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The Differential Effects of Slow and Fast Music on Cardiovascular Parameters and Stress Levels Among College Students

Indumathi[1], S. Jayaprakash[2], B. Thrisha Gabrin[2], L. Priyadharshini[2], J. Pooja[2] and V. Amala Deepa[1*]

[1]*Department of Biochemistry, Faculty of Allied Health Science, Dr. M.G.R. Educational and Research Institute, Chennai, Tamil Nadu, India.*

[2]*Department of Cardiac Care Technology, Dr. M.G.R. Educational and Research Institute, Chennai, Tamil Nadu, India.*

[*]amala04vincent@gmail.com (Corresponding Author)

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ABSTRACT

Background: Music is a universally accessible, non-invasive tool with potential therapeutic effects on stress and autonomic function. College students, frequently exposed to high levels of psychological stress, may benefit from music-based interventions for stress reduction.

Purpose: The study aimed to investigate the immediate effects of slow and fast tempo music on heart rate (HR), blood pressure (BP), and emotional well-being in college students with moderate to high stress levels.

Methods: A within-subject experimental study was conducted among 122 college students aged 17–25 years. Based on Perceived Stress Scale (PSS-10) scores, 60 individuals with moderate or high stress were selected for intervention. Resting HR and BP were measured prior to exposure. Participants were sequentially exposed to slow-beat music ("Weightless," 71 bpm) and fast-beat music ("Worldwide Chopper," 128 bpm) with a washout period to minimize carryover effects. HR was recorded during, and BP was measured after, each music session. A mood state questionnaire was administered post-intervention.

Results: Exposure to slow tempo music produced a significant reduction in HR and BP, suggesting enhanced parasympathetic activity. In contrast, fast tempo music induced a mild elevation in HR and BP within physiological limits, indicating sympathetic arousal. Mood questionnaire responses aligned with physiological findings, with participants reporting feelings of relaxation during slow music and feelings of energy and stimulation during fast music.

Conclusion: Slow tempo music appears to be a promising, non-pharmacological intervention for stress reduction and autonomic regulation in college students. It may aid in balancing cardiovascular responses while improving emotional well-being. Further longitudinal studies are warranted to explore long-term effects on cardiovascular health and psychological outcomes.

1. Introduction

Music bridges divide geography, culture, and language, embodying a fundamental essence of humanity. In addition to providing expression and beauty, it also has therapeutic benefits. The ancient healing chants and modern music therapy illustrate how sound has always been used for mental and physical well-being (Wang *et al.*, 2022). Music was practiced in India during ancient times when therapy was not even conceptualized; as one of the oldest continuous musical traditions in the world, India recognized and harnessed the healing power of music centuries ago (Rebecchini, 2021). Indian Classical Music (ICM), both Hindustani and Carnatic, is structured around human emotions through raga and taal, deeply intertwined with feelings as well as the autonomic nervous system (Nagarajan *et al.*, 2015). Certain ragas, like Raag Bhupali, aid in reducing anxiety by decreasing sympathetic activity while increasing parasympathetic responses, while Raag Darbari may enhance cognitive processing alongside neural efficiency boosts (Bardekar, 2018; Vedabala, 2017).

Listening to music stimulates brain regions that regulate emotion and reward systems together with autonomic control. Several processes support this notion. Apart from enhancing emotions through dopamine release, music can modulate autonomic system (ANS) activity linked to cardiovascular regulation. Along with this, tempo-rhythm synchronization occurs, as our bodies naturally tend to align with the rhythm and beat of the music. This synchronization helps regulate physiological functions such as heart rate and respiration, effectively influencing the autonomic responses in our bodies. Mojtabavi *et al.* (2020) and Niu *et al.* (2024) have stated that the rhythm, tempo, and melody are elements that have a direct influence on biological parameters such as blood pressure (BP), respiration rate, and heart rate variability (HRV), which is an indicator of how adaptable the ANS is along with the overall health of the heart. This close relationship between auditory stimuli, emotional response, and bodily regulation allows music to impact emotional experiences and cardiovascular system responses, demonstrating the deep connection between sound, brain activity, and physical health. Students at the college experience academic stress coupled with a potential sedentary lifestyle with daunting cardiovascular challenges, making music interventions non-invasive ways to relieve stress. Increased levels of stress along with early-stage hypertension have long been noted in students, which puts them at risk for developing long-term cardiovascular issues (Iqra, 2024; Geller *et al.*, 2024; Teuber *et al.*, 2024). It has been shown that relaxation response along with parasympathetic dominance can be enhanced using slow-tempo or classical music by reduction in systolic and diastolic blood pressure and improvement in HRV. On the other hand, fast tempo music may increase arousal and sympathetic activity (McCrary *et al.*, 2021; Wu & Chang, 2021).

