

A Study On Traditional Indian Instruments And Their Effects On Heart Rate And Perceived Exertion During Exercise

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Citation: Ms. Rimma Quadros, Dr. Mala Kharkar (2024), A Study On Traditional Indian Instruments And Their Effects On Heart Rate And Perceived Exertion During Exercise, *Educational Administration: Theory and Practice*, 30(1) 3720 -3732
Doi: 10.53555/kuey.v30i1.7475

ARTICLE INFO	ABSTRACT
	This paper aims to understand how traditional Indian musical instruments impact physiological parameters such as HR, HRV, perceived exertion rate, and cardiovascular response during exercise. A randomised controlled design involving 80 healthy participants (40 males and 40 females) was used to compare exercise performance under two conditions: with and without Indian instrumental music (sitar, tabla, flute). During the trials, the participants performed moderate exercise while the biochemical measures, comprising systolic and diastolic blood pressure, pulse rate, and respiratory rate on were assessed. Cardiopulmonary exercise testing involves the determination of perceived exertion using the Borg RPE scale. Outcomes showed that music group players demonstrated decreased systolic blood pressure, and perceived exertion of effort compared to the control group. It is worth mentioning that, when implementing gender-specific comparisons, patients reported a more significant decrease in systolic blood pressure among females exposed to music than among males. The findings of the study are positive and in favour of the hypothesis that listening to traditional Indian music decreases cardiovascular stress and further improves exercise by decreasing perceived exertion. However, the study has its limitations due to the limited number of subjects used in the study and the fact that treatment was done in a laboratory setting, therefore, the findings cannot be generalised to the entire population. Future research should further investigate the consequences of listening to diverse music genres on long-term exercise compliance, cardiovascular risk profiles, and subjective well-being, especially in individuals with special health needs.

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CHAPTER 1: INTRODUCTION

Music is characterised by its structured and continuous auditory delivery via singers or instrumentals. Music calms, and keeps heart rate stable while working out (Kulinski et al., 2022). Music is tied to every culture and civilization, unlike ancient Greek, Chinese, Indian, and Roman literature mentions music's role in daily life. Music has stimulated physical activity for over 2800 years, starting in ancient Greece. Playing the flute or kithara, a harp-like instrument, was supposed to boost Olympic performance.

These instruments are from traditional Indian music and have different rhythms and tones, which affect cultural values and physiological reactions to particular activities (Chandra, Chand, & Dutt, 2023). listening to Indian musical instruments affects heart rate and perceived effort. Music may decrease pulse rate, alleviate fatigue, and increase workout motivation, according to various research. Since most study has concentrated on Western music, little has been done on traditional Indian music and instruments. The flute, sitar, and tabla sound different from Western instruments, making their music unique and exhilarating. These instruments may elicit different emotions and physiological responses than standard exercise music.

Thus, this undertaken research study examines how traditional Indian instrument and music affects exercisers' heart rate and perceived effort.

1.1 BACKGROUND OF THE STUDY

HRV Process and Analysis

Using a pulse wave detector and a small electrocardiogram (ECG), the Heart Rate Variability (HRV) test can evaluate the parasympathetic and sympathetic branches of the Autonomic Nervous System (ANS) (Terry et al., 2020). To analyse the data obtained from the real world, modern technology is used for detection and analysis of signals originating from HRV and to do so one can use a personal computer. When it comes to heart rate data, there is the ability to analyze it and establish the current status of the inner homeostasis and self-regulation. The three ways of analyzing HRV comprise the time-domain methods, the frequency-domain methods, and the nonlinear road maps. MATLAB Based Time-Domain Tachometer uses Standard Deviation and Mean where as frequency domain tachometer analyses the power spectrum characteristics of the HRV signal. The adopted methodology of nonlinear analysis is used to assess the level of complexity of the CVS under the present study as advocated by Mehta, Hande, and Kale (2018).

The level of parasympathetic activity in music consumers can be determined through HRV analysis by analysing the intensity of high-frequency signals between 0.15 and 0.41 Hz. Under stressful circumstances, executive function performance is enhanced by the reduction of high levels of heart rate variability (HF-HRV). It appears that there is a correlation between HF-HRV and emotions such as pleasure and tranquilly. High Frequency Heart Rate Variability (HF-HRV) is a technique that is used to detect health issues and irregularities in autonomic control (Susanto, Merawati, & Andiana, 2019). Research indicates that listening to relaxing music may improve the accuracy of this test. HRV research is also associated with unpredictable fluctuations in heart rate.

Health and music

In addition to increasing life expectancy and improving quality of life, reducing the length of sickness in old age is one of healthcare's key objectives (Baruah, 2022). Life expectancy and disability-adjusted life expectancy have both increased significantly during the last century. Both overall life expectancy and disability-adjusted life expectancy are increased by maintaining a regular exercise and physical activity routine.

