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Comparative Efficacy of Nadi Shodhana and Bhastrika Pranayama on Autonomic Modulation and Cognitive Attentional Tasks in Healthy Subjects - A 2-Arm pre-test post-test pilot Study

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Abstract - *Pranayama, the yogic regulation of breath, encompasses techniques traditionally classified as heating (Surya) and cooling (Chandra) in Hatha Yoga. This comparative randomized controlled trial examines fast (Bhastrika) and slow (Nadi Shodhana) pranayama to determine their differential effects on cardiorespiratory and cognitive parameters in healthy young adults. To compare the short-term effects of Bhastrika and Nadi Shodhana pranayama on pulse rate, blood pressure, respiratory rate, breath holding time, and sustained attention. Twenty healthy young adults were randomly allocated into two parallel groups: Bhastrika (n=10) and Nadi Shodhana (n=10) in a two-armed parallel group design. Both groups underwent supervised 15-minute daily sessions for five consecutive days. Outcome measures included pulse rate, systolic and diastolic blood pressure, respiratory rate, breath holding time, and Six Letter Cancellation Test scores. Assessments were conducted at baseline and post-intervention. Bhastrika practice produced significant improvement in breath holding time, indicating enhanced respiratory efficiency through diaphragmatic strengthening. Nadi Shodhana practice demonstrated significant reduction in blood pressure with concomitant decrease in pulse rate, reflecting parasympathetic activation. Sustained attention improved significantly in both groups, with Nadi Shodhana showing greater enhancement in concentration scores. Pulse rate responses exhibited opposite directional changes between groups, confirming autonomic duality. Between-group comparison confirmed Nadi Shodhana as the more efficient technique for cardiovascular modulation and cognitive enhancement. Bhastrika optimizes respiratory efficiency while Nadi Shodhana demonstrates superior efficiency in cardiovascular relaxation and cognitive enhancement. These findings support technique-specific prescription based on desired outcomes, with Nadi Shodhana recommended for blood pressure management and cognitive enhancement in healthy young adults.*

Key Words: Nadi Shodhana, Bhastrika, Pranayama, Blood Pressure, Sustained attention, Six Letter Cancellation Test (SLCT), Autonomic Nervous System

1. INTRODUCTION

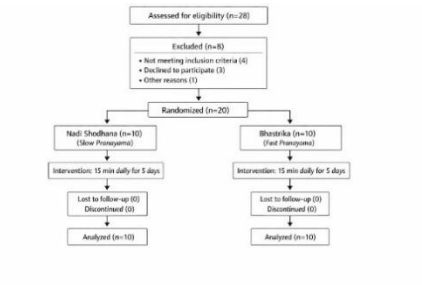
Pranayama, the fourth limb of Patanjali's Ashtanga Yoga, represents conscious regulation of breath bridging the voluntary and autonomic nervous systems [1] . In Hatha Yoga, derived from "Ha" (sun) and "Tha" (moon), pranayama is traditionally classified into Surya (solar, heating, stimulating) and Chandra (lunar, cooling, calming) practices[2], suggesting distinct physiological effects, although modern literature has often examined pranayama as a homogeneous intervention. Bhastrika Pranayama ("Bellows Breath") involves forceful, rapid diaphragmatic inhalations and exhalations, traditionally described as generating internal heat (Agni) and physiologically hypothesized to activate the sympathetic nervous system, increase metabolic rate, and strengthen respiratory musculature[3]. In contrast, Nadi Shodhana Pranayama ("Alternate Nostril Breathing") involves slow, controlled breathing with specific inhalation-retention-exhalation ratios and is traditionally prescribed to balance ida and pingala nadis; contemporary research associates it with enhanced parasympathetic activity, improved baroreflex sensitivity, and reduced cardiovascular workload. The Six Letter Cancellation Test (SLCT) is a validated

tool for assessing sustained attention and visual scanning, enabling integrated evaluation of cognitive and physiological responses. Despite widespread practice of both techniques, limited comparative evidence guides therapeutic selection; therefore, this randomized controlled trial compared the short-term effects of Bhastrika and Nadi Shodhana on cardiorespiratory parameters and sustained attention in healthy young adults to examine their autonomic duality.

