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Original Article

"Cardiovascular responses to different musical tempo during post exercise recovery in healthy medical students."

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ABSTRACT

Aim: This study aimed to understand the role of music in increasing the exercise performance. Method: Ninety seven volunteers (54 male, 43 female) were subjected to isotonic exercise (sub maximal treadmill work) on three consecutive days. The exercise protocol on the first day consisted of rest, exercise for 5 min, and then rest. On the second day, they were asked to exercise and rest with slow music and the third day with fast music. Parameters such as Pulse rate, SBP and DBP were measured for the pre- and post-exercise periods. Bruce protocol and BORG scale of rating of perceived exertion was used. Post exercise recovery was also correlated with gender and BMI. Results: It was found that listening to music during exercise has favorable influence on cardio vascular variables like pulse rate, systolic blood pressure, diastolic blood pressure and also lessens individual's perception of exertion. Slow music favoring recovery of PR &DBP ($p>0.05$), fast music hastens SBP recovery ($p=0.003$). Conclusion: The study concluded that music hastens post exercise recovery and slow music has greater relaxation effect than fast or no music.

1. Introduction

Music is a well known relaxation technique from times immemorial. Listening to music is a complex phenomenon, involving psychological, emotional, neurological and cardio-respiratory changes [1]. Recent studies emphasize the value of music in lowering stress and its role in enhancing the exercise performance [2].

Physical exercise is associated with changes in cardio respiratory parameters and increases psychological stress and exertion. Following exercise, these parameters return to the resting values once the O2 debt is recovered. In mild to moderate exercise, music improves the exercise performance and reduces the perceived exertion [3].On the contrary, in severe exercise, music has the potential to maximize the motivational and affective components but does not enhance the performance quality.

Further, the tempo of music has its own influence- on exercise. Studies conducted on the effect of different musical tempo on physiological changes during exercise yielded controversial results. Some studies showed that switching from slow to fast music during progressive exercise results in more work efficiency with significant changes of physiological parameters [4] while other studies have shown that physiological parameters were not affected. The contradictory findings may be due in part to variations in experimental design, such as differences in exercise mode, intensity, and duration. The type of music selected and the manner in which it was selected have also varied among the studies. Additionally, subjects differed in age, health and physical conditioning.

Given the limited physiological evaluation of the effects of music on exercise in previous studies as well as the mixed findings, this study was done to acquire a better understanding of the cardiovascular responses to fast and slow music during steady-state treadmill exercise. Cardiovascular variables like pulse, systolic blood pressure (SBP), diastolic blood pressure (DBP) and rating of perceived exertion (RPE) was studied. Also an attempt was made to correlate post-exercise recovery with gender and body mass index.

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MATERIALS AND METHODS:

Study subjects: Second year MBBS students in Mysore Medical College and Research Institute.

A. Inclusion Criteria:

- Second year MBBS students who were willing to participate in the study.
- Aged 20- 21 years.

B. Exclusion Criteria:

- Hearing impaired and physically challenged persons.
- Any person who found music caused agitation.
- Using sedative medications at the time of the study.
- History of Respiratory disease (e.g. asthma).
- History of cardiac disease.

METHOD OF COLLECTION OF DATA:

Sample size: Ninety Seven Second year medical students who satisfied the inclusion criteria during the study period. Following parameters were recorded:

- Age in years.
- Body weight in kg and height in meters.
- Body mass index kg/m2

The subjects were explained about the procedure of the exercise, a prior trial was given for them for acquaintance with the treadmill exercise.

