Original Article

A Pilot Study to Check Effects of Alternate Nostril Breathing on Heart Rate Variability in Indian Male Adults

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ABSTRACT

Background and Aim: Alternate Nostril Breathing (ANB) modulates autonomic functions, and different breath-holding patterns improve Heart Rate Variability (HRV). Voluntary regulation of breathing with pauses between inspiration and expiration makes respiration rhythmic by modulating the autonomic nervous system. **Materials and Methods:** We studied the effects of two ANB methods with different inspiration-end inspiratory pause-expiration patterns on HRV in 30 healthy, untrained male medical students (18-25 years). After obtaining written voluntary consent and ethical approval, participants performed ANB-1 (4-6-6 sec) and ANB-2 (4-8-8 sec) for 8 min each. HRV parameters were measured before and after both methods using standard precautions. **Results:** Parasympathetic activity markers like HF nu and HF% significantly improved after both ANB methods. Significant improvements were observed in Mean HR, HF Power (Lomb statistics), HF Power, and LF/HF ratio (FFT statistics) in both ANB-1 and ANB-2. However, ANB-2 (4-8-8 cycle) showed more significant changes in HF Power and LF/HF ratio (Lomb statistics) and LF Power (FFT statistics) compared to ANB-1. Total HRV power increased in both methods but was not statistically significant. **Conclusion:** ANB with a slower breathing rate, prolonged end-inspiratory breath-holding, and extended expiration enhances parasympathetic dominance in young, yoga-naïve male medical students.

Keywords: Alternate nostril breathing, End inspiratory pause, End-expiratory pause, Heart rate variability.

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INTRODUCTION

Patanjali's Yoga Sutras, a foundational text of ancient Indian yogic science, views breath as a vital link between the body and mind. It emphasizes the practice of voluntary breath regulation, known as Pranayama, to create rhythmic breathing patterns.[1] One specific technique, Nadi Shodhana Pranayama-commonly referred to as Alternate Nostril Breathing (ANB)-helps practitioners control the inhalation and exhalation phases, thereby purifying and balancing the body's energy pathways, leading to integrated psychosomatic well-being.[2] The standard form of ANB involves inhaling through one nostril and exhaling through the other in a continuous sequence without pausing. Reversing this order completes one full cycle of ANB. Advanced forms of ANB introduce varying durations of inhalation, breath-holding, and exhalation, which ancient texts suggest offer even greater benefits than the basic practice.[3]

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Several studies have scientifically validated the effects of slow breathing, alternate nostril breathing, and breath-holding individually on physiological outcomes.

The physiological effects of alternate nostril breathing are largely attributed to its autonomic, cardiovascular, and respiratory influences.[4,5] Breath-holding, on the other hand, is known to enhance vagal tone while reducing sympathetic activity. Heart Rate Variability (HRV) serves as a key marker of autonomic (sympatho-vagal) balance. However, limited research has examined how higher-level ANB, involving variable inspiration-hold-expiration phases, affects HRV. Yogic breathing practices have been shown to significantly impact neurocognitive, psychophysiological, respiratory, biochemical, and metabolic functions in healthy individuals.[6] Additionally, alternate nostril breathing has been found beneficial in managing conditions like anxiety, depression, and other psychiatric disorders.[7-9]

Kayser described the nasal cycle as the periodic alternation of congestion and decongestion in the nasal turbinates and septum, which modifies unilateral nasal airflow resistance and reflects underlying sympathetic or parasympathetic dominance.[10] Sympathetic activation leads to vasoconstriction and decreased airflow resistance, while parasympathetic activation causes vasodilation, increasing resistance. This cyclical shift occasionally results in transiently balanced airflow through both nostrils.[11]

Breath control techniques like pranayama are increasingly recognized as valuable health-promoting practices. However, to fully appreciate and apply their benefits, comprehensive scientific research and documentation are necessary. Rigorous studies are needed to elucidate the mechanisms underlying these practices and explore their broader applications. In this context, the present study was designed to evaluate the effects of two different alternate nostril breathing cycles-with variable inspiration, breath-hold, and expiration times-on HRV in healthy Indian male adults.

