.002). The outdoor group's change in perceived stress scores showed a greater significance and greater reduction when compared to the indoor group's scores pre to post and mid to post. Perceived stress scores across time for both groups are shown (Figure 4).

Outdoor Physical Activity

A second mixed ANOVA was performed to analyze the effects of the group exercise in indoor and outdoor environmental conditions on outdoor physical activity (Table 6). The mixed ANOVA concluded the main effect of time on outdoor physical activity levels was not significant in the total sample, (F (2, 12) = 1.194, *p* = 0.337, Partial Eta squared = 0.166). Outdoor physical activity scores stayed consistent pre to post-intervention for the outdoor group and for the indoor group the activity levels started high, reduced at mid, and rose for post-intervention measurements. The main effect of the group exercise experimental condition (indoor or outdoor) was non-significant overall, (F (1,6) = 0.508, *p* = 0.503, Partial Eta squared = 0.078). This effect tells us that if we ignore all other variables, the indoor group's outdoor physical activity levels were not significantly different than the outdoor group's outdoor physical activity levels. The interaction between time and the condition was not significant, (F (2, 12) = 0.948, *p* = 0.415, Partial Eta squared = 0.136), demonstrating the effect of the group exercise on outdoor physical activity levels was not different between the indoor and outdoor environmental conditions. Given this, we know the lack of significance occurs for all the measurements from pre to mid, mid to post and pre to post. Outdoor physical activity levels across time for both groups are shown (Figure 5).

Table 5. Perceived Stress and Outdoor Physical Activity by Time-point

Outcome variable	Time-point	Indoor (n = 5) Mean (SD)	Outdoor (n = 3) Mean (SD)	P- values
PSS	Pre	10.40 (1.67)	12.00 (1.73)	0.785
	Mid	11.40 (1.67)	11.67 (2.52)	
	Post	8.60 (1.67)	6.00 (2.00)	
OPA	Pre	266.00 (225.34)	110.00 (105.36)	0.118
	Mid	90.00 (134.16)	100.00 (91.65)	
	Post	180.00 (202.36)	120.00 (0.00)	

PSS = Perceived Stress, measured by the Perceived Stress Scale. OPA = Outdoor Physical Activity, measured by the Modified IPAQ.

Table 6. Mixed ANOVA Table

	Perceived Stress				Outdoor Physical Activity			
Source	df	F	p	Eta squared	df	F	p	Eta Squared
Between-subjects effects								
Condition	1	0.040	0.851	0.007	1	0.508	0.503	0.078
Error (Condition)	6				6			
Within-subjects effects								
Time	2	48.36	0.000*	0.890	2	1.194	0.337	0.166
Time * Condition	2	10.05	0.003*	0.626	2	0.948	0.415	0.136
Error (Time)	12				12			

