International Journal of EXERCISE SCIENCE

Original Research

The Effect of Outdoor and Indoor Group Exercise Classes on Psychological Stress in College Students: A Pilot Study with Randomization

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ABSTRACT

International Journal of Exercise Science 16(5): 1012-1024, 2023. Emerging evidence suggests that outdoor group exercise may reduce stress more than indoor group exercise because the outdoor environment provides unique mental health benefits. Stress leads to illnesses and diseases, but exercise mitigates harmful impacts. This study explored differences in perceived stress and outdoor physical activity participation among college students in an indoor or outdoor group exercise class. Data were collected pre-, mid- (after four sessions), and post-intervention (after eight sessions). Seventeen participants indicated an interest in the study, but 13 signed up. Participants completed a four-week group exercise intervention that met twice weekly in outdoor and indoor conditions. Mixed ANOVAs with Tukey post hoc tests determined between-group differences in perceived stress and outdoor physical activity levels. Partial eta-squared (η^2_p) estimated effect sizes. Significant differences in perceived stress scores existed across time for the whole sample [$f(2, 12) = 48.359$, $p < 0.001$, $\eta^2_p = 0.890$] and for the interaction between time and condition [$f(2, 12) = 10.051$, $p = 0.003$, $\eta^2_p = 0.626$]. Post hoc analysis revealed that the outdoor group's perceived stress ($p < 0.001$) was reduced more than the indoor group post-intervention ($p = 0.028$).

KEY WORDS: Physical activity, social interaction, mental health, nature exposure, university students

INTRODUCTION

Some exercise environments are more beneficial than others. Research shows that outdoor exercise may enhance physiological (e.g., lower blood pressure, heart rate, cortisol) and psychological benefits (e.g., decreased anger, anxiety, depression, confusion) compared to indoor exercise (5,9,10,14,16,26,27,29,36,42,44). Other benefits of outdoor exercise include increased exercise intensity and duration and decreased sedentary time (5,12). Exercising outdoors exposes one to nature (green, blue, and brown landscapes) and additional sensory inputs (sun, wind, etc.) that support psychological restoration (6). As such, outdoor exercise can be more enjoyable, increase self-esteem, improve mood, and enhance psychological well-being (3,14). Furthermore, several studies suggest that outdoor exercise reduces stress more than indoor exercise (9,10,21,25,36); however, we note that this relationship is understudied in the

context of group exercise and college populations. Given this, it is vital to explore the differences in students' stress levels when exercising indoors compared to outdoors. Reinforcing the enhanced benefits of outdoor exercise can increase physical activity participation among college students and alleviate stress.

Stress is a natural reaction to a perceived or real threat that disrupts the body's homeostasis (23). Stress is problematic for the general population, and elevated stress can lead to poor health outcomes (24,45). Prolonged exposure to increased stress can lead to chronic illness (43). Stress and exercise have a positive inverse relationship where increased exercise participation corresponds to decreased stress (40). Evidence from a recent systematic review of 168 studies describes this relationship in 72.8% of the reviewed studies (40). Moreover, the exercise environment can influence stress reduction benefits (9,10,16,27,29,36,42,44). While the impact of stress is problematic for the general population, college students' stress has increased significantly in the past ten years (2,13,41).

College students experience stress throughout their college careers (2,13,24,41,43,45). Evidence suggests that up to 60% of college students are exposed to elevated stress, which can impact their academic performance (37,43). College presents multiple potential stressors, including changes in living environment, eating and sleeping habits, and an increased class workload (1,15). Ineffective stress management in students has been associated with increased worry, loneliness, nervousness, and sleep disruptions (38). Given the trends in rising stress among college students, finding effective stress management strategies is critical (2,6,12,13,35,41).

Exercise is a well-known coping mechanism that has been shown to reduce perceived stress in college students (4,8,18,19,30). Exercise is a subset of physical activity that is performed with the intent to sustain or improve health (12). Exercise improves how the body handles stress due to changes in hormonal responses by increasing the production of feel-good neurotransmitters (i.e., dopamine and serotonin) (23). Students who choose to exercise and maintain it during high academic stress buffer stress's adverse effects and improve mental well-being and sleep quality (48). Exercise also improves other mental health components, including mood and self-esteem, and reduces symptoms of depression and anxiety (28,33). A regular exercise routine can help moderate the detrimental effects of high-stress levels on college students' mental health. Indeed, exercise may serve as a "time-out" from stress (23). Likewise, group exercise may be particularly motivating for college students who enjoy the fun social environment of group exercise classes. Group exercise classes implement safely designed workouts requiring no prior knowledge or experience in a consistent schedule (47). Group exercise classes are offered in various formats that target specific physiological adaptations (i.e., strength, aerobic fitness, flexibility, etc.) based on the class type (47). Students attending weekly group exercise classes can reduce stress levels and improve their well-being and physical and emotional quality of life (49).

