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Mindfulness Meditation: An Interventional Tool to Attenuate Cardiovascular Reactivity to Mental Stress in Undergraduate Medical Students

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Abstract

Objectives- We studied the effect of a single bout of mindfulness meditation on cardiovascular reactivity (CVR) to acute mental stress to devise a method to assess and attenuate mental stress among Indian undergraduate medical students.

Material and Methods- This was a pre- and post-comparative interventional study conducted in thirty healthy male under- graduate medical students. Anthropometric measurements, Heart rate and Blood pressure readings were recorded during the assessment. These healthy male undergraduate medical students were selected based on age criteria, history of prior exposure to mindfulness meditation. Data of Pre-mindfulness meditation reactivity (T1-R1) and Post mindfulness meditation reactivity (T2-R2) were compared and analysed for significance to draw a conclusion.

Results- Systolic blood pressure reactivity when compared between Pre-Mindfulness Meditation reactivity (T1-R1) and Post Mindfulness Meditation reactivity (T2-R2) showed statistically significant results with p value 0.01, with no significance seen between diastolic blood pressure reactivity and Heart rate reactivity.

Conclusion - A significant difference in systolic blood pressure reactivity after mindfulness meditation, points towards the role of mindfulness meditation in decreasing sympathetic flow as opposed to its increased sympathetic response seen during mental stress without mindfulness meditation intervention

Index Terms— *Mindfulness Meditation, Medical students, Cardiovascular reactivity, Mental stress, Undergraduate students*

INTRODUCTION

The history of meditation practice in India could be traced back to 5000 years ago, as evident from the text Yoga Sutra Patanjali written roughly around 5000 BCE by the great sage Patanjali, he defined Meditation/yoga as 'Stillness of fluctuations of mind'[1]. The great sage Patanjali is the pioneer of the Yoga system which is one of the 06 systems of Native Indian philosophy called 'Shad Darshanas'. He complied Sutras (aphorisms) about the essential features and principles of Yoga with various Yoga techniques, including the different meditation techniques that were in vogue in ancient India, this compilation is the very well-known the Yoga Sutra Patanjali. Mindfulness is being in an attentive state and being aware of what is taking place in the present movement[2]. Mindfulness mediation deals with allowing thoughts to arise with a dispassionate examination, and subsequently letting them fade away, without emotionally reacting to any of it[3], it consists of techniques of focusing attention in a non-analytical way aiding in the non-active management of discursive, persistent, or obsessive thoughts. Meta-analysis of the studies about the mindfulness-based approach for the management of mental stress has been found to produce satisfactory and significant results in relation to the reduction of stress, anxiety, and depression[4,5].

The father of stress research Hans Selye defined stress as a "nonspecific physiological response to any threat that the body encounters" [6], and the WHO website defined stress as a "state of worry or mental tension caused by difficult situation". Mental stress is a form of stress that occurs because of events in one's external or internal environment, resulting in psychological anguish and anxiety[7] and it is also accompanied by the exaggerated physiological response leading to alteration in the homeostasis[8,9].

Mental stress affects an individual's concentration, cognition, and ability to make personal as well as professional decisions[10] and it has also been found to affect the autonomic functions[6], which act as risk factors for non- communicable diseases such as Hypertension, Diabetes mellitus and CAD[11,12].

Undergraduate medical students undergo mental stress right from the movement of the selection process to getting enrolled into a medical college which apart from being difficult [13] is also intricate. Once enrolled, the medical college education is known to be daunting and challenging amounting to higher mental stress experienced by the students till the degree is obtained[14,15] followed by which further preparations for joining graduate speciality courses also results in a continuation of stress which would only increase further when enrolled for higher speciality training and eventually one starts to practice as Health care professional/ Qualified registered medical doctor. The ability to handle stress generated during medical college education needs assistance[16] or training or mental preparedness as medical professionals live a greater part of their life being in Mental stress. It would affect doctors professionally too since they are expected to be at optimum conditions in emotional, physical, and mental state for better delivery of Health care services and since medical professionals themselves believe the same as they consider their profession to be Nobel[10]

Among a few of the main systems documented to be affected by mental stress are the hypothalamic- pituitary-adrenal (HPA)axis and the Autonomic nervous system[17]. The parasympathetic nervous system tries to counteract the changes to stress occurring due to the altered Sympathetic nervous system and HPA axis and has a main role in adjusting to changing variables during stressful conditions[18,19]. Endocrine, nervous system and immunity interact with each other to counteract the changes as a bodily response to stress, during which it also alters cardiovascular response too[20]