*P-values < 0.05

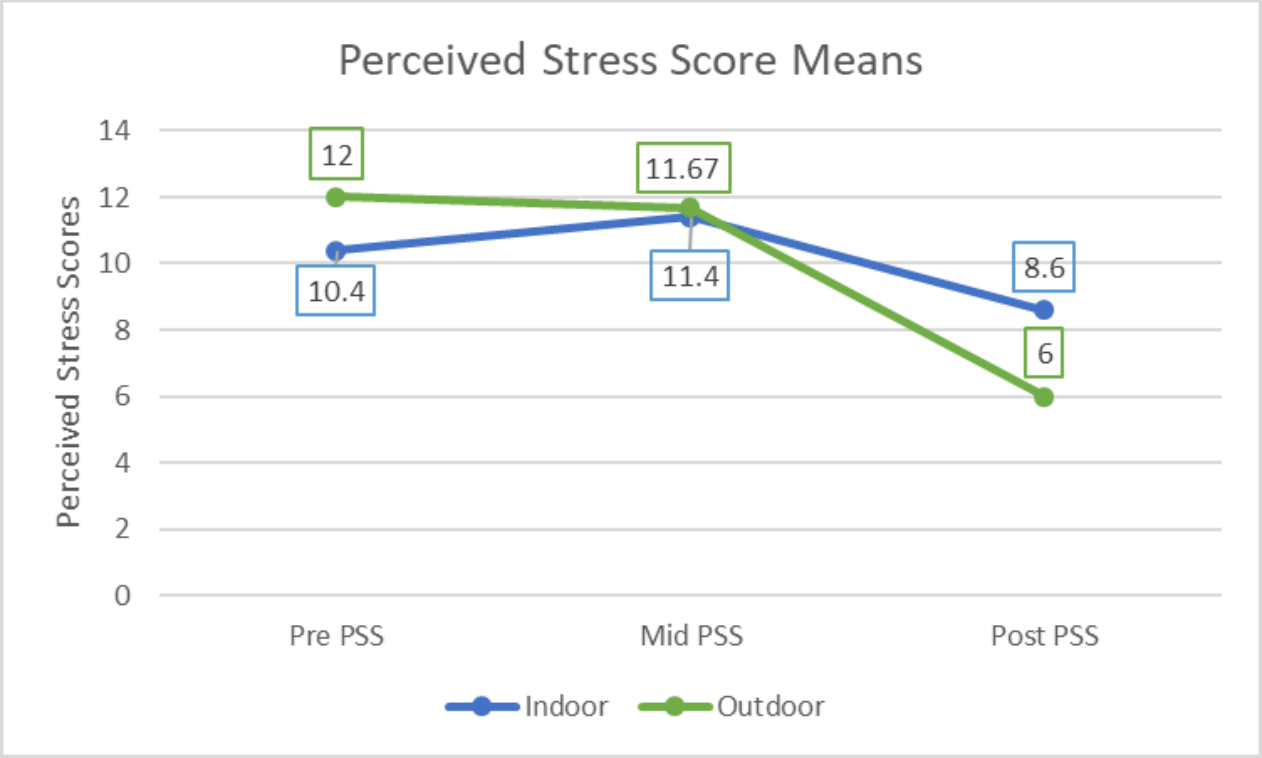

Figure 4. Perceived Stress Score Means

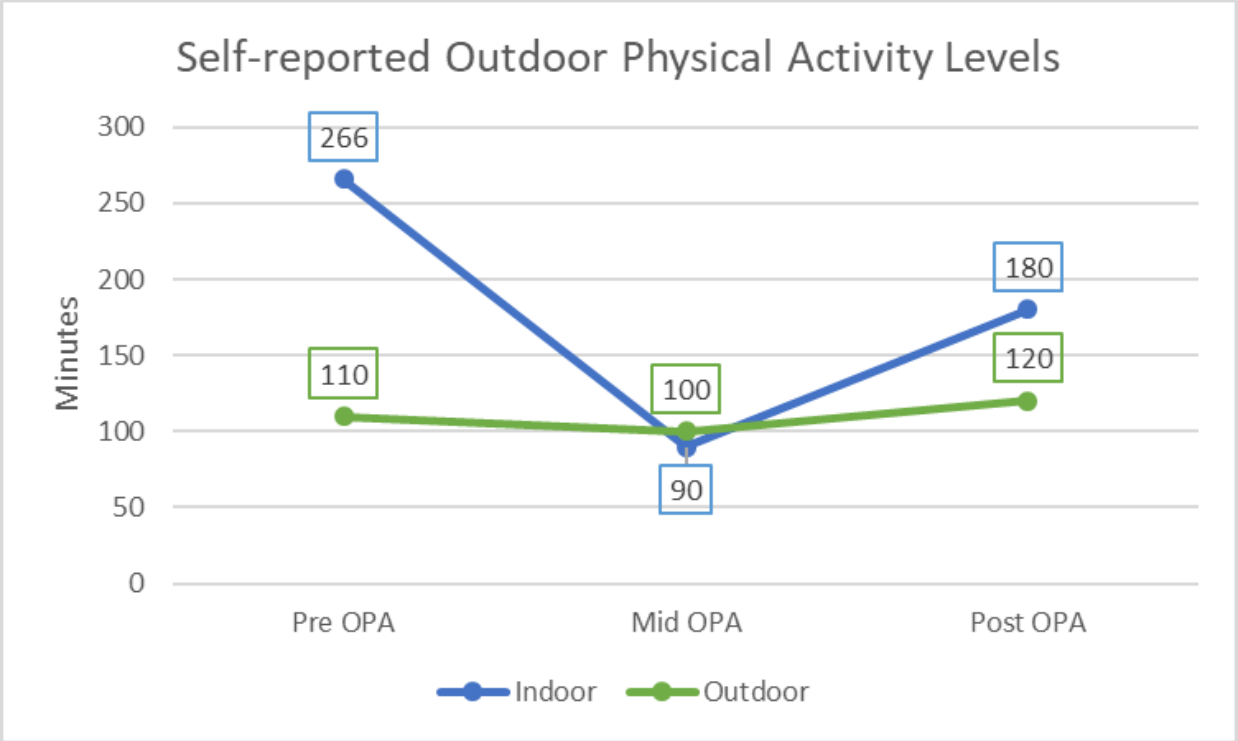

Figure 5. Outdoor Physical Activity Level Means (minutes per week)

Program Evaluation

After the intervention, participants were asked about their satisfaction with the intervention and if they had any recommendations. A majority of participants liked the length of the intervention because it was enough to encourage a morning exercise routine, though a couple of participants thought the intervention length of four weeks was a little too long. The strength-based exercise done with resistance bands was enjoyed by all participants. A few participants mentioned that the resistance bands were helpful because they were challenging, but didn't feel pressured to go up in weight. The indoor group enjoyed their environment because it had abundant space and was temperature controlled, but some participants would have preferred to be in the outdoor group. The outdoor group liked their environment even though it was cold most mornings. They mentioned that the cold temperatures helped to wake them up and motivate them to keep moving. The only negative comment about the outdoor environment was that it was dark some days. Participants overall mentioned that they enjoyed the music, exercises, length of the workout, and familiarity with other participants during the exercise sessions, however, participants disliked the time of the exercise classes and the cold weather at that time.