It is well established that regular participation in exercise decreases perceived stress in college students. However, it is unknown how an outdoor exercise environment impacts college students perceived stress and engagement in outdoor exercise. As stress rises among college

students, exploring healthy mechanisms that mitigate stress and increase student well-being is critical. Moreover, outdoor exercise provides unique benefits to mitigate stress. This study aims to examine differences in perceived stress among college students randomly assigned to outdoor vs. indoor group exercise classes. It was hypothesized that outdoor group exercise class participants would demonstrate greater decreases in perceived stress 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 physically active outdoors than those in the indoor group.

METHODS

Participants

An a priori power calculation indicated 30 participants per treatment condition would be required for 80% power, an effect size of 0.80, and considering a 40% attrition rate (27). However, 13 college students participated in this study. The majority of participants were female (69.2%), aged 18-24 (76.9%), and lived off-campus (69.2%) (see Table 1 for complete demographic information). Participants were recruited through recruitment flyers containing a link to a screening survey distributed by email, in university newsletters, and on bulletin boards at the university health care center and university buildings. Participants were included in the study if they met the following inclusion criteria: 1) they were over 18 years old, 2) full-time students, and 3) considered low risk for exercise participation as determined by the American College of Sports Medicine risk screener questionnaire (47). Informed consent was obtained before study participation began. The researcher enforced all university COVID guidelines for participant safety. The university's Institutional Review Board approved the study, approval #10820. The study conformed to the standards set by the Declaration of Helsinki, except for database registration. Moreover, adherence to the International Journal of Exercise Science standards was maintained throughout this research (34).

Protocol

The study protocol was a four-week, two-arm, randomized controlled trial in a midwestern state in the USA in October and November 2021. Randomization was conducted 1:1 by flipping a coin; no minimum or maximum was determined for each group (Figure 1).

The intervention included group exercise classes in two different settings: outdoor and indoor. The outdoor group exercise classes were conducted in a grassy baseball recreation field surrounded mostly by trees. The temperature ranged from 2.8 to 16.1°C. Humidity ranged from 46-90% and averaged 76%. The weather conditions were primarily cloudy and moderately windy (5-20 mph); however, there were a couple of sunny days. The indoor setting was a large dance studio in the university recreation center. The temperature was a constant 22.2°C. Visual contact with the outdoors was limited to small windows facing a parking lot. A large wall-sized mirror covered the front and back walls of the studio. A ceiling fan and ballet bar were used during the sessions in the studio.

Table 1. Participant demographic information and descriptive statistics.

	Total (n = 13)	Indoor (n = 6)	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
Year in School	n (%)	n (%)	n (%)
1st	2 (15.4%)	0	2 (28.6%)
2nd	3 (23.1%)	2 (33.3%)	1 (14.3%)
3rd	2 (15.4%)	2 (33.3%)	0
4th	1 (7.7%)	0	1 (14.3%)
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%)