MATERIALS AND METHODS

Participants Recruitment

This study was conducted at the Research Laboratory of the Department of Physiology in a medical college located in western India between March 2022 and February 2023. Approval was obtained from the Institutional Ethics Committee (Ref. No. IEC/BU/136/Faculty/3/35/2022). Participants were thoroughly briefed about the experimental procedures, and informed written consent was collected on a voluntary basis. Detailed medical histories were taken, and individuals with a history of smoking, alcohol consumption, acute or chronic illness, hypertension, diabetes, those on respiratory depressants, and regular yoga/pranayama practitioners were excluded. A total of 30 healthy male participants, aged 18 to 25 years, were enrolled. Each participant visited the research facility on two consecutive days for the study procedures.

Procedure

Participants were instructed to fast from food, tea, and coffee for at least 3 hr before each session. Upon arrival, they relaxed in a supine position on a couch for 10 min. HRV recordings were then taken for 10 min, capturing beat-to-beat variations in R-R intervals via lead II ECG using the RMS Polyrite D system.[12] 5 min of artifact-free HRV data were selected for analysis. HRV parameters included time-domain measures (SDNN, RMSSD, pNN50, NN50) and frequency-domain measures (LF, HF, TP). HRV was recorded both before and after alternate nostril breathing on each day.

Intervention

The Paced Breathing app (Version 2.1) was utilized to standardize the timing of breathing cycles. On Day 1, participants practiced ANB-1 with an inspiration-hold-expiration ratio of 4-6-6 sec (approximately 4 breaths per minute) for 8 min. On Day 2, they practiced ANB-2 with a 4-8-8 sec breathing pattern for the same duration. Each session followed a specific sequence:

- Block the right nostril with the thumb and use the ring and little fingers to close the left nostril as needed.
- Inhale through the left nostril for the prescribed duration, then close both nostrils to hold the breath.
- Release the right nostril and exhale through it while keeping the left nostril closed.
- Inhale through the right nostril, hold by closing both nostrils, and then exhale through the left nostril.
- This cycle was repeated continuously for 8 min with eyes closed.

Statistical Analysis of Data

All values were expressed as mean±Standard Deviation (SD). Data analysis was conducted using SPSS software version 20.0 (trial version). The paired t-test was employed to determine statistical significance between the two ANB methods. Additionally, Bland-Altman plot analysis was used to assess the absolute limits of agreement between HRV variables following ANB-1 (4-6-6 sec) and ANB-2 (4-8-8 sec).

RESULTS

Mean age, weight and height and body mass index of the participants were 20.93±1.76 years, 72.58±7.51 kg, 175.2±8.27 cm and 23.67±2.27 kg/m^2 respectively.

HRV parameters recorded during the ANB-1 and ANB-2 sequence are shown in Tables 1 and 2 respectively. We observed significant improvement in Mean HR, HF Power (lomb frequency statistics), HF Power and LF-HF ratio (FFT frequency statistics) in ANB-1 and ANB-2 sequences. However, in ANB-2, (4-8-8 cycle) results of HF Power and LF/HF ratio (Lomb frequency statistics) and LF Power (FFT frequency statistics) were more significant as compared to ANB-1 (4-6-6 cycle). An increase in total power of HRV was seen on both days but the change in total power was not statistically significant.

As per Figure 1, Bland-Altman Plot Analysis showed no statistically significant difference between two ANB methods. Bland-Altman Plot Analysis showed relatively good agreement between ANB-1 and ANB-2 methods. Short-term HRV parameters like mean HR, mean RR, LF (nu), HF (nu), LF/HF ration and total power showed good agreements between two methods of alternate nostril breathing.

