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Impact of Mindfulness Meditation and Physical Activity on Stress Levels in University Students

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Abstract

This study aimed to examine the impact of mindfulness meditation and physical activity on perceived stress levels among university students using a true experimental design. Fifty participants (aged 18–25) were randomly assigned to three groups: mindfulness meditation (n = 15), physical activity (n = 15), and control (n = 20). Stress was measured using the Perceived Stress Scale (PSS-10) before and after a four-week intervention. Guided by Lazarus and Folkman's Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), the Mindfulness-Based Stress Reduction (MBSR) model (Kabat-Zinn, 1990), and the Endorphin Hypothesis (Meeusen & De Meirleir, 1995), the study employed a true experimental pre-test post-test control group design. Statistical analyses including paired sample t-tests, independent sample t-tests, and one-way ANOVA revealed no statistically significant differences in stress levels across groups ($p > .05$), with small effect sizes across all comparisons ($\eta^2 = .011–.028$; $d = .068–.209$). Although the mindfulness group showed a directional reduction in stress scores, findings suggest that a four-week intervention window may be insufficient to produce measurable change. The study was also constrained by a small sample size, low scale reliability in subgroups, and the absence of compliance monitoring—factors that collectively limited statistical power. These findings highlight the urgent need for longer, better-controlled interventions and offer practical insights for evidence-based campus mental health programming in resource-limited academic settings.

Keywords: *mindfulness meditation, physical activity, perceived stress, university students, experimental design*

Introduction

University students face a wide range of stressors that jeopardize their mental health and academic performance, including financial strains, social pressures, academic demands, and uncertainty about the future. Research indicates that 70–80% of students experience high levels of stress during academic periods, contributing to burnout, anxiety, depression, and poor academic performance (Gonzalez-Martin et al., 2023). This study examines two evidence-based interventions mindfulness meditation and physical activity to determine whether they reduce perceived stress in university students using a true experimental design.

Mindfulness meditation emphasizes nonjudgmental, present-moment awareness through techniques such as focused breathing, body scans, and loving-kindness meditation. University students who participate in mindfulness-based interventions (MBIs) such as MBSR report significantly lower levels of stress, anxiety, and depressive symptoms (Pan et al., 2024). Physical activity, encompassing aerobic exercise, strength training, and recreational sports, offers both physiological and psychological benefits. Leisure-time physical activity has been associated with reduced stress and improved academic performance in college students (Tuber et al., 2024).

Literature Review

A growing body of literature supports the efficacy of mindfulness meditation in reducing perceived stress among university students. Alvarado-García et al. (2025) examined a 12-session mindfulness meditation program among 128 university students through a rigorous randomized controlled trial. Their experimental group demonstrated statistically significant improvements across all measured outcomes, including stress ($\eta^2 = 0.376$), anxiety ($\eta^2 = 0.538$), sleep quality ($\eta^2 = 0.306$), and life satisfaction ($\eta^2 = 0.510$). These large effect sizes confirm that structured mindfulness programs, when delivered with sufficient duration and fidelity, are effective mental health interventions for student populations, a conclusion directly relevant to the present study.

Gallego et al. (2022) conducted a randomized controlled trial comparing mindfulness training and physical education in reducing stress among 125 Bachelor of Education students. Consistent with the Transactional Model of Stress and Coping, students in the mindfulness group demonstrated significantly greater stress reduction than those in the physical education and control groups, $F(2) = 5.9$, $p = .004$, $\eta^2 = .106$, with total scores across all mental health variables declining significantly, including stress, $t(29) = 2.95$, $p = .006$, $d = .667$. These findings reinforce the theoretical premise that mindfulness restructures how individuals cognitively appraise stressors, thereby reducing their psychological impact.

Meltzer et al. (2021) conducted two randomized studies examining the effects of single-session physical or mindfulness training. Both conditions significantly improved mood across medium to large effect sizes ($\eta^2 = .08–.30$). Physical activity improved attention ($\eta^2 = .11$), while mindfulness improved

executive function ($\eta^2 = .17$), suggesting complementary benefits for academic performance.

A meta-analysis by Alzahrani et al. (2023) synthesizing 19 randomized controlled trials found that mindful movement interventions significantly reduced both anxiety (SMD = −0.42, $p < 0.0001$) and depression (SMD = −0.61, $p < 0.0001$) among university students. A pilot RCT with Pakistani university students by Sarfraz et al. (2023) demonstrated higher mindfulness and wellbeing alongside reduced stress in the mindfulness training group versus the waitlist control. Ahmad (2021) further established that mindfulness and resilience together explained 26% of the variance in perceived stress among Pakistani university students ($r = -.49$, $p < .001$).