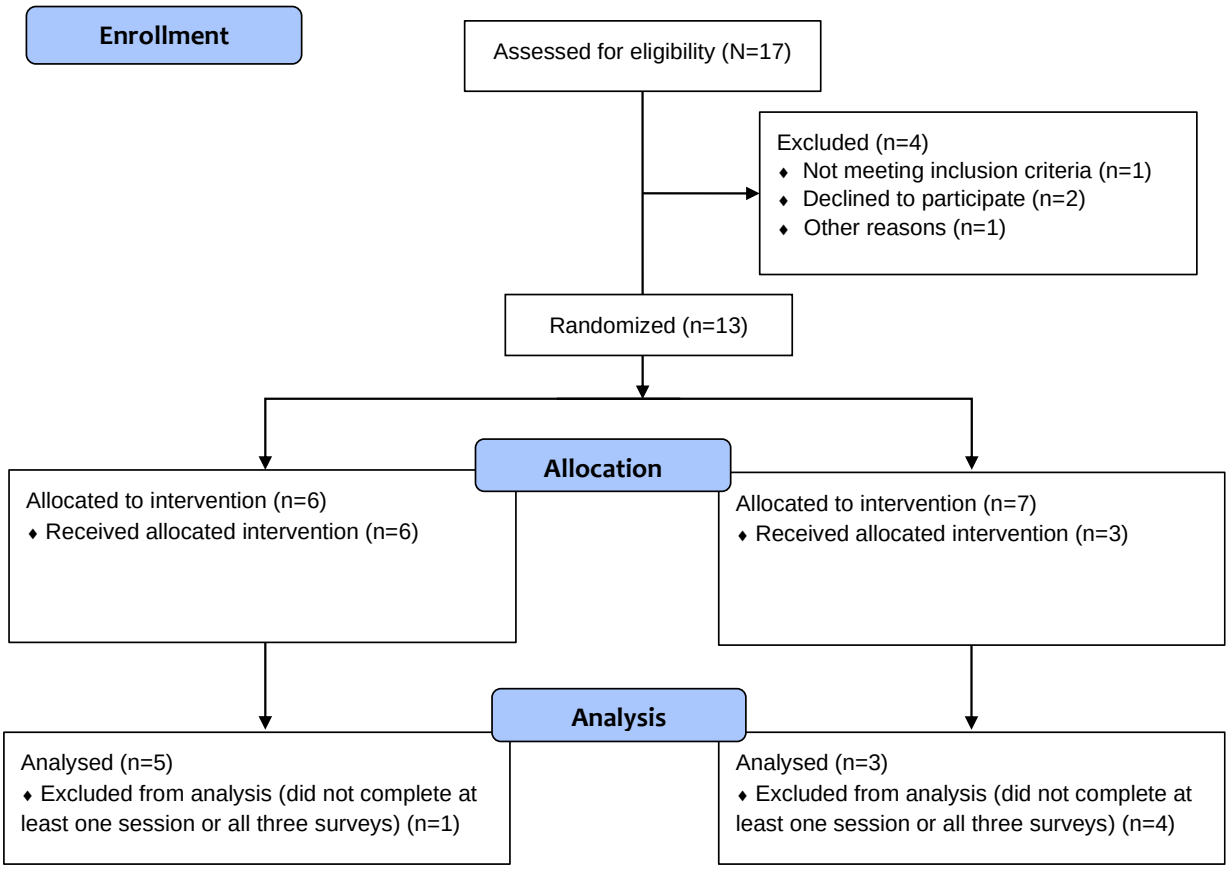

Figure 1. CONSORT 2010 flow diagram.

Participants completed the same one-hour group exercise class twice weekly, indoors or outdoors, for four weeks. Each session began at 7:00 AM. The indoor group met on Tuesdays and Thursdays, while the outdoor group met on Mondays and Fridays. The researcher, a certified group fitness instructor, led all exercise sessions. Three research assistants helped with data collection and took field notes. Upon completing the four-week intervention, make-up sessions were offered for two weeks for those missed sessions. Make-up sessions were included in the data analysis for those participants who did not complete all eight sessions during the four-week intervention.

Session workouts were replicated for each group to provide consistency. The exercise sessions used elastic resistance bands with handles, elastic resistance band loops, and fitness mats. Upper body exercises were performed during the week's first session (Mon. or Tues.), while lower body exercises were performed during the second session (Wed. or Thurs.). Exercise session protocols were similar to previous research that reduced perceived stress during a four-week program (8). All exercises were performed at a light to moderate intensity based on a self-determined rate of perceived exertion values from six to twenty (7). One corresponded with light-intensity exercise, and ten corresponded with the highest intensity possible. Sessions were structured identically:

1. Pre-exercise survey (5 minutes).
2. Warm-up (5 minutes).
3. Banded resistance training, upper or lower body focused (30 minutes).
4. Walking (10 minutes).
5. Cool down (5 minutes).
6. Post-exercise survey (5 minutes).

The pre-intervention survey assessed perceived stress, current outdoor physical activity participation, 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 for future interventions. Participants who missed an exercise session indicated why by selecting one of the following options: conflict, sick/injury, parents, weather, or did not like their assigned group. Questions about intervention satisfaction and recommendations were open-ended.

