



## Original Research Article

# Effects of Nadishodhana and Bhramari Pranayama on heart rate variability, auditory reaction time, and blood pressure: A randomized clinical trial in hypertensive patients

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## ABSTRACT

**Background:** Hypertension (HTN) is a chronic elevation of arterial blood pressure (BP) due to environmental and lifestyle factors. The lifelong treatment protocol causes poor adherence to anti-hypertensive drugs. *Nadi Shodhana* and *Bhramari pranayama* are the most effective yogic treatment for the management of HTN.

**Objectives:** This study was done to assess and compare the immediate effect of *Nadi Shodhana* and *Bhramari Pranayama* on HRV and ART in hypertensive individuals. Thus, to understand the effectiveness of specific pranayama on hypertension.

**Methodology:** This study is a randomized, comparative study design. The hundred participants were recruited into two groups 1 (n = 50) and 2 (n = 50). The study was conducted on pre-diagnosed patients with HTN, from the inpatient department of SDM Nature Cure Hospital, Shanthivana. Group 1 was asked to practice *Nadi Shodhana Pranayama* and Group-2 was asked to practice *Bhramari Pranayama* for 20 min. The patients were assessed for Heart Rate Variability & Auditory Reaction Time before and immediately after the intervention.

**Results:** *Nadi Shodhana Pranayama* showed a significant decrease in ART ( $p = 0.01$ ) and *Bhramari Pranayama* showed a highly significant decrease in ART ( $p < 0.00001$ ). Whereas there was no statistically significant difference in both the groups in HRV parameters.

**Conclusion:** The study showed that both *Nadi Shodhana* and *Bhramari Pranayama* can be effective in balancing the sympathovagal tone. Thus, *Nadi Shodhana* and *Bhramari Pranayama* can be practised for the management of essential hypertension.

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## 1. Introduction

Hypertension is the most prevalent non-communicable disorder affecting the major population of India and it is a huge health challenge in the 21st century [1,2]. HTN is linked with structural changes in the cardiovascular system which may lead to cardiovascular mortality and morbidity [3]. The global load of hypertension prevalence is due to the aging population, exposure to lifestyle risk factors and, sedentary life. In 2015 approximate number of

deaths that were correlated with SBP  $\geq 110$ -115 mmHg was 10.7 million (19.2% of all deaths) and with SBP  $\geq 140$  mm Hg was 7.8 million (14% of all deaths). The substantial number of deaths that were linked to SBP  $\geq 110$ -115 mmHg were attributed to ischemic heart disease (IHD), ischaemic stroke, and haemorrhagic stroke [4]. An alarming Indian study of 2019 revealed that the country-level prevalence of hypertension among the young in India was 13.6% in men, 8.8% in women, and 11.3% overall. Hypertension due to specific causes i.e., secondary hypertension is observed in a small number of cases, but for the majority of individuals ( $\approx 90\%$ ), its etiology cannot be determined i.e., Primary/Essential hypertension [5]. The exact pathogenesis of essential hypertension is not clear, but the anomaly in the sympathetic nervous system and pressure natriuresis system dysfunction is briefly formulated and the most

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widely accepted pathophysiology. Genetic (family history), behavioural (such as salty food inclination), psychosocial (mental stress), and lifestyle influences (such as physical inactivity) cause an increased sympathetic activity in the early stage of essential hypertension [6].

Numerous studies have shown that elevated blood pressure (BP) is a major risk factor for cardiovascular morbidity and mortality. There is an increased risk of stroke and IHD on a 20 mmHg difference in usual SBP [7].

In developed countries, despite multiple drug therapy and genetic advancements, the burden of hypertension has not decreased due to nonadherence to the prescribed treatment and strict lifestyle modification. Additionally, poor access to medications, healthcare services, and illiteracy situation is worsening the situation in developing countries [8,9]. The ultimate goal of hypertension management is to reduce the excess of cardiovascular morbidity and mortality due to chronically elevated blood pressure and this can be achieved initially by lifestyle modification like stress management, physical activities, weight reduction, and dietary modification [10].

