

Jericho High School

Breaking the Cycle of Stress: Exercise as a Regulator of Academic Pressure

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Introduction

Acute academic stress is a critical issue that can hamper students' cognitive performance and physical health in high-stress circumstances [1]. Previous efforts to mitigate stress in high-stakes environments have shown that physical exercise could reduce acute academic stress. However, there is still an ongoing investigation into whether exercise effectively reduces acute academic stress [2].

Recent advancements in wearable sensing technologies enable the capture of physiological stress indicators, such as heart rate variability (HRV) measured through PPG, and galvanic skin response (GSR). HRV displays the autonomic nervous system based on the IBI, which is widely applied as a stress indicator, while GSR measures skin conductance changes based on the nervous system's reactions[3][4]. This study mainly focuses on whether short-duration exercise interventions can quickly reduce acute academic stress in students by utilizing wearable sensors like PPG and GSR to track physiological markers in real time.

Results

Baseline stress detection

At baseline, each group's mean self-reported stress levels were 9.25, 8.50, and 9.75 for the running, meditation, and control groups, respectively. The physiological data (PPG), immediately collected after starting the test, were 82 for the running, 83 for the meditation, and 83 for the control groups. There were no statistically significant differences in the baseline stress levels for each group.

Post-intervention comparisons

After the exercise interventions, running showed the greatest reduction in both subjective and physiological stress indicators. For self-reported measures, the running group's average stress rating decreased from 3.00 to 1.25, with a decrease of 1.75. Meditation displayed no changes for average self-reported stress levels, staying stagnant in the range for two, and the control group had a slight decrease of 2.25 to 2.00, resulting in a decrease of 0.25 points.

Physiological indicators mostly aligned with the trends from subjective data points. The running group had the greatest decrease in GSR (-19.66), followed by meditation (-46.79) and the control group (-84.75).