Theoretical Framework

This study is grounded in three psychological theories. Lazarus and Folkman's (1984) Transactional Model of Stress and Coping posits that stress arises when perceived demands exceed coping resources, explaining why students under academic pressure feel overwhelmed and how adaptive strategies like mindfulness and exercise can reframe stress appraisals. The Mindfulness-Based Stress Reduction (MBSR) model, developed by Kabat-Zinn (1990), outlines how structured mindfulness practices foster greater emotional regulation and awareness to reduce psychological stress. The Endorphin Hypothesis (Meeusen & De Meirleir, 1995) suggests that physical activity increases endorphin production, elevating mood and reducing anxiety. Together, these frameworks justify both interventions and guide interpretation of results.

Rationale

University students are increasingly affected by stress-related disorders yet often lack access to adequate mental health resources. Low-cost, scalable interventions like mindfulness and physical activity offer viable alternatives that can be embedded into university curricula and wellness programs. This study provides empirical validation for their effectiveness in real academic settings, informing evidence-based mental health policymaking in higher education.

Operational Definitions

Mindfulness Meditation

Bishop states that mindfulness meditation involves paying attention on purpose, in the present moment, and non-judgmentally. It encompasses two key components: self-regulation of attention and a specific attitudinal stance. The attentional aspect involves bringing awareness to the present moment, observing thoughts, feelings, and sensations without getting carried away. The attitudinal aspect involves approaching these experiences with curiosity, openness, and acceptance (Bishop et al., 2004).

Physical Activity

According to CJ Caspersen Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. The energy expenditure can be measured in kilocalories. Physical activity in daily life can be categorized into occupational, sports, conditioning, household, or other activities. CJ Caspersen (1985).

Stress

Stress is the psychological, physiological and behavioral response by an individual when they perceive a lack of equilibrium between the demands placed upon them and their ability to meet those demands, which, over a period of time, leads to ill-health. S. Palmer (1989).

Method

Research Design

This study employed a true experimental Pre-test Post-test Control Group Design. Fifty university students were randomly assigned to three groups: Group A
(Mindfulness Meditation, n = 15), Group B (Physical Activity, n = 15), and Group C (Control, n = 20). This design enables control over confounding variables and facilitates causal inference.

Research Question

What is the impact of mindfulness meditation and physical activity on the stress levels of university students?

Objectives

- To measure baseline perceived stress levels using a standardized tool.
- To examine the effectiveness of mindfulness meditation in reducing stress.
- To assess the impact of physical activity as a stress-management strategy.
- To compare the relative effectiveness of both interventions.
- To evaluate whether a combined approach produces more significant benefits than either intervention alone.

Hypothesis

- **Null Hypothesis (H_0):** There is no significant difference in stress levels before and after intervention among the groups.
- **Alternative Hypothesis 1 (H_1):** Mindfulness meditation will significantly reduce perceived stress levels in university students compared to the control group.
- **Alternative Hypothesis 2 (H_2):** Physical activity will significantly reduce perceived stress levels in university students compared to the control group.

Participants

The study recruited 50 university students aged 18–25 through random sampling. Inclusion criteria required enrollment in full-time academic programs, moderate-to-high stress levels screened via the PSS, and willingness to commit to the four-week program. Students with diagnosed mental health conditions, physical impairments preventing participation, or prior mindfulness training were excluded.

Instrument

The Perceived Stress Scale (PSS-10; Cohen, Kamarck, & Mermelstein, 1983) was used to measure perceived stress. The scale consists of 10 items rated on a

5point Likert scale (0 = Never to 4 = Very Often), with higher scores indicating greater perceived stress. The PSS has demonstrated high internal consistency (Cronbach's α = 0.84) and is widely validated for use with student populations.

Sample

The study will recruit 50 university students, aged between 18 and 25, through random sampling. Participants will be assigned to three groups of individuals.

Inclusion criteria

- Students enrolled in full-time academic programs.
- Individuals reporting moderate to high stress levels, screened using the Perceived Stress
- Scale (PSS)
- Willingness to participate and commit to a four-week intervention program.

Exclusion Criteria

- Diagnosed mental health conditions (e.g., anxiety disorders, depression).
- Physical impairments that prevent participation in physical activity.
- Prior experience or training in mindfulness meditation.

Procedure

Following ethical approval and informed consent, a baseline PSS assessment was administered. Group A participated in daily 20-minute mindfulness meditation sessions led by a certified instructor for four weeks. Group B engaged in supervised aerobic physical activity for 30 minutes, five days per week. Group C received no intervention. Post-test PSS assessments were administered at the conclusion of the four-week period. Data were collected via Google Forms or paper-based questionnaires, and compliance was monitored through attendance logs and selfreported diaries.

