

# Effect of music on heart rate variability and stress in medical students

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## Abstract

**Background and Aim:** The stress in medical students is associated with concerns about mastering knowledge, personal endurance and lack of time for other activities. This study had been planned to assess the effect of music on frequency domain measures of heart rate variability (HRV) as markers of autonomic functions and the stress level in medical students.

**Methods:** Both male and female medical students aged between 17-20 years were randomly divided into two groups: Music ( $n = 39$ ) and nonmusic ( $n = 41$ ) groups. The participants in music group were asked to listen, a preselected classical music (Rag bilahari) for 30 minutes daily for one month. The frequency domain parameters of HRV were assessed in both the groups and the stress level was assessed by perceived stress scale in the music group.

**Results:** The music group demonstrated a significant decrease in heart rate ( $P < 0.0001$ ), mean arterial pressure ( $P < 0.02$ ) and rate pressure product ( $P < 0.01$ ) compared with non-music group. The music group also showed a significant increase in the total power ( $P < 0.0001$ ) and high frequency normalized unit ( $P < 0.0001$ ) and a significant decrease in low frequency normalized unit ( $P < 0.0001$ ) and low frequency/high frequency ratio, the most reliable marker of sympathovagal balance ( $P < 0.0001$ ) compared with nonmusic group. The stress level in music group was reduced significantly ( $P < 0.0001$ ) after listening to music.

**Conclusion:** The study shows the possibility that classical music may have a beneficial effect on HRV and reduces the stress level in medical students, as the autonomic balance shifts towards the improvement of parasympathetic tone.

**Key words:** Autonomic balance, heart rate variability, music, stress

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## INTRODUCTION

Autonomic nervous system (ANS) regulates the function of various systems in human body to maintain homeostasis and adaptation to stressful situations. The autonomic functions are not normal even in healthy subjects, because of routine stress, which has become an integral part of the modern lifestyle. The education in medical colleges is recognized as stressful, that can exert negative effect on physical health of students.<sup>[1]</sup> Studies on stress among medical students have identified three

main reasons for stress such as academic pressures, social issues and financial problems.<sup>[2]</sup> The factors causing stress vary with the time spent in medical training, concern about workload and personal competence, which seems particularly more pronounced in the first year.<sup>[3,4]</sup>

Depression and anxiety are associated with concerns about mastering knowledge, personal endurance and lack of time for other activities.<sup>[5]</sup> Hence, it is desirable to know the status of sympathovagal balance (SVB, marker of autonomic functions) in medical students. Analysis of heart rate variability (HRV) has emerged as a simple, non-invasive and reliable method to study the SVB. Therefore, this study was conducted to assess whether classical music had any beneficial effect on HRV and thereby reduce the stress level in medical students.

## MATERIALS AND METHODS

This interventional study was conducted among

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80 medical students aged between 17 and 20 years in Sri Venkateshwaraa Medical College Hospital and Research Centre in Puducherry. The students were randomly divided by simple randomization method into two groups viz., music group ( $n = 39$ ) and nonmusic group ( $n = 41$ ). A short medical history from the students revealed that they were not on any medication for anxiety, depression and systemic illness; and they had no aversion towards music.

The ethical approval for the study was obtained from the Institutional Ethics Committee. Informed consent was obtained from the medical students before the commencement of the study. The participants in the music group were asked to listen to a preselected classical music (Rag Bilahari)<sup>[6]</sup> for 30 minutes daily for one month in sitting posture with the aid of earphones. An electrocardiogram (ECG) record (5 minutes), using PHYSIOPAC- PP<sub>4</sub> software (MEDICAID SYSTEMS, Chandigarh) was obtained prior to music intervention in both the groups. The basal cardiovascular parameters such as heart rate (HR), blood pressure and the frequency domain parameters of HRV such as total power (TP), low frequency normalized unit (LFnu), high frequency normalized unit (HFnu) and low frequency-high frequency (LF/HF) ratio, were measured in both music and non-music groups. The stress level was assessed using perceived stress scale (PSS) in the music group alone before and after music intervention.<sup>[7]</sup> The PSS scale is a widely used psychological instrument to measure perception of stress, in which subjects have to answer 10 questions (items) related to feelings and thoughts experienced as stress during the last one month. The score for each item ranges from 0 = Never, 1 = Almost Never, 2 = Sometimes, 3 = Fairly Often, 4 = Very Often. Reverse coding is done for items 4,5,7 and 8. The total score ranges from 0 to 40. The subjects with high PSS score are considered to have stress.<sup>[7]</sup>

### Statistical analysis of data

The data were expressed as mean  $\pm$  SD. To test the significance, unpaired 't' test (using SPSS version 17) and Pearson's correlation analysis were applied. The statistical probability  $P < 0.05$  was considered to be significant.

## RESULTS

The baseline characteristics of the subjects were compared between the two groups [Table 1]. As evident from table 1, the music and nonmusic groups did not differ across their demographics such as age, body mass index (BMI) and basal cardiovascular parameters, which indicates an effective randomization.

