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Comparative Study Between Alternate Nostril Breathing and Humming Bee Breathing on Heart Rate Variability in Primary Hypertension

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Abstract:

- ***Background & Objectives***

Primary hypertension is a major public health concern worldwide and a leading risk factor for cardiovascular morbidity and mortality. Its management includes lifestyle modifications, pharmacological treatment with antihypertensive medications, and complementary non-pharmacological interventions. Among these, yoga has gained considerable attention for its beneficial effects in the management of hypertension. Pranayama, a key component of yogic practice, has been shown to enhance parasympathetic activity, reduce sympathetic activity, improve cardiovascular and respiratory functions, and alleviate the physiological effects of stress. Among the various pranayama techniques, alternate nostril breathing (Nadi Shodhana) and humming bee breathing (Bhramari Pranayama) have demonstrated promising effects on autonomic regulation and blood pressure control. Therefore, the present study aimed to evaluate and compare the effects of alternate nostril breathing and humming bee breathing on individuals with primary hypertension.

- ***Methods***

Sixty pre-diagnosed individuals with primary hypertension, aged 25–50 years, were recruited for the study after screening according to the predefined inclusion and exclusion criteria. Participants were randomly allocated into two equal groups using a computer-generated randomization method: Group 1 received Alternate Nostril Breathing (ANB), and Group 2 received Humming Bee Breathing (HBB). Baseline measurements were recorded two minutes before the intervention, and post-intervention measurements were obtained two minutes after the completion of the intervention. Following data collection, the dataset was assessed for normality of distribution and homogeneity of variance. Statistical analysis was performed using appropriate parametric (t-tests) and non-parametric tests based on the distribution of the data.

- ***Result:***

Both intervention groups demonstrated a statistically significant reduction in systolic blood pressure, diastolic blood pressure, low-frequency (LF) power, and the low-frequency/high-frequency (LF/HF) ratio, along with a significant increase in high-frequency (HF) power following the intervention. Comparative analysis between the two groups revealed that the reduction in both systolic and diastolic blood pressure was significantly greater in Group 1 (Alternate Nostril Breathing), whereas improvements in heart rate variability (HRV) parameters, particularly the increase in HF power and reduction in LF and LF/HF ratio, were more pronounced in Group 2 (Humming Bee Breathing).

- ***Conclusion:***

The findings of the present study suggest that both Alternate Nostril Breathing (ANB) and Humming Bee Breathing (HBB) are effective complementary interventions for the immediate management of primary hypertension. Humming Bee Breathing was more effective in producing an immediate improvement in heart rate variability, indicating enhanced parasympathetic activity and autonomic balance. In contrast, Alternate Nostril Breathing demonstrated a greater immediate reduction in both systolic and diastolic blood pressure. Therefore, HBB may be preferred for improving autonomic regulation, whereas ANB may be more beneficial for the immediate reduction of blood pressure in individuals with primary hypertension.

Keywords: *Primary Hypertension, Pranayama, Alternate Nostril Breathing, Humming Bee Breathing, HRV.*

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I. INTRODUCTION

Hypertension (HTN), also known as high blood pressure (HBP), is a chronic medical condition characterized by persistently elevated arterial blood pressure.[1] It is a major contributor to cardiovascular morbidity and mortality worldwide, including in India. [2] The prevalence of hypertension increases with age, and approximately 80% of individuals with hypertension are over 45 years of age. Globally, hypertension is estimated to account for 13.5% of all deaths and contributes to approximately 54% of stroke cases and 47% of ischemic heart disease cases. It is also recognized as the third leading risk factor for disability-adjusted life years (DALYs).[3]

Hypertension is directly responsible for nearly 57% of stroke-related deaths and 24% of coronary heart disease deaths in the country. [4] Epidemiological studies have shown that the prevalence of hypertension is increasing more rapidly in urban than in rural populations. Based on current diagnostic criteria, more than two-fifths of the urban adult population in India has hypertension.[5] Several factors have contributed to this increasing prevalence, including rapid urbanization, unhealthy lifestyle changes, dietary modifications, psychological stress, population growth, and rising unemployment.[6]

Non-pharmacological interventions are considered the cornerstone of hypertension prevention and management, particularly among individuals with pre hypertension and early-stage hypertension. Lifestyle modifications are strongly recommended as first-line strategies because they effectively lower blood pressure, reduce cardiovascular risk, and may delay or eliminate the need for antihypertensive medications.[7] These interventions include weight reduction, dietary modifications, regular physical activity, sodium restriction, moderation of alcohol consumption, and smoking cessation. In addition to improving blood pressure control, lifestyle modifications provide several health benefits, including improved glycemic control, reduced serum cholesterol levels, decreased healthcare costs, and a lower risk of medication-related adverse effects.[8]