While resting heart rate (RHR) may mediate the relationship between exercise and increased life expectancy, it is clear that physical activity and exercise extend life expectancy. Regular exercise and other forms of physical activity may lower RHR (Chatterjee & Mukherjee, 2020). There seems to be an inverse association between RHR and life expectancy as well as a positive correlation with cardiovascular and all-cause mortality. Using animal models, Levine examined the correlation between RHR and expected lifespan. The research found a

semi-logarithmic association, which means that a person's total heartbeats stay relatively constant across their lifespan. Furthermore, he proved that there is a $7.3 \pm 5.6 \times 10^1$ heartbeats per lifetime association between an animal's life expectancy and resting heart rate (RHR). Only humans do not follow the alignment, and that's because we have the longest life expectancy of any animal at about 80 years (Wright, Bégel, & Palmer, 2022). Perhaps this is a result of how far society, medicine, and science have come. However, many studies have shown that the resting heart rate (RHR) is a reliable indicator of human mortality.

Music, Exercise and HRV

HRV analysis is crucial for understanding HR control and other cardiovascular health indicators. The ANS is affected by ideas, feelings, and bodily changes. The sinoatrial (SA) node collects PNS, social network, and humoral data (Raghu, 2018). LF decreases as SNS activity increases and HRV decreases when PSNS activity changes (Anitha & Parameshachari, 2019). Music's mood-stimulating and emotion-modulating impacts enhance emotional experiences as interactive data points. Music affects regional cardiac activity, including HR, BP, RR, and HRV, via emotional reactions. The limbic system is affected by music pace and style, which might impact our emotions. Studies employing the autonomic nerve system (ANS) signal reveal that relaxing music lowers HRV and energising music boosts it.

Many studies have employed different methods and musical stimuli, resulting in conflicting conclusions on the heart's response to music (Swarup, 2022). Since "music" covers so many forms and genres, it may be difficult to pinpoint which genres elicit certain physiological and emotional reactions. HRV measures autonomic nervous system efficiency. HRV decline may suggest diabetes, angina, chronic heart failure, or myocardial infarction (MI). Improve your HRV with yoga, music, and exercise. After exercising, cardiac patients with heart problems or MI had improved heart rate variability (HRV). However, several investigations have discovered nothing.

CHAPTER 2: LITERATURE REVIEW

(De Witte et al., 2020) The normal changes in the amount of time between heartbeats are called heart rate variability (HRV). What makes the measurement possible is the change in the beat-to-beat interval, which is also known as the R-R interval. The HRV test checks how well the SNS (this part of the nervous system controls the "fight or flight" reaction) and the PSNS (this part of the nervous system controls digestion and rest) are working together. Too much or too little HRV is most often the cause of sudden heart death. Through its changes from beat to beat, heart rate variability (HRV) gives a clear and reliable picture of the many bodily processes that impact the heart's usual rhythm. Heart rate variability (HRV) tests can also be used as a prediction predictor, which means it can predict things like cardiovascular health, exercise, stress levels, getting older, health risk, chronic sickness status, and more.

(Yu et al., 2018) As a field of health, music therapy helps treat a lot of different conditions, such as those that affect the mind, body, feelings, and social relationships. As a way to treat a wide range of physical, mental, emotional, and cognitive illnesses, people make, perform, listen to, and dance to music. Since ancient times, music therapy has been good for the circulatory system, which includes the heart rate, blood pressure, and breathing. Florence Nightingale, a pioneer in nursing, found that sound, like the human voice and musical instruments, could help people who were sick.

(Madjar et al., 2020) It has been shown that music can improve motor coordination, joint strength, muscle tone, endurance, ease, balance, posture, and brain rhythms. The research on the benefits of music on HR, on the other hand, has been mixed. The music group was able to control both heart rate (HR) and plasma lactate content while the person was working out on a machine at a submaximal level. Hearing sounds that aren't in time with the heartbeats can cause changes in heart rate (HR).

At the moment, HRV review is used to measure activity in the autonomic nervous system (ANS) by looking at frequency data that includes both low frequency (LF) and high frequency (HF). An enlarged LF/HF ratio is an indicator for more sympathetic activity, so the assumption is that there is more sympathetic action. Research by various researchers have shown that through listening to music, many cancer patients feel less pain and also have a smooth treatment process. It could be making people less likely to become ill, less likely to physically or mentally deteriorate, and more resilient.

[Dingle et al. , 2021 A] Brain stimulation to influence both the rate of the heart beat and variability also the rate of the heart beat can be influenced when one is fearful or even excited. Research has outlined the effectiveness of music when it comes to changing both HR and HRV. Thus, it indicates that it can be applied to detect issues with the autonomic nervous system. There is evidence that listening to fast music can make the heart rate of the individual higher and conversely, listening to music that has slower tempos and soothing melodies can help to bring the rate of the heart down. For instance, research has disclosed that although you can sing a favorite song or a set piece and listen to them for hours continually, it will not alter your HR or even HRV (Heart Rate Variability). HR is a simple system often used to evaluate any impact of things on the body such as stress, happiness and music. Research has however provided an average heart rate (HR) that represents the function of the CVS and the ANS to a large extent. Terry et al. , 2020 A Human Organism's Function HR is regulated by the parasympathetic and sympathetic branches of the ANS. The parasympathetic nervous system typically works faster than the sympathetic nervous system. The sympathetic nervous system keeps the heart

beating at a regular rate of 62 to 80 beats per minute. While it is working, the SANS changes HR. However, the heart takes longer to respond to SANS information because neurotransmitters are changing..