Perceived stress was measured using an adapted version of the four-item Perceived Stress Scale (PSS-4) (Cronbach's α before and after exercise = 0.75 and 0.79, respectively (23) (25). According to previous research, the adapted version assessed how participants felt at the moment rather than during the last month (23,29,35) (25,31,37). The adapted PSS-4 was scored according to standard procedures (31). Scores ranged from 4 to 20, and higher scores indicated greater levels of perceived stress.

Outdoor physical activity participation was measured using the International Physical Activity Questionnaire-Short Form (IPAQ-SF) and two additional questions to determine participants'

indoor or outdoor exercise participation. Outdoor PA was captured in minutes of walking, light-, moderate-, and vigorous-intensity PA. The IPAQ-SF is a valid and reliable measurement of physical activity among college students compared to other self-report physical activity questionnaires (criterion validity correlation ranging from 0.15-0.26, intraclass correlation coefficients between two administrators ranging from 0.71-0.89) (17).

Statistical Analysis

Statistical Package for Social Sciences (Version 27) was used for statistical analyses (22). Descriptive statistics were calculated for frequencies, means, and standard deviations. Values are reported as mean ± standard deviation. Data were checked for skewness and kurtosis, as well as Levene's test of equality of error variances and Mauchly's test of sphericity. A mixed analysis of variance (ANOVA) with the Tukey post hoc test tested the effectiveness of group exercise in outdoor compared to indoor environments on perceived stress and outdoor physical activity participation. Partial eta-squared (η^2_p) was used to estimate effect sizes, interpreted as small (0.01), medium (0.06), and large (0.14). A per-protocol analysis was implemented to reveal the differences between treatment groups (32).

RESULTS

Overall, eight participants attended all sessions. In the indoor condition, 100% attendance was recorded, but in the outdoor condition, only two participants attended all sessions. In the outdoor condition, 57.2% of participants attended five or more sessions. Baseline moderate and vigorous activity among indoor and outdoor participants (n = 13) was not statistically different (moderate: p = 0.967, vigorous: p = 0.835). Participants who completed the intervention had higher outdoor physical activity levels at baseline (207.50 ± 196.74) than those who did not (60.00 ± 69.28, p = 0.088). Perceived stress levels were not statistically different (p = 0.502) at baseline between those who completed the intervention (11.00 ± 1.77) versus those who did not (10.00 ± 2.45).

Four participants in the outdoor group and one in the indoor group were excluded from the data analysis because they did not complete the study entirely. However, given the small sample size (n = 8, indoor = 5, outdoor = 3), data from participants who completed at least one session and all three measurement time points were analyzed. The remaining data were normally distributed according to the skewness and kurtosis guidelines for normality.

There was a significant main effect on perceived stress for the interaction between time and condition [f(2, 12) = 10.051, p = 0.003, η^2_p = 0.626]. Post hoc analysis revealed that the outdoor group (p < 0.001) showed a more significant reduction in perceived stress from baseline to post-intervention compared to the indoor group (p = 0.028). Time also has a significant main effect on perceived stress across all conditions [f(2, 12) = 48.359, p < 0.001, η^2_p = 0.890]. There were no significant differences in outdoor physical activity between groups or for time [f(2, 12) = 0.948,

$p = 0.415$] and [$f(2, 12) = 1.194$, $p = 0.337$]. However, there was a medium and large effect size for the interaction between groups and time ($\eta^2_p = 0.136$; $\eta^2_p = 0.166$).

The measurements for each time point (pre-, mid-, and post-) are shown with the mean perceived stress scores and mean outdoor physical activity in both groups (Figures 2 and 3).

Figure 2. Perceived stress among college students who completed four weeks of indoor (n = 6) and outdoor (n = 7) group exercise programming. * Represents statistical significance ($p < 0.001$).