Statistical Analysis

Data were analyzed using SPSS. Descriptive statistics summarized participant characteristics and stress scores. Reliability of the PSS was evaluated using

Cronbach's alpha. A paired sample t-test assessed within-group changes in stress from pre- to post-intervention. Independent sample t-tests examined between-group differences at both time points. A one-way ANOVA with post-hoc pairwise comparisons compared post-test stress scores across all three groups.

Results

Proposed Analysis

Data were analyzed using SPSS through descriptive statistics, independent sample t-test, paired sample t-test, one-way ANOVA, and pairwise comparisons.

Descriptive Statistics
Table 1

Descriptive Statistics of Meditation, Physical Exercise (Experimental) and Control Group (N=50)

Variable	Category	n	%	Pre-Test *M* (*SD*)	Post-Test *M* (*SD*)
Gender	Male	30	60		
	Female	20	40		
Interventi on	Control	20	40	19.00 (3.36)	18.50 (2.40)
	Mindfulne ss Meditatio n	15	30	18.73 (4.56)	17.87 (3.72)
	Physical Activity	15	30	17.47 (4.16)	17.93 (2.37)

The table shows descriptive statistics for stress scores across gender and intervention groups. The sample included 50 participants, with 60% males and 40% females. Across intervention groups, the control group (n = 20) showed a slight decrease in stress from pre-test (M = 19.00, SD = 3.36) to posttest (M = 18.50, SD = 2.40). The mindfulness meditation group (n = 15) demonstrated a larger reduction in stress (pre-test M = 18.73, SD = 4.56; post-test M = 17.87, SD = 3.72), suggesting potential effectiveness of the intervention. The physical activity group (n = 15) showed a small increase in stress scores from pre-test (M = 17.47, SD = 4.16) to post-test (M = 17.93, SD = 2.37). Overall, the results indicate that mindfulness meditation was associated with a modest reduction in stress, whereas physical activity did not produce a similar effect, and the control group showed minimal change.

Paired Sample T-Test

Table 2

Paired sample t-test analysis (N=50)

	Before Intervention		After Intervention					95% CI	
Variables	M	SD	M	SD	t(df)	p	d	L.L	U. L
Stress Levels	18.46	3.960	18.14	2.807	.557(49)	.580	0.079	-.835	1.475

p>0.05

The table shows paired sample t-test results by comparing stress level scores before and after the intervention among 50 participants. The results showed that stress levels before the intervention (M = 18.46, SD = 3.96) and after the intervention (M = 18.14, SD = 2.81) did not differ significantly, t (49) = 0.56, p=. 580.Since p > .05, there was no statistically significant effect of the intervention on stress levels. The effect size was very small (d = 0.079), indicating a negligible practical impact.

Independent Sample t-test Analysis

Table 3

Independent sample t-test analysis (N=50)

					Levene's test			95% Confidence Intervals	
Variable	M	SD	t	df	sig	d	p		
								L.L	U. L
Pre-Test	.267	.843	0.20	33	.175	.068	.843	-2.452	2.985
Post -Test	1.305	.545	0.61	33	.326	.209	.545	-1.471	2.738

The table shows that there is no statistically significant differences between groups at both pre-test (t = 0.20, df = 33, p = .843) and post-test (t = 0.61, df = 33, p = .545). Levene's test indicated homogeneity of variances was met at pre-test (p = .175) and post-test (p = .326). The effect sizes were small at both time points (d = .068 for pre-test; d = .209 for post-test), suggesting minimal practical difference between groups. The 95% confidence intervals for mean differences included zero at both pre-test (LL = -2.452, UL = 2.985) and post-test (LL = -1.471, UL = 2.738), further supporting the absence of significant group differences.

One Way ANOVA Analysis for Pre-Test

Table shows that the assumption of homogeneity of variances is met, as Levene's test was non-significant (p = .427). The one-way ANOVA revealed no statistically significant difference in the dependent variable across groups, (F = .685, p = .509) indicating that the groups did not differ from each other. The effect size

Table 4

One way ANOVA Analysis for pre-test (N=50)

			Test of Homogeneity of variances		ANOVA		95% CI			
Group	Mean	S. D	Levene's Statistic	Sig.	F	Sig.	LL	UL	S. E	η2
Control Group	19.00	3.36	.866	.427	.685	.509	17.43	20.57	0.75	.028
Mindfulness Meditation	18.73	4.56					16.21	21.26	1.18	
Physical Activity	17.47	4.16					15.17	19.77	1.07	

was small (η^2 = .028), suggesting minimal variance explained by group membership.