Like other vital signs, blood pressure serves as a crucial indicator of cardiovascular health and is controlled through the combination of cardiac output and vascular resistance and the ANS (Parvan *et al.*, 2024). The impact of music on blood pressure has been studied both independently and in conjunction with deep breathing exercises or lifestyle modifications (Kumari *et al.*, 2024). Active listening to Indian classical ragas has been shown to acutely alter BP and HRV, indicating its possible effect on autonomic balance restoration. Though music therapy is widespread, there is a lack of research investigating its impact among Indian populations, particularly youths and students. With rising rates of stress-related cardiovascular malfunction in this population group, Raaga Chikitsa raga-based music therapy publicly shows how traditional Indian methods can effectively control physiological variables such as BP and HRV through specific musical scales (Niu *et al.*, 2024).

We aimed to evaluate how exposure to slow and fast-paced music affects the cardiovascular parameters of college students. For that, we will utilize validated tools such as BP monitors alongside stress questionnaires and HRV analysis. We hope that our efforts will enhance the existing research using an interdisciplinary approach in order to consider music's potential role in mitigating cardiovascular risks and promoting emotional well-being in young adults.

2. Methodology

2.1. Study Design and Setting

This was a within-subject experiment study conducted over a period of six months in three locations: Dr. M.G.R. Educational and Research Institute, ACS Medical College and Hospital, AHS Skill Laboratory, and Sri Lalithambigai Medical College and Hospital, Chennai, Tamil Nadu, India. Ethical clearance was obtained from the institutional ethical committee No. 1434/2024/ICE/ACSMCH Dt. 11.12.2024.

2.2. Participants and Sampling

A total of 122 college students, aged 17 to 25 years, were initially recruited through convenience sampling. All participants were asked to complete the Perceived Stress Scale (PSS-10) questionnaire, a validated psychometric tool used to measure the perception of stress. Based on their scores, 60 students falling under the moderate and high stress categories were selected for further intervention.

2.3. Inclusion Criteria and Exclusion Criteria

College students between the age group of 17 and 25 years with a PSS-10 score indicating moderate or high stress were included in the study. There was no known history of cardiovascular or psychiatric disorders. The willingness to participate in the current study was obtained as an informed consent. Students above 25 years of age and students with low stress scores (below moderate level on PSS-10) were excluded after initial screening. Individuals on medication affecting HR and BP, participants with known hearing impairment or sensitivity to loud sounds, and those under severe stress or in crisis situations were excluded from the study.

2.4. Intervention Procedure

The selected 60 participants underwent a two-stage music intervention in a quiet, ambient environment. Baseline measurements of resting heart rate (HR) and blood pressure (BP) were recorded using an LED digital blood pressure monitor. All participants received a fixed sequence: Initially 5 minutes of slow-beat music first, followed by a 3-minute washout period, then finally 5 minutes of fast-beat music. This standardized order ensured consistency across all participants. Although participant familiarity or preference for the musical tracks was not formally assessed, the selected pieces 'Worldwide Chopper' and 'Weightless' are generally unfamiliar to the local student population, minimizing potential bias due to prior exposure and supporting the standardization of the auditory stimulus. During the slow beat music exposure, participants listened to "Weightless" (71 beats per minute) through wireless headphones for a set duration, with heart rate recorded midway through the session and blood pressure measured immediately after. A washout period was implemented between music interventions to allow for initial physiological recovery and to maintain participant engagement within the experimental session. In the fast-beat music exposure, participants listened to "Worldwide Chopper" (128 bpm) through the same audio setup, with HR measured during the music and BP post-intervention. Immediately after both sessions, participants completed a Mood States Survey to evaluate emotional changes and psychological responses. Primary outcomes included HR and SBP/DBP before and after each music exposure, and secondary outcomes comprised subjective mood changes based on survey responses.

