EFFECT OF MUSICAL TEMPO ON POST-EXERCISE RECOVERY TIME OF CARDIOVASCULAR PARAMETERS FOLLOWING MODERATE ISOTONIC EXERCISE IN YOUNG HEALTHY INDIAN MALES

Samir J. Mendpara[1], Pratik N. Akhani[2], Geetanjali Purohit[3], Veena Jasuja[4], B. M. Palan[5], J. M. Harsoda[6]

[1]Assistant Professor, Department of Physiology, C.U. Shah Medical College, Surendranagar, Gujarat, India.

[4]Assistant Professor, Department of Physiology, Gujarat Adani Institute of Medical Sciences (GAIMS), Bhuj, Gujarat, India.

[2]P.G. Final year, [3]Assistant Professor, [5]Associate Professor, [6] Professor & Head, Department of Physiology, SBKS MI & RC, Sumandeep Vidyapeeth, Piparia-391760, Vadodara, India.

Abstract: **Background & objectives:** People are increasingly using background music for enhancing exercise and sports performance, but selection of a particular musical tempo is often based on individual preference, rather than scientific evidence. Therefore, this study aimed at investigating the effect of musical tempo on post exercise recovery of physiological parameters. **Methods:** Fifty young healthy males were allowed to relax in silence, with slow Indian classical music and with fast hip-hop music after moderate isotonic exercise by Harvard step test. Radial pulse rate and blood pressure were measured pre and post exercise, and post-exercise recovery time of these parameters was noted. **Results:** Post-exercise recovery time of pulse rate, systolic blood pressure and diastolic blood pressure was significantly less when participants were allowed to relax with music. Furthermore, these parameters returned to baseline earlier with slow music as compared to fast music. **Interpretation & Conclusion:** Music, especially slow Indian classical music, can accelerate post-exercise recovery of physiological parameters.

Key Words: Diastolic blood pressure, Exercise, Male, Music, Systolic blood pressure.

Author for correspondence: Pratik N. Akhani, Department of Physiology, SBKS MI & RC, Sumandeep Vidyapeeth, Piparia-391760, Vadodara, India. E- mail: pratikakhani@yahoo.com

Introduction:

From times immemorial, music is considered to be a good relaxation technique for body and mind. Listening to music can have a variety of effects on psychology, emotions, nervous system and cardio-respiratory system.[1,2] In past few years, advancement in internet and music technology especially that in smart phones, has taken music even to the lower socio-economic strata in India, and around the world. Music has been used as a therapy owing to its ability to influence the limbic system to bring about relaxation, pain relief, and decrease stress.[3] Recent studies emphasize the role of music in lowering stress and in improving the exercise performance.[4] Use of music is gaining increasing importance among athletes and exercisers to augment athletic performance,[5] but selection of type of music is often confusing, and hence, exercise and sports scientists are devising evidence-based guidelines for use of music in physical activity.[6]

Physical exercise induces cardiovascular and respiratory changes. Music can have significant effect on these parameters. Past research has suggested that, music reduces perceived exertion and improves exercise performance in mild to moderate exercise.[7,8,9] While in severe exercise, music does not improve the quality of performance, although it can enhance the affective components and motivation.[10,11]

Variation in auditory stimulus in terms of tempo, intensity, and tone evokes dynamic psycho-physiological responses in an individual.[12] The tempo of music can influence exercise on its own. A change in musical tempo from slow to fast during progressive exercise enhances work efficiency with significant alterations in physiological parameters,[13] while some studies have demonstrated no effect on physiological parameters.[14] Consequently, the effect of diverse musical tempo on physiological parameters during and after exercise remains unclear. There is a lack of substantial literary information regarding the effect of musical tempo on the post exercise recovery time. Hence, in the present study we endeavoured to investigate the effect of music and different musical tempo on post-exercise recovery time of physiological parameters.

Material and Methods:

It was a cross sectional type of observational study conducted during June, 2012 to December, 2012. Prior ethical permission to conduct the study was obtained from Sumandeep Vidyapeeth Instituitional Ethics Committee (SVIEC). Then, the first year undergraduate medical students of S. B. K. S. Medical College were invited to participate in the study as volunteers.

All the 86 volunteers (70 males, 16 females) were invited to the research laboratory in the department of Physiology and were detailed about the study protocol by providing the Participant Information Sheet. All volunteers who agreed to take part in the study (60 males), signed the written informed consent form approved by the SVIEC, followed by their history taking and detailed physical examination by a qualified medical personnel who was unaware about the details the study.