2. METHODOLOGY

2.1 Study Design and Participants

This was a two-armed parallel-group prospective comparative randomized controlled trial conducted over five consecutive days in accordance with CONSORT guidelines. Assessments were performed at baseline (Day 1, pre-intervention) and post-intervention (Day 5, immediately after the final session). All measurements were recorded between 6:00 AM and 7:00 AM under controlled environmental conditions to minimize circadian variability. Twenty healthy female participants aged 18–25 years were recruited through campus word-of-mouth communication. Inclusion criteria were healthy female individuals willing to provide written informed consent and adhere to the five-day protocol. Exclusion criteria included self-reported cardiovascular, respiratory, or neurological disorders; hypertension (BP > 140/90 mmHg) or hypotension (BP < 90/60 mmHg); recent surgery or acute illness; and engagement in other forms of yoga or intense physical exercise during the study period.



2.2 Randomization and Blinding

Participants were randomly allocated to either the Bhastrika group (n=10) or the Nadi Shodhana group (n=10) using a computer-generated random sequence. Allocation concealment was ensured through sequentially numbered, opaque, sealed envelopes prepared by an independent researcher not involved in data collection or analysis. The study was single-blinded, with the outcome assessor unaware of group allocation, and participants were instructed not to disclose their intervention.

2.3 Intervention

Sessions were conducted daily for five days, each lasting approximately 25–30 minutes including preparation and supine rest. Participants maintained regular diet and sleep habits and avoided caffeine and heavy meals for at least two hours prior. Group 1 performed Nadi Shodhana Pranayama in a seated position (Sukhasana) with eyes closed. After two minutes of natural breath observation, alternate nostril breathing was practiced in a 1:4:2 ratio (4:16:8 seconds), producing approximately 4–5 breaths per minute for ten minutes continuously. Group 2 performed Bhastrika Pranayama in a seated position after two minutes of breath observation. Forceful inhalations and exhalations were executed at 60–65 strokes per minute; each round consisted of 20 strokes followed by recovery, with five rounds performed and 30-second rests between rounds.

2.4 Outcome Measures & Stastical analysis

All assessments were performed at two time points: baseline (Day 1, before the first intervention session) and post-intervention (Day 5, immediately after the final session). Measurements were taken after five minutes of supine rest to

ensure stable resting state. Data were analyzed using JASP software. Normality was assessed using the Shapiro-Wilk test. Within-group comparisons were conducted using paired t-tests, and between-group comparisons were analyzed using independent t-tests. Statistical significance was set at $p < 0.05$, and results are presented as mean ± standard deviation. Pulse rate, systolic and diastolic blood pressure, respiratory rate, breath-holding time, and Six Letter Cancellation Test scores were measured using standard clinical instruments and established protocols.

3. RESULTS & DISCUSSION

3.1 Intra-Group Physiological and Cognitive Responses

Statistical analysis demonstrated clear physiological and cognitive adaptations in both cohorts after the five-day intervention, with distinct autonomic and respiratory profiles for Nadi Shodhana (Group 1) and Bhastrika (Group 2).

Intra-group findings:

Group 1 ($n = 10$) showed significant reductions in Diastolic Blood Pressure ($t = 6.106$, $p < .001$) and Respiratory Rate ($t = 7.997$, $p < .001$), together with large improvements in Breath-Holding Time (BHT; $t = -8.243$, $p < .001$) and Six Letter Cancellation Test (SLCT) scores ($t = -27.588$, $p < .001$). Changes in Systolic Blood Pressure ($p = 0.065$) and Pulse Rate ($p = 0.082$) did not reach conventional significance thresholds, although a Wilcoxon signed-rank test indicated a significant pulse rate change ($Z = 2.141$, $p = 0.036$). Group 2 ($n = 10$) exhibited highly significant increases in BHT ($t = -5.442$, $p < .001$) and SLCT scores ($t = -31.482$, $p < .001$) but no significant intra-group changes in SBP ($p = 0.153$), DBP ($p = 0.100$), Pulse Rate ($p = 0.120$), or RR ($p = 0.343$)

Table – 3.1:presents pre- and post-intervention means (±SD) and p-values for each parameter in both groups.

PARAMETER	GROUP	PRE (MEAN±SD)	POST (MEAN±SD)	p-value
SBP (mmHg)	1	110.1±8.3	97.4±19.4	0.010
	2	107.9±10.3	102.0±12.6	0.090
DBP (mmHg)	1	81.2±10.8	75.8±12.5	0.036
	2	77.1±5.3	74.9±3.3	0.100
HR (bpm)	1	79.5±12.2	76.2±15.2	0.082
	2	87.7±14.2	91.3±17.8	0.120
BHT (sec)	1	24.3 ± 5.5	31.6 ± 5.7	< 0.001
	2	28.7 ± 8.2	42.2 ± 10.2	< 0.001
RR (breaths/min)	1	19.0 ± 2.9	14.5 ± 1.9	< 0.001
	2	10.7 ± 2.4	10.5 ± 1.9	0.343
SLCT Score	1	53.5 ± 6.2	65.7 ± 7.5	< 0.001
	2	54.5 ± 7.4	64.4 ± 8.2	< 0.001

