YOGIC BREATHING VERSUS PHYSICAL ACTIVITY ON CARDIAC AUTONOMIC REGULATION IN YOUNG ADULTS: A RANDOMISED TRIAL

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Abstract
Background: Both yogic breathing and physical activity influence autonomic function, but direct comparisons of their short-term effects on standardised parasympathetic and sympathetic indices are limited.
Methods: This randomised controlled trial assigned 170 healthy young adults (aged 18–34 years) to either a 5-week yogic breathing programme (n=85) or a 5-week structured physical activity programme (n=85). Assessments at baseline and post-intervention included resting heart rate, E: I ratio, 30:15 ratio, standing diastolic blood pressure, and systolic/diastolic blood pressure responses to isometric handgrip. Within-group changes were analysed with paired t-tests; between-group changes were compared using unpaired t-tests.
Results: Both interventions significantly improved all autonomic parameters ($p<0.05$ to $p<0.0001$). Between-group comparisons showed equivalent reductions in resting heart rate (yoga: −5.67±8.34 bpm; physical activity: −5.73±7.25 bpm, p=0.9601) and equivalent increases in E: I ratio. However, the yoga group exhibited significantly greater improvements in the 30:15 ratio (0.033±0.04 vs. 0.020±0.02, p=0.0081) and standing diastolic blood pressure reduction (−3.82±2.53 vs. −2.65±2.18 mmHg, p=0.0015). Conversely, the physical activity group showed greater attenuation of handgrip systolic (−6.34±3.44 vs. −5.14±3.26 mmHg, p=0.0208) and diastolic (−5.72±2.36 vs. −4.46±2.18 mmHg, p=0.0004) pressor responses.
Conclusion: Five weeks of yogic breathing or physical activity both improve cardiac autonomic regulation. Yogic breathing enhances reflex parasympathetic responsiveness and orthostatic diastolic control more effectively, while physical activity better blunts sympathetic reactivity to isometric stress. These complementary effects support integrating both modalities for autonomic resilience in young adults.
Keywords: Yogic breathing, physical activity, autonomic nervous system, heart rate, parasympathetic tone.
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INTRODUCTION

Autonomic nervous system (ANS) imbalance, characterised by heightened sympathetic tone and reduced parasympathetic activity, is increasingly recognised as an early, modifiable contributor to cardiovascular morbidity and stress-related disorders [1,2]. Even among young, ostensibly healthy adults, chronic psychosocial stress and sedentary behaviour can shift autonomic equilibrium toward sympathetic predominance, manifesting as elevated resting heart rate, exaggerated cardiovascular reactivity to stressors, and blunted baroreflex sensitivity [3,4]. Identifying effective, non-pharmacological strategies that restore sympathovagal balance is therefore of substantial preventive importance. Yogic breathing (pranayama) and structured physical activity are two such lifestyle interventions. Previous research has documented that slow, controlled breathing enhances vagal afferent signalling and modulates limbic activity, thereby reducing stress responsiveness [5]. Yoga-based practices have been associated with increased heart rate variability (HRV), lower resting heart rate, and improved baroreflex sensitivity [6,7,8]. Concurrently, regular aerobic exercise is known to augment cardiac parasympathetic modulation and reduce sympathetic outflow, contributing to long-term cardiovascular protection [9,10]. However, existing studies have largely examined these interventions in isolation, often using different outcome measures and heterogeneous populations.

A notable gap persists: direct, head-to-head comparisons of yogic breathing versus structured physical activity using a comprehensive battery of standardised autonomic function tests (e.g., E:I ratio, 30:15 ratio, isometric handgrip response) in young adults are scarce. Furthermore, most previous trials have employed longer intervention durations (≥8 weeks) or focused on clinical populations, leaving the relatively short-term (5-week) effects of these two modalities on dynamic autonomic regulation unclear. Therefore, the present randomised controlled study was designed to compare the effects of a 5-week yogic breathing intervention versus a structured physical activity programme on key autonomic parameters – resting heart rate, E:I ratio, 30:15 ratio, and blood pressure responses to orthostatic and isometric stress – in healthy young university students.

.MATERIAL AND METHODS

Study Design: This was a prospective, parallel-group, randomised controlled trial conducted at the Department of Physiology, NIMS University, Jaipur, in accordance with the CONSORT 2010 guidelines [10]. Outcome assessors were blinded to group allocation**.**

Participants: Healthy university students aged 18–34 years [12] of either gender were eligible. Exclusion criteria were: regular yoga or organised exercise in the past 6 months; tobacco or substance use; irregular sleep; medications affecting autonomic function or sleep; and any cardiovascular, respiratory, neurological, psychiatric, or endocrine disorder. Assuming a moderate effect size (Cohen's d = 0.5) for autonomic changes, 80% power, $\alpha = 0.05$, and 20% attrition, 85 participants per group (total N = 170) were enrolled. Eligible participants were randomly allocated (1:1) using computer-generated block randomisation (block size 4), stratified by gender and baseline stress level**.**

Interventions: Both interventions lasted 5 weeks with 6 supervised sessions/week. Yogic Breathing group: 35-min sessions (5 min rest – 25 min breathing – 5 min rest) including Nadi Shuddhi, Kapalabhati, Bhastrika, Sheetali, and OM chanting, led by a certified instructor. Physical Activity group: 30–35 min sessions (plus warm-up/cool-down) of brisk walking, jogging, cycling, dance aerobics, or Harvard step test at 60–80% estimated maximal heart rate, with progressive intensity**.**

Outcome measures

Assessments were performed at baseline and 12–48 hours post-intervention [13].