Yoga is an ancient practice that was first mentioned in Rigveda (yogic meditation), whereas Yajurveda explains yoga practice to boost mental health, physical strength, and prosperity [11]. Yoga is a holistic mind-body intervention aimed at physical, mental, emotional, and spiritual wellbeing. The core components of yoga include stretching exercises, physical postures (*Asanas*), breath control (*Pranayama*), and concentration techniques (Meditation) [12].

Pranayamas are gaining significance and becoming more acceptable to the scientific community [13]. Chhandogya Upanishad says that *Prana* is an internal matrix (subtle energy) and *Vayu* is an external matrix (gross energy). According to Yoga, the gross body (*Annamaya kosha*) is nourished by the subtle body (*Pranamaya kosha*) which consists of *Chakras* and *Nadis*. These *Nadis* carry the *prana* which stimulates the *chakras* and thereby nourishes various organs and systems and affects all the physiological activities in the human body [14].

Previous study on pranayama and hypertension showed a reduction in the heart rate, blood pressure, and rate pressure product [15]. Improvement in cardiorespiratory parameters were seen in a recent study on *Nadi Shodhana Pranayama*, which is suggestive of an increase in cardiorespiratory efficiency [16]. *Bhramari Pranayama* has been shown in a recent study to boost pulmonary functions, improve autonomic function, sleep quality, and lower infection risk [17]. *Bhramari Pranayama* practice in home isolated COVID-19 patients showed improvement in the psychological health disorders such as anxiety, depression, and sleep deprivation [18]. The six-month practice of *Bhramari Pranayama* showed reduction in reaction time in healthy adolescent group which implies improvement in reflexes and information processing [19]. Regular practice of *Bhramari Pranayama* can be effective in improving stress response [20].

There is a connection between hypertension and HRV, that lies in the autonomic nervous system regulating blood pressure, the sympathetic nervous system, which accelerates the heart rate and constricts blood vessels, and the parasympathetic nervous system, which slows the heart rate and helps in the relaxation. In patients with hypertension, there is often an imbalance of sympathetic activity and parasympathetic activity. This imbalance led to reduced HRV in the time intervals between heartbeats. Low HRV is associated with increased cardiovascular risk [21]. Hypertensive patients are associated with an increased risk of cognitive impairment. By evaluating reaction time, researchers found that yoga and pranayama are more significant in patients with hypertension. Reaction time is index arousal and a reduction in it showed an enhanced sensory-motor performance and improved processing capability of

the central nervous system [22]. A study done by McIntyre D et al. found that hypertensives have slower reaction times than normotensives [23].

Although *Nadi Shodhana Pranayama* and *Bhramari Pranayama* are used extensively in the management of essential hypertension, there has been no study conducted to compare the immediate effects of *Nadi Shodhana* and *Bhramari Pranayama* in hypertensive patients.

The aim of this study is to compare the immediate effects of *Nadi Shodhana* and *Bhramari Pranayama* on blood pressure, heart rate variability (HRV), and Auditory reaction time in hypertensive individuals. To demonstrate the scope of efficiency of short-term and specific effect of *Pranayama* in the management of essential hypertension.

This study hypothesized that there is a different effect following the intervention of *Nadi Shodhana* and *Bhramari Pranayama* on hypertensive individuals.

## 2. Materials and methods

### 2.1. Trial design

This study is a randomized, comparative study. The patients were randomly divided into group 1 and group 2 with 1:1 allocation ratio.

### 2.2. Participants

Participants were recruited from the in-patient department of SDM Nature Cure Hospital, Karnataka, India. 138 hypertensive individuals were screened for the study. Out of which 100 participants were able to fulfill the inclusion criteria and were eligible for the study. Recruited patients were randomized in two groups using a simple randomization method (lottery method). The inclusion criteria for the study were male & female within the age group of 30–60 years, pre-diagnosed with essential hypertension, with or without antihypertensive drugs. The participants were excluded from the study if they were diagnosed with secondary hypertension, valvular heart disease, pericarditis/myocarditis, heart failure with EF 35%, CABG, PTCA with or without stenting. Patients who refused to fill the consent form were not included in the study. There were no deviations from the protocol of the study. Any participants who did not fulfill the inclusion criteria and were not willing to participate in the study were excluded in the initial phase of the study. Fig. 1 (trial profile).