The music group showed a significant decrease in

HR ( $P < 0.0001$ ), mean arterial pressure ( $P < 0.02$ ) and rate pressure product (RPP) ( $P < 0.01$ ) compared with nonmusic group. The TP which is the marker of the magnitude of HRV and HFnu were significantly increased ( $P < 0.0001$ ) in the music group compared with nonmusic group. But the LFnu was decreased significantly ( $P < 0.0001$ ) in the music group compared with nonmusic group. Furthermore, the LF/HF ratio was significantly decreased ( $P < 0.0001$ ) depicting the decreased sympathetic activity and increased parasympathetic activity in the music group compared with nonmusic group [Table 2].

Figure 1 depicts the effect of music on stress level in the music group before and after music intervention. There was a significant decrease ( $P < 0.0001$ ) in the mean stress score after the music therapy in the music group. The LF-HF ratio was not significantly correlated with TP and stress score in both the music and nonmusic groups [Table 3].

## DISCUSSION

The present study was undertaken to investigate

**Table 1:** Age, BMI and basal cardiovascular parameters of the subjects in music and nonmusic groups

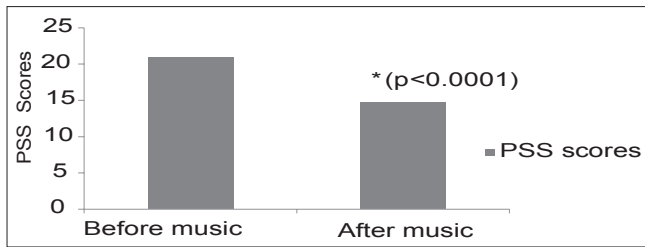
Parameters	Music group (n=39)	Nonmusic group (n=41)	P value
Age (years)	19.15 $\pm$ 0.51	19.02 $\pm$ 0.63	0.315
BMI (kg/m <sup>2</sup> )	21.4 $\pm$ 4.13	22.6 $\pm$ 4.49	0.218
HR (bpm)	67.96 $\pm$ 8.97	70.03 $\pm$ 11.18	0.365
SBP (mmHg)	122 $\pm$ 8.2	124 $\pm$ 6.4	0.296
DBP (mmHg)	78 $\pm$ 4.6	80 $\pm$ 6.8	0.110
RPP (mmHg)	83.3 $\pm$ 15.2	86.72 $\pm$ 11.2	0.253

BMI: Body mass index, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RPP: Rate pressure product. Expressed in mean $\pm$ SD. Statistical analysis was done by students' unpaired 't' test.  $P < 0.05$  was considered statistically significant

**Table 2:** Cardiovascular parameters and frequency domain indices of HRV in both the music and nonmusic groups following music therapy

Parameters	Music group (n=39)	Nonmusic group (n=41)	P value
HR (bpm)	59.3 $\pm$ 7.21	70.6 $\pm$ 13.62	0.0001
MAP (mmHg)	88.2 $\pm$ 9.2	93.6 $\pm$ 10.6	0.0200
RPP (mmHg)	79.6 $\pm$ 10.9	85.1 $\pm$ 9.3	0.0100
TP (ms <sup>2</sup> )	2058.9 $\pm$ 753.39	1572.6 $\pm$ 473.82	0.0001
LFnu	53.61 $\pm$ 13.03	68.45 $\pm$ 2.95	0.0001
HFnu	46.38 $\pm$ 13.01	34.55 $\pm$ 2.91	0.0001
LF/HF ratio	1.15 $\pm$ 0.51	1.98 $\pm$ 1.14	0.0001

HR: Heart rate, MAP: Mean arterial pressure, RPP: Rate pressure product, TP: Total power, LFnu: Low frequency in normalized units, HFnu: High frequency in normalized units, LF/HF ratio: Low frequency/high frequency ratio. Expressed in mean $\pm$ SD. Statistical analysis was done by students' unpaired 't' test.  $P$  value $<$ 0.05 was considered statistically significant



**Figure 1:** Effect of music on stress level in music group. PSS: Perceived stress score

**Table 3:** Correlation of LF-HF ratio with total power and stress score in both music and nonmusic groups

Days	Music group (n=39)		Nonmusic group (n=41)	
	r	P	r	P
Total power	-0.089	0.588	0.142	0.377
Stress score	0.181	0.271	-0.017	0.918

Data are expressed as mean±SD. Statistical analysis was done by Pearson's correlation.  $P < 0.05$  was considered statistically significant

whether listening to classical music has any impact on improving the HRV and reduces the stress in medical students. The TP is a short-term estimate of power spectral density in the range of frequencies between 0 and 0.4Hz. The TP and HFnu, marker of vagal power of HRV were increased in the music group following one month of intervention, which reflects the improvement in HRV and vagal potency of cardiac modulation [Table 2]. The HR was found to be decreased in the music group compared with nonmusic group, which could be attributed to the increased TP of HRV. The RPP, which is an index of myocardial work stress, was also decreased in the music group compared with nonmusic group [Table 2].