I. **Resting heart rate (bpm):** After 10 min supine rest (ECG).
II. **E:I ratio:** Longest expiratory R-R / shortest inspiratory R-R during deep breathing (6 breaths/min).
III. **30:15 ratio:** R-R interval at beat 30 / beat 15 after standing.
IV. **Orthostatic blood pressure:** Supine and standing SBP/DBP.
V. **Isometric handgrip test:** Sustained grip at 30% MVC for 3 min; peak SBP/DBP change.

Statistical analysis: Data are mean ± SD. Paired t-tests for within-group changes; unpaired t-tests for between-group change scores (Δ = post – pre). Chi-square for categorical variables. Significance at $p < 0.05$ (two-tailed). No correction for multiple comparisons (planned a priori).

Ethical approval: Approved by the Institutional Ethics Committee of NIMS University, Jaipur **(Approval No. IEC/P/600/2024).** Written informed consent obtained**.**

RESULT

Table 1. Within-group changes in resting heart rate and parasympathetic indices after five weeks of intervention (paired t-test)

Parameter	Group	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	p-value	Interpretation
Resting heart rate (BPM)	Yoga	91.96 ± 8.34	86.29 ± 7.91	p < 0.0001	Significant reduction
	Physical activ	88.14 ± 7.5	82.41 ± 6.9	p < 0.0001	Significant reduction

Parameter	Group	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	p-value	Interpretation
	ity				
E:I ratio (parasympathetic)	Yoga	1.27 ± 0.12	1.34 ± 0.13	p = 0.0066	Significant increase
	Physical activity	1.29 ± 0.11	1.37 ± 0.12	p < 0.0001	Significant increase
30:15 ratio (cardiac parasympathetic)	Yoga	1.008 ± 0.04	1.041 ± 0.05	p = 0.0009	Significant increase
	Physical activity	1.03 ± 0.03	1.05 ± 0.04	p < 0.0001	Significant increase

Both interventions significantly reduced resting heart rate and improved cardiac parasympathetic tone as measured by the E: I ratio and the 30:15 ratio.

Table 2. Within-group changes in handgrip blood pressure response (sympathetic reactivity) after five weeks of intervention (paired t-test)

Parameter	Group	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	p-value	Interpretation
Handgrip systolic blood pressure (mmHg)	Yoga	132 ± 4.72	129 ± 6.15	p = 0.0007	Significant reduction
	Physical activity	127.3 ± 6.2	121 ± 5.9	p < 0.0001	Significant reduction
Handgrip diastolic blood pressure (mmHg)	Yoga	87.48 ± 5.1	85 ± 4.65	p = 0.0004	Significant reduction
	Physical activity	80 ± 4.0	75.26 ± 3.7	p < 0.0001	Significant reduction

Both interventions significantly attenuated the sympathetic-driven pressor response to isometric handgrip stress, as shown by reductions in both systolic and diastolic blood pressure during the manoeuvre.

Table 3. Between-group comparison of autonomic change scores (post minus pre) using an unpaired t-test

Autonomic parameter	Yoga group change (Mean ± SD)	Physical activity group change (Mean ± SD)	Unpaired t-test	p-value	Superior intervention
Resting heart rate reduction (beats per minute)	-5.67 ± 8.34	-5.73 ± 7.25	0.05	0.9601	Equivalent
E:I ratio	0.07 ± 0.12	0.08 ± 0.11	-0.57	0.5719	Equivalent
30:15 ratio	0.03 ± 0.04	0.020 ± 0.02	2.68	0.0081	Yoga superior
Standing diastolic blood pressure	-3.82 ± 2.53	-2.65 ± 2.18	3.23	0.0015	Yoga superior
Handgrip systolic blood pressure	-5.14 ± 3.26	-6.34 ± 3.44	-2.33	0.0208	Physical activity superior
Handgrip diastolic	-4.46 ± 2.	-5.72 ± 2.36	-3.62	0.0004	Physical activity superior

Autonomic parameter	Yoga group change (Mean ± SD)	Physical activity group change (Mean ± SD)	Unpaired t-test	p-value	Superior intervention
blood pressure	18				

Yogic breathing produced greater improvement in the 30:15 ratio (cardiac parasympathetic response to standing) and in standing diastolic blood pressure. In contrast, physical activity produced greater attenuation of the sympathetic pressor response during handgrip.