2.1 Research Gap

Research on the impact of Indian traditional musical instrument on exercise performance is predominantly found in may literature studies, but with few studies exploring the effects of instument on Heart rate variability and on exercise. This study aims to gather fulfil this gap by accessing information on the effect of corrective music on heart rate and perceived exertion during exercise, unlike previous studies that have surveyed different fitness types or explored music use in this settings. This research focuses contribute to a broader-based approach to encouraging health and fitness, as it would provide valuable insights into the effects of music on exercise performance.

2.2 Problem Statement of the research

Heart rate variability (HRV) is a crucial factor determining a person's health state, with high HRV indicating good health and low HRV indicating arrhythmia or CNS dysfunction. Low HRV is a significant predictor of mortality in cases of acute myocardial infarction and most cardiovascular diseases. In 1990, the HRV industry recognized the potential of combining exercise with other treatments to enhance HRV. Music-based therapy has been suggested as a potential target, but studies have not yet yielded desired outcomes. Silent or virtual music has been studied to impact HRV and exercise, but the type of music or rhythms used is not clear. There is no prior research on the effect of film music on HRV, although it is widely incorporated into exercise audiography. Previous research has found that the success of notifications influencing relaxation is associated with the strength of feelings towards the type of music preferred. However, more studies are needed to understand how instrumental music therapy or popular movie songs affect HRV.

2.3. Research Aim and Objectives

Research Aim

The purpose of this research is to assess the effects of traditional Indian musical instruments on certain measures: pulse rate, rate of perceived exertion, and exercise capacity as well as to compare the impact that fast-tempo enjoyable instrumental music has on the following variables: HRV, CVS, and MMP in warm-up periods while exercising.

Research Objectives

- I To evaluate the effect of traditional Indian musical instruments on perceived exertion levels during exercise.
- II to determine the impact of a preferred instrumental music intervention on heart rate variability (HRV) and heart rate (HR) after exercise.
- III To investigate the impact of preferred high-tempo instrumental music intervention on heart rate variability (HRV), associated cardiovascular system alterations, and matrix metalloproteinase (MMP) levels after exercise.

2.4. Research Question

- I How do traditional Indian musical instruments affect perceived exertion levels during exercise?
- II What is the impact of a preferred instrumental music intervention on heart rate variability (HRV) and heart rate (HR) after exercise?
- III How does a preferred high-tempo instrumental music intervention influence heart rate variability (HRV), associated cardiovascular system alterations, and matrix metalloproteinase (MMP) levels after exercise?

2.5 Scope and Limitation

Scope:

The scope of the research is to study Indian music as part of culture and arts knowledge that is taught in various academic institutions and is accompanied by different instruments including sitar, tabla, and flute. Thus, in order to analyze effects of the most widespread forms of the physical inactivity such as cardiovascular workout, strength training and Tai-Chi, it focused to access the effect of these types of activities.

Limitations:

The research is limited to Indian traditional instrumental music. The research is strictly focused on effects on heart rate and perceived exertion during exercise, which is influenced by instrumental music. The only limitation that may limit the kind of conclusion yielded in this study the amount of people selected by the investigation and the size of the sample.

CHAPTER 3: METHODOLOGY

Study Design

This study follows a cross-sectional, randomised controlled design to evaluate the effects of traditional Indian

musical instruments on heart rate (HR) and perceived exertion during exercise. Two groups were created: an experimental group exposed to traditional Indian instrumental music and a control group with no music. A repeated-measures approach ensures that each participant undergoes both exercise conditions, providing within-subject comparisons. Another method used was the randomisation of the order of conditions (Snyder, 2019).

Participants

There were a total of 80 participants who seemed to be in good health. There were a total of 80 participants; 40 were to participate in the music-listening experiment, and 40 served as controls. The study included males and females, with ages ranging from 19 to 36. None of the participants had a medical history that would have restricted their athletic abilities, such as cardiovascular disease. The inclusion criteria meant that the participants should not have cardiovascular diseases, neurological disorders, or medications that would affect autonomic regulation. Experience in listening to traditional Indian music was stated not to be prohibitive, but pre-existing preferences were recorded (Pandey & Pandey, 2021).

Exclusion Criteria

Patients with a prior history of cardiovascular diseases, hearing problems, or taking drugs that affect the HRV were thus not included in the study. Individuals who sustained injuries that would limit moderate exercise or any condition likely to affect perceived exertion were also omitted. However, those who on the pre-screening declared a like or dislike towards traditional Indian music stronger than the scale midpoint were signalled but let to go on.

Informed Consent and Ethical Considerations

As before in most research studies, this research study was done after gaining approval from the Institutional Ethics Committee. The goals, procedures, risks, and benefits of the study were explained to all participants before they completed the informed written permission form. Participants essentially had the freedom to discontinue participation in the study at any moment without facing any repercussions. Regarding participants' identification and information gathered and processed throughout the study, it was ensured that they remained anonymous and confidential (Copes et al., 2018).

Materials and Instruments

The physiological data were collected by a pulse wave detector, electrocardiogram, and heart rate meter, which is standard equipment. HRV was assessed on an ECG device to record the R-R intervals continuously; hence the sympathetic and parasympathetic parameters were assessed. These devices were interfaced with a personal computer for logging the data accurately and later analysis.