One Way ANOVA Analysis for Post-Test

Table 5

One way ANOVA Analysis for post-test (N=50)

			Test of Homogeneity of variances		ANOVA		95% CI			
Group	Mean	S. D	Levene's Statistic	Sig.	F	Sig.	LL	UL	S. E	η2
Control Group	18.50	2.395	.948	.395	.268	.766	17.38	19.62	.536	.011
Mindfulness Meditation	17.87	3.720					15.81	19.93	.960	
Physical Activity	17.93	2.374					16.62	19.25	.613	

Table shows that the assumption of homogeneity of variances is met, as Levene's test was non-significant (p = .395). The one-way ANOVA revealed no statistically significant difference in the

dependent variable across groups, (F = .268, p = .766) indicating that the groups did not differ from each other. The effect size was small (η^2 = .011), suggesting minimal variance explained by group membership.

Discussion

The findings of this study indicate that neither mindfulness meditation nor physical activity produced statistically significant reductions in perceived stress among university students over a four-week intervention period. The following discussion integrates each statistical table with relevant literature and theoretical frameworks to contextualize these results, followed by an examination of the methodological constraints that may have shaped the outcomes. Table 1 presents descriptive statistics for the three intervention groups at baseline and post-test. The mindfulness meditation group demonstrated the greatest directional reduction in stress (pre-test M = 18.73, SD = 4.56; post-test M = 17.87, SD = 3.72), consistent with Alvarado-García et al.'s (2025) randomized controlled trial, which found significant stress reductions (η^2 = 0.376) following a structured 12-session mindfulness program. The control group also showed a modest decline (pre-test M = 19.00, SD = 3.36; post-test M = 18.50, SD = 2.40), while the physical activity group showed a slight increase (pre-test M = 17.47, SD = 4.16; post-test M = 17.93, SD = 2.37). This marginal increase in the physical activity group may reflect the additional physiological and psychological burden of structured aerobic exercise on students unaccustomed to regimented training routines. From the perspective of Lazarus and Folkman's (1984) Transactional Model of Stress and Coping, students who perceived the exercise regimen as a new demand—rather than a coping resource—may have experienced a temporary elevation in appraised stress. Table 2, the paired sample t-test across all 50 participants, showed no statistically significant change in perceived stress from pre-test (M = 18.46, SD = 3.96) to post-test (M = 18.14, SD = 2.81), t(49) = 0.56, p = .580, d = 0.079. The negligible effect size (d = 0.079) indicates that the combined intervention, across all three groups, produced minimal practical impact on stress levels. This aligns with findings by Meltzer et al. (2021), who noted that single-session or brief interventions improve mood acutely but require sustained practice to effect lasting stress change. The constraint of time was a key limiting factor in the present study; the four-week window was likely insufficient to produce the neurological and psychological adaptations that underpin lasting stress reduction, as emphasized by the MBSR model (Kabat-Zinn, 1990), which prescribes an 8-week minimum program. Table 3, the independent sample t-test, confirmed no significant between-group differences at either pre-test (t = 0.20, df = 33, p = .843, d = .068) or post-test (t = 0.61, df = 33, p = .545, d = .209). Levene's test confirmed variance homogeneity at both time points (pre-test p = .175; post-test p = .326). The 95% confidence intervals for both comparisons included zero, reinforcing the absence of meaningful group differentiation. These results diverge from Gallego et al.'s (2022) finding of a significant mindfulness advantage over physical education, F(2) = 5.9, p = .004, η^2 = .106, and from Sarfraz et al.'s (2023) Pakistani RCT demonstrating significantly higher wellbeing in the mindfulness condition. The discrepancy is likely attributable to the present study's shorter duration,

smaller sample, and limited compliance monitoring rather than an absence of any true treatment effect. Table 4, the one-way ANOVA for pre-test scores, confirmed baseline equivalence across the three groups ($F = .685$, $p = .509$, $\eta^2 = .028$), with Levene's test non-significant ($p = .427$). This indicates that randomization was successful and that the groups were comparable at the start of the intervention—a methodological strength that supports internal validity. This equivalence is important for the causal interpretation of subsequent comparisons. Table 5, the one-way ANOVA for post-test scores, similarly revealed no statistically significant group differences ($F = .268$, $p = .766$, $\eta^2 = .011$), with homogeneity of variances confirmed ($p = .395$). The very small effect size ($\eta^2 = .011$) suggests that group membership explained less than 2% of the variance in post-test stress scores. These results are inconsistent with Alzahrani et al.'s (2023) meta-analysis of 19 RCTs, which found significant stress, anxiety, and depression reductions through mindful movement interventions (SMD = −0.42 to −0.61). The Endorphin Hypothesis (Meeusen & De Meirleir, 1995) predicts that sustained physical activity triggers endorphin-mediated mood elevation; however, the short duration and potentially inconsistent compliance in the present study may have prevented this physiological pathway from being activated. Collectively, these findings underscore the importance of intervention duration, fidelity, compliance monitoring, and sample size in stress research.