The results of our study has shown that LF/HF ratio, which indicates the overall balance between the sympathetic and parasympathetic nervous systems was significantly decreased in the music group [Table 2]. This shows the possibility of the autonomic balance shifting towards the improvement of parasympathetic tone. The results of our study are in agreement with the study of Lee *et al.*<sup>[8]</sup> on effect of music on preoperative patient's anxiety, where the music group showed a significant reduction in low-frequency power of HRV and LF/HF ratio and a significant increase in high frequency power of HRV compared with the control group. Lee *et al.* had also reported that listening to music could significantly lower the anxiety levels of patients before surgery. A study on the effects of musical auditory stimulation on cardiac autonomic regulation in healthy women had shown that the acute exposure to heavy metal music reduced the sympathetic activity.<sup>[9]</sup> On the contrary, Mikutta *et al.* have studied the relation between ANS activity and listening to a complex musical piece and reported increased LF/HF ratio and decreased HF component of HRV

during music listening.<sup>[10]</sup>

A previous study on the effects of music therapy on subjective sensations and HRV in treated cancer survivors had shown that music therapy might be clinically useful for promoting relaxation sensation and increasing parasympathetic activity in treated cancer survivors.<sup>[11]</sup> The enhanced parasympathetic activity seen in the music group could be attributed to the reduced levels of plasma cytokine and catecholamines by music therapy.<sup>[11]</sup> In another study, Chuang *et al.* have reported that after a 4-week period of music therapy, HF component of HRV had significantly increased but no change was seen in LF/HF ratio of HRV in anthracycline-treated breast cancer patients.<sup>[12]</sup> These results support the findings of our study, where the sympathetic activity had significantly decreased, as evidenced by the decrease in LFnu of the HRV in the music group. The parasympathetic activity or the vagal modulation of cardiac function was enhanced, as the HFnu were significantly increased in the music group. The results of our study goes in agreement with the recent report of Pal *et al.* who have clearly depicted that TP and HF power were increased following a short-term relaxation therapy (shavasana with music therapy) and thus demonstrated the improvement of autonomic balance by the short-term relaxation therapy.<sup>[13]</sup> These effects are further supported by a study of Lin *et al.*, where he had provided an evidence of increased parasympathetic tone in children with epileptic discharges during music exposure.<sup>[14]</sup>

Li and Dong have reported that a preoperative music intervention can reduce anxiety and pain in women undergoing cesarean delivery.<sup>[15]</sup> In their study, the LF component of HRV and LF/HF ratio were decreased, whereas HF component of HRV was increased and mean anxiety score was decreased after music intervention. Our results are also supported by a study by Lee *et al.*, where LF component of HRV, LF/HF ratio and visual analog scale score were decreased in preoperative patients after listening to music.<sup>[16]</sup> Recently, Trappe reported that in intensive care medicine patients, the benefit on health was found when they heard classical music, whereas heavy metal music or techno music was not only ineffective but possibly dangerous and could lead to stress or arrhythmias.<sup>[17]</sup>

The significant decrease in stress levels, which was assessed by PSS in the music group are in agreement with a previous study, where the preoperative patients who listened to music demonstrated significant reduction in visual analog scale scores.<sup>[8]</sup> There are also evidences that music therapy improved the symptoms of depression and increase in HRV in demented patients.<sup>[18]</sup> Chang *et al.* have studied the psychophysiological responses to sedative music in patients awaiting cardiac catheterization and reported that

music listening resulted in a significant decrease in anxiety scores in these patients.<sup>[19]</sup>

The beneficial effects of the music therapy on elderly patients with cerebrovascular disease and dementia has been studied by Okada *et al.* and they have reported that the music therapy enhanced parasympathetic activities and decreased the frequency of congestive heart failure in these patients, as evidenced by the reduced levels of plasma cytokine and catecholamine levels in their studies.<sup>[20]</sup> Bringman *et al.* have shown that relaxing music significantly decreases the anxiety in preoperative patients.<sup>[6]</sup> Koelsch and Siebel have reported that the music can be used to re-establish neural activity in hippocampus and stimulate neurogenesis in depressive patients.<sup>[21]</sup> A randomized crossover study done in mechanically ventilated patients at the intensive care unit by Beaulieu-Boire *et al.* have shown that there was a rapid reduction of blood cortisol after listening to music.<sup>[22]</sup> Chen *et al.* also have reported that music therapy had decreased the anxiety level and systolic blood pressure in oncology patients, who received the music intervention prior to radiotherapy.<sup>[23]</sup> The absence of correlation of LF-HF ratio with TP and stress score in both the music and nonmusic groups could be due to the lesser sample size or lesser duration of music therapy. Therefore, further studies should be conducted in larger sample size and by increasing the duration of music therapy to assess the details of the effect of music therapy on stress score.

### Limitations of the study

The limitations of the study would include lesser sample size, and the estimation of stress hormone (cortisol), plasma cytokines and catecholamines have not been done.

## CONCLUSION

Music therapy is a complementary and alternate medicine. In the present study, music therapy could reduce the stress levels in the medical students. Therefore, this study provides the preliminary evidence that listening to classical music could be an effective method of relaxation, as indicated by a shift of the autonomic balance towards the parasympathetic activity among medical students.

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