Young, healthy students who were ready to give a valid consent for participation were included in the study. Those who had Body Mass Index (BMI) < 18.5 kg/m2 or BMI >24.99 kg/m2, those who were on any diet/exercise regime, those who were on any medications, those who had any disease/disorder e.g. thyroid disorders, diabetes mellitus, any cardiovascular or neuropsychiatric disorders, and who were smokers and/or alcoholics were excluded from the study. As shown in the figure 1, the CONSORT (Consolidated Standards of Reporting Trials) diagram,[15] out of a total of 86 students, 52 were selected for study according to the inclusion and exclusion criteria and final data analysis of 50 students was done.

Height measurement: The subject was asked to stand erect on the stadiometer bare foot and the height was recorded during inspiration, placing the horizontal bar of the stadiometer on the vertex of the subject.

Weight measurement: The subject stood erect on the digital standing scale bare foot and wearing light clothes. The readings were recorded from the digital scale of the weighing machine.

Body Mass Index: The Body Mass Index (BMI) was calculated using the following formula[16]:

BMI = Weight (in kg)/Height^2 (in m^2)

Exercise protocol: Participants were instructed to avoid heavy meal, caffeine or nicotine for 4 hours prior to testing and to refrain from strenuous physical activity or exercising for 24 hours prior to testing. Each study session was conducted at approximately the same time of day for each subject and was separated by at least 48 hours. It was ensured that the subject properly understood the instructions and followed them each time that they were tested.

After 30 minutes of rest, radial pulse was counted for full one minute, followed by blood pressure measurement with the help of mercury sphygmomanometer. The participants performed moderate isotonic exercise by modified Harvard step test suitable for Indian students by climbing and descending two steps at a rate of 20 times in a minute for two minutes using metronome, height of each step being 30 cm. If the participant requested to stop or he had any of the following during exercise, the procedure was stopped and the participant was excluded from the study- nausea and/or dizziness (headache), heart problems (angina-like symptoms), irregular heartbeat, physical or verbal manifestations of severe fatigue, breathlessness or a feeling of a lack of air, fainting, leg cramps or claudication.

During the post exercise relaxation time, participants were allowed to rest without any music in silence on first study session, with slow Indian classical instrumental music on second study session and with fast hip-hop music on third study session. Music was played using an I-pod through headphones. During the post exercise relaxation time, pulse rate and blood pressure were measured immediately and after every 1 min until the parameters returned to resting values. The recovery time (RT) of cardiovascular parameters was recorded in minutes using a stopwatch.

All the instruments used during the study were regularly checked and calibrated using the standard guidelines. To minimize any subjective or technical errors, all the parameters were recorded

by the same person (a qualified medical personnel) using the same instruments in all study sessions. The principles of the Declaration of Helsinki were strictly adhered to throughout the course of study.[17]

Statistical analysis: Statistical analysis was done using SPSS version 20®. Difference between means of the two groups was analyzed for significance using students paired t-test. The alpha error was set at 5% level and p-values < 0.05 were considered significant.

Result:

As shown in Table 1, the mean age of study participants was 18.47 ± 0.78 years. The mean height of the participants was 1.60 ± 0.07 meters. The mean weight of the participants was 56.77 ± 4.64 Kg and the mean Body Mass Index (BMI) of the participants was 22.27 ± 1.38 Kg/m^2.

As shown in Table 2, post-exercise recovery time of systolic blood pressure was significantly higher with slow music (7.1 ± 2.1 min) when compared to that with no music (10.4 ± 2.4 min) (P < 0.05). Post-exercise recovery time of diastolic blood pressure was significantly higher with slow music (5.2 ± 2.9 min) as compared to that with no music (7.9 ± 3.0 min) (P < 0.05). Pulse rate recovery was also faster with slow music (7.3 ± 2.1 min) than with no music (11.0 ± 2.7 min) (P < 0.05).

As shown in Table 3, post-exercise recovery time of systolic blood pressure was significantly higher with fast music (8.4 ± 2.0 min) when compared to that with no music (10.4 ± 2.4 min) (P < 0.05). Post-exercise recovery time of diastolic blood pressure was significantly higher with fast music (6.5 ± 2.9 min) as compared to that with no music (7.9 ± 3.0 min) (P < 0.05). Pulse rate recovery was also faster with fast music (8.2 ± 2.3 min) than with no music (11.0 ± 2.7 min) (P < 0.05).