DISCUSSION

We aimed to investigate the effects of a single session of Alternate Nostril Breathing (ANB) involving two distinct slow breathing sequences on Heart Rate Variability (HRV) in healthy, untrained student participants. As detailed in the results, we found significant improvements in mean heart rate, High-Frequency (HF) power (measured by Lomb-Scargle frequency analysis), HF power, and LF/HF ratio (measured by FFT analysis) following both ANB-1 and ANB-2 sessions. Notably, in ANB-2, changes in

Table 1: Heart rate variability parameters before and after the alternate nostril breathing with inspiration-pause-expiration cycle for 4-6-6 sec on first day (ANB-1).

	HRV parameters before the alternate nostril breathing	HRV parameters after the alternate nostril breathing cycle for 4-6-6 sec	p Value
Mean RR*	0.79±0.12	0.75±0.17	0.01
Mean HR**	77.7±11.91	70.25±15.87	<0.01
SDNN	47.42±19.21	48.23±17.86	0.65
RMSSD	36.29±19.41	39.25±22.84	0.27
NN50	104.2±105.46	119.62±112.85	0.33
pNN50	16.24±17.44	18.55±18.98	0.40
LF-Power(nu)	27.93±12.10	28.82±10.61	0.44
HF-Power(nu)**	18.24±11.89	20.85±13.23	0.001
LF/HF-Power nu**	1.96±0.96	1.80±0.75	<0.01
Total Power (TP)	2638.27±2291.8	3049.51±2783.02	0.36

Table 2: Heart rate variability parameters before and after the alternate nostril breathing with inspiration-pause-expiration cycle for 4-8-8 sec on second day (ANB-2).

	HRV parameters before the alternate nostril breathing	HRV parameters after the alternate nostril breathing cycle for 4-8-8 sec	P Value
Mean RR	0.79±0.12	0.84±0.20	0.14
Mean HR*	78.03±11.48	74.56±10.97	<0.01
SDNN	51.28±25.23	54.50±22.31	0.22
RMSSD	39.43±26.48	40.62±24.79	0.57
NN50	107.46±98.46	110.46±94.40	0.70
pNN50	18.29±18.71	18.13±18.01	0.94
LF-Power(nu)*	31.09±12.67	24.87±11.22	0.03
HF-Power(nu)*	18.55±15.29	20.17±16.54	0.03
LF/HF-Power nu**	2.25±1.06	1.84±0.94	<0.01
Total Power (TP)	3002.01±2570.76	3464.08±2752.13	0.20

HF power and LF/HF ratio (Lomb statistics), as well as LF power (FFT statistics), were more pronounced compared to ANB-1.

Previous studies have independently established the physiological benefits of slow breathing and alternate nostril breathing, yet the combined effect of these practices, particularly when incorporating variable durations of inspiration, breath-holding, and expiration, on HRV remains relatively underexplored. Research has consistently shown that ANB tends to shift autonomic balance towards parasympathetic predominance by reducing sympathetic activity. One study investigating controlled breathing at 8 and 16 breaths per minute found that slower breathing significantly enhanced HF power, decreased LF power, and reduced the LF/HF ratio after correcting for spectral analysis, supporting a parasympathetic shift.[13] Another study demonstrated that prolonging the exhalation phase relative to inhalation, without altering breathing rate, acutely increased RMSSD and HF-HRV, indicative of enhanced vagal tone, aligning with our findings.[14] Research has also reported significant improvements in HF parameters and reductions in LF parameters of HRV among non-practitioners using breath-holding techniques.

However, immediate effects of ANB on HRV have shown inconsistent results across studies involving both trained and untrained individuals, with or without breath-holding.[15] Some investigations reported no significant HRV changes with ANB without breath-holding in trained practitioners. In contrast, Krishna *et al.*, observed an increase in sympathetic dominance following ANB practice in non-yoga practitioners.[16,17]

Such discrepancies likely stem from methodological variations across studies. For instance, Shreya *et al.*, maintained a fixed rate of 5 breaths per minute.[15] A systematic review titled "Psycho-Physiological Correlates of Slow Breathing" by Andrea Zaccaro concluded that slow breathing generally improves HRV parameters.[18] Nevertheless, most of the reviewed studies lacked the critical component of breath-holding between inhalation and exhalation phases. Additionally, long-term ANB practice among first-year undergraduate students has been associated