Suggestions for the intervention were that the exercise sessions should take place later in the day compared to in the mornings. Additionally, a participant recommended having each participant engage in both environments during the same week. Lastly, including a session introducing the individuals to each other to accelerate the social effect of group exercise.

Chapter 5 - Discussion

The purpose of this study was to determine whether the outdoor versus indoor environment influenced the effect of group exercise on perceived stress and outdoor physical activity levels in college students. The outcome of lower perceived stress in both groups in this study agrees with previous research indicating that participation in exercise (in any environment) can provide a reduction of perceived stress (Bennett, 2019; Bretland & Thorsteinsson, 2015; Leininger et al., 2014). These results align with Bretland & Thorsteinsson (2015) finding that resistance training and cardiovascular exercise performed over four-weeks reduced perceived stress levels in workers aged 19 to 68, and Bennett (2019) found that participating in a POUND class, which incorporated choreographed movements with drumsticks, reduced perceived stress levels, in women aged 18-60 years, when attended twice a week for eight weeks. As well, Leininger et al. (2014) found that perceived stress scores were reduced significantly for ladies participating in a walking competition. The findings in this study support the inverse relationship between exercise and perceived stress indicating as exercise increases, stress decreases.

The first hypothesis examined if the outdoor exercise group had a greater reduction of perceived stress compared to the indoor exercise group relative to baseline. The main interaction between the environmental condition (outdoor vs. indoor group exercise) and time was significant. This tells us that the environment had a different effect on perceived stress scores in the outdoor compared to the indoor group exercise condition. The posthoc analysis revealed that the outdoor group had a greater reduction in perceived stress scores compared to the indoor group. These findings reject the null hypothesis and accept hypothesis 1.

These findings align with multiple studies that have found significant effects of outdoor exercise on perceived stress levels (Hawkins et al., 2011; Klaperski et al., 2019). For example,

Hawkins et al. (2011), found that there was significantly less perceived stress in outdoor gardeners than participants of indoor exercise classes ($p < 0.05$). Klaperski et al. (2019) found evidence that an outdoor environment for sports was perceived as more calming and provided more stress-reducing effects compared to an indoor environment ($p = 0.000$) (Klaperski et al., 2019).

Outdoor physical activity levels were not significantly different over time or between conditions, nor was there a significant interaction between the condition and time points. The second hypothesis proposed that the outdoor group would have higher levels of outdoor physical activity compared to the indoor group. Hypothesis 2 was not supported since the findings regarding outdoor physical activity were not significant and the levels of outdoor physical activity for the outdoor group were not greater than the indoor group. Participation in the outdoor exercise classes was hoped to encourage participants to engage in outdoor activity outside of the intervention. However, this was not the case for these participants. This finding could have resulted from the short intervention time and participants were not able to internalize the outdoor exercise preference and engage in enough outside of the intervention. Weather could have played a role in outdoor physical activity behavior. Additionally, participants could have also replaced their outdoor physical activity with their assigned exercise class.

Strengths

This intervention had several strengths. The intervention was a randomized controlled trial, which is one of the highest valued types of intervention designs that can reduce bias and accurately examine the cause-effect relationships of an intervention and its outcome variables (Hariton & Locascio, 2018). The exercise session protocol was consistent among groups with the same exercises, order, duration, and instructor. This intervention was also conducted during the COVID-19 pandemic which made the intervention difficult to accomplish, but it was still completed.

Though the intended plan for this intervention was to start earlier in the fall, the intervention still took place and the researcher found a significant change in perceived stress, providing more information that outdoor resistance group exercise can reduce perceived stress in college students. This study can also be considered an exploratory analysis to determine if this is an effective and feasible intervention for this population.

Limitations

This intervention had multiple limitations. The outdoor exercise session environment that the intervention was set in was adequate, but the addition of measuring more elements in the outdoor environment can help us better understand what about the outdoor environment contributed to improved perceived stress levels. This can include the characteristics, temperature, and the aesthetic pleasure of the environment (Lachowycz & Jones, 2013).

Researcher bias was also a limitation. The researcher, who was also the group exercise instructor, knew the hypotheses of the study, which could have impacted their encouragement during classes between environments to obtain the projected outcome. Field notes were also taken by research assistants, but only observed the participants and not the instructor. The researcher did their best to make each class as consistent as possible with the exercises and social interaction with participants.

Although a validated scale was used to measure the main outcome variable of perceived stress, it is a subjective measure that could be affected by social desirability bias (Anwer et al., 2020). Participants knew of the study purpose, but did not know of the study hypotheses. Participants may have knowledge that their stress should be reduced through exercise, which could influence their responses, but was uncontrollable by the researcher. Objective measures of cortisol via blood or saliva may have found different results. The PSS-4 was used because it has been

validated in my population of college students (Anwer et al., 2020) and was a good option given limited resources (e.g., quick, cheap, non-invasive). Surveys for mid and post were sent to participants when they completed 4 exercise sessions (mid) and after completing 5-8 sessions (post). Since these surveys were not filled out at the same time with the other participants, this would be a limitation of the study and attribute to the instrumental threat to internal validity. Additionally, a few measurements were not included in this analysis because they did not directly apply to the research question evaluated. Social support, physical activity, perceived exertion, and mood were also measured in this intervention. Because social support was not analyzed, no mediation was run to see how social support could have affected the participants' stress levels during the intervention.