### 2.3. Sample size calculation

The sample size was calculated based on the effect size of systolic blood pressure, post-mean and standard deviation of the study group ( $113.05 \pm 8.01$ ) and control group ( $119.90 \pm 7.05$ ) appropriately. The total sample size of 62 patients were calculated ( $\alpha = 0.05$ ) and power ( $1 - \beta = 0.90$ ) by G\* power software, version 3.1.9.2 based on a previous study [24]. Due to the higher probability of dropout, researchers expected a 25% dropout because of the common trend in Yoga interventions, but after the intervention, there was no dropout. Therefore, analysis was done for 100 participants. For the protocol and basis of analysis, 100 people were recruited. Considering the 25% attrition and dropout rates, all the participants completed the intervention, so the analysis was reported for 100 people.

### 2.4. Randomization

The randomization of the patients was done using lottery method, where the numbers 1 to 100 were written on the paper

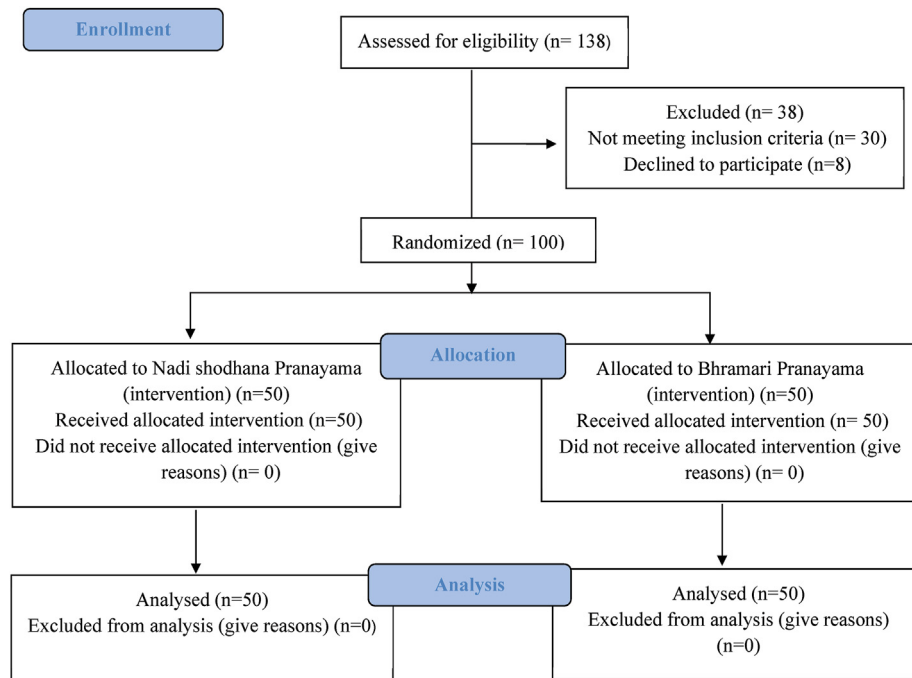


Fig. 1. Participants flow of this study.

and put in the bowl. The patients were asked to pick a chit from the bowl under the supervision of researchers. If patient gets an odd number, he/she was put in group 1 (*Nadi Shodhana Pranayama*), if patient gets an even number, he/she was put in group 2 (*Bhramari Pranayama*).

As the patients were taught the *pranayama*, they were aware of the treatment given to them. Also, the researcher was aware of the practice given to them. The blinding/masking was not done in this study.

### 2.5. Ethical considerations & trial registration

The study was approved by the institutional ethical committee prior to the study. The study was registered with the clinical trial registry of India (<https://ctri.nic.in>) under CTRI registration number CTRI/2019/12/022,263. A signed informed consent was obtained from the patients by explaining the study objectives, methods, intervention, and all the rights of the patients pertaining to the study orally in the language best known to them and in writing form in English (Sample of consent form is enclosed).