1. Pre-exercise values for the following parameters were recorded after 30 minutes of rest in the laboratory.

- Pulse rate/min(radial pulse recording manually)
- Systolic blood pressure
- Diastolic blood pressure
- Both blood pressure in mmHg using sphygmomanometer

2. Exercise: Three exercise sessions were held on three consecutive days.

Session 1: The participants were subjected to sub maximal exercise on treadmill (Stage 5 of Bruce Protocol11) for 5 minutes without music and allowed to rest. (Control)

Session 2: The participants were subjected to same exercise (as session 1) with slow music. Melody songs with less than 100 db were played using iPod through headphones. (Intervention 1)

Session 3: The participants were subjected to same exercise (as session 1) with fast music. Dance beats with more than 200 db were played using iPod through headphones. (Intervention 2)

3. Post exercise: After each exercise session the following parameters were recorded every 2 minutes until they returned to resting values.

- Pulse rate (beats/min)
- Systolic blood pressure (mmHg)
- Diastolic blood pressure (mmHg)
- Rating of perceived exertion scale (RPE: BORG) immediately and then every 4mins until the person reported of complete recovery from exertion. This scale allows participants to give a subjective exertion rating for the physical task at any time during or after the activity. The scale ranges from 0 to 10. Higher the RPE score, higher the rating of perceived exercise [12].

Statistics: Analysis of the data was done using SPSS 16.5 statistical package.

- Descriptive statistics like mean and standard deviation was used

Differences among the interventions were determined by Repeated measures ANOVA test. 5 % significance was considered.

RESULTS:

Table I: To analyse the effect of slow and fast music on post exercise recovery a total 97, II year MBBS students were considered as subjects. Of them 43 (44%) were females and remaining 54 (56%) were males with a mean age of 21 yrs. Body Mass Index was found to be around 22 in females and 21 in males.

Table I: Characteristics of study subjects

Gender	Number	Age (Mean± SD)	BMI
Female	43	21±1.23	22±2.33
Male	54	21±1.35	21±1.97

BMI: Body mass index; SD: Standard deviation

Table II: Average resting pulse rate was found to be 86 beats/min among females and 80 beats/min among males. The average base line systolic blood pressure was lower, 111mmHg in females when compared to 117mmHg in males. Average resting diastolic blood pressure was almost equal measuring 72.3mmHg among females and 71.7mmHg among males. The maximum values measured post exercise also showed the same pattern: average pulse rate being greater in females than males by 4 units, average SBP was lesser in females by 18mmHg and average DBP equal among both (75mmHg).

Table II: Baseline and maximum values (during exercise) of cardiovascular variables in study subjects

Gender	Pulse rate		SBP		DBP	
	Baseline	Maximum	Baseline	Maximum	Baseline	Maximum
Female	86±9.43	150.1±15.2	111±9.63	134.2±9.2	72.3±7.37	75.7±6.7
Male	80±8.92	146.7±18.4	117±9.03	152.5±14.6	71.7±8.44	75.6±9.4

SBP: systolic blood pressure; DBP: Diastolic blood pressure

Table III: With regard to pulse rate the values obtained immediately after exercise with fast or slow music were found to be nearly equal to that obtained without music (i.e.=150 beats/min). In case of SBP there was slight reduction in the maximum value obtained with fast music during exercise (132mmHg) compared to either exercise with slow music (137mmHg) or without music (134mmHg). DBP values were slightly reduced with music intervention during exercise (more with fast music 74.3mmHg than slow music 74.9mmHg) when compared to 75.7mmHg obtained without music. But none of these findings were statistically significant.

Table III: Cardio Vascular variables with different musical interventions post exercise

Cardio vascular variables	No music	No music	Fast music	F value	Sig
Pulse rate	150.1±15.19	149.9±11.64	150.5±13.67	3.65	0.732
SBP	134.2±9.20	137.3±11.08	132.3±10.51	4.78	0.665
DBP	75.7±6.75	74.9±7.66	74.3±7.97	2.13	0.542

SBP: systolic blood pressure; DBP: Diastolic blood pressure; sig: significance

Table IV: The recovery pattern of cardiovascular variables was studied in males and females without any music during exercise. The pulse rate of females returned to baseline earlier than their male counterparts. This difference in recovery time of pulse rate was not statistically significant. SBP of females recovered faster than males and it was statistically significant. DBP of females touched the base line earlier than males which was also statistically significant.