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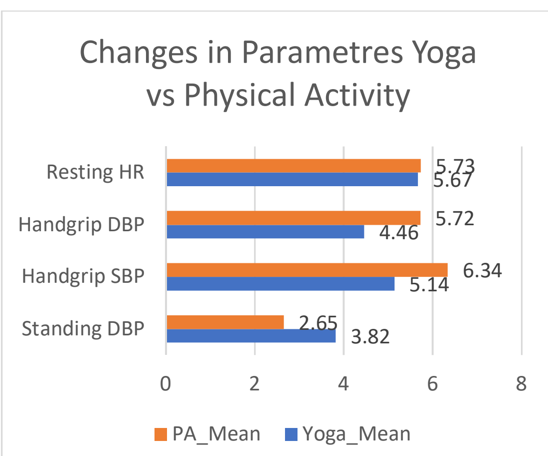
Figure 1: Mean changes in autonomic parameters (Δ, post-pre) in Yoga vs. Physical Activity groups



DISCUSSION

The present trial compared five weeks of yogic breathing versus structured physical activity on autonomic function in healthy young adults. Both interventions improved cardiac parasympathetic and sympathetic indices, but the profiles of benefit differed substantially.

Table 1 shows significant reductions in resting heart rate (yoga: 91.96 to 86.29 bpm, $p < 0.0001$; physical activity: 88.14 to 82.41 bpm, $p < 0.0001$) and significant increases in E:I and 30:15 ratios in both groups. Table 1b demonstrates marked attenuation of the handgrip pressor response in both arms. These findings align with Pal, Velkumary and Madanmohan [16], who reported improved autonomic function after short-term breathing exercises, and with Telles, Singh and Balkrishna [6], who observed heart rate variability changes during yoga breathing. Similarly, Sandercock et al. [9] and Cornelissen and Smart [10] showed that aerobic training enhances vagal modulation and reduces blood pressure.

Between-group differences: Table 3 and Figure 1 reveal distinct patterns. Resting heart rate reduction and E:I ratio improvement were equivalent ($p = 0.9601$ and $p = 0.5719$). However, the increase in the 30:15 ratio was significantly greater in the yoga group (0.033 vs. 0.020, $p = 0.0081$), indicating superior reflex-mediated parasympathetic responsiveness. This is consistent with Shinba et al. [17], who described autonomic normalisation in yoga-naïve individuals, and with Rajeswari et al. [18], who reported improved cardiac vagal tone after yoga. Standing diastolic blood pressure reduction was also greater in the yoga group (3.82 vs. 2.65 mmHg, $p = 0.0015$), concurring with Bhagat et al. [19] and Anasuya et al. [20], who found enhanced orthostatic regulation via baroreflex sensitisation after yogic breathing. In contrast, attenuation of the handgrip pressor response was significantly greater in the physical activity group (handgrip SBP: 6.34 vs. 5.14 mmHg, $p = 0.0208$; handgrip DBP: 5.72 vs. 4.46 mmHg, $p = 0.0004$). Our findings parallel those of Cornelissen and Smart [10] and McNally et al. [21], who demonstrated that aerobic and isometric training blunt stress-induced pressor responses. Wiles et al. [22] also reported that isometric wall squat training lowers resting and stress-evoked blood pressure. The superior sympathetic blunting in the physical activity group reflects training-induced adaptations in muscle metaboreflex and endothelial function, as described by Green et al. [23] and Brook et al. [24].

Physiological mechanism: Yogic breathing, particularly slow, rhythmic patterns with prolonged exhalation, enhances vagal afferent traffic to the nucleus tractus solitarius, increases respiratory sinus arrhythmia, and improves baroreflex sensitivity [5,7]. These changes strengthen parasympathetic modulation of heart rate and peripheral vascular tone, explaining the greater improvement in the 30:15 ratio and standing diastolic blood pressure. Additionally, regular pranayama increases GABAergic activity and reduces allostatic load [7], further supporting autonomic stability. This vagal upregulation also dampens central sympathetic outflow at rest, which may contribute to better orthostatic tolerance. Conversely, structured physical activity improves autonomic balance through metabolic conditioning, enhanced endothelial nitric oxide bioavailability, and reduced resting sympathetic outflow [23,24]. Repeated exposure to exercise haemodynamics also attenuates the muscle metaboreflex and central sympathetic drive, leading to a more pronounced blunting of the pressor response during isometric handgrip. These distinct pathways suggest yogic breathing preferentially targets reflex vagal circuits, whereas physical activity conditions sympathetic reactivity to acute stress.

Clinical significance and limitations: A five-week intervention of either modality produced a clinically meaningful ≈5.7 bpm reduction in resting heart rate. Yoga may be particularly useful for improving reflex parasympathetic function and orthostatic regulation; physical activity is superior for attenuating sympathetic reactivity.

CONCLUSION

Both yogic breathing and physical activity significantly improved cardiac autonomic regulation in young adults after 5 weeks. Yogic breathing produced greater improvement in the 30:15 ratio and standing diastolic blood pressure. Physical activity produced greater attenuation of systolic and diastolic blood pressure responses to isometric handgrip. These findings are significant because they identify distinct, complementary autonomic benefits of each modality. These findings support integrating both yogic breathing and physical activity as lifestyle therapeutic modalities for optimising autonomic resilience in young adults.

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