2.5. Data Analysis

The data collected were analyzed using SPSS software (version 22). Paired t-tests were used to compare pre- and post-intervention changes in cardiovascular parameters. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Distribution of Stress Levels by Age and Gender

Among 122 college students, aged 17 to 25 years, who initially volunteered for the study. Based on the PSS score obtained through the questionnaire generated, 60 students whose PSS score was under the moderate and high stress categories as mentioned in Table 1 were chosen for further studies. In brief, 69% of teenagers and 37% of young adults reported moderate stress, and 18% of teenagers and 59% of young adults showed high stress values. When compared with the male and female, moderate stress was observed to be high in females with 57.1% and low in males with 42%. Whereas the high stress of 51% was seen in males and 39.2% in females.

Table 1: Distribution of Stress Levels by Age Group and Gender among College Students

Variable	Category	Low Stress (%)	Moderate Stress (%)	High Stress (%)
Age	Teenagers (17–19)	13.0	69.0	18.0
	Young Adults (20–23)	4.0	37.0	59.0
Gender	Male	6.0	42.0	51.0
	Female	3.5	57.1	39.2

This table presents the distribution of stress levels categorized by age group and gender among the screened college students (N=122).

3.2. Effect of Music on HR, SBP, and DBP

A total of 60 participants were enrolled for this phase. The effects of slow- and fast-paced music on cardiovascular parameters like HR and BP were examined. Subjects had a mean resting HR of 82.1+/-11.379 beats per minute, a mean resting systolic blood pressure of 117.33+/-8.495 millimeters of mercury, and a mean resting diastolic blood pressure of 71.167+/-9.037 millimeters of mercury. With fast music, the mean heart rate was 84.81+/-13.0587 beats per minute, with a mean systolic blood pressure of 124.166+/-11.003 millimeters of mercury and a mean diastolic blood pressure of 76+/-10.924 millimeters of mercury. For slow music, the mean heart rate was 77.81+/-13.313 millimeters of mercury, the mean systolic blood pressure was 110.5+/-12.544, and the mean diastolic blood pressure was 70.833+/-13.637 millimeters of mercury. The mean difference in resting, fast music, and slow music heart rate, systolic blood pressure, and diastolic blood pressure was statistically significant ($p < 0.05$, Table 2).

Table 2: Comparison of Cardiovascular Parameters at Rest, Slow, and Fast Tempo Music Exposure

Parameters	Resting	Slow music	Fast music	p-VALUE
	Mean ±SD	Mean±SD	Mean±SD	
HR	82.1±11.39	77.81±13.3	84.81±13.058	0.005*
SBP	117.3±8.49	110.5±12.5	124.16±11.0	0.000 *
DBP	71.16±9.03	70.83±13.6	76±10.9	0.006*

The mean and standard deviation (SD) of heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) showed statistically significant differences with p-values of 0.005, 0, and 0.006, respectively, among Selected Participants (N=60). *$p \leq 0.05$ was statistically significant.

3.3. Impact of Music on Mood Dynamics

Among the 65 subjects, 65 completed a mood survey using a scale of 1-5 (1 being lowest, 5 being highest). The mean score for mood survey Q1, "Which of the two-music seemed uplifting to you during the study?" was 26.7% for fast music and 73.3% for slow music. The mean score for mood survey Q2, "Which of the two-music seemed calming to you during the study?" was 20.0% for fast music and 80.0% for slow music. The mean score for mood survey Q3, "According to you, which music gave positive emotions during the study?" was 81.7% for slow music and 18.3% for fast music. The mean score of mood survey Q4, "Do you think the music created negative emotion during the study? If so, which music?" was 1.7% for slow music and 6.7% for fast music, and 91.7% reported that either the fast or slow music did not really impact them. The mean score of mood survey Q5, "During the study did you feel like fast music reduced your stress?" was 76.7% for fast music and 23.3% for slow music. A total of 6.7% of subjects reported that fast music created negative emotions, while 1.7% of subjects reported that slow music created negative emotions, and 91.7% reported that either fast or slow music did not really impact them (Figure 1).

