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Alternate nostril breathing (Nadi-Shodhana Pranayama) and its impact on perceived stress and hearing threshold among medical students; a prospective study

Smitha Nagendrappa[1], Sudhir Goppenahalli Kumaraswamy[2], Vinay Hosagavi Ramalingaiah[3]

[1]Assistant Professor, Department of Physiology, [3]Associate Professor, Department of Psychiatry, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, Mandya, [2]Professor and Head, Department of Physiology, PES University Institute of Medical Sciences, Bengaluru, Karnataka, India

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ABSTRACT

Background: Medical students often experience significant psychological stress, which can negatively impact their academic performance, cognitive functions, and overall well-being. Psychological/emotional stress can also affect hearing if severe or if it lasts long enough. Amongst stress reduction strategies, meditation techniques are found to be helpful. **Aims and Objectives:** This study aimed to assess the effect of alternate nostril breathing (Nadi-Shodhana Pranayama) on perceived stress and auditory thresholds (AT) among medical students. **Materials and Methods:** Following institutional ethics committee approval, a sample of 60 consenting students aged 18–26 years participated in a 3-month intervention, where they practiced pranayama for 15–20 min, 5 days a week. Baseline and post-intervention data were collected using the perceived stress scale (PSS) and pure tone audiometry. **Results:** The results demonstrated a statistically significant reduction in PSS scores ($P<0.001$), indicating decreased stress levels. In addition, ATs in both ears improved, with a more pronounced change observed in the left ear ($P<0.001$). These findings suggest that pranayama not only reduces psychological stress but also enhances auditory perception, possibly through the regulation of stress hormones and improved inner ear functioning. **Conclusion:** The study supports the use of pranayama as a simple, non-invasive intervention to reduce stress which tends to improve cognitive performance in medical students, contributing to better academic outcomes and overall well-being. Further research is warranted to explore long-term benefits and potential mechanisms behind the observed improvements in auditory function and stress resilience.

Key words: Alternate nostril breathing; Perceived stress; Pranayama; Hearing threshold

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INTRODUCTION

Psychological stress refers to a relationship with the environment that the person appraises as significant for his or her well-being and in which the demands exceed available coping resources.[1] The ubiquitous "stress" occurs in greater proportion in certain professions due to the very nature of work, environmental factors they are frequently exposed to, and expectations out of their societal role. One such well-agreed, and much-explored group of people are doctors and in particular, medical undergraduates.[2] The existence of plenty of articles from various countries related to stress and medical students during literature review from standard database subtly indicates that the fact is well acknowledged across the globe. In this context, elevated stress levels can impede performance in them on tasks that require divided attention, working memory, memory retrieval, and decision-making.[3] Apart from these,

Address for Correspondence:
Vinay Hosagavi Ramalingaiah, Associate Professor, Department of Psychiatry, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Nagamangala Taluk, Mandya District - 571 448, Karnataka, India. **Mobile:** +91-8904093422. **E-mail:** drvinayhr@gmail.com

stress has an indirect effect over academic performance by causing unexplained physical problems, poorer attendance, and thus overall deterioration on the academic front.[4] There is also preliminary evidence of associations between stress and hearing problems in humans.[5] Psychological/emotional stress can affect hearing if severe or if it lasts long enough.[6] Though there were various techniques specifically attempted for the reduction of stress among medical students, such as yoga, wellness programs, music, biofeedback intervention, curricular changes and self-hypnosis, meditation techniques had the most robust evidence as per the systematic reviews and meta-analysis.[7,8] Available evidence from the literature suggests that; even brief practice of a simple meditation technique can improve negative mood and perceived stress in healthy adults, which could yield long-term health benefits.[9]

The current study is undertaken in a prospective design, with an effort to know the effectiveness of a practicable and simple meditation technique in reducing stress and altering hearing thresholds among medical students.

Aims and objectives

- To record and compare the perceived stress scale (PSS) scores and pure tone audiometry findings in medical students before and after 3 months of practicing alternate nostril breathing (Nadi-Shodhana Pranayama).

MATERIALS AND METHODS

Source of data

The study was approved by the institutional ethics committee with registration number EC/NEW/INST/2024/KA/0382. Medical students (in the age group of 18–26 years) belonging to both sexes were considered for this study after obtaining informed consent. Based on a similar previous study by Bhimani et al.,[10] at Pune which had a sample size of 59 students and a comparable duration of 2 months with meditation sessions lasting for 1 h each day for 5 days in a week, we decided to have a sample size of 60 for set of a comparable number of variables under our study.