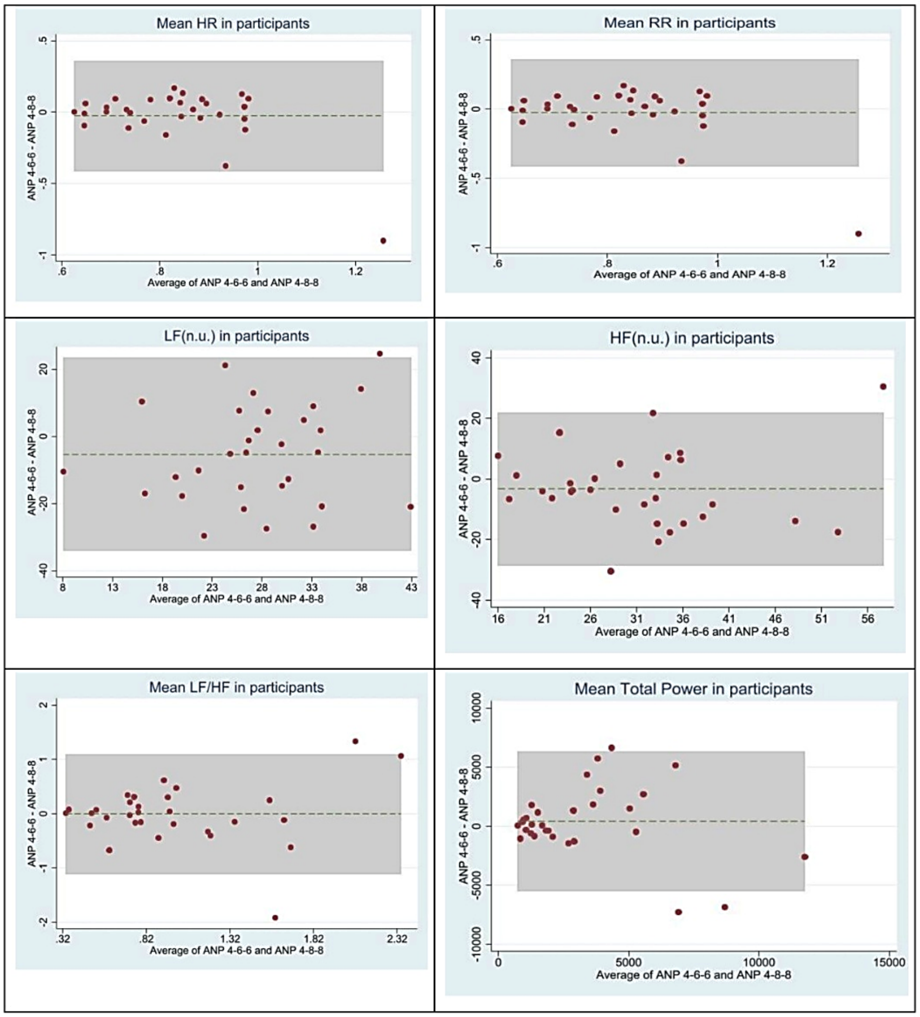

Figure 1: Bland-Altman plot of Heart Rate Variability (HRV) parameters obtained with Alternate Nostril Breathing Method 1 with breathing cycle 4-6-6 sec (ANB 4-6-6) and Alternate Nostril Breathing Method 2 with breathing cycle 4-8-8 sec (ANB 4-8-8). The centre line represents the mean differences between the two ANB methods.

with significant reductions in heart rate, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and DBP response to an isometric handgrip test after 12 weeks of training.[19]

Other research indicates that slow breathing with an unequal Inhalation-to-Exhalation (I:E) ratio is more effective in modulating physical and psychological arousal. Cappo and Holmes concluded that breathing at 6 bpm with an I:E ratio of 2:8 (quick inhalation followed by slow exhalation) more effectively reduced physiological and psychological arousal under stress compared to a reverse or equal I:E ratio.[20] Similar findings have been corroborated by other studies.[21] Importantly, existing literature has yet to definitively distinguish whether improvements in HRV stem primarily from slow breathing, ANB practice, or a combination of both. In the present study, we combined slow breathing, alternate nostril breathing, and graded durations of breath-holding and expiration, leading to enhanced parasympathetic dominance, likely resulting from the synergistic effects of these individual components.