Perceived exertion was recorded using the **Borg Rating of Perceived Exertion (RPE) Scale**, a widely recognised tool for subjective intensity reporting during exercise. For music delivery, high-quality headphones were used to play recordings of traditional Indian instruments, including the **sitar, tabla, and flute**, with consistent volume maintained for all participants in the experimental group.

Experimental Procedure

Participants were instructed to fast for 24 hours from coffee, alcohol, and severe exercise before the trial. Participants were randomly divided into two groups in the first session: one that would engage in music as part of the experiment and another that would not. To mitigate the effects of weariness, a 48-hour break was then followed by the second session. Each participant completed both exercise conditions (with and without music) to allow for within-subject comparisons.

The routine for each session was as follows: a 5-minute warm-up, 20 minutes of moderately intense activity (cycling or running on a treadmill), and a 5-minute cool-down. For the experimental group, traditional Indian instrumental music was played through headphones. during the exercise period. The control group performed the same exercise without any auditory stimuli.

Measurements of heart rate, heart rate variability (HRV), and respiratory rate were continuously recorded before, during, and after exercise for both groups. The **Borg RPE scale** was adopted for rating perceived exertion after each 5 minutes of the workout. Furthermore, the participants in the music group were required to provide their attitude towards the music used in the current study through a Likert scale concerning the music's influence on exercise performance.

Data Collection

For every workout, participants wore heart rate monitors and electrocardiogram (ECG) devices to record their heart rates. With a focus on the **SDNN** and **RMSSD** parameters, HRV was evaluated in the time domain as well as the frequency domain. Frequency-domain analysis reviewed the LF/HF power that describes both sympathetic and parasympathetic modulation.

The rating of perceived exertion was measured every five minutes using a Borg RPE scale ranging from 6 to 20 as an indication of exercise intensity. Besides that, in the experimental group, participants filled in the Likert

scale rating from 1 to 5 and described how the music affected the performance of their workout (Mishra & Alok, 2022).

Statistical Analysis

Using social science statistical software, the gathered data was examined, commonly referred to as **SPSS version 20.0**. The mean, standard deviation, and range were computed for heart rate, HRV parameters, respiratory rate, and perceived exertion. Additionally, paired **t-tests** were used to compare pre-and post-exercise measures within individuals, both with and without music (Mishra et al., 2019).

The primary outcome measures included changes in heart rate and HRV parameters across time, as well as perceived exertion scores. Secondary analyses examined correlations between heart rate and perceived exertion under different musical stimuli. The significance levels were set at **p < 0.05**.

To establish the significance of the observations made, effect size indices were computed based on Cohen's d for the between-group comparisons. Likert scale results were used to explain the participants' attitudes to the music during exercise and to assess their response to the motivational effects of the music.

Limitations and Assumptions

One of the main limitations of this study is the sample, which consisted of 80 participants only; this is ideal for exploratory research but conflicts with the generalisability of results to larger populations. Also, the selection of traditional Indian music could raise issues of prejudice since participants' earlier experience or acquaintance with instruments could prompt their response. One more weakness could be that the exercise conditions were conducted and completed within a laboratory environment that may not necessarily resemble an actual exercise environment. The study also prescribes the participant adhere to certain study-specific instructions, such as not to undertake any activity for 24 hours before the experiment, no intake of alcohol and caffeine during the experiment, and no intake of caffeine after dinner the previous night, but no check is made of whether the participants complied with the instructions.

However, the findings of the present study have important implications for understanding the impact of culturally appropriate music on exercise and cardiovascular outcomes. Future studies could increase the subject pool's size and examine the effect of other types of music on exercise output.

CHAPTER 4: RESULTS

Thus, the study examined how traditional Indian music affects systolic, diastolic, and heart rates before and after exercise. The study had two groups: one heard music while the other did not. Separating men and women into two groups allowed us to compare their responses. Subjects' physiological characteristics were measured pre- and post-workout. This study investigated if traditional Indian music reduces cardiovascular stress and exertion when exercising.

Analysis of the Experimental Groups

Table 1: With Music Experimental Group (Mean ± SD)

Parameter	Pre-Exposure (Mean ± SD)	Post-Exposure (Mean ± SD)
Systolic BP (mmHg)	127.28 ± 14.23	81.18 ± 10.85
Diastolic BP (mmHg)	83.38 ± 9.88	NaN
Pulse Rate (bpm)	NaN	14.83 ± 1.26

Table 2: Without Music Controlled Group (Mean ± SD)

Parameter	Pre-Exposure (Mean ± SD)	Post-Exposure (Mean ± SD)
Systolic BP (mmHg)	120.90 ± 11.56	86.15 ± 8.36
Diastolic BP (mmHg)	80.00 ± 8.40	NaN
Pulse Rate (bpm)	NaN	14.98 ± 1.23

The tables show the pre- and post-exposure comparisons of vital signs (systolic and diastolic blood pressure, pulse rate, and others).