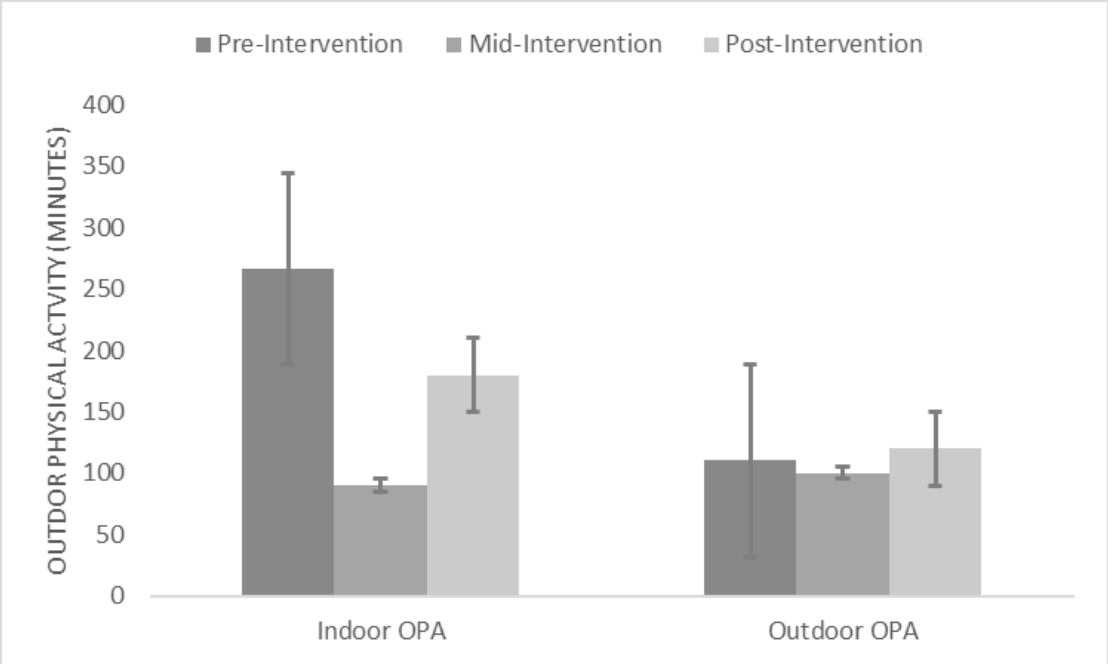

Figure 3. Outdoor physical activity among college students who completed four weeks of indoor (n = 6) and outdoor (n = 7) group exercise programming.

DISCUSSION

This study aimed 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 first hypothesis examined if the outdoor exercise group had a more significant reduction of perceived stress than the indoor exercise group relative to baseline. The primary interaction between the environmental condition (outdoor versus indoor group exercise) and time was significant, indicating that the outdoor environment had a different effect on perceived stress scores. Likewise, the post hoc analysis revealed that the outdoor group had a more significant perceived stress score reduction than the indoor group. These findings support our first hypothesis since the outdoor exercise group had a more significant reduction of perceived stress than the indoor exercise group relative to baseline.

The additional measurement in this study was outdoor physical activity levels measured with the IPAQ-SF. 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. We hypothesized that the outdoor group would obtain greater outdoor physical activity levels than the indoor group since we thought participating in the outdoor exercise classes would encourage participants to engage in additional outdoor activity outside the intervention. This was not the case for this study's participants, perhaps because the intervention was held in the late fall when temperatures dropped. Moreover, attendance was lower in the outdoor group and, thus, did not meaningfully increase the overall amount of outdoor physical activity in which they participated. These findings fail to support our second hypothesis because the outdoor group's outdoor physical activity was not greater than the indoor group's outdoor physical activity after the exercise intervention concluded.

There are several reasons that perceived stress was lowered in both exercise groups, but more so in the outdoor group. It is well-established that exercise reduces perceived stress. Previous research indicates that exercise participation (in any environment) can reduce perceived stress (4,8,30). For example, Bretland and Thorsteinsson found that resistance training and cardiovascular exercise reduced stress during a four-week intervention among workers aged 19 to 68 (8). Similarly, Bennett found that participating in eight weeks of a twice-weekly group exercise class incorporating choreographed movements with drumsticks reduced perceived stress among women aged 18-60 (4). Leininger and colleagues also found that perceived stress scores were reduced significantly for women who participated in a walking competition (30). The findings in this study support the inverse relationship between exercise and perceived stress, indicating that stress decreases as exercise increases.