While a detailed discussion of the physiological and yogic mechanisms underlying ANB is beyond the scope of this paper, a brief overview is warranted. It is well-established that vagal nerve activity is modulated by respiration-being inhibited during inspiration and enhanced during expiration, facilitating the generation of cardiac vagal tone through medullary centers.[22-24] Deep pranayamic breathing is hypothesized to influence the autonomic nervous system by promoting two physiological signals: (i) increased inhibitory neural impulses via activation of lung stretch receptors during deep inhalation (Hering-Breuer reflex) and (ii) enhanced hyperpolarization currents generated by stretching connective tissues (fibroblasts) around the lungs.[25]

These hyperpolarization and inhibitory impulses are believed to mediate the autonomic shift observed during pranayamic breathing. They synchronize rhythmic cellular activity between cardiopulmonary centers and the central nervous system,[26,27] regulating nervous tissue excitability and promoting synchronization of frequency patterns-a hallmark of deep relaxation states.[28] Synchronization across the hypothalamus and brainstem likely plays a pivotal role in inducing the parasympathetic response during breathing practices.[29] Numerous studies have also reported psychological benefits of such breathing techniques, including reductions in anxiety and enhanced relaxation.[30]

Edmonds *et al*., demonstrated a direct relationship between physiological variables and perceived behavioural outcomes: participants reported greater ease and comfort during breathing conditions associated with the highest SDNN and LF values.[31] Further, respiratory rates below 7 breaths per minute were shown to elicit strongest cardio-ventilatory coupling, a parasympathetic-mediated phenomenon responsible for creating a coherent, resonant autonomic state involving Parasympathetic Nervous System (PNS) and vasomotor oscillations.[31] This phenomenon forms the physiological basis for the positive impacts of ANB on both mental and physical health. Harvey also reported that yogic breathing exercises contribute to beneficial emotional and mood changes, with slower, deeper, and more irregular breathing being associated with parasympathetic activation.[32]

In conclusion, the present study demonstrates the physiological benefits of combining slow breathing, alternate nostril breathing, and variable breath-holding and exhalation durations. It offers a physiological rationale for the multi-dimensional positive effects of higher-level pranayama practices, an area previously under-investigated in a comprehensive manner. The ease of practicing the ANB technique and participants' expressed willingness to continue it for long-term health benefits are also promising observations, paving the way for future long-term investigations. Given its simplicity, convenience, and low resource requirement, if validated by further studies, the ANB method presented could serve as a practical and effective tool to enhance youth health and well-being.

LIMITATIONS

Smaller sample size and demonstration of only immediate effects of ANB in naïve participants' standout as limitations of our design. There is also a need to compare effects of two breathing sequences (with or without ANB) of identical duration, wherein one is with breath-holding interval and the other without breath-holding interval. Another limitation of this pilot study is inclusion of male participants due to smaller sample size.

CONCLUSION

Present study demonstrates that alternate nostril breathing with slow breathing rate and prolongation of end-inspiratory breath-holding, and expiration time enhances parasympathetic dominance in young yoga-naïve male medical students.

CONFLICT OF INTEREST

The authors of this study declared no conflict of interest.

ABBREVIATIONS

ANB: Alternate Nostril Breathing; **HRV:** Heart Rate Variability; **FFT:** Fast Fourier Transform; **LF:** Low Frequency; **HF:** High Frequency; **VLF:** Very Low Frequency; **PSD:** Power Spectral Density; **BRS:** Baroreflex Sensitivity; **RMSSD:** Root Mean Square of Successive Differences; **SDNN:** Standard Deviation of Normal-to-Normal Intervals; **ANOVA:** Analysis of Variance; **SPSS:** Statistical Package for the Social Sciences; **SD:** Standard Deviation; **SEM:** Standard Error of Mean; **CI:** Confidence Interval; **BPM:** Breaths Per Minute; **ms:** Milliseconds; **AU:** Arbitrary Units; **Hz:** Hertz.