Materials used for data collection

1. Weighing machine (Venus digital weighing machine) A pedestal type of weighing scale was used, with a maximum weighing capacity of 120 kg and with an accuracy of 100 g
2. Stadiometer (SICA 213 stadiometer)-It has a ruler and a horizontal headpiece which can be placed on the head and adjusted. The height was measured with an accuracy of 0.5 cm
3. PSS is the most widely used psychological instrument for measuring the perception of stress.[11] It is a measure of the degree to which situations in one's life are appraised as stressful. The 10 questions in this scale elicit their feelings and thoughts during the past 1 month. In each case, they will be asked to indicate by circling how often they felt or thought a certain way on a Likert scale ranging from 0= "never" to 4= "very often." PSS scores were obtained by reversing responses (0=4, 1=3, 2=2, 3=1 and 4=0) to the four positively stated items (items 4, 5, 7, and 8) and then summing across all scale items
4. Elkon Audiometer EDA 3N3 MULTI-An audiogram to indicate the hearing threshold for the entire range of audible frequencies of the human ear was recorded with the help of an audiometer. The air conduction threshold is defined as the faintest tone a subject can hear through air conduction.
    i. The subject was made to sit in a soundproof chamber
    ii. A headphone was properly placed such that the diaphragm of the headphone faces the external auditory meatus
    iii. The subject was instructed to raise the index finger if the sound was heard (even if faintly heard) from the headphone
    iv. The Hughson-Westlake ascending technique was used wherein the test was begun with 250 Hz followed by 500, 750, 1000, 2000, 4000, and 8000 Hz frequency stimuli in an increasing order
    v. Under each frequency the sound stimulus was given in descending order starting from 40 dB with 10dB decrements till the subject does not hear. When the subject stopped hearing, confirmation of the threshold was done by increasing the intensity by 5 dB from the level he/she had stopped hearing
    vi. A similar procedure was repeated for the other ear
    vii. The values in dB were tabulated under each frequency
    viii. The average of frequencies 500 Hz, 1000Hz, and 2000Hz was taken and the final threshold was calculated.

Method of data collection

The study group was selected by purposive sampling technique with the following inclusion and exclusion criteria:

Inclusion criteria

Undergraduate medical students who were between 18 and 26 years, had given written consent and were not on any medications at the time of study.

Exclusion criteria

Individuals with

1. Known cardio-respiratory diseases, such as hypertension and bronchial asthma

2. Diseases, such as hypothyroidism, diabetes mellitus, and other endocrine disorders, acute/chronic illnesses due to infections, or psychiatric illness
3. History of alcohol and or tobacco consumption in any form or other substance abuse
4. History of practicing yoga or any other relaxation techniques and doing regular physical exercise previously.

Alternate nostril breathing

The subjects were made to sit comfortably on the floor with the left hand resting on the left thigh and the right hand controlling the flow of breath. Instructions were given for the placement of fingers i.e., the thumb on the right nostril, ring finger along with little finger on the left nostril and index and the middle finger on the forehead between the eyebrows. After initial relaxation for 5 min with simple breathing, the subjects were asked to perform the breathing procedure with eyes closed as described below:

1. Closing the right nostril, exhale through the left nostril completely and inhale slowly and maximally from the same nostril, then exhale slowly through the right nostril completely. Now again inhale up to maximum from the right nostril and exhale through the left nostril completely-this completes one cycle of alternate nostril breathing
2. The above breathing procedure is continued for a duration of 20 min. Later the subjects were instructed to relax by simple breathing for 5 min with eyes open.

Following 3 months of practice of alternate nostril breathing, the same set of parameters were re-assessed in the subjects.

Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean±SD (standard deviation) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Student t-test (two-tailed, dependent) has been used to find the significance of study parameters on the continuous scale within each group. Microsoft Word and Excel have been used for analysis and to generate Charts, tables, etc.

RESULTS

Table 1 shows the age-wise distribution of the study subjects. The mean age and standard deviation of the study population was 20.38±0.87 years with 51.7% of the subjects in the 20-year age group.

Table 2 indicates the gender-wise distribution of the study subjects. Females comprised most study subjects, at 61.7%.

Table 3 shows the distribution of subjects according to the body mass index (BMI). In terms of BMI, 23% of them were below 18.5 kg/m^2 and 77% of them were between 18.5 and 24.9 kg/m^2. None of the subjects belonged to the overweight or obese category.

Table 4 indicates the changes in PSS scores and auditory thresholds (AT) of the right and left ear separately in the subjects before and after Pranayama. It was observed that there is a statistically significant (P<0.001) decrease in the PSS scores in the studied subjects following Pranayama. Furthermore, there was a significant decrease (P<0.001) in ATs of both ears following Pranayama with further observation of relatively greater reduction noted in the left ear as depicted in Table 4.