Additionally, our findings that perceived stress decreased more in the outdoor group than in the indoor group may be due to outdoor exercise's unique physical and mental health benefits. While many outdoor sessions were cold and windy, participants were exposed to green, blue, and brown landscapes and additional sensory inputs that may have had positive stress reduction benefits (25). These results align with previous studies that have found significant

effects of outdoor exercise on perceived stress levels (21,25). For example, Hawkins and colleagues found that there was significantly less perceived stress in outdoor gardeners than in participants of indoor exercise classes, and Klaperski and colleagues found evidence that an outdoor environment for sports was perceived as more calming and provided more stress-reducing effects compared to an indoor environment (21,25).

We utilized a group exercise format which may have impacted our results. We implemented randomization and replicated intervention delivery to mitigate the impact of group assignments. We hoped to create a fun, social group exercise environment across both conditions, yet we had low attendance in the outdoor condition. Again, the weather may have impacted attendance more than any other element of the study. At the same time, perceived stress among participants in the outdoor condition was reduced more than in the indoor condition. Our results suggest that outdoor group exercise is beneficial despite cooler weather. Additionally, since stress decreased across all conditions, our results agree with previous group exercise research (49).

Several strengths and limitations should be addressed. This intervention had several strengths. The intervention used a randomized controlled trial experimental design, 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 (20). Most participants (61.5%) received the total dose of all eight exercise sessions (range 0-8). In addition, the exercise session protocol was consistent among groups with the same exercises, order, duration, and instructor. This study can also be considered an exploratory analysis to determine if this is a practical and feasible intervention for this population.

Nonetheless, several limitations should be addressed. This study was underpowered, limiting generalizability. For example, we observed large and medium effect sizes for time and between conditions on outdoor physical activity, and there were no significant differences between groups. This result indicates there were not enough participants. Had we been adequately powered, we may have observed a significant difference for this variable as we did for stress. We hoped to recruit 30 participants for each group, but the weather, time of day, and study duration may not have been ideal for the participants. Moreover, the intervention period unfortunately aligned with the ongoing COVID-19 pandemic, which may have led to low sample size and attrition (13,39). Objective physical activity measurements could have been obtained through accelerometers. Although a validated scale was used to measure perceived stress, it is subjective. Objective cortisol measures via blood or saliva should be used in the future. Another limitation of this intervention included a participant who took all three surveys but did not attend any sessions. Lastly, while we hoped participants in the outdoor condition would realize the unique benefits (i.e., it was more enjoyable and had additional health benefits) of outdoor exercise and, thus, be inclined do outdoor exercise, we did not provide a strong intervention-based pathway to encourage additional outdoor exercise outside of the intervention.

Practical implications of this study include using physical activity, particularly in outdoor environments, to address perceived stress in college students. Outdoor exercise programs can be implemented at university recreation centers to improve students' well-being and perceived stress. Furthermore, gyms or fitness centers rarely have environments to use for outdoor exercise and should work to incorporate outdoor group exercise as a part of their facility. Providing adequate outdoor or green exercise space, including a flat and well-shaded area for independent and group exercise, is needed to make this possible. Alternatively, outdoor spaces at recreation centers or gyms, like tennis courts or baseball fields, are another feasible option. College recreation centers can also partner with student mental health services to encourage students with elevated perceived stress to use outdoor exercise as a coping mechanism.

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 ((11). This transitional time for students can negatively influence factors like diet, weight, and physical activity, which can also be affected by high-stress levels (35). The detrimental impact of high-stress levels on physical and mental health is well documented, and it continues to rise, emphasizing the need for practical coping skills (2,13,41). Participation in outdoor exercise may be a better stress-coping mechanism than indoor exercise. Furthermore, outdoor exercise is associated with physiological, psychological, and social benefits (6).

The findings of this intervention provide valuable insights that may be used for future research. The time of day of the intervention is crucial to participant retention, and a different time from this study should be considered. Additionally, researchers must consider the weather and the intervention's season to ensure better class participation. This study could inform future research and guide the development of effective stress reduction interventions in college students. Future research should focus on adding a specific survey that measures current stressors in students' lives and how they cope with stress before participating in the intervention. This study, in addition to previous research, successfully confirmed that exercise reduces perceived stress and that the reduction in perceived stress is greater for those participating in outdoor activities (21,25). However, more research will be needed to examine the mechanisms of the outdoor environment on health behaviors and outcomes.

ACKNOWLEDGEMENTS

This study could not have been completed without the help and hard work of our research assistants, Kendra Marstall, and Tyler Vallendar.

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