AUTHORS' CONTRIBUTION

Rutam Vaishnav has contributed in concept design, definition if intellectual content, literature search data acquisition and manuscript writing. Dr Hasmukh shah contributed in concept design, definition if intellectual content, literature search data acquisition and manuscript writing, and manuscript review. Dr Rajnikant Solanki contributed in intellectual content, data analysis, statistical analysis manuscript editing, and manuscript review. Dr Hasmukh Shah takes the responsibility of the complete work.

REFERENCES

1. Jayawardena R, Ranasinghe P, Ranawaka H, Gamage N, Dissanayake D, Misra A. Exploring the Therapeutic Benefits of Pranayama (Yogic Breathing): A Systematic Review. Int J Yoga. 2020;13(2):99-110. doi: 10.4103/ijoy.IJOY_37_19. Epub 2020 May 1. PMID: 32669763; PMCID: PMC7336946.
2. Ram, Narayan, Mishra. Alternate nostril breathing (Nadi shodhan): -Importance and effects SEEJPH. 2025;26: 612-5. 10.70135/seejph.vi.4509.
3. Pal GK, Velkumary S, Madanmohan. Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. Indian J Med Res. 2004;120(2):115-21. PMID: 15347862.
4. Pal GK, Agarwal A, Karthik S, Pal P, Nanda N. Slow yogic breathing through right and left nostril influences sympathovagal balance, heart rate variability, and cardiovascular risks in young adults. North Am J Med Sci. 2014; 6(3): 145-51.
5. Naik GS, Gaur GS, Pal GK. Effect of modified slow breathing exercise on perceived stress and basal cardiovascular parameters. Int J Yoga. 2018; 11(1): 53-6.
6. Kalaivani SK, Kumari MJ, Pal GK. Effect of alternate nostril breathing exercise on blood pressure, heart rate, and rate pressure product among patients with hypertension in JIPMER, Puducherry. J Educ Health Promot. 2019; 8: 117.
7. Bhavanani AB, Ramanathan M, Balaji R, Pushpa D. Differential effects of uninostril and alternate nostril pranayamas on cardiovascular parameters and reaction time. Int J Yoga. 2014; 7(1): 60-5.
8. Kamath A, Urval RP, Shenoy AK. Effect of alternate nostril breathing exercise on experimentally induced anxiety in healthy volunteers using the simulated public speaking model: A randomized controlled pilot study. Biomed Res Int. 2017; 2017: 1-7.
9. Ismail AMA, Saif HFAEA, Taha MM. Effect of alternate nostril breathing exercise on autonomic functions, ocular hypertension, and quality of life in elderly with systemic

hypertension and high-tension primary open-angle glaucoma. Geriatr Nurs. 2023; 52: 91-7.