With 30 participants needed for each group and only 6-7 recruited per group, shows this study is underpowered. The low sample size of this study was potentially due to the COVID-19 pandemic occurring throughout my intervention (Füzéki et al., 2020). This low sample size in a small town of the midwestern US shows low generalizability. Participants also were required to wear a mask in the university recreation center, which could have been a deciding factor, yet it did not affect drop-out rates in the indoor group. Participants in the outdoor group were not required to wear a mask and thus shows inconsistency. Another limitation of this intervention included a participant who took all three surveys but did not attend any sessions. Due to this, a per-protocol analysis was conducted to better show the differences between treatments groups compared to an intent to treat analysis (Matilde Sanchez & Chen, 2006). As stated above, the individual who did not attend any sessions was excluded from the data analysis because their results would not have reflected an adequate dose of engaging in the outdoor exercise sessions that were needed to explore the effect on perceived stress. Another limitation related to the low sample size is attrition rates.

There was differential dropout or uneven distribution of individuals failing to complete the intervention between groups, including a higher amount of attrition in the outdoor group (n = 4) compared to the indoor group (n = 1).

Weather, location, transportation, and time of day were also considered limitations in this study. The outdoor environmental condition averaged temperatures from 37 to 61 degrees Fahrenheit and the colder weather could have discouraged some participants from attending. The location of the exercise classes took place at the university recreation center outside on the baseball fields and having the class out in the open could have affected participation in the outdoor group. A few students relied on transportation to the exercise class location and this seemed to be an issue for participation. The time of the class is in the morning was not considered ideal for all interested students and would have been better enjoyed during sunny afternoons.

Throughout the intervention, stress adaptation may have played a role because everyone adapts to stressors differently (Ahrndt et al., 2016). This element could have mitigated the reduction in perceived stress among the population in the study. In this study, participants were in the same group throughout the intervention. Developing rapport with other participants in their exercise group may have improved their stress levels in a different magnitude from the beginning sessions to the last sessions. Knowing the participants better at the end of the intervention may have improved their stress levels more. With this, the small group sizes may have encouraged socialization among participants and increased rapport more than if there were larger groups. Though acute perceived stress was studied, exploring specific stressors can be beneficial. For example, in college, some deadlines and exams can be stressful for many students but having set goals or deadlines can help with time management and deadlines in the real world that students need to be prepared for when they graduate (Lareau & Weininger, 2008).

Practical Implications and Future Directions

Given the opportunity to do this intervention again, applying for funding would have been helpful to provide a form of incentive for individuals to enroll in the study. Additionally, investigating objective measurements of stress and finding one that is more sensitive to acute changes among college students. Another method that could have been added is a survey asking about current stressors going on in the students' lives and this may explain why their stress levels are higher or lower each time it is measured. Another survey measure that could be utilized includes questions about how each student is coping with their stress. It may ask what coping resources they are using currently for their stress and could provide additional resources that could be used later to improve their stress levels.

Another improvement to include for this study would be changing the time of day and season it was conducted in. This study took place in October and November 2021 during the early mornings around 7-8 am. Though this was done to include as many students as possible, it also could have discouraged some as well. A better option would be to have the class in the afternoon during the late spring months. The weather would be warmer, and people may be more likely to attend if it is not early in the morning.

Practical implications of this study include the use of physical activity, particularly in outdoor environments to address perceived stress in college students. Programs can be implemented at university recreation centers . Gyms or fitness centers rarely have environments to use for outdoor exercise and should find ways to incorporate outdoor group exercise as a part of their facility. Consideration into providing adequate space for outdoor or green exercise is needed. For example, a flat and well-shaded outdoor space can be used for outdoor group exercise classes, but not many facilities have a great space for this. An option for this is to use outdoor

shared spaces of the recreation center for outdoor group exercise classes like tennis courts or baseball fields. College recreation centers can also partner up with student mental health services to encourage students with mental health issues to use outdoor exercise as a coping mechanism.

The findings of this intervention provide valuable information that may be used for future research. This study confirmed that exercise reduces perceived stress levels and that the reduction in stress levels is greater for those participating in outdoor activities. However, more research will be needed to examine the mechanisms of the outdoor environment on health behaviors and health outcomes. As proposed in the framework of Lachowycz and Jones (2013), these mechanisms may include the characteristics and aesthetic pleasure of the greenspace that need to be further explored.