### 2.6. Intervention

#### 2.6.1. Group 1

Group 1 performed *Nadishodhana Pranayama* for 20 min. During the practice participants were asked to sit in "*Sukhasana*". The participants were then instructed to perform the following steps: Assume *Nasikagra Mudra* in the right hand and *Chin/Gyan Mudra* in left hand. Inhale & exhale slowly & deeply with both nostrils. Inhale slowly and quietly through the left nostril while closing the right. At the end of the inhalation, Keep the left nostril closed and exhale through the right as slowly as possible. After exhaling completely, inhale slowly and quietly through the right nostril. Close the right nostril and then open the left nostril and exhale slowly and silently. Inhale through the same nostril and continue.

#### 2.6.2. Group 2

Group 2 performed *Bhramari Pranayama* for 20 min. Participants were asked to sit in "*Sukhasana*". The eyes must be closed during this process to cut off external inputs of sounds and sight, to internalize the consciousness. *Sanmukhi mudra* will be adopted so that the sensation of vibration on the facial region is experienced by placing the fingers on the different regions of the face. Inhalation and exhalation should be through nostrils, slowly and deeply. While exhaling, the participants will have to produce sound (humming sound) like a bumble bee strictly through nasal airways, keeping oral cavity closed by the lips, ears closed by fingers. The procedures of both *Nadi Shodhana* and *Bhramari Pranayama* were demonstrated by a qualified Yoga expert.

### 2.7. Assessments

The primary outcome variables were Arterial blood pressure and Heart rate variability. The secondary outcome variable was Auditory reaction time.

#### 2.7.1. Arterial blood pressure (BP)

Blood pressure was recorded before and after the interventions by using a digital sphygmomanometer (OMRON – 7113), auscultating over the right brachial artery, it had a pressure accuracy of  $\pm 3$  mmHg. The systolic pressure was noted as the first clear tapping sound (Korotkoff sounds) and diastolic pressure was noted as the reading at which the Korotkoff sounds appeared muffled. Blood pressure sample was not continuously monitored.

#### 2.7.2. Heart rate variability (HRV)

The standard electrocardiogram (ECG) was recorded using standard bipolar limb lead II configuration for 5 min as a baseline with patients lying in a supine posture comfortably on a bed. Signals were digitized and recorded with a PowerLab 17T device (ADInstruments Inc., Bella Vista, NSW, Australia). The R waves were detected to obtain a point event series of successive R–R intervals, from which the beat-to-beat heart rate series was computed.

### 2.7.3. Auditory reaction time (ART)

The reaction time was recorded with patients in sitting posture on bed. The signals were digitized and recorded with a PowerLab 17T device (ADInstruments Inc., Bella Vista, NSW, Australia).

## 2.8. Data extraction

### 2.8.1. Heart rate variability

The energy in the HRV series of the following specific bands was studied, viz., the very low- frequency component (0.0–0.05 Hz), low -frequency component (0.05–0.15 Hz), and high -frequency component (0.15–0.50 Hz). The low -frequency and high- frequency values were expressed as normalized units. The low- frequency and high- frequency values are expressed as normalized units. Both time domain and frequency domain values were analyzed. In time domain RMSSD, pRR50 and in frequency domain VLF, LF, HF, LF/HF values were extracted by using the Lab chart software (ADInstruments Inc.) [25]. Limb lead two II is selected for the HRV recording because of the placement of positive electrode in lead II which view the wavefront of the impulse from the inferior aspect of the heart. All the waves are prominent in lead –II, including P wave.

### 2.8.2. Blood pressure

BP was recorded using the digital sphygmomanometer (OMRON – 7113).

### 2.8.3. Auditory reaction time

The simple reaction time (ART) waveform is extracted by using the lab chart software (AD Instruments Inc.).

### 2.8.4. Data analysis

Statistical analysis was done using the SCIKIT-LEARN package in Python. Data was checked for normal distribution using Saphiro Wilk test and analyzed by using Wilcoxon rank sum test and Mann Whitney U test. A P value less than 0.05 was accepted with the confidence interval (CI) 95% as an indicator of significance.