Table IV: Post exercise recovery pattern of cardio vascular variables according to gender

Cardio vascular variable	Male (Time in min)	Female (Time in min)	T value
Pulse rate	47±4.23	46±7.53	2.13
SBP	9.33±3.84	8.8±3.40	6.11*
DBP	6.53±5.03	5.33±4.98	5.76*

SBP: systolic blood pressure; DBP: Diastolic blood pressure; *significant

Table V: As predicted the time taken for pulse rate to reach normal value post exercise with slow music intervention was very less (37min) compared to that without music (46min). Recovery time with fast music was also less (41min) but the results were not statistically significant. With respect to SBP, there was better recovery with fast and slow music, the time taken being 7.22min and 7.88min respectively to reach the normal value than that without music which was 9.11min. This finding was statistically significant with an'F' value of 7.93. The time taken for DBP to reach the base line value without music was 6.53min that with slow music was 4.56min and with fast music was 5.59min the values were not statistically significant.

Table V: Time taken for cardiovascular variables to return to base line values post exercise

Cardio vascular variables	No music (Time in min)	Slow music (Time in min)	Fast music (Time in min	F value	Sig
Pulse rate	46±7.53	37±9.47	41±9.31	4.31	0.258
SBP	9.11±8.55	7.88±9.23	7.22±7.51	7.93	0.003*
DBP	6.53±5.67	4.56±2.99	5.59±4.22	2.02	0.512

SBP: systolic blood pressure; DBP: Diastolic blood pressure; *significant

Table VI: Out of 97 study subjects 12 were underweight with a BMI of less than 18.5, 67 were normal weight with a BMI of 18.5 to 25. 18 subjects were overweight with BMI more than 25. The recovery time of pulse and systolic blood pressure after the exercise was maximum for overweight subjects and it was statistically significant. The fastest recovery of diastolic pressure was found in the normal weight group when compared to over and underweight subjects. This difference was not statistically significant.

Table VI: Relation between BMI and time taken for cardiovascular variables to return to base line values post exercise

Variable recovery	BMI			F value
	Underweight (<18.5)	Normal weight (18.5-25)	Overweight (>25)	
Pulse (time in min)	49±5.53	42±4.33	54±2.77	7.42*
SBP (time in min)	12.11±8.55	7.3±3.24	14.11±3.92	6.76*
DBP (time in min)	7.53±4.61	5.87±4.12	8.73±2.98	2.71

SBP: systolic blood pressure; DBP: Diastolic blood pressure; BMI: body mass index *significant

Table VII: On average females gave a rating of 5.4 on BORG scale after exercise without music. The ratings were less with both slow and fast music, ratings being 4.6 and 4.7 respectively. Rating of the maximum exertion after exercise among the males was less with slow music (4.7) compared to both that with fast music (5.2) and that without music (5.3). Both this effects of music was found to be statistically significant.

Table VII: Perceived exertion of study subject according to musical intervention

Perceived exertion	No music (time in min)	Slow music (time in min)	Fast music (time in min)	F value	Sig.
Female	5.4(10±5.81)	4.6(8.5±4.24)	4.7(8.3±4.22)	8.97	0.002*
Male	5.3(11.2±4.5)	4.7(8.7±4.01)	5.2(9±3.36)	7.56	0.002*

*significant

DISCUSSION:

Ninety seven young adults were studied. The study subjects had a mean age of 21years and a mean BMI of 21.5.

The mean resting Pulse Rate was higher for females when compared to males. A study published in the Journal of American College of Cardiology by Ryan et al had found out that mean heart rate did not differ between male or female participants in any age group 13. In the present study the mean resting SBP was less among females than males, but the resting DBP was the other way round. Suzanne Oparil, Andrew P. Miller, in their study, found out that women have lower systolic blood pressure (SBP) levels than men during early adulthood, while the opposite is true after the sixth decade of life. Diastolic blood pressure (DBP) tends to be slightly lower in women than men regardless of age [14].