Despite the absence of statistically significant differences, Ahmad (2021) established that mindfulness and resilience together explained 26% of the variance in perceived stress among Pakistani university students ($r = -.49$, $p < .001$), affirming the theoretical relevance of mindfulness-based coping even when short-term experimental designs fail to reach statistical thresholds. The direction of findings for the mindfulness group aligns with these theoretical expectations: Lazarus and Folkman's (1984) Transactional Model suggests that adaptive coping strategies can reframe stress appraisals, and the modest reduction observed in the mindfulness group is consistent with this cognitive reappraisal mechanism. The physical activity group's marginal increase in post-test stress may further reflect the additional demands of structured exercise as an unfamiliar routine, suggesting that exercise-based interventions require adequate habituation periods to translate into measurable psychological benefit.

These findings underscore the importance of intervention duration, compliance monitoring, and sample size in stress research. A key practical constraint in the present study was time: the four-week program was designed and executed within the confines of a semester-bound academic project, leaving insufficient scope for an 8-week MBSR protocol, physiological data collection, or follow-up assessments. Future studies should employ longer intervention programs (8–12 weeks) following the MBSR protocol, incorporate physiological stress measures (e.g., cortisol assays) to complement self-report, and use larger, more diverse samples to enhance statistical power and generalizability. Integrating compliance tracking systems and employing trained mindfulness instructors would also improve intervention fidelity. Universities are encouraged to embed these evidence-based programs into orientation weeks and student

welfare services, given their low cost and potential scalability. Collaboration with student counseling centers and health departments could facilitate implementation of structured wellbeing initiatives that address the growing mental health burden documented in Pakistani and global student populations.mples to enhance statistical power and generalizability.

Limitations

The study encountered several noteworthy limitations. Foremost among these was the constraint of time: as a semester-bound academic project, the intervention could not exceed four weeks, which is likely insufficient to produce measurable changes in chronic stress. Standard evidence-based protocols such as MBSR require a minimum of eight weeks (Kabat-Zinn, 1990), and the condensed timeline prevented adherence to this benchmark. Low internal consistency values on the PSS across subgroups further limited confidence in scale performance. The small group sizes (n = 15–20) reduced statistical power, and uncontrolled external variables such as exam schedules, sleep patterns, financial pressures, and personal stressors may have independently influenced stress levels. The absence of follow-up assessments prevents evaluation of intervention sustainability over time, and the reliance on self-report data without physiological corroboration (e.g., cortisol levels) limits objectivity. Limited compliance monitoring also means adherence to assigned protocols cannot be confirmed across all participants.

Recommendations

Based on the findings and limitations of this study, the following recommendations are offered. First, universities should implement integrated wellness programs combining mindfulness meditation and physical activity as part of orientation and student support services, guided by evidence-based frameworks such as the MBSR model (Kabat-Zinn, 1990). Second, future research should employ longer intervention windows of 8–12 weeks, as the four-week duration of the present study was a key constraint that limited the detection of significant change. Third, larger and more diverse samples are needed to ensure adequate statistical power and generalizability across Pakistani and international student populations. Fourth, mixed-methods approaches incorporating qualitative data alongside physiological stress markers (e.g., cortisol, heart rate variability) would provide richer insight into the mechanisms of change. Fifth, compliance monitoring through structured attendance systems and digital tracking tools should be embedded in future trials to strengthen intervention fidelity. Sixth, mental health awareness campaigns on campuses can reduce stigma and encourage proactive engagement with these low-cost wellbeing strategies. Finally, collaboration between academic researchers, student counseling centers, and health departments is recommended to co-design, implement, and evaluate scalable campus mental health programs.

Conclusion

This study found no statistically significant reduction in perceived stress following four weeks of mindfulness meditation or physical activity among university students. Although the mindfulness group showed a slight directional improvement, effect sizes were negligible across all analyses. Limited intervention

duration, small sample sizes, and low scale reliability likely constrained the findings. Future research should use longer programs, larger samples, and objective stress measures to more conclusively evaluate these interventions.

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