Cardiovascular reactivity is defined as "change in Heart rate and Blood pressure indicating the alteration in cardiovascular function". Stress seems to have a direct correlation with increased blood pressure due to initial nervous and followed by sympathetic system activation within minutes of exposure to stress[21,22] and it has also been documented that stress can delay blood pressure recovery to normal thus alter- ing homeostasis. Mental stress initially increases the heart rate and blood pressure which if not corrected will lead to further activation of the sympathetic nervous system, which in turn will cause vasoconstriction leading to further

rise in blood pressure, deranged clotting profiles, altered lipid levels, which will lead to vascular changes and it further accentuate the probability of developing the arrhythmias or myocardial infarction[23]

With this study, we tried to answer for the lacunae about the impact of a single bout of mindfulness meditation on Cardiovascular reactivity to mental stress in undergraduate medical students.

METHODOLOGY

This was a before and after comparative interventional study, conducted over 12 months in the Department of Physiology, Maulana Azad Medical College, New Delhi, India after obtaining ethical clearance from the Institutional ethics committee along with permission from the Dean of Maulana Azad Medical College, New Delhi, India. The Study participants were normal healthy male undergraduate medical students who have passed 1st prof exams in the age group of 18-25years, with no previous exposure to mindfulness meditation among those who have a habit of smoking and alcohol intake, those who indulge in regular physical exercise and Individuals with parental history of Hypertension and Diabetes Mellitus are excluded. After informed written consent, thirty healthy male undergraduate medical students of Maulana Azad Medical College, New Delhi, India in the mean age group of **21.50±1.10 years** with a mean BMI **of 22.63±1.64 kg/m2** were enrolled.

Recording of parameters- After study participants provided informed consent, research parameters were recorded. They were evaluated in two stages: preliminary screening and analysis of research parameters. During the first stage, participants basic information such as their name, age, residence, and any relevant sickness or treatment history (based on inclusion and exclusion criteria) were recorded, followed by study relevant personal history (e.g. smoking, drinking habits) and parental history. During this stage, the study participants were explained about the mindfulness meditation session, as well as the procedure for recording heart rate and blood pressure during the research session at the ANS lab in the Department of Physiology at Maulana Azad Medical College in New Delhi, India, end of this stage I, we informed them to report to the ANS lab on the allocated day for the stage of research parameter assessment.

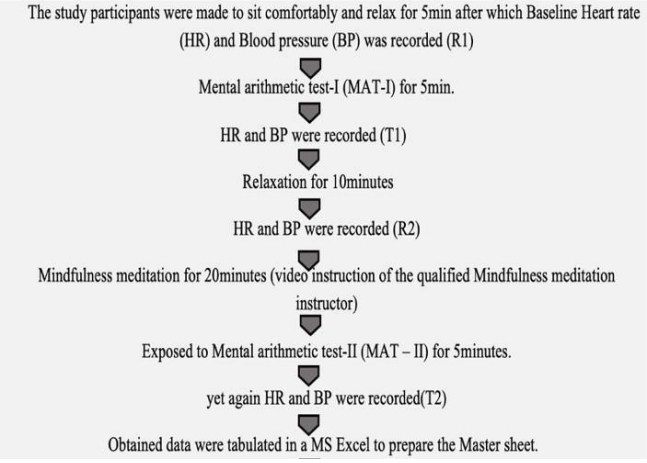


Figure 1 Flowchart of Assessment of Research-related data

They have also been told not to consume caffeinated beverages, such as tea or coffee, for at least 4-6 hours before their research visit. During the next step, a brief history of recent illness is taken before the session, and once it has been examined, the assessment of research-related data was done according to the flowchart below. And at the end (T1-R1) and (T2-R2) were analysed.

Statistical Analysis for Meditation Study

Let σ_1 be the standard deviation before meditation and σ_2 be the standard deviation after meditation.

Sample Size Formula

$$n = (\sigma_1 + \sigma_2)^2 \frac{(z_{1-\alpha/2} + z_{1-\beta})^2}{(m_1 - m_2)^2}$$

Figure 2 – Sample size formula

For a confidence level of 95%, the critical value is:

$$Z_{(1-\frac{\alpha}{2})} = 1.96$$

For a power of 80%, the critical value is:

$$Z_{(1-\beta)} = 0.842$$

Where: α = type I error

β = type II error

m1 = mean of the sample before Meditation
m2= mean of the sample after Meditation

A sample size of 116 was calculated as per the formula above with a confidence level of 95 percent and a power of 80 percent, based on a 2013 study conducted on the effect of mindfulness meditation on well-being. Considering the time constraint and data of similar studies that have taken a sample size of about 30–40, a sample size of 30 study participants has been preferred. Accordingly, 30 study participants were enrolled after providing informed written consent

TEST PROCEDURES AND PARAMETER

Mental arithmetic test (MAT) for 5 minutes:

Mental Arithmetic Test I (MAT-I):

Subjects were explained about the test procedure.