Chapter 6 - Conclusion

High levels of stress can cause poor health outcomes and can greatly affect college student success. Exercise is a method for reducing stress levels and improving other aspects of mental and physical health including mood, self-esteem, anxiety, and depressive symptoms (Lane & Lovejoy, 2001; Mikkelsen et al., 2017). Exercising outdoors can provide a multitude of benefits compared to indoor exercise (Byrka & Ryczko, 2018; Calogiuri et al., 2015; Deckbar et al., 2017; Lahart et al., 2019; Legrand et al., 2018; Niedermeier et al., 2017; Thompson Coon et al., 2011; Turner & Stevinson, 2017). This study found that perceived stress can be reduced significantly in college students by participating in outdoor group exercise for four weeks.

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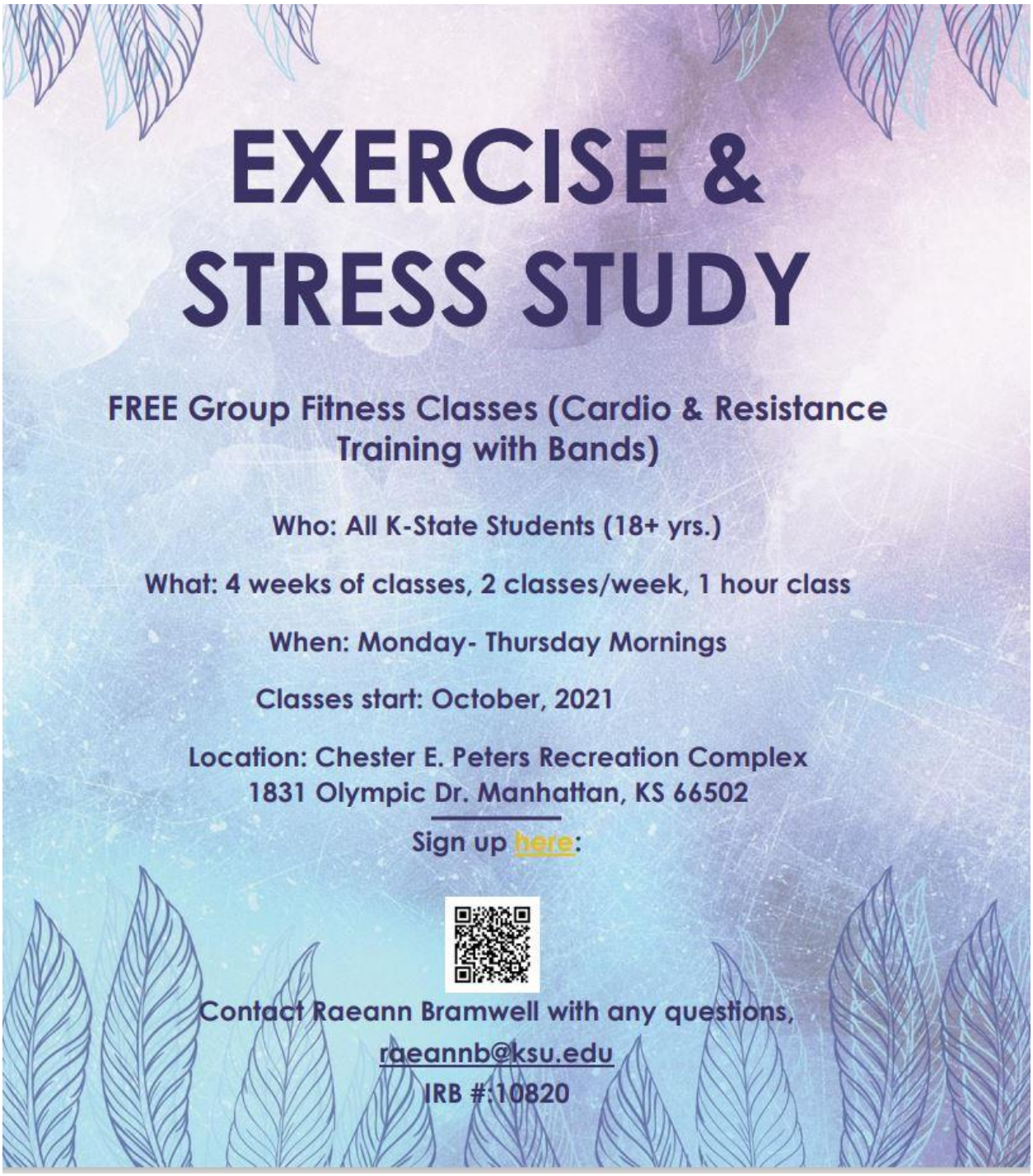
Appendix A - Study Recruitment Flyer



Appendix B - Inclusion Criteria Questions

1. Are you over 18 years old?
    a. Yes
    b. No

2. Are you a K-State Student?
    a. Yes
    b. No

If any of these questions are marked “No”, the individual will not be eligible to participate in the intervention.

If all questions are marked “Yes”, the individual is eligible to participate in the intervention.

*Questions were asked using an online survey distributor (Qualtrics)

Appendix C - ACSM Risk Screener Questions

AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire

Assess your health needs by marking all *true* statements.