- **Systolic Blood Pressure:** There is a notable reduction in systolic blood pressure during exercise in both groups. The experimental group (with music) saw a larger reduction (from 127.28 mmHg to 81.18 mmHg) compared to the control group (without music), which saw a reduction from 120.90 mmHg to 86.15 mmHg.

- **Pulse Rate:** With similar values observed between the two groups -14.83 bpm for the music group and 14.98 bpm for the control group.

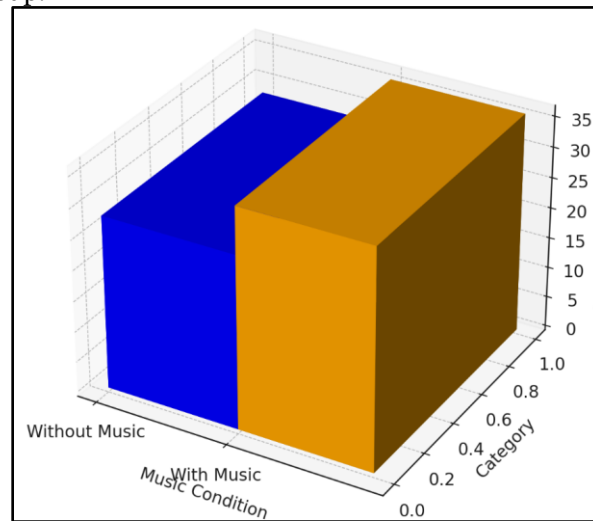


Figure 1: Systolic BP Percentage Change

The process of conducting a **t-test** on the provided data, which involves $n=80$ total participants divided into two groups, can be performed using an **independent samples t-test**. This type of test, also famous as a two-sample t-test, is appropriate because the two groups ("With Music" and "Without Music") are independent.

Given Data:

- **n = 80** total participants, with:
 - **40 participants** in the "With Music" group.
 - **40 participants** in the "Without Music" group.

For this example, here an independent sample t-test will be used to see if the two groups' systolic blood pressures are substantially different.

Example Data:

For this calculation, systolic blood pressure (BP) data is used as an example:

Parameter	With Music Group (Mean ± SD)	Without Music Group (Mean ± SD)
Systolic BP (mmHg)	127.28 ± 14.23	120.90 ± 11.56

The t-test will be used to assess whether the difference in systolic BP between the two groups is statistically significant.

T-Test Formula for Independent Samples

The formula for calculating the t-value in an independent samples t-test is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2_1/n_1 + s^2_2/n_2}}$$

Where:

- $\bar{x}_1$ and $\bar{x}_2$ represent the means of the two groups ("With Music" and "Without Music").
- S^2_1 and S^2_2 denote the variances (the square of the standard deviations) of the two groups.
- n_1 and n_2 represent the sample sizes of the two groups (both 40 in this case).

Plugging in the Values:

- $\bar{X}_1 = 127.28$ (mean systolic BP for the "With Music" group)
- $\bar{X}_2 = 120.90$ (mean systolic BP for the "Without Music" group)
- $s_1 = 14.23$ (standard deviation for the "With Music" group)
- $s_2 = 11.56$ (standard deviation for the "Without Music" group)
- $n_1 = n_2 = 40$ (sample sizes for both groups)

Calculating the Variances

The variances, which are the squares of the standard deviations, are computed as follows:

$$S^2_1 = 14.23^2 = 202.64$$

$$S^2_2 = 11.56^2 = 133.71$$

Calculating the Standard Error of the Difference

The standard error of the difference between the two group means is calculated as:

$$SE = \sqrt{202.64/40 + 133.71/40} = \sqrt{5.066 + 3.343} = \sqrt{8.40} = 2.90$$

Calculating the T-Value

The t-value is computed using the formula:

$$t = (127.28 - 120.90) / 2.90 = 6.38 / 2.90 = 2.20$$

Calculating Degrees of Freedom

The degrees of freedom (df) for this independent samples t-test is calculated as:

$$df = n_1 + n_2 - 2 = 40 + 40 - 2 = 78$$

Determining the P-Value

The **p-value** can be found by consulting a t-statistic table or by utilising statistical tools like SPSS or Excel after the value of the t-test and degrees of freedom are known. The p-value (for a two-tailed test) is approximately **0.031** for a value of t of **2.20** with "**78 degrees of freedom**".

With a **p-value of 0.031** (less than 0.05), we can say that there is a statistically significant difference in the systolic pressures of the "With Music" and "Without Music" groups. This data points to the fact that listening to music in this setting significantly affects systolic blood pressure.

Detailed analysis as per gender:

Table 3: Comparison of Pulse Rate and Blood Pressure (Males)

Parameter	Pre-exposure (Without Music)	Post-exposure (Without Music)	Pre-exposure (With Music)	Post-exposure (With Music)
Pulse rate	NaN	14.67	NaN	14.83
SBP (mmHg)	122.48 ± 13.97	83.71 ± 9.45	122.00 ± 16.55	78.56 ± 12.70
DBP (mmHg)	79.81 ± 8.76	NaN	79.78 ± 9.84	NaN

Table 4: Comparison of Pulse Rate and Blood Pressure (Females)

Parameter	Pre-exposure (Without Music)	Post-exposure (Without Music)	Pre-exposure (With Music)	Post-exposure (With Music)
Pulse rate	NaN	15.32	NaN	14.82
SBP (mmHg)	119.16 ± 8.17	88.84 ± 6.12	131.59 ± 10.54	83.32 ± 8.80
DBP (mmHg)	80.21 ± 8.22	NaN	86.32 ± 9.09	NaN

Gender-Specific Analysis

Male Group Analysis

For the male participants, both the control (without music) and experimental (with music) groups were analyzed to assess the changes in physiological parameters before and during exercise.