As shown in Table 4, post-exercise recovery time of systolic blood pressure was significantly higher with slow music (7.1 ± 2.1 min) when compared to that with fast music (8.4 ± 2.0 min) (P < 0.05). Post-exercise recovery time of diastolic blood pressure was significantly higher with slow music (5.2 ± 2.9 min) as compared to that with fast music (6.5 ± 2.9 min) (P < 0.05). Pulse rate recovery was also faster with slow music (7.3 ± 2.1 min) than with fast music (8.2 ± 2.3 min) (P < 0.05).

Table 1: Demographic characteristics of study participants.

	Mean ± SD (n=50)
Age (years)	18.47 ± 0.78
Height (meters)	1.60 ± 0.07
Weight (Kg)	56.77 ± 4.64
Body Mass Index (Kg/m^2)	22.27 ± 1.38

Table 2: Comparison of recovery time of cardiovascular parameters following moderate isotonic exercise in case of relaxation with no music and relaxation with soft music.

	Post-exercise recovery time (in minutes)		t value	P value
	No music (mean±SD)	Slow music (mean±SD)		
SBP	10.4 ± 2.4	7.1 ± 2.1	7.32	< 0.05
DBP	7.9 ± 3.0	5.2 ± 2.9	4.57	< 0.05
Pulse rate	11.0 ± 2.7	7.3 ± 2.1	7.65	< 0.05

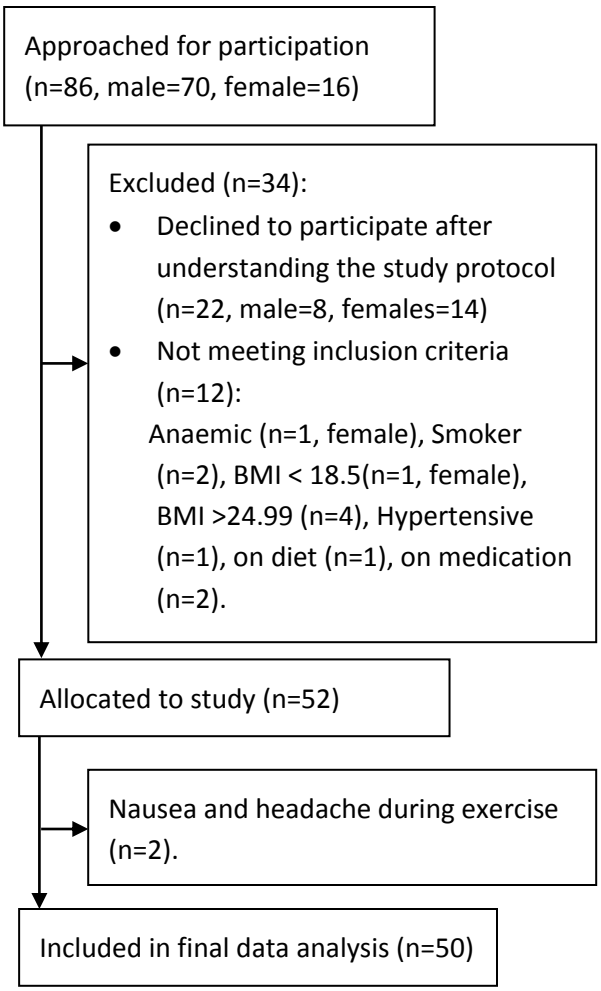
Table 3: Comparison of recovery time of cardiovascular parameters following moderate isotonic exercise in case of relaxation with no music and relaxation with fast music.

	Post-exercise recovery time (in minutes)		t value	P value
	No music (mean±SD)	Fast music (mean±SD)		
SBP	10.4 ± 2.4	8.4 ± 2.0	4.53	< 0.05
DBP	7.9 ± 3.0	6.5 ± 2.9	2.37	< 0.05
Pulse rate	11.0 ± 2.7	8.2 ± 2.3	5.58	< 0.05

Table 4: Comparison of recovery time of cardiovascular parameters following moderate isotonic exercise in case of relaxation with slow music and relaxation with fast music.