## 3. Results

The data obtained was analysed for normality by Shapiro Wilk test which shows that the data was skewed distribution. So, the pre-post data of *Nadi Shodhana* and *Bhramari Pranayama* groups were analysed separately using Wilcoxon rank sum test and comparative analysis between the *Nadi Shodhana* and *Bhramari Pranayama* groups were done by using the Mann Whitney U test. In Group-1 there were 58.6% of males and 41.4% of females with a mean age of 32.38 years and in Group-2 there were 63.4% of males and 36.6% of females with a mean age of 31.5 years.

**Table 1**

Comparison of pre and post- test values *Nadi Shodhana* and *Bhramari Pranayama* group.

Variables	Nadi Shodhana Pranayama Group		Bhramari Pranayama Group	
	Mean ± SD Pre	Mean ± SD Post	Mean ± SD Pre	Mean ± SD Post
SBP	124.98 ± 10.58	122.18 ± 9.25**	126.74 ± 10.66	122.56 ± 8.06 **
DBP	79.04 ± 8.15	76.00 ± 7.24*	81.34 ± 8.68	79.08 ± 7.94*
Median RR	741.04 ± 115.21	755.07 ± 139.63*	764.16 ± 110.11	784.90 ± 114.48 **
Mean HR	84.93 ± 16.37	82.16 ± 18.01**	86.50 ± 13.81	80.11 ± 12.22 **
RMSSD	52.14 ± 45.57	59.50 ± 56.36 *	45.95 ± 31.21	57.10 ± 53.59 *
pRR50	19.66 ± 22.51	23.04 ± 23.60	19.37 ± 22.89	22.27 ± 25.51*
VLF	42.00 ± 22.15	37.50 ± 20.06	44.32 ± 26.54	38.86 ± 20.58
LF	55.08 ± 20.83	45.24 ± 19.43	54.63 ± 20.91	48.61 ± 20.16
HF	46.07 ± 20.46	52.21 ± 20.74	45.54 ± 20.73	53.52 ± 18.61*
LF_HF	1.80 ± 1.70	1.21 ± 0.96 *	1.82 ± 1.78	1.17 ± 0.89*
ART	0.42 ± 0.22	0.38 ± 0.14**	1.11 ± 0.76	0.45 ± 0.29**

There is significant change seen in the pre and post of *Nadi Shodhana* and *Bhramari Pranayama* \* p < 0.05, \*\*-p<0.01, \*\*\*- p < 0.001.

## 3.1. Between the group changes

The two groups did not show significant differences in the variables at baseline. The comparison between both groups showed no significant difference in HRV parameters. There was a statistically significant difference in Auditory reaction time in *Bhramari* group (p < 0.00001). The post scores of the pranayama (*Nadi Shodhana* and *Bhramari*) group of the mean SD ± are in [Table 1](#).

## 3.2. Within group changes

### 3.2.1. Nadi Shodhana pranayama

There was a significant decrease in SBP (p = 0.01) and DBP (p = 0.02). In the time domain of heart rate variability, there was a significant increase in RMSSD (p = 0.029), median RR (p = 0.02), and pRR50 (p = 0.031). In the frequency domain of HRV, there was a insignificant increase in HF (p = 0.08857), a decrease in VLF (p = 0.09315), and LF (p = 0.19087). There was a significant decrease in LF/HF ratio (p = 0.02745) and ART (p = 0.011). The *Nadi Shodhana* group mean ± SD scores are in [Table 1](#).

### 3.2.2. Bhramari Pranayama

There was a significant decrease in SBP (p = 0.011) and DBP (p = 0.04). In the time domain of HRV, there was a significant increase in RMSSD (p = 0.0295), median RR (0.003), and pRR50 (p = 0.031). In the frequency domain of HRV, there was a significant increase in HF (p = 0.042) and there was a significant decrease in LF/HF ratio (p = 0.023). Whereas there was an insignificant decrease in LF (p = 0.167) and VLF (p = 0.08764). There was a significant decrease in the ART (p < 0.00001). The *Bhramari* group Mean ± SD scores are in [Table 1](#).

## 3.3. Repeated measures analysis of variance (RM-ANOVA)

The HRV and ART components show significant change in [Table 2](#).