- They were then asked to serially subtract 17 from a four-digit prime number (2479) in their mind
- They were instructed to say the answer to keep in pace with a metronome that was making a sound at every 30 seconds; this was continued for 5 minutes.

Mental Arithmetic Test-II (MAT-II):

Subjects were explained about the test procedure.

- They were then asked to serially subtract 19 from a four-digit prime number (3579) in their minds.
- They were instructed to say the answer to keep in pace with a metronome that was making a sound every 30 seconds; this was continued for 5 minutes.

Cardiovascular reactivity (CVR):

Cardiovascular reactivity is the difference between BP or HR after stress minus the basal value[24]

Instruments used:

Digital BP Apparatus.

Intervention Used:

Single bout mindfulness meditation of 20 minutes duration.

STATISTICAL ANALYSIS

The data recorded was submitted for statistical analysis using the Statistical Package for the Social Sciences (SPSS, software version 25). The statistical data was entered into the proforma, and accordingly, a paired t-test was applied for pre-mindfulness meditation reactivity (T1-R1) and post-mindfulness meditation reactivity (T2-R2) comparison. A p-value <0.05 was considered significant.

RESULTS

Thirty undergraduate medical students were enrolled as study participants to study their cardiovascular reactivity, before and after mindfulness meditation. The various data are listed below.

Demographic and Anthropometric Data

The mean age of the study participants, i.e., undergraduate medical students (n = 30), was 21.50 ± 1.10 years, while the mean BMI of the students was 22.63 ± 1.64 kg/m^2.

Cardiovascular Reactivity (CVR)

The readings of blood pressure (BP) and heart rate (HR) were taken at rest 1, rest 2, before and after mindfulness meditation intervention post mental stress. The difference in their reactivity was analyzed for significance.

Systolic Blood Pressure (SBP) Reactivity

As per the data in Table 3, difference between (T1-R1) and (T2-R2) reactivity of SBP found to be statistically significant with p value 0.01. This indicates significant decrease in the systolic blood pressure after mindfulness meditation intervention post mental stress.

Diastolic Blood Pressure (DBP) Reactivity

Table 3 shows, p value of the difference in diastolic blood pressure reactivity between (T1-R1) and (T2-R2) to be 0.37, suggesting decrease DBP after meditation was insignificant.

HR (bpm) Reactivity

Table 3 shows, difference in heart rate reactivity between (T1-R1) and (T2-R2) to be statistically in-significant (p=0.26), indicating no significant change in heart rate after meditation intervention.

Summary: Significant difference seen in systolic blood pressure reactivity between before meditation and after meditation

DISCUSSION

With this study, we evaluated the hypothesis that a single bout of mindfulness meditation influences cardiovascular reactivity to mental stress in study participants. The data obtained was analysed for correlation and significant influence of mindfulness meditation on cardiovascular reactivity after exposure to mental stress. The study participants were in the mean age group of 21.50±1.10 years with a BMI range of 22.63±1.64 kg/m2. Tables 1 and 2 show a shift towards sympathetic dominance from R1 to T1 and R2 to T2, characterized by increased systolic and diastolic blood pressure along with a higher heart rate on exposure to acute stress. This finding also points towards increased activation of the sympathetic system as a stress response [11,28]. A significant increase in systolic blood pressure (129±11.43) on exposure to acute mental stress before the intervention of meditation indicates that acute exposure to mental stress significantly increases systolic blood pressure. This result upholds the findings of a 2011 study by Carroll D et al., about increased systolic blood pressure reactions to acute mental stress. However, after the intervention, when participants were exposed to mental stress, the systolic blood pressure (126±11.36) has reduced comparatively. When pre- and post-meditation reactivities were evaluated, systolic blood pressure reactivity showed statistically significant findings with $p<0.01$. These findings and evaluations showed the effect of mindfulness meditation on reducing sympathetic activity, as evident by reduced systolic blood pressure values. Systolic blood pressure has a positive correlation with acute stress [29] and increased sympathetic flow [11]. These results indicated role of mindfulness meditation in modulating the altered sympathetic flow to mental stress.

CONCLUSION

The intervention of twenty minutes of single bouts of mindfulness meditation in undergraduate medical students before exposure to acute mental stress showed a decreased cardiovascular reactivity, with a significant decrease in systolic blood pressure reactivity when compared between before and after meditation reactivities which indicates the active role of the Mindfulness meditation in decreasing cardiovascular reactivity on exposure to acute mental stress.