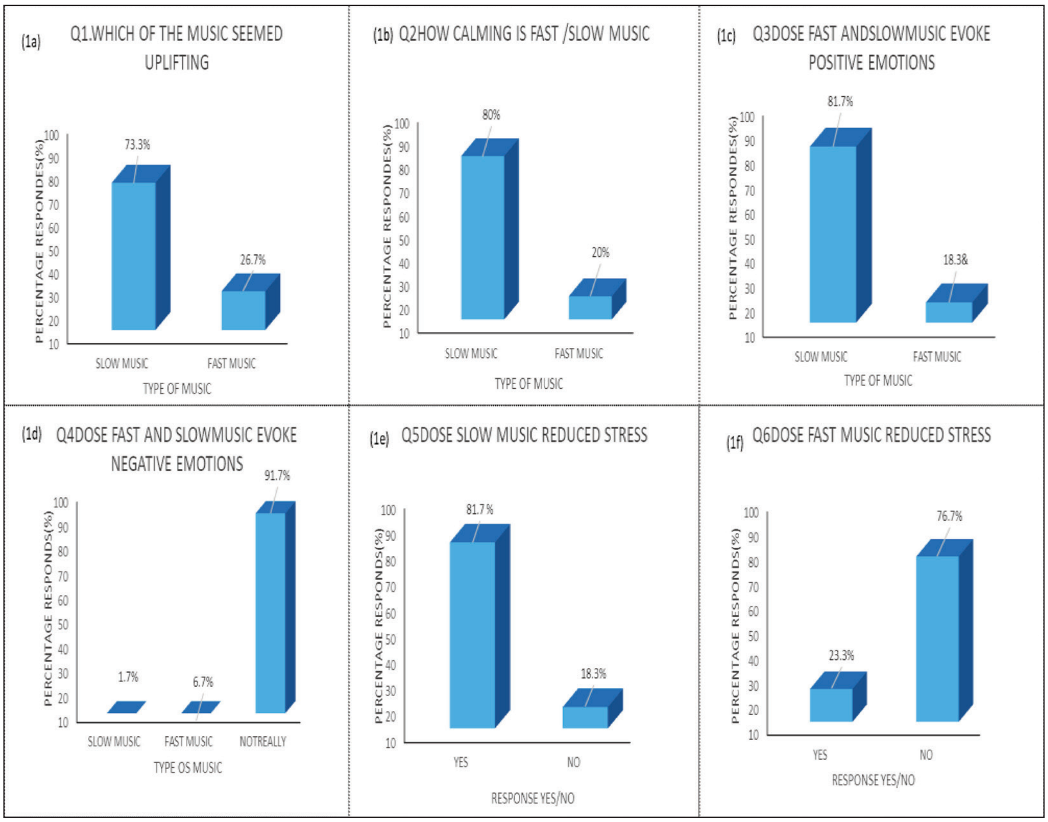

Figure 1: Mood State Responses to Slow and Fast Music; Uplifting effect: Slow vs Fast music (1a, 1b); Calming effect: Slow vs Fast music (1c); Positive emotions: Slow vs Fast music (1d); Negative emotions: Slow vs Fast music (1e); Stress reduction: Slow music (1f); Stress reduction: Fast music

4. Discussion

This study sought to explore the influence of music on HR, BP, and mood states to analyze how musical experience can modulate both emotional well-being and cardiovascular responses. The findings of this study show how music tempo affects physiological markers like HR and BP in young adults dealing with moderate to high stress levels. Participants with moderate to high stress were carefully selected using the PSS-10 to target those who stand to benefit most from musical interventions. Exploring how individual stress levels influence changes in heart rate and blood pressure could provide valuable insight. Based on descriptive statistics on perceived stress levels, college students, especially those aged 17 to 25, are increasingly at risk for stress, and within the same population, the stress patterns show males have elevated stress levels. In another study by Guo *et al.* (2024), high stress was observed in adulthood compared to adolescence in respect to their body fat, obesity, and higher AG ratio. Adults with higher stress reported higher levels of SBP and DBP and increased risk for CIMT, leading to poor cardiac health (Guo *et al.*, 2024). Female participants show a moderate stress range even though a significant subset have high stress due to various factors, including hormonal changes, academic pressures, career uncertainty, financial issues, and changing relationships. In contrast to this, in a study by Agarwal *et al.* (2021), females showed higher stress values compared to males. The mean rank value of females was 132, and males was 101, which was analyzed by the Perceived Stress Scale-10 against demographic variables. These differences in variables are due to the locality, occupation, education, and age of the volunteers involved (Agarwal *et al.*, 2021).