History

You have had:

___ A heart attack
___ Heart surgery
___ Cardiac catheterization
___ Coronary angioplasty (PTCA)
___ Pacemaker/implantable cardiac defibrillator/rhythm disturbance
___ Heart valve disease
___ Heart failure
___ Heart transplantation
___ Congenital heart disease

Symptoms

___ You experience chest discomfort with exertion.
___ You experience unreasonable breathlessness.
___ You experience dizziness, fainting, blackouts.
___ You take heart medications.

*If you marked any of the statements in this section, consult your physician or other appropriate healthcare provider before engaging in exercise. You may need to use a facility with a **medically qualified staff**.*

Other health issues

___ You have diabetes
___ You have or asthma other lung disease.
___ You have burning or cramping in your lower legs when walking short distances.
___ You have musculoskeletal problems that limit your physical activity.
___ You have concerns about the safety of exercise.
___ You take prescription medication(s).
___ You are pregnant.

Cardiovascular risk factors

___ You are a man older than 45 years.
___ You are a woman older than 55 years, you have had a hysterectomy, or you are postmenopausal.
___ You smoke, or quite within the previous 6 mo.
___ Your BP is greater than 140/90.
___ You don't know your BP.
___ You take BP medication.
___ Your blood cholesterol level is >200 mg/dL.
___ You don't know your cholesterol level.
___ You have a close blood relative who had a heart attack before age 55 (father or brother) or age 65 (mother or sister).
___ You are physically inactive (i.e., you get less than 30 min. of physical activity on at least 3 days per week).
___ You are more than 20 pounds overweight.

*If you marked two or more of the statements in this section, you should consult your physician or other appropriate healthcare provider before engaging in exercise. You might benefit by using a facility with a **professionally qualified exercise staff** to guide your exercise program.*

___ None of the above is true.

You should be able to exercise safely without consulting your physician or other healthcare provider in a self-guided program or almost any facility that meets your exercise program needs.

Appendix D - Informed Consent

Project Title: The Effect of Indoor and Outdoor Group Fitness Classes on Psychological Stress in College Students

Principal Investigator: Dr. Gina M. Besenyi, Kansas State University

Graduate Student: Raeann Bramwell, Kansas State University

Purpose:

Exercise provides mental health benefits. For example, exercise can reduce stress levels. Some research says that outdoor exercise is more beneficial for mental health than indoor exercise. Group fitness classes are an opportunity for everyone to engage in exercise. We are interested in understanding the difference in mental health benefits between outdoor and indoor group fitness classes. In particular, we hope to determine the effect of group fitness classes in outdoor vs. indoor environments on stress and outdoor physical activity levels of college students. No deception of the participants will be included in the study.

Description of subject involvement:

This study will take place in Fall 2021. If you join this study, you will be asked to take part in a four-week group exercise program. Exercise sessions will last 60 minutes. They will take place two times a week for four weeks. They will consist of a warmup, a set of medium intensity exercises, a short walk, and a cool down. You will be randomly assigned to attend either the indoor or outdoor classes. You will be asked to complete baseline, mid, and post surveys asking about your physical activity participation, perceived stress, mood, social support, and information about yourself (e.g., gender, age, major, year in school). You will also be asked to provide information on your stress and mood before and after each exercise session. Your rate of perceived exertion (RPE) will be recorded before each exercise session and every fifteen minutes during the session.

Anticipated Benefits:

Physical activity has many physical and mental health benefits. You may learn new ways to be active. You may also notice better mood, energy, and fitness level. You may also feel less fatigued, anxious and stressed. Data from this study may help other college students in the future.

Risks or discomforts anticipated:

For this study, there is no more than minimal risk. You may have some soreness during or after activity. The instructor will do their best to explain what to do when you feel sore after a session. There is also a risk of injury during activity. The instructor will reduce risks by teaching safety and good form. The instructor will also include warmup and cool down exercises. You will be encouraged to work at your own pace. You may stop and rest at any time. The instructor will provide water during and after sessions. The instructor is CPR and first aid certified. Every

session will have an automated external defibrillator (AED) and first aid kit available nearby or one will be brought if needed. In the case of a subject injury, Raeann Bramwell will follow the protocols and standards the Rec has in place to determine transportation and care of the individual and cost for both. Water will be provided to participants every session. The outdoor group fitness classes will take place outside. The weather may be unpredictable. We will strive to hold sessions at convenient times of the day in the shade. We will reschedule sessions if there is inclement weather, including snow, lightning, and rain.

Compensation

You will receive compensation in the form of free group fitness classes and two health assessments. There will be no other compensation available.

Withdrawal Procedures:

As a participant, you may choose to withdrawal from the study at any time. Please contact Raeann Bramwell (raeannb@ksu.edu) if you choose to withdrawal from the study. Participants that have withdrawn from the study may still attend the health assessment at the end of the intervention.

Extent of confidentiality:

There will be steps taken to protect your privacy. You will be assigned a random ID number. Data that can identify you will not be published.