DISCUSSION

The perceived stress documented in the medical students, pre- and post-Pranayama showed a definitive decrease, which is in line with many studies, such as those by Lane et al., Warnecke et al., and Sharma et al., which have documented a similar significant reduction in PSS scores following Pranayamic intervention.[9,12,13]

Table 1: Age-wise distribution of subjects (n=60)

Age in years	No. of subjects	Percentage
19	7	11.7
20	31	51.7
21	14	23.3
22	8	13.3
Total (n)	60	100.0

Mean±SD: 20.38±0.87

Table 2: Gender-wise distribution of subjects (n=60)

Gender	No. of subjects	Percentage
Female	37	61.7
Male	23	38.3
Total (n)	60	100.0

Table 3: Distribution of subjects according to their BMI (n=60)

BMI (in Kg/m^2)	No. of subjects	Percentage
<18.5	14	23.3
18.5–24.9	46	76.7
25–29.9	0	0.0
≥30	0	0.0
Total (n)	60	100.0

Mean±SD: 19.93±2.10

Table 4: Comparative assessment of perceived stress scale (PSS) score and auditory threshold of right ear AT (R) and left ear AT (L) before and after Pranayama for 3 months

Variables	Before Pranayama	After Pranayama	difference	t-value	P-value
PSS	21.62±5.34	14.85±4.60	6.767	9.958	<0.001*
AT (R)	7.51±4.08	5.17±3.22	2.346	6.117	<0.001*
AT (L)	9.23±7.48	5.70±3.82	3.529	4.203	<0.001*

*Strongly significant (P≤0.01)

This reduced perception of stress could be explained by the following two hypotheses. First, the activation of the pre-frontal cortex (PFC) and lateral hypothalamus mentioned earlier also brings about increased production and distribution of serotonin (5-HT) from the dorsal raphe nucleus.[14] These moderately increased 5-HT levels correlate with a positive affect while deficiency of it is seen in depression, the relationship which has been clearly demonstrated with regards to the effects of Selective Serotonin Reuptake Inhibitor medication used in the treatment of depression.[15] Second, the increased glutamatergic neuronal activity in PFC is known to stimulate the hypothalamic arcuate nucleus in producing β-Endorphins and Neuropeptide-Y.[16] While β-Endorphins are regarded as endogenous opioids causing reduced pain perception, sense of well-being and at times euphoria-like state, Neuropeptide-Y is being considered in recent times as a biologic correlate of resilience or positive coping at times of stress. In addition to its prevention of depressive-like behavior, Neuropeptide-Y has a vital role in learning and memory as per the preliminary evidence.[17-20]

With regard to the results obtained in our study on the changes in AT following Pranayama, the theoretical predictions come true. There is a statistically significant reduction in ATs in both ears following the intervention. The noxious effect on the ear can be theoretically explained by the high level of blood catecholamines and exaggerated activity of the cochlear sympathetic innervation.[21] The explanation for this observed phenomenon can be provided by stating the following two hypotheses. First, ATs get elevated with stress-induced cortisol secretion and vice versa.[22] In addition, another stress hormone epinephrine has the potential to alter inner ear fluid homeostasis and thus auditory perception.[23] Second, there might be some physical interference at times of stress to vibrations of the tympanic membrane by the tensor tympani, thus dampening the vibrations which in turn increases the AT. The basis for the difference noted between right and left ears with relation to AT as per the review by Lazard et al., centered on the Dichotic listening (DL) paradigm. DL is a behavioral test consisting of presenting two different acoustic stimuli simultaneously, one in each ear, and noting which stimulus was perceived more accurately. Irrespective of the gender, dichotic consonant/vowel syllables presented to the right ear are repeated with better accuracy than the ones presented to the left ear. However, the theories stated explain better hemispheric asymmetry at higher order speech processing than the peripheral auditory system. It is further noted in their review that, large inter-individual variability of the callosal area correlates with the speed of inter-hemispheric communication.[24] Though these mechanisms are little understood, there is no harm in adopting Pranayama techniques for better auditory perception and focused learning.[25]

Limitations of the study

1. The sample size based on previous studies though is adequate to show statistical significance, falls short when it comes to generalizing the same results to a larger population.
2. The present study has not considered factors like dietary intake, sleep duration and other psychological factors during the study period which may have an influence on the stress levels and auditory thresholds.
3. The Perceived Stress Scale used in this study has its own social desirability bias inherent to it as seen with any self-reported questionnaire.
4. In the female participants, the phase of menstrual cycle not being considered while interpreting the results, could have biased the findings.

CONCLUSION

The significantly reduced perceived stress levels due to the alternate nostril breathing meditation technique serves to be advantageous for better coping during a strenuous course of medical under graduation. The significant reduction noticed in ATs are suggestive of possible improvement in auditory focused learning.

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SN- Study conception and design, data collection, analysis and interpretation of results, draft manuscript preparation; **SGK-** Design of study, statistical analysis and interpretation, manuscript revision; **VHR**- Study conception and design, analysis and interpretation of results, draft manuscript preparation, and submission.

Work attributed to:
Department of Physiology and Psychiatry, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, Mandya.

Orcid ID:
Smitha Nagendrappa - https://orcid.org/0009-0005-9573-7260
Sudhir Goppenahalli Kumaraswamy - https://orcid.org/0000-0001-5691-8003
Vinay Hosagavi Ramalingaiah - https://orcid.org/0000-0002-1047-5531

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