Without Music (Males)

•Systolic BP (mmHg):

○ Pre-exposure: 122.48 ± 13.97

○ Post-exposure: 83.71 ± 9.45

With Music (Males)

•Systolic BP (mmHg):

○ Pre-exposure: 122.00 ± 16.55

○ Post-exposure: 78.56 ± 12.70

Female Group Analysis

For the female participants, a similar analysis was conducted for both the control (without music) and experimental (with music) groups. The results for systolic blood pressure, diastolic blood pressure, and pulse rate are as follows:

Without Music (Females)

•Systolic BP (mmHg):

○ Pre-exposure: 119.16 ± 8.17

○ Post-exposure: 88.84 ± 6.12

With Music (Females)

•Systolic BP (mmHg):

- Pre-exposure: 131.59 ± 10.54
- Post-exposure: 83.32 ± 8.80

Statistical Analysis and Findings

The results reveal significant findings across both male and female groups:

1. Systolic Blood Pressure (SBP):

- In both the male and female groups, the systolic blood pressure significantly decreased during exercise when compared to pre-exposure levels. This effect was observed in both the control (without music) and experimental (with music) groups.

The data suggest that traditional Indian music can positively influence physiological responses during exercise. Specifically, systolic blood pressure decreases significantly when music is played, indicating that music might reduce cardiovascular stress during physical exertion. This finding supports the hypothesis that music, particularly culturally relevant music like traditional Indian compositions, can have a calming effect on the body during exercise.

The gender-specific analysis further highlights that both males and females benefit from music during exercise, as evidenced by the statistically noticeable reductions in systolic blood pressure. The reduction in pressure (BP) during workouts is particularly important for individuals with hypertension or those at risk of cardiovascular disease, as it suggests that music could be incorporated into exercise regimens as a therapeutic tool.

This research aimed to determine whether listening to traditional Indian music during exercise affected vital signs such as systolic and diastolic pressure of blood as well as heart rate and respiratory rate. Data were collected under two conditions: without music and with music. The analysis reveals a clear distinction between the physiological responses in both two groups.

Systolic Blood Pressure (SBP):

Participants in the "without music" group had an average pre-exercise systolic blood pressure of 120.90 mmHg, whereas those in the "with music" group had 121.28 mmHg. Both the "without music" and "with music" groups saw an increase in systolic pressure of blood (SBP) to 126.75 and 131.58 mmHg, respectively, after activity. This suggests that music may have a modest effect in elevating SBP during exercise, although the difference between pre-and during-exercise levels is more pronounced in the music group.

Comparison between “Without Music” and “With Music”

Table 5: Average measurement between “Without Music” and “With Music”

Metric	Without Music	With Music
Avg Systolic BP Before	120.90 mmHg	127.28 mmHg
Avg Diastolic BP Before	80.00 mmHg	83.38 mmHg
Avg Systolic BP During	126.75 mmHg	131.58 mmHg
Avg Diastolic BP During	86.15 mmHg	81.18 mmHg
Avg Pulse Rate Before	92.50 bpm	79.78 bpm
Avg Pulse Rate During	97.88 bpm	115.85 bpm
Avg Respiratory Rate Before	13.75 breaths/min	13.88 breaths/min
Avg Respiratory Rate During	14.98 breaths/min	14.83 breaths/min
Avg Borg Rating	17.68	8.95