Storage and Future Use of Data

All information will be stored on a password-protected server at Kansas State University. Hard copies will be stored in a locked office at Kansas State University. Researchers may keep the raw data for up to 2 years after the study for analysis. Data from this study will not be used in future studies without additional informed consent. No information that could identify you will be shared.

Contact Information:

Questions about your role in this study can be sent to: Raeann Bramwell at raeannb@ksu.edu. If you have questions about your rights as a subject, you may contact: Rick Scheidt Chair, Committee on Research Involving Human Subjects at (785) 532-3224 or Cheryl Doerr Associate Vice President for Research Compliance at (785) 532-3224 located in 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506.

Terms of participation:

I understand this project is research. My participation is voluntary. I understand that if I decide to participate in this study, I may withdraw my consent at any time. I can stop participating at any

time without explanation, penalty, loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form. My signature also shows that I willingly agree to participate in this study under the terms described. My signature also shows that I consent to the intent to treat and the use of CPR and/or AED if needed. I understand that I will receive a signed and dated copy of this consent form.

(Remember that it is a requirement for the P.I. to maintain a signed and dated copy of the same consent form signed and kept by the participant).

PARTICIPANT NAME: _____

PARTICIPANT SIGNATURE: _____
Date:_____

WITNESS SIGNATURE: _____
Date:_____

Appendix E - Intervention Participant Surveys

Pre-intervention

Pre-Intervention Survey: ID: ____ Date: ____

Perceived Stress Scale (PSS)

The questions in this scale ask you about your feelings and thoughts right now. In each case, you will be asked to indicate your response by choosing a number (1-5) representing HOW STRONGLY you agree or disagree to the statements. Please mark an X on the space given near the statement. Although some of the questions are similar, there are differences between them, and you should treat each one as a separate question. The best approach is to answer fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

Please answer these questions about how you feel RIGHT NOW.

	Strongly Disagree 1	2	Neutral 3	4	Strongly Agree 5
1. I feel that I am unable to control the important things in my life.					
2. I feel confident in my ability to handle my personal problems.					
3. I feel that things are going my way in life.					
4. I have felt difficulties piling up so high that I cannot overcome them.					

International Physical Activity Questionnaire (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. **During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?**

____ days per week

If none, Skip to Question 3.

2. **How much time do you usually spend doing vigorous physical activities on one of those days?**

_____ hours per day

_____ minutes per day

Don't know or not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

No moderate physical activities-→ Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a weekday?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Additional Physical activity questions:

8. During the last 7 days, how many days did you engage in outdoor physical activity?

_____ days

Don’t know/Not sure

9. How much time did you spend engaging in outdoor physical activity on one of those days?

_____ hours per day

_____ minutes per day

Don’t know/Not sure

Social Provisions Scale (SPS)

In answering the next set of questions I am going to ask you, I want you to think about your current relationship with friends, family members, coworkers, community members, and so on IN THE PAST TWO WEEKS. Please mark to what extent you agree that each statement describes your current relationships with other people. Use the following scale to give me your opinion (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4= Disagree). For example, if you feel a statement is very true of your current relationships, you would mark “strongly agree”. If you feel a statement clearly does not describe your relationships, you would mark “strongly disagree”.

1. While exercising with others, I feel that I had close personal relationships with other people.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

2. While I was exercising with others, there was someone I could turn to for guidance in times of stress.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

3. While I was exercising with others, other people viewed me as competent.

1	2	3	4

Strongly Disagree Disagree Agree Strongly Agree

4. While I was exercising with others, I felt part of a group of people who share my attitudes and beliefs.

1 2 3 4

Strongly Disagree Disagree Agree Strongly Agree

5. While I was exercising with others, there were people I could count on in an emergency.

1 2 3 4

Strongly Disagree Disagree Agree Strongly Agree

Demographics questions

1. What is your age?
    a. 18-24
    b. 25-34
    c. 35-44
    d. 45-54
    e. 55-64
    f. 65+

2. What is your year in school?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. 5th year
    f. Graduate student

3. What is your major in school?

4. What is your gender?
    a. Male
    b. Female
    c. Non-binary/third gender/Transgender
    d. Prefer not to say

5. Are you now single, in a non-married couple, married, widowed, divorced, or separated?
    a. Single
    b. Non-married couple
    c. Married
    d. Widowed
    e. Divorced
    f. Separated

6. Do you live on campus or off campus?
    a. On campus
    b. Off campus

7. Please circle any stressors you experience in your life. Select all that apply.
    a. School
    b. Work
    c. Parents
    d. Romantic relationship

e. Other/s:

Thank you for participating in this study. You have completed the pre-intervention survey.

Mid-intervention

Mid-intervention Survey: ID: ____ Date: ____

Perceived Stress Scale (PSS)

The questions in this scale ask you about your feelings and thoughts right now. In each case, you will be asked to indicate your response by choosing a number (1-5) representing HOW STRONGLY you agree or disagree to the statements. Please mark an X on the space given near the statement. Although some of the questions are similar, there are differences between them, and you should treat each one as a separate question. The best approach is to answer fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

Please answer these questions about how you feel RIGHT NOW.