There was no significant difference in the maximum values of pulse rate and DBP obtained post exercise. Maximum SBP value attained was less with fast music by 2 units ($p>0.005$).

Females seem to be physically fitter than males in this study group. This can be justified by the findings (table 4) where there was faster recovery of all the cardiovascular variables in females than males. In a similar study, by Savitha D, Mallikarjuna Reddy N, ChythraRao, it was found that there is no gender difference in the recovery duration with respect to both types of music. They concluded that both males and females have the same psychological and physiological responses to music listening 10.

The present study supported the hypothesis that relaxation with music after a bout of physical exercise caused faster recovery of physiological parameters namely pulse rate and blood pressure in comparison with relaxation in silence. It is consistent with other study by Yamamoto T, Ohkuwa T which proved that music has the potential to reduce physiological indicators of anxiety including pulse rate, blood pressure and also theorised that music reduced muscular and mental tension, thereby decreasing the sympathetic stimulation [15].

The heart rate and diastolic blood pressure returned to base line faster while listening to slow music when compared to fast music. But the only significant finding was the faster recovery of systolic blood pressure with fast music intervention. Savitha D, Mallikarjuna Reddy N, ChythraRao, in their study, found a beneficial effect of slow music on all the 3 cardiovascular variables-PR, SBP&DBP. They theorised that music of slow tempo reduced the arousal, leaving the subject in a state of relaxation [10]. Another study by Szmedra L, Bacharach DW suggested that the introduction of music has a psychobiological impact on the exerciser demonstrated by changes in perceived effort, lactate and nor epinephrine [5]. Urakawa & Yokoyama (2005) in their study about the effect of music on HRV (Heart Rate Variability) compared to no music in an exercise condition, theorised that after exercise in which SNS activity is dominant, music synchronised with the stimulated SNS, resulting in further increased SNS activity(i.e increased HR) [6].

Overweight individuals, i.e. BMI>25, take longer time for the recovery of all the cardiovascular variables (PR&SBP in particular) to pre exercise values.

The subjective feeling of exertion perceived by each individual at the end of exercise was rated on the Rating of perceived exertion (RPE) scale. The peak levels of perceived exertion were found to be the almost same at the end of the exercise tasks with the two tests and control for each subject. During the post exercise relaxation period, the subjects felt faster recovery from exertion in presence of music than relaxing in silence. Further relaxation was fastest with slow music when compared to fast music. Yamashita S, Iwai K, Akimoto T, Sugawara J, Kono I, studied effects of music during exercise on RPE, heart rate and the autonomic nervous system. They suggested that music evokes a ''distraction effect'' which might decrease the influence of stress caused by fatigue, thus increasing the ''comfort'' level of performing the exercise but not influencing the autonomic nervous system [8].

The present study is limited to a small bout of exercise and is conducted on healthy volunteers. Further studies have to be conducted on these lines to investigate gender differences with larger sample size; on patients during the hospital stay; prior, during and following surgical procedures with more specific parameters included to confirm the mechanism of relaxation brought about by music. The present study should also be extended on patients under various types of stress as in spite of having several studies in these lines there is a need for more structured study due to several controversial results found till date.

CONCLUSION:

· Listening to music during exercise has favourable influence on cardio vascular variables like pulse rate, systolic blood pressure, diastolic blood pressure.

· Slow music seems to hasten the recovery of pulse rate after exercise when compared to fast music.

· Fast music exerts the maximum favourable effect on recovery of Systolic Blood Pressure after exercise when compared to slow music.

· Slow music is better with respect to recovery of Diastolic Blood Pressure after exercise.

· Higher BMI has a negative effect in the recovery of cardio vascular variables after exercise.

· Listening to music during exercise results in less perception of exertion when compared to doing the same exercise without any music.

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