These combined stressors often lead to what is known as a "poly-crisis," which worsens mental health in this group (Suguna *et al.*, 2017). In this study, listening to slow tempo music (71 bpm), such as "Weightless," significantly lowered HR and BP. This suggests improved parasympathetic activity and relaxation. These effects might come from music's ability to influence the hypothalamic-pituitary-adrenal (HPA) axis, which reduces cortisol secretion (Lata & Kourtesis, 2021). Lower cortisol levels lessen sympathetic activity and increase vagal nerve response, creating a state of calm and reduced cardiac workload (Cuberos Paredes *et al.*, 2025). Changes in HR and BP are established physiological indicators that reflect autonomic nervous system activity. The observed reductions in HR and BP in this study align with recognized patterns of parasympathetic activation and sympathetic modulation, providing reliable physiological evidence of the calming effects of music.

In contrast, fast tempo music (128 bpm) like "Worldwide Chopper" increased HR and BP, though still within normal ranges. This can be explained by activating the sympathetic nervous system (SNS) and stimulating brain areas like the amygdala, which boosts the release of norepinephrine and adrenaline. Such stimulation is linked to heightened cardiovascular activity and arousal (Ziegler *et al.*, 2025). This supports the idea that different music tempos trigger different psychophysiological reactions. These findings highlight the potential of slow tempo music as a non-pharmacological approach to manage stress and support cardiovascular health in young adults. This is especially important in places like schools, where effective stress-reduction strategies are needed. While the immediate effects of music are clear, the long-term benefits like sustained physiological balance, emotional resilience, and better mental health that require more study were discussed by Darki ***et al*.** **(**2022**)**. It is important to note that certain factors such as caffeine intake, physical activity, and meal timing were not specifically controlled, reflecting real-life variability in cardiovascular responses. The fixed sequence of music exposure may introduce order effects; however, this design ensured a consistent protocol for all participants. To assess music's lasting impact on cardiovascular health, future research should employ larger sample sizes, explore various music genres, compare genders, and include long-term monitoring. Adding other biomarkers, like salivary cortisol, EEG recordings, or HRV measures, could strengthen the physiological foundation of these findings.

5. Conclusion

This study highlights the valuable role of music, especially slow-tempo compositions, in reducing stress and improving physical well-being among college students. The intervention showed that slow-beat music significantly lowered HR and BP within normal limits, indicating better activity of the parasympathetic nervous system and a calming effect on the body. Participants also reported feeling better emotionally, with less anxiety and mental fatigue. These findings suggest that music helps in regulating emotions, making it a promising, non-invasive tool for managing stress in young adults. Incorporating music into daily routines or structured college wellness programs could serve as an effective strategy to boost emotional resilience and mental well-being. Music therapy sessions, relaxation playlists, or designated "music mindfulness" activities in schools may help students cope better with academic and social pressures. It is important to explicitly acknowledge the study's limitations, including the brief intervention, the limited sample size, and the potential for gender bias. Future studies could explore chronic exposure and various musical genres and incorporate longitudinal self-reported stress data, and long-term research is encouraged to explore the lasting effects of music on autonomic function, academic performance, and mental health in student populations.

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Authorship Contribution

All authors contributed equally to the work, reviewed the manuscript, and approved the final version for submission.

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Ethical Approvals

Ethical clearance number was obtained from the institutional ethical committee- No.1434/2024/ICE/ACSMCH Dt.11.12.2024.

Declarations

The authors declare that this work is original and has not been submitted elsewhere for publication. All data, methodologies, and system components have been developed and reported in adherence to academic standards. All referenced materials have been duly cited, and the authors accept full responsibility for the integrity and accuracy of the findings presented.

Conflict of Interest

The authors declare no conflict of interest related to this study.

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