	Post-exercise recovery time (in minutes)		t value	P value
	Slow music (mean±SD)	Fast music (mean±SD)		
SBP	7.1 ± 2.1	8.4 ± 2.0	3.17	< 0.05
DBP	5.2 ± 2.9	6.5 ± 2.9	2.24	< 0.05
Pulse rate	7.3 ± 2.1	8.2 ± 2.3	2.04	< 0.05

Figure 1: CONSORT diagram showing allocation of participants to the study.



Discussion:

The present study was planned to investigate whether the tempo of music influences post-exercise recovery time of blood pressure and pulse rate. The main finding of our study was that blood pressure and pulse rate recovered to baseline faster when post-exercise relaxation was accompanied by music. Also, slow musical tempo caused earlier recovery of post-exercise blood pressure and pulse rate as compared to fast musical tempo. Present study is consistent with the studies, which proposed that music has the potential to reduce pulse rate and blood pressure.[18,19] However, a latest research found that music was similar to silence in affecting heart rate recovery, salivary cortisol and pulse rate.[20]

Music may influence one's responses to exercise in different ways. Music reduces sympathetic nervous control and therefore heart and respiration rates, metabolism, oxygen consumption, and muscle tension.[21] It diminishes mental and muscular tension thereby lowering sympathetic stimulation.[22] Music causes distraction that lessens physiological awareness and decreases perceived exertion.[14] Additionally, plasma catecholamine is also lowered when relaxation is accompanied by music.[23,24] Probably these factors together caused faster recovery of blood pressure and pulse rate to baseline, when relaxation was accompanied by music in our study.

Slow music reduces the arousal and induces a state of relaxation, especially during a pause or slower rhythm.[25] Listening to slow rhythm music decreases, while listening to fast rhythm music increases the plasma norepinephrine level.[23] These effects of slow relaxing music may be attributed to the diminished muscular tension,[26] reduction in cardiac pressure,[27] decline in plasma norepinephrine,[13] reduction in factors associated with pain and discomfort[13] and/or the nervous effects of slower musical tempo which are not yet precisely understood. Whereas, the effects of fast musical tempo might be related to the increase in plasma cortisol levels,[28] increase in plasma norepinephrine,[13] and the nervous effects of faster musical tempo. Besides, co-ordinated minute movements of different limbs with musical tempo and rhythm might have affected these results.[29]

Limitations and directions for future research:
In our study, participants were subjected to moderate isotonic exercise and. The results of our study may not be applicable in mild and severe isotonic exercise or in isometric exercise. Similar studies may be conducted in different types of exercise settings. Also, we applied music after the exercise was over. Application of music prior to or during exercise may also be investigated.

We measured pulse rate and blood pressure manually. Use of automated instruments may generate different results. We could not fully control the background noise which could have been a distracting factor. Use of a sound proof study room could have improved the validity of findings.

Although participants' socio-cultural background was taken into consideration while selecting music, individual musical preferences were not taken into account. Moreover, the musical tempo was not homogeneous throughout and participants were not enquired whether they found the music played to be distractive or not. Further studies may incorporate homogenous music and music as a tool for distraction.

As female students opted out of study, gender related differences in effect of musical tempo on post-exercise recovery could not be investigated. Further research may be directed towards this gender factor.

Conclusion: The present study supports the view that physiological parameters recover faster after a bout of physical exercise when a person is allowed to relax with music. Further, slow relaxing musical tempo causes earlier recovery of cardiovascular parameters following exercise than fast musical tempo. These findings can have important implications in exercise and sports physiology and cardiopulmonary physiotherapy.

Acknowledgment: The authors are grateful to the medical students who participated as volunteers in the study.

References:

1. Orem J and Trotter RH. Behavioural control of breathing. Physiology. 1994; 9:228-32.
2. Shea SA. Behavioural and arousal-related influences on breathing in humans. Experimental Physiology. 1996; 81:1-26.
3. Lee D, Henderson A and Shum D. The effect of music on pre-procedure anxiety in Hong Kong Chinese day patients. Journal of clinical nursing. 2004; 13 (3):297-303.
4. White JM. Effects of relaxing music on cardiac autonomic balance and anxiety after acute myocardial infarction. American Journal of Critical Care. 1999; 8:220-30.
5. Birnbaum L, Boone T and Huschle B. Cardiovascular responses to music tempo during steady-state exercise. Journal of Exercise Physiology online. 2009; 12 (1): 50-7.
6. Karageorghis CI and Priest DL. Music in the exercise domain: a review and synthesis (Part II). International Review of Sport and Exercise Psychology. 2012; 5 (1):67-84.
7. Crust L. Carry-over effects of music in an isometric muscular endurance task. Perceptual and Motor Skills. 2004; 98:985-91.
8. Szmedra L and Bacharach DW. Effect of music on perceived exertion, plasma lactate, nor epinephrine and cardiovascular hemodynamic during treadmill running. International Journal of Sports Medicine. 1998; 19:32-7.
9. Tenenbaum G et al. The effect of music type on running perseverance and coping with effort sensations. Psychology of Sports and Exercise. 2004; 5:89-109.
10. Augustin P and Hains AA. Effect of music in ambulatory surgery patients' preoperative anxiety. AORN Journal. 1996; 63 (4):753-8.
11. Urakawa and Yokoyama. Music can enhance exercise-induced sympathetic dominancy assessed by heart rate variability. The Tohoku Journal of Experimental Medicine. 2005; 206:213-8.
12. Brownley KA, McMurray RG and Hackney AC. Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. International Journal of Psychophysiology. 1995; 19 (3):193-201.
13. Copeland BL and Franks BD. Effects of types and intensities of background music on

treadmill endurance. The Journal of Sports Medicine and Physical Fitness. 1991; 51(1):100-3.
14. Szabo A, Small A and Leigh M. The effects of slow and fast-rhythm classical music on progressive cycling to voluntary exhaustion. Journal of Sports Medicine and Physical Fitness. 1999; 39:220-5.
15. Schulz KF, Altman DG and Moher D. for the CONSORT Group. (2010) CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. Ann Int Med. 2010; 152.
16. Garrow JS and Webster JD. Quetelet's index (W/H2) as a measure of fatness. International Journal of Obesity and Related Metabolic Disorders. 1985; 9 (2):147-53.
17. http://www.wma.net/en/30publications/10policies/b3/index.html
18. Edworthy J and Waring H. The effects of music tempo and loudness level on treadmill exercise. Ergonomics. 2006; 49 (15):1597-1610.
19. Siritunga S, Wijewardena K, Ekanayaka R and Mudunkotuwa P. Effect of music on blood pressure, pulse rate and respiratory rate of asymptomatic individuals: A randomized controlled trial. Health. 2013; 5 (4A):59-64.
20. Tan F, Tengah A, Nee LY and Fredericks S. A study of the effect of relaxing music on heart rate recovery after exercise among healthy students. Complimentary therapies in clinical practice. 2014; 20 (2):114-7.
21. Kachanathu SJ, Verma SK and Khanna GL. The effect of music therapy and meditation on sports performance in professional shooters. International Journal of Research in Ayurveda and Pharmacy. 2012; 3 (1):133-6.
22. Schwartz SE, Fernhall B and Plowman SA. Effects of music on exercise performance. Journal of Cardiopulmonary Rehabilitation. 1990; 10:312-6.
23. Yamamoto T et al. Effects of pre-exercise listening to slow and fast rhythm music on supra-maximal cycle performance and selected metabolic variables. Archives of Physiology and Biochemistry. 2003; 111 (3):211-4.
24. Mockel M et al. Immediate physiological responses of healthy volunteers to different types of music: cardiovascular, hormonal and mental changes. European Journal of Applied Physiology and Occupational Physiology. 1994; 68 (6):451–9.
25. Thornby MA, Haas F and Axen K. Effect of distractive auditory-stimuli on exercise tolerance in patients with COPD. Chest. 1995; 197:1213-7.
26. Sears W. The effect of music on muscle tonus. In E.G. Gaston. (Ed), 1975; music therapy (pp. 199-205). Lawrence, KS: Allen Press.
27. Carla H and Rachel K. Effect of music on cardiovascular performance during on treadmill endurance. Journal of music and imagery of physical Fitness. 1996; 31:100-3.
28. Lorch CA, Lorch V, Diefendorf A and Earl PW. Effect of simulative and sedative music on systolic blood pressure, heart rate, and respiratory rate in premature infants. Journal of music therapy. 1994; 31 (2):105-18.
29. Karageorghis C, Terry P, Lane A, Bishop D and Preist D. The BASES Expert Statement on the Use of Music in Exercise. The Sport and Exercise Scientist. 2011; 28:19.

Disclosure: No conflicts of interest, financial, or otherwise are declared by authors