## 4. Discussion

In the present study, the effect of 20 min practice of *Nadi Shodhana* and *Bhramari Pranayama* was found to reduce the heart rate variability along with a significant change in auditory reaction time. This finding indicates that the practice of *Nadi Shodhana* or *Bhramari Pranayama* both reduces blood pressure and improves the reaction time in patients with essential hypertension. This is the first study to compare the immediate effect of *Nadi Shodhana* and *Bhramari Pranayama* on HRV and ART.

A previous study done on pranayama showed a decrease in the SBP, DBP , and HR due to de-stressing effect of pranayama.



**Table 2**  
Repeated Measure Analysis of Variance (RM-ANOVA) showing the value of results.

Variables	Effect	F Value	df	Level of significance/P	pEta <sup>2</sup>
SBP	TIME	11.32	1,98	0.001	0.10
	GROUP	0.43	1,98	0.51	0.004
	TIME* GRUOP	0.44	1,98	0.51	0.004
DSP	TIME	8.31	1,98	0.005	0.078
	GROUP	4.17	1,98	0.043	0.041
	TIME* GRUOP	0.180	1,98	0.672	0.002
Median R	TIME	4.02	1,98	0.047	0.040
	GROUP	1.37	1,98	0.242	0.014
	TIME* GRUOP	0.150	1,98	0.699	0.002
Mean HR	TIME	16.14	1,98	0.001	0.141
	GROUP	0.007	1,98	0.933	7.322
	TIME* GRUOP	2.50	1,98	0.116	0.025
RMSSD	TIME	7.85	1,98	0.006	0.074
	GROUP	0.230	1,98	0.632	0.002
	TIME* GRUOP	0.31	1,98	0.568	0.003
pRR50	TIME	8.80	1,98	0.004	0.083
	GROUP	0.013	1,98	0.907	1.385
	TIME* GRUOP	0.050	1,98	0.821	5.243
VLF	TIME	6.76	1,98	0.011	0.065
	GROUP	0.204	1,98	0.652	0.002
	TIME* GRUOP	0.061	1,98	0.803	6.356
LF	TIME	11.23	1,98	0.001	0.103
	GROUP	0.18	1,98	0.660	0.002
	TIME* GRUOP	0.64	1,98	0.421	0.007
HF	TIME	9.08	1,98	0.003	0.085
	GROUP	0.014	1,98	0.906	1.426
	TIME* GRUOP	0.14	1,98	0.696	0.002
LF/HR	TIME	15.17	1,98	0.001	0.134
	GROUP	0.002	1,98	0.968	1.617
	TIME* GRUOP	0.02	1,98	0.859	3.225
ART	TIME	59.45	1,98	0.001	0.378
	GROUP	27.83	1,98	0.001	0.221
	TIME* GRUOP	45.39	1,98	0.001	0.317

This leads to a reduction in sympathetic arousal resulting in decrease in adrenaline secretion, stimulation of stretch receptors in the lungs leading to stimulation of the Hering-Breuer inflation reflex which causes the sympathetic tone withdrawal and vasodilatation and activation of parasympathetic nervous system [26]. In this study, following *Nadi Shodhana Pranayama* was observed to have a significant reduction in the SBP and DBP. A previous study done by Tripathy et al. on the immediate effect of *Nadi Shodhana Pranayama* showed a reduction in SBP and DBP which may be due to the activation of parasympathetic dominance [27].

Mechanism behind the effect of *Nadi Shodhana Pranayama* in reduction of BP may be due to the breathing, that stimulates the olfactory nerves situated in the roof of the nasal cavity. This is transferred to olfactory bulbs which are situated in the region of cribriform plate. This olfactory bundle is connected to the front of the brain, which is in turn connected to the hypothalamus. Hypothalamus is the part of the brain that regulates hormones. In any perceived stress condition, the serotonin receptors in the hypothalamus with the help of splanchnic pathway regulate the stress. When there is a dysregulation of respiration, the face lock of the olfactory signals occurs, and hypothalamus does not receive proper signal. This causes disorganized information to hypothalamus and due to this phenomena hypothalamus pituitary adrenal dysfunction occurs. The regulated breathing pattern in *Nadi Shodhana Pranayama* causes regulation of the HPA axis. Hence, reduction in BP is observed [28]. In this study, the results showed decrease in LF, VLF, and LF/HF ratio after the intervention. Also, there was an increase in HF after an intervention. Similar changes in HRV can be seen in the study done by Supriya et al. following the *Nadi Shodhana Pranayama* [29]. A significant decrease in the ART following *Nadi Shodhana Pranayama* may be due to the voluntary change in the breathing pattern and the state of the parasympathetic dominance