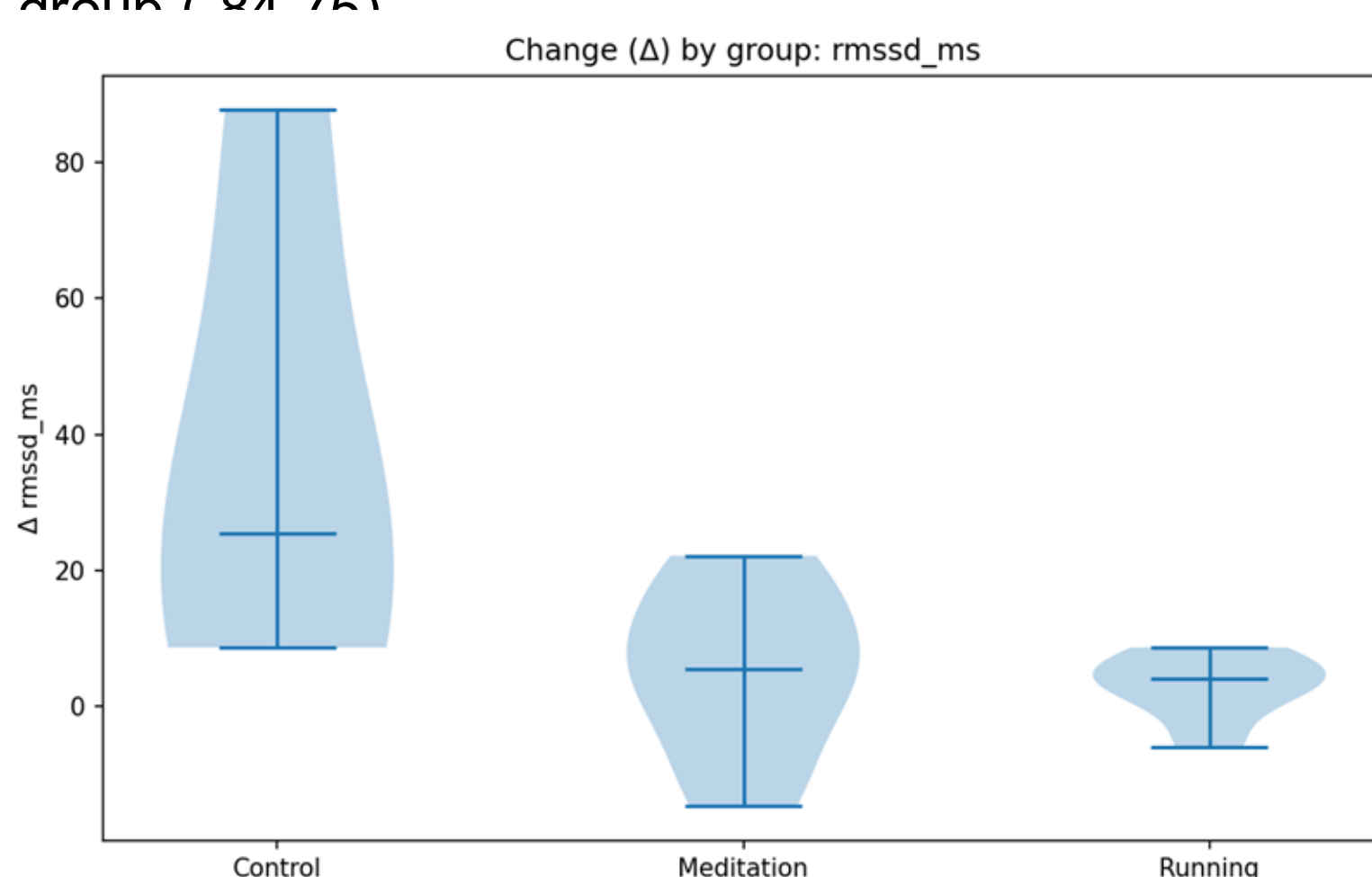


Fig 1. Average change (Δ) in skin conductance (μS) across groups (Control, Meditation, Running)

Methods

Study Procedure

The exercise intervention lasted for 10 minutes for running meditation and phone scrolling (control). Running was given an additional 10 minutes after the intervention for cooldown. This combined approach of objective and subjective measurement allowed for direct comparison between physiological responses and participants' perceived stress levels. The study was designed to capture both post-intervention changes and sustained effects on stress during the second exam.



Fig 2. The participant wears a PPG sensor on the earlobe and GSR sensors on the index and middle fingers during the exam.

Intervention Types (running, meditation, control)

12 participants ages 15-19 were separated into 3 groups: running, meditation, and a control group (scrolling on a phone). Each group included an equal number of athletic and non-athletic individuals to keep the results balanced. Unlike other groups, for running we have additionally a 10-minute break after the exercise intervention for them to cool down and get back to their normal heart rate.



Fig 4. Participants completing their assigned exercise activity as an intervention period between the first and second exam.

Measurement Tools

Objective stress measures were recorded with PPG sensors to capture heart rate variability (HRV) based on BPM and galvanic skin response (GSR) sensors for skin conductance. Both were continuously monitored during the two 20-minute exams, and interventions were taken in between. Subjective stress was assessed using a modified PSS-Q4 survey during four periods: before the first exam, after the first exam, after the intervention, and after the second exam.

Currently, how often have you felt that things were going your way?
(0 - never / 1 - almost never / 2 - sometimes / 3 - fairly often / 4 - very often)

0 1 2 3 4
Never Very often

Currently, how often have you felt confident about your ability to handle your personal problems?
(0 - never / 1 - almost never / 2 - sometimes / 3 - fairly often / 4 - very often)

0 1 2 3 4
Never Very often

Fig 3. Example survey items for self-reported stress data based on a modified PSS-4 Questionnaire.

Conclusion

This study aimed to study the effects of exercise on physiological and perceived acute academic stress, measured through PPG, GSR, and self-reported stress scores(modified from PSS-4). Running and meditation were introduced as exercise interventions, and the control group(phone scrolling) was included. There were no statistically significant differences in baseline stress levels between groups, reducing external factors.

In both self-reported stress and physiologically measured stress, running exhibited the greatest stress reduction in (1) between after the first exam and after the intervention, and (2) after the first exam and after the second exam. This was followed by meditation, while the control group showed minimal change.

These results suggest that running is an effective, accessible intervention for reducing stress, with meditation serving as a viable secondary option when running is not feasible.

References

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