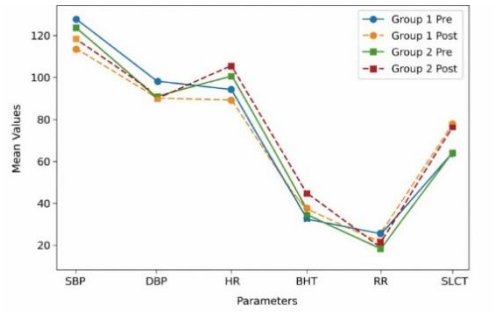


Figure - 3.1: illustrates the interaction of pre/post means across the six parameters for Group 1 (solid lines) and Group 2 (dashed lines), highlighting the divergent respiratory and hemodynamic trajectories

Abbreviations - SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, HR: Pulse rate, BHT: Breath-Holding Time, RR: Respiratory Rate, SLCT: Six Letter Cancellation Test, SD: Standard Deviation.

3.2 Inter-Group Comparative Analysis

Independent samples t-tests comparing post-intervention parameters between Group 1 and Group 2 highlight distinct recovery or performance profiles between the two arms. A highly significant difference was observed in post-intervention Respiratory Rate (Student's t=4.636, p<.001), indicating that Group 1 achieved a significantly lower respiratory frequency than Group 2. Furthermore, a significant difference was noted in post-intervention Breath-Holding Time (Student's t=-2.898, p=0.01), suggesting superior respiratory breath-holding capacity in one cohort over the other

4. DISCUSSION

In the Nadi Shodhana cohort (Group 1), significant reductions in Diastolic Blood Pressure (DBP) and Respiratory Rate (RR) reflect the physiological cascade of slow alternate-nostril breathing [5]. This practice activates the Hering-Breuer reflex, suppresses medullary sympathetic outflow, and enhances vagal discharge. The concurrent increase in Breath-Holding Time (BHT) and Six Letter Cancellation Test (SLCT) scores indicates improved chemoreceptor tolerance and executive attention[6]. In contrast, the Bhastrika cohort (Group 2) showed significant gains in BHT and SLCT without hemodynamic changes, suggesting that rapid bellows breathing sharpens cognitive focus and respiratory endurance via sympathetic activation but does not immediately lower blood pressure[2]Independent samples t-tests highlight the primary distinction: Group 1 achieved significantly lower RR and superior BHT compared to Group 2, establishing Nadi Shodhana as more effective in inducing hypometabolic stability. However, no significant post-intervention differences were observed in SBP, DBP, or SLCT scores, indicating both techniques normalize these outcomes to comparable baselines. Group 1 demonstrated significant reductions in DBP ($p < .001$) and RR ($p < .001$), confirming parasympathetic dominance through enhanced baroreflex sensitivity and vagal signaling. Group 2 did not show intra-group changes in blood pressure or pulse rate, identifying Bhastrika as a sympathomimetic practice emphasizing metabolic activation. Inter-group analysis confirmed this divergence, with Group 1 attaining significantly lower RR ($p < .001$)[i]. Both groups achieved highly significant improvements in SLCT ($p < .001$), showing that slow and fast breathing enhance visual attention, psychomotor speed, and cortical arousal via modulation of the ascending reticular activating system. Post-intervention SLCT scores did not differ significantly ($p = 0.72$), confirming equal effectiveness in boosting cognitive performance. BHT increased significantly in both groups ($p < .001$), reflecting reduced chemoreceptor sensitivity and improved tolerance to apnea. Group 1 achieved higher post-intervention BHT ($p = 0.01$), highlighting the conditioning effect of prolonged retention phases in Nadi Shodhana compared to rapid exhalations in Bhastrika. Nadi Shodhana reduces systemic vascular resistance through parasympathetic activation, while Bhastrika emphasizes thoracic mobilization and CO_2 tolerance. Both enhance cognition, but their autonomic trajectories differ. Limitations include small sample size (n=20) and absence of long-term follow-up. Larger studies with biomarkers such as HRV are recommended.

5. CONCLUSION

We definitively reject the null hypothesis for BHT and SLCT in both groups, confirming that both pranayama techniques yield immediate cognitive and respiratory benefits. Nadi Shodhana provides superior autonomic cooling, while both techniques enhance cognitive performance. Integrating these brief, evidence-based protocols into clinical settings offers a cost-effective tool to interrupt the pathogenesis of stress-related cardiovascular morbidity.

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