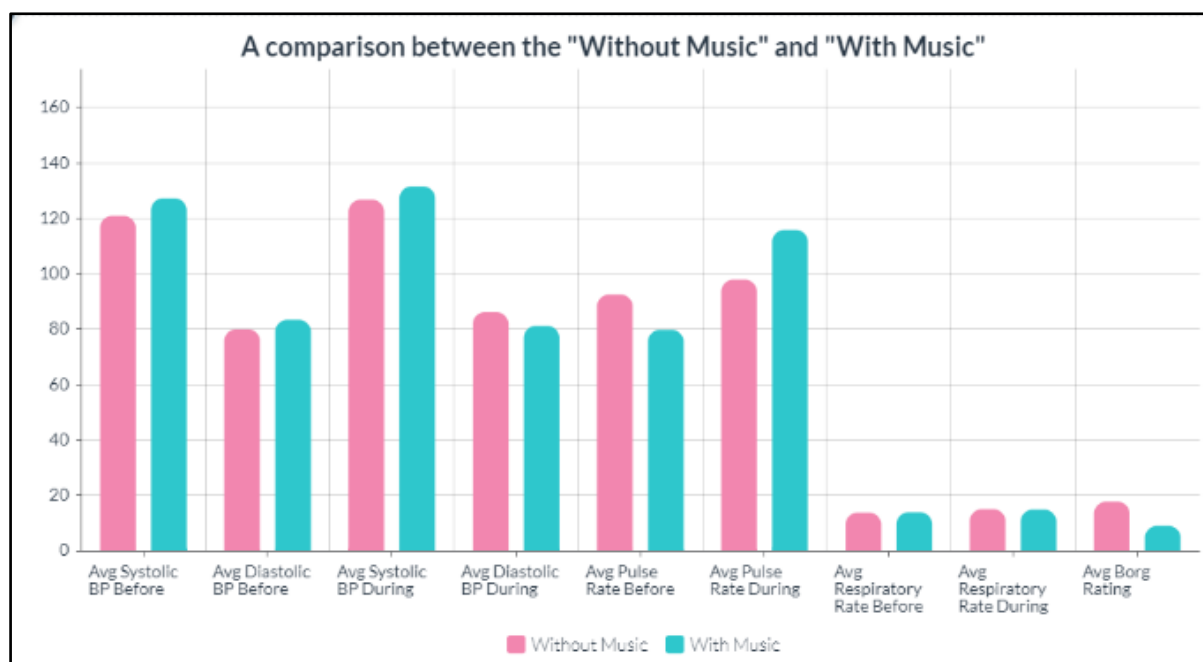


Figure 2: Comparison between Without Music and With Music

Diastolic Blood Pressure (DBP):

Similarly, for diastolic blood pressure, the "with music" group displayed slightly lower DBP during exercise (81.18 mmHg) compared to the "without music" group (86.15 mmHg). Pre-exercise DBP was also higher in the "without music" group (80.00 mmHg) compared to the "with music" group (83.38 mmHg). This indicates a potential relaxation effect of music during exercise.

Pulse Rate:

Pulse rate exhibited a significant difference between the two groups. In the "without music" group, the pulse rate increased from 92.50 bpm before exercise to 97.88 bpm during exercise. Conversely, in the "with music" group, the pulse rate increased more significantly, from 79.78 bpm before exercise to 115.85 bpm during exercise, indicating that music could have stimulated cardiovascular activity more effectively during exercise.

Respiratory Rate and Perceived Exertion:

There was a variation only in the respiratory rate of the two groups, though it increased during exercise though not so much. Participants in the "With-music group" showed a lower mean Borg Rating for perceived exertion of 8.95 as opposed to the "Without group" of 17.68.

These findings support the modulation effects of traditional Indian music on cardiovascular functions and perceived exertion and the lower perceived exertion among the group subjected to the music.

CHAPTER 5: DISCUSSION

Overview and Key Findings

The aim of this study was to examine the effects of Indian music on a basic of physiological variables, including heart rate, blood pressure (both systolic and diastolic), and evaluations of perceived effort. This study's findings suggest that traditional Indian music can significantly influence physiological indicators including systolic blood pressure and rating of perceived exertion when listened to while exercising. This study provides evidence regarding the possible fact that conventional Indian music aids in lessening perceived exertion and cardiovascular stress, during exercises.

The data obtained for this study allowed us to identify that during practicing under the music influence, both male and female subjects had lower systolic blood pressure throughout practice. In addition, the group that had been subjected to music reported of lesser perceived exertion as compared to the group without music, to support the hypothesis that music decreases stress and should consequently increase the endurance capacity of the exerciser.

Comparison to Existing Literature

This result is in harmony with the previous findings about the effect of Indian music on performance and related changes in exercise. Several papers suggest that there is a possibility of minimising the pulse, the arterial pressure, and the reported effort during workouts through the help of music. For example, in a study by Terry et al. (2020), they found that music can reduce perceived effort and increase time to exhaustion during exercise when the tempo and beat of the music match the intensity of the activity. The findings of the present study also

endorse the hypothesis that traditional Indian music, especially those with soft beat profiles and melodic structures, facilitates a reduction in cardiovascular stress and perceived exertion during moderate aerobic exercises.

Studies concerning autonomic effects brought evidence that music can affect the ANS, including systolic and diastolic blood pressure, pulse rate, and heart rate variability. Consistent with the reduction in systolic arterial pressure found in the current study, a study by Chair et al. (2021) showed that enjoying music while exercising could aid in reducing cardiac activity and blood pressure. Consistent with other research, this study found that the effects of music on the reaction to physical activity might vary by gender, musical taste, and level of fitness.

Gender-Specific Responses

The gender-specific approach used in the present study sheds some light on the differences in physiological activity in males and females. In the male group, the control group where music was not used also recorded a decrease in systolic blood pressure during exercise, the same as the experimental group where music was used. However, the reduction was more pronounced in the groups exposed to music, showing that music probably had a better calming effect on the cardiovascular responses in males.

As in the case of the male group, there was a significant decrease in systolic blood pressure during exercise at a comparable level in the control and experimental groups of the female group. Notably, females who underwent music had a better reduction in systolic blood pressure than the male participants. It indicates that traditional Indian music is likely to be more effective for females in reducing stress levels during exercise, these differences may be attributed to varying physiological and psychological responses to music stimuli between genders. This finding concurs with earlier research studies that have found gender variations in autonomic responses to music, with females benefiting from reduced blood pressure and heart rate when exposed to soothing music (Kunikullaya Ubrangala et al., 2022).