LIMITATIONS

In the present study, a single bout of mindfulness meditation of 20-minute duration was used; the duration of meditation

RECOMMENDATIONS

Future studies with both healthy male and female subjects to evaluate the difference if any among them in cardiovascular reactivity indicated by findings in BP and Heart rate readings with an increased duration of single bout mindfulness meditation may be done.

TABLE 1 BEFORE MINDFULNESS MEDITATION REACTIVITY **(T1-R1)**

	REST 1-(R1)	TEST 1-(T1)	T1-R1
SBP (mmhg)	119±9.71	129±11.43	**10.30±7.61**
DBP (mmhg)	72±6.87	78±10.58	5.87±8.27
HR (bpm)	75±10.93	80±13.43	5.47±6.90

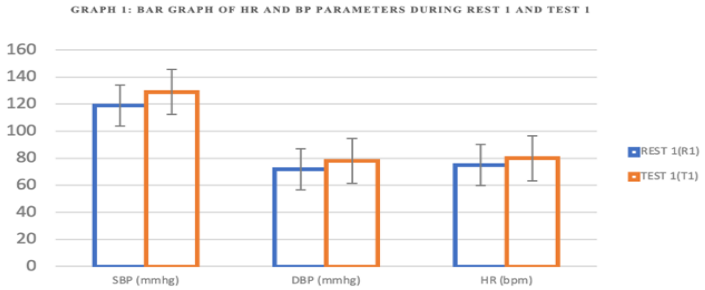
TABLE 2 AFTER MINDFULNESS MEDITATION REACTIVITY **(T2-R2)**

	REST 2(R2)	TEST 2(T2)	T2-R2
SBP (mmhg)	119±10.80	126±11.36	**6.60±8.65**
DBP (mmhg)	73±7.64	77±8.07	4.53±5.82
HR (bpm)	72±10.19	77±11.68	0.26

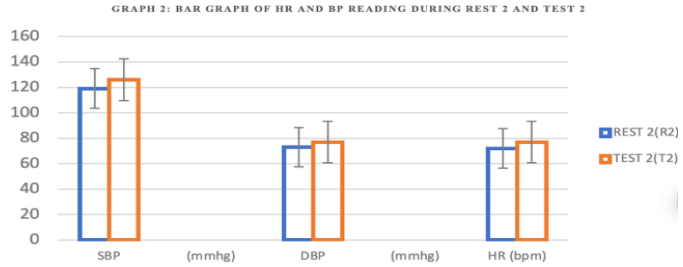
TABLE 3 BEFORE AND AFTER MEDITATION REACTIVITIES **(T1-R1) - (T2-R2)**

	T1-R1	T2-R2	P value
SBP Reactivity	**10.30±7.61**	**6.60±8.65**	**0.01** $
DBP Reactivity	5.87±8.27	4.53±5.82	0.37
HR Reactivity	5.47±6.90	4.17±7.99	0.26

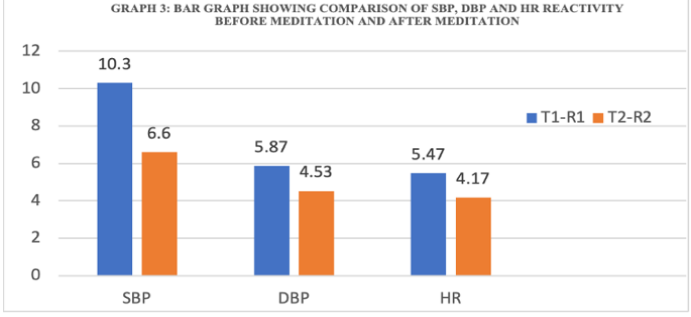
GRAPH 1: BAR GRAPH OF HR AND BP PARAMETERS DURING REST 1 AND TEST 1



GRAPH 2: BAR GRAPH OF HR AND BP READING DURING REST 2 AND TEST 2



GRAPH 3: BAR GRAPH SHOWING COMPARISON OF SBP, DBP AND HR REACTIVITY BEFORE MEDITATION AND AFTER MEDITATION



would have been increased to 40 minutes, as it may have shown more statistically significant results.

Two or more bouts of mindfulness meditation sessions may have provided adequate time to document a better sympathovagal balance when exposed to mental stress.

RECOMMENDATIONS

Interventions like yoga, such as meditation, different asanas, and breathing exercises, along with stress management, may warrant to combat mental stress
arising from challenges in the personal or professional spheres.

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