10. Hasegawa M, Kern EB. The human nasal cycle. Mayo Clin Proc 1977; 52(1): 28-34.
11. Srivastava RD, Jain N, Singhal A. Influence on alternate nostril breathing on cardiorespiratory and autonomic functions in healthy young adults. Indian J Physiol Pharmacol. 2005; 49(4): 475-83.
12. Shah H, Patel S, Prajapati T, Patel H, Vaishnav B. Comparison of heart rate variability in normotensive and hypertensive Indian adults. Indian Heart J. 2023; 75(3): 210-2.
13. Li C, Chang Q, Zhang J, Chai W. Effects of slow breathing rate on heart rate variability and arterial baroreflex sensitivity in essential hypertension. Medicine (Baltimore). 2018; 97(18): e0639.
14. Kromenacker BW, Sanova AA, Marcus FI, Allen JJ, Lane RD. Vagal mediation of low-frequency heart rate variability during slow yogic breathing. Psychosom Med. 2018; 80(6): 581-7.
15. Ghiya S, Lee CM. Influence of alternate nostril breathing on heart rate variability in non-practitioners of yogic breathing. Int J Yoga 2012; 5(1): 66-9.
16. Raghuraj P, Ramakrishnan AG, Nagendra HR, Telles S. Effect of two selected yogic breathing techniques on heart rate variability. Indian J Physiol Pharmacol. 1998; 42: 467-72.
17. Subramanian RK, Devaki PR, Saikumar P. Alternate nostril breathing at different rates and its influence on heart rate variability in non-practitioners of yoga. J Clin Diagn Res. 2016; 10(1): CM01.
18. Zaccaro A, Piarulli A, Laurino M, Garbella E, Menicucci D, Neri B, Gemignani A. How breath-control can change your life: a systematic review on psycho-physiological correlates of slow breathing. Front Hum Neurosci. 2018; 12: 353.
19. Dhanvijay AD, Chandan L. Effect of Nadi Shuddhi Pranayama on perceived stress and cardiovascular autonomic functions in 1st year undergraduate medical students. Natl J Physiol Pharm Pharmacol. 2018; 8(6): 898-902.
20. Cappo BM, Holmes DS. The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. J Psychosom Res 1984; 28(4): 265-73.
21. Van Diest I, Verstappen K, Aubert AE, Widjaja D, Vansteenwegen D, Vlemincx E. Inhalation/exhalation ratio modulates the effect of slow breathing on heart rate variability and relaxation. Appl Psychophysiol Biofeedback. 2014; 39: 171-80.
22. Klintworth A, Ajtay Z, Paljunite A, Szabados S, Hejjel L. Heart rate asymmetry follows the inspiration/expiration ratio in healthy volunteers. Physiol Meas. 2012; 33(10): 1717-29.
23. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med Hypotheses. 2006; 67(3): 566-71.
24. Russo MA, Santarelli DM, O'Rourke D. The physiological effects of slow breathing in the healthy human. Breathe. 2017; 13(4): 298-309.
25. Robinson RB, Siegelbaum SA. Hyperpolarization-activated cation currents: from molecules to physiological function. Annu Rev Physiol. 2003; 65: 453-80.
26. Roberts L, Greene JRT. Hyperpolarization-activated current (Ih): a characterization of subicular neurons in brain slices from socially and individually housed rats. Brain Res. 2005; 1040(1-2): 1-13.
27. Cuttle MF, Rusznák Z, Wong AY, Owens S, Forsythe ID. Modulation of a presynaptic hyperpolarization-activated cationic current (Ih) at an excitatory synaptic terminal in the rat auditory brainstem. J Physiol. 2001; 534(3): 733-44.
28. Newberg AB, Iversen J. The neural basis of the complex mental task of meditation: neurotransmitter and neurochemical considerations. Med Hypotheses. 2003; 61(2): 282-91.
29. Lutz A, Greischar LL, Rawlings NB, Ricard M, Davidson RJ. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. Proc Natl Acad Sci U S A. 2004; 101(46): 16369-73.
30. Gruzelier JH, Thompson T, Redding E, Brandt R, Steffert T. Application of alpha/theta neurofeedback and heart rate variability training to young contemporary dancers. Int J Psychophysiol. 2014; 93(1): 105-11.
31. Edmonds WA, Kennedy TD, Hughes PA, Calzada PJ. A single-participants investigation of the effects of various biofeedback-assisted breathing patterns on heart rate variability: a practitioner's approach. Biofeedback. 2009;37(4):141-6.
32. Russo MA, Santarelli DM, O'Rourke D. The physiological effects of slow breathing in the healthy human. Breathe (Sheff). 2017;13(4):298-309. doi: 10.1183/20734735.009817. PMID: 29209423; PMCID: PMC5709795.
33. Harvey JR. The effect of yogic breathing exercises on mood. The Journal of the American Society of Psychosomatic Dentistry and Medicine. 1983;30(2):39-48.

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