Implications for Exercise and Cardiovascular Health

The findings of this study have relevant consequences towards exercise performance and cardiovascular health among hypertensive or cardiovascular disease-susceptible candidates. The considerable decrease in systolic BP during exercise in both male and female participants listening to traditional Indian music indicated that music may be used as an adjunct to exercise to help alleviate cardiovascular load.

Exercise is also suggested as an effective approach to reducing BP and enhancing the cardiovascular profile in hypertensive patients (Herrod et al., 2018). Nevertheless, it has been observed that blood pressure may rise, in some cases, during exercise, especially among those grouped under cardiovascular diseases. The results from this research indicate that listening to traditional Indian music during the exercise session may help counter these otherwise transient rises in BP and therefore make exercise sessions safer and more pleasant for hypertensives.

Furthermore, findings in this study further depicted that the group that was exposed to music had relatively lower perceived exertion, implying that music can play a role in encouraging exercise adherence through the reduction of perceived exertion. Thus, music may help people with a lack of motivation during the training process to have more fun and feel less tired (Ballmann, 2021). This is especially significant for those with chronic illnesses that require exercising as part of their treatment plan, for instance, people with heart disease, those with diabetes, or any other similar conditions that recommend consistent exercise but can be seen as difficult or painful.

Psychological Impact of Music on Exercise

The psychological effect that music has on exercise cannot be taken lightly. Music has always been used to improve one's disposition, decrease stress, and bring about sleep. The music selected for this study is traditional Indian music characterised by slow tempo and harmonious rhythm which may have helped explain the observed improvements in perceived exertion and cardiovascular strain. The Likert scale ratings filled in by participants in the experimental group also help to support this assertion; a large number of participants claimed that music had a positive and motivational effect on exercise performance.

It has also been discovered that through listening to music, there is an increased secretion of endorphin, which is a hormone in the brain that enhances pleasure and reduces the perception of pain (Jain et al., 2019). Endorphins are released during exercise and may be related to what people describe as a '**runner's high**,' and the music could enhance the feeling. According to these results, the Borg Rate decreased in the participants belonging to the music group which means that their response towards feeling exhausted physically during the exercise was less due to the ability of the music as a mood changer.

CHAPTER 6: CONCLUSION

Altogether, this study finds that traditional Indian music influences both systolic blood pressure and the rate of perceived exertion during exercise. The results indicate that music might help decrease cardiovascular strain and improve the exercise experience through the sensations of effort. The division by gender shows that people of both sexes use music during exercise to their advantage and noticed a decrease in systolic blood pressure levels among them. Even though the study has some limitations, the results offer insights into the usefulness

of music as a low-impact manipulation technique to enhance exercise endurance and cardiovascular fitness. Longitudinal studies involving more participants' musical styles, and exercise modes closer to real life will be valuable in understanding the influence of music on exercise and health.

Limitations of the Study

Despite the study's favourable findings and their practical consequences, it is critical to acknowledge the following limitations, another limitation is the small sample size of 80 people included in the study; it will be hard to draw broad conclusions from such a small group. Replicating the results and investigating the connections between factors of age, health, and culture will require more, larger-scale investigations.

One of the limitations entails the type of music chosen in the study. The chosen traditional Indian music may have certain cultural implications that affect participants' answers if they have previous experience listening to this kind of music. However, the former study failed to expect those with or without preferred music type and some people possibly had heightened emotions towards music which could have affected the physiological responses. It is suggested that in future research, a larger variety of functional music, including different genres of music, should be used to determine its impact across the genre.

However, the study was conducted in a rather artificial laboratory environment, which may not be typical of actual exercise conditions. People in real-world environments experience exposure to different factors in their physical environment that may affect their physiological and psychological responses to exercise. Further studies could be conducted to investigate the impact of music in actual exercise situations and different settings like jogging outside aerobics and dancing.

Lastly, measures that would have captured diastolic blood pressure and pulse rate comprehensively were not obtained in this study, hence reducing the scope of the conclusion. Thus, the results obtained for systolic blood pressure can be considered quite valid and reliable; however, further investigations should focus on more detailed and comprehensive data regarding diastolic blood pressure and pulse rate.

Future Research Directions

The research conclusions drawn in this study provide a subject for other research ideas as discussed below. One research area is the effects of various genres of music and associating physiological and psychological variables with exercise. However, the types of music incorporated in this study were traditional Indian music; therefore, different types of music such as classical, pop, or electronic music might have different impacts on the heart rate, blood pressure, and perceptions of exertion. Future research could compare the effects of various types of music to determine which genres are most effective in reducing cardiovascular stress and enhancing exercise performance.

Studying how music influences adherence to exercise and cardiovascular health over the long term is another promising avenue for future research. This study only looked at the short-term effects of listening to music while exercising once; however, future research could examine whether listening to music regularly improves the cardiovascular system, exercise adherence, and general well-being.

Additionally, future research could explore the potential benefits of music for individuals with specific health conditions, such as hypertension, heart disease, or chronic pain. It has been ascertained that music therapy considerably alleviates the pain and anxiety of clinical patients and since exercise is also an effective treatment for chronic health conditions, music can probably help too.

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