followed by the distressing effect and relaxation effect of *Nadi Shodhana Pranayama* [30].

In the current study following 20 min of *Bhramari Pranayama*, there was a significant decrease in SBP, DBP and HR. The results of the current study are supported by the study conducted by Vungarala Satyanand et al. which shows a significant reduction in BP and HR following *Bhramari Pranayama* practice for 10 min due to the humming of the “O–U–Mmmma” sound causes vibration of the nasal/laryngeal mucous membrane during exhalation which causes switching off the inspiratory centres leads to reflex apnoea which causes bradycardia through chemoreceptor sinu-aortic mechanism [31]. The humming helps to boost the production of nitric oxide from sinuses and nasal mucosa which acts as vasodilator, improves blood circulation, and maintain the oxygen supply to heart muscles. Nitric oxide is known to modulate norepinephrine, serotonin, dopamine, glutamate, and the other major neurotransmitters [32,33].

In our study, there was highly significant reduction in ART after the practice of *Bhramari Pranayama*. Similar observation was done in the study conducted by S. Jore et al. which showed significant reduction in reaction time following pranayama practice in medical students. The stress can cause altered behavioral changes i.e., depression and anxiety, whereas reduction in reaction time could be due to greater cortical arousal & faster rate of information processing, improved concentration power, ability to ignore external stimuli. This act of breathing removes attention from worries & distress and practitioner can better handle day to day emotional, physical & mental stress [34].

In the present study, the effect of 20 min practice of *Nadi Shodhana* and *Bhramari Pranayama* was found to reduce the heart rate variability along with the significant change in auditory reaction time.

There no control group in this study and the intervention given to both groups was a different pranayama. Hence, we cannot claim changes in the outcome of this study. Therefore, this limitation has been added to this study.

The strength of this study is that it is the first study done to compare the effect of *Nadi Shodhana* and *Bhramari Pranayama* and participated a greater number of hypertensive patients using HRV and ART as assessment criteria. It was a Parallel Randomized controlled trial with clinical application. Standard assessment equipment is used to assess HRV and ART hence precise, reliable data was obtained.

The major limitation of this study was that it was an immediate and comparative study with no control group, and demographical data and Antihypertensive drug levels were not recorded in this study due to a lack of information. For further study, a long-term comparison with the inclusion of educational and occupational background and levels of antihypertensive drugs can be done with various parameters.

## 5. Conclusions

Our findings suggest that *Nadi Shodhana* and *Bhramari Pranayama* are simple, non-invasive, and cost-effective methods that can be helpful in the management of hypertension for immediate blood pressure reduction. As the study was conducted at Nature Cure Hospital, participants were also receiving other yoga and naturopathy interventions during the study period, which can be a confounding factor for the study.

## Author contributions

Junu Upadhyay: Conceptualization, Writing Original draft, Writing-review, editing, Funding acquisition, Supervision, Project

administration & Resources. Nandish NS: Conceptualization, Writing-Original draft, Writing-review and editing, Formal analysis. Shiva Prasad Shetty: Conceptualization, Investigation. Apar Avinash Saoji: Software, formal analysis, Methodology & Visualization. Sunil Singh Yadav: Editing, Software, Data curation and Validation.

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None.

### Declaration of interest statement

The authors have no conflicts of declaration. The contents of the manuscript are seen and agreed upon by the authors. There is no financial interest to report. The author certifies that the submission is original work and not under revival at any publication.

### Data availability

Data can be obtained from the author on request.

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