	Strongly Disagree 1	2	Neutral 3	4	Strongly Agree 5
1. I feel that I am unable to control the important things in my life.					
2. I feel confident in my ability to handle my personal problems.					
3. I feel that things are going my way in life.					
4. I have felt difficulties piling up so high that I cannot overcome them.					

International Physical Activity Questionnaire (IPAQ):

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. **During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?**

____ days per week

If none, Skip to Question 3.

4. **How much time do you usually spend doing vigorous physical activities on one of those days?**

_____ hours per day

_____ minutes per day

Don't know or not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

No moderate physical activities-→ Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a weekday?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Additional Physical activity questions:

8. During the last 7 days, how many days did you engage in outdoor physical activity?

_____ days

Don’t know/Not sure

9. How much time did you spend engaging in outdoor physical activity on one of those days?

_____ hours per day

_____ minutes per day

Don’t know/Not sure

Social Provisions Scale (SPS-5)

In answering the next set of questions I am going to ask you, I want you to think about your current relationship with friends, family members, coworkers, community members, and so on IN THE PAST TWO WEEKS. Please mark to what extent you agree that each statement describes your current relationships with other people. Use the following scale to give me your opinion (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4= Disagree). For example, if you feel a statement is very true of your current relationships, you would mark “strongly agree”. If you feel a statement clearly does not describe your relationships, you would mark “strongly disagree”.

6. While exercising with others, I feel that I had close personal relationships with other people.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

7. While I was exercising with others, there was someone I could turn to for guidance in times of stress.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

8. While I was exercising with others, other people viewed me as competent.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

9. While I was exercising with others, I felt part of a group of people who share my attitudes and beliefs.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

10. While I was exercising with others, there were people I could count on in an emergency.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

This is the end of this survey, thank you for participating!

Post-intervention

Post-intervention Survey: ID: ____ Date: ____

Perceived Stress Scale (PSS)

The questions in this scale ask you about your feelings and thoughts right now. In each case, you will be asked to indicate your response by choosing a number (1-5) representing HOW STRONGLY you agree or disagree to the statements. Please mark an X on the space given near the statement. Although some of the questions are similar, there are differences between them, and you should treat each one as a separate question. The best approach is to answer fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

Please answer these questions about how you feel RIGHT NOW.

	Strongly Disagree 1	2	Neutral 3	4	Strongly Agree 5
1. I feel that I am unable to control the important things in my life.					
2. I feel confident in my ability to handle my personal problems.					
3. I feel that things are going my way in life.					
4. I have felt difficulties piling up so high that I cannot overcome them.					

International Physical Activity Questionnaire (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

5. **During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?**

____ days per week

If none, Skip to Question 3.

6. **How much time do you usually spend doing vigorous physical activities on one of those days?**

_____ hours per day

_____ minutes per day

Don't know or not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

No moderate physical activities-→ Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a weekday?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Additional Physical activity questions:

8. During the last 7 days, how many days did you engage in outdoor physical activity?

_____ days

Don't know/Not sure

9. How much time did you spend engaging in outdoor physical activity on one of those days?

_____ hours per day

_____ minutes per day

Don't know/Not sure

Social Provisions Scale (SPS)

In answering the next set of questions I am going to ask you, I want you to think about your current relationship with friends, family members, coworkers, community members, and so on IN THE PAST TWO WEEKS. Please mark to what extent you agree that each statement describes your current relationships with other people. Use the following scale to give me your opinion (1 = Strongly Disagree, 2= Disagree, 3= Agree, 4= Disagree). For example, if you feel a statement is very true of your current relationships, you would mark "strongly agree". If you feel a statement clearly does not describe your relationships, you would mark "strongly disagree".

11. While exercising with others, I feel that I had close personal relationships with other people.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

12. While I was exercising with others, there was someone I could turn to for guidance in times of stress.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

13. While I was exercising with others, other people viewed me as competent.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

14. While I was exercising with others, I felt part of a group of people who share my attitudes and beliefs.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

15. While I was exercising with others, there were people I could count on in an emergency.

1	2	3	4
Strongly Disagree	Disagree	Agree	Strongly Agree

Additional Post-Intervention Questions:

1. Did you like the length of the intervention? Why or why not?

2. Did you like the type of exercise done in the exercise sessions? Why or why not?

3. Did you like the setting of the exercise sessions? Please provide whether you were in the Outdoor or Indoor group. (O= outdoor, I= indoor).

4. What are some things you enjoyed about the exercise sessions?

5. What is something you did not like about the exercise sessions?

6. During the study, were you able to attend all of the 8 sessions?

a. Yes

b. No

7. If you were unable to attend 1 or more sessions, please select your reasoning (Select all that apply):

a. Conflict

b. Sick/injury

c. Parents

d. Weather

e. Didn't like assigned group

f. Other:

8. Do you have any suggestions to make the intervention better or something that could have been improved?

This is the end of the survey. Thanks for participating.