Among the various dietary interventions, the Dietary Approaches to Stop Hypertension (DASH) diet has been extensively studied and is widely recommended for the prevention and management of hypertension. Evidence suggests that adherence to the DASH dietary pattern not only reduces blood pressure but also promotes weight loss, lowers resting heart rate, improves insulin sensitivity, decreases inflammatory markers such as C-reactive protein, reduces apolipoprotein B and homocysteine concentrations, and is associated with a lower risk of cardiovascular diseases, including heart failure and type 2 diabetes mellitus.[9,10]

The primary objective of non-pharmacological management is to achieve and maintain optimal blood pressure levels while reducing overall cardiovascular risk through sustainable lifestyle changes.[11] Clinical evidence indicates that weight reduction is one of the most effective interventions, with an estimated reduction of 6–16 mmHg in systolic blood pressure for every 10 kg of weight lost. Regular moderate-intensity physical activity for at least 30 minutes on most days of the week can reduce systolic blood pressure by approximately 3.8 mmHg, whereas limiting alcohol consumption may result in an average reduction of 3.3 mmHg. Dietary sodium restriction to less than 6 g of salt per day has been shown to lower blood pressure by approximately 4.6–6.7 mmHg. Additional lifestyle measures such as fish oil supplementation, increased dietary fiber, calcium supplementation; stress management, meditation, and yoga have also demonstrated varying degrees of effectiveness, although the supporting evidence remains limited or inconsistent.[11]

Overall, comprehensive lifestyle modification remains an essential component of hypertension management and is recommended as the initial therapeutic approach for most individuals with elevated blood pressure. When implemented consistently, these interventions significantly reduce blood pressure, decrease the risk of cardiovascular complications, and improve long-term health outcomes.

Yoga is an ancient holistic discipline that aims to unite individual consciousness with universal consciousness through the integration of physical, mental, and spiritual practices. Owing to its comprehensive approach, yoga has gained widespread acceptance as a feasible and effective non-pharmacological intervention for promoting mental health, enhancing psychological resilience, reducing stress, and improving overall quality of life.[12]

Lifestyle-related diseases are strongly associated with unhealthy behavioral patterns, including physical inactivity, unhealthy dietary habits, chronic stress, inadequate sleep, and other irregular lifestyle practices.[13] Adopting a healthy lifestyle characterized by balanced nutrition, regular physical activity, stress management, and adequate rest is considered one of the most effective strategies for preventing and managing chronic non-communicable diseases.

Yoga therapy integrates physical postures, breathing techniques, meditation, and relaxation practices with principles of healthy living, thereby promoting both physical and

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psychological well-being. [14] Breathing plays a fundamental role in maintaining physiological homeostasis and regulating the interaction between the body and mind. In yogic philosophy, pranayama refers to the conscious regulation of breathing to enhance the flow of vital energy (prana) and promote physical, mental, and emotional well-being.[15,16] Unlike automatic breathing, which is primarily regulated by the medulla oblongata in the brainstem, conscious breathing involves activation of higher cortical centers within the cerebral cortex. This cortical activation is believed to influence neural pathways associated with emotional regulation, attention, and cognitive control, thereby promoting relaxation, reducing stress, and enhancing psychological well-being.[15,16] Through conscious modulation of breathing patterns, pranayama may alter autonomic nervous system activity, improve emotional stability, and facilitate a state of mental calmness and heightened awareness.

Among the various pranayama techniques, nostril breathing involves a controlled sequence of inhalation, breath retention, and exhalation. This practice is believed to enhance pulmonary ventilation, improve oxygen uptake, and facilitate the efficient elimination of carbon dioxide, thereby supporting optimal respiratory function. Regular practice of controlled breathing has been associated with improved gas exchange, enhanced cardiovascular efficiency, and reduced physiological stress by decreasing the workload on the heart and lungs. Furthermore, pranayama has been reported to improve autonomic balance by increasing parasympathetic activity and reducing sympathetic over activity, which may contribute to its beneficial effects on cardiovascular health, stress management, and overall quality of life.[16]

Alternate Nostril Breathing (ANB), also known as Nadi Shuddhi Pranayama or Nadi Shodhana Pranayama, is a yogic breathing technique that involves controlled inhalation and exhalation through alternate nostrils in successive respiratory cycles.[17] ANB is one of the most widely practiced pranayama techniques and has gained increasing scientific attention because of its potential therapeutic effects on cardiovascular and autonomic function. Emerging evidence suggests that regular practice of Alternate Nostril Breathing positively influences the autonomic nervous system by enhancing parasympathetic activity and reducing sympathetic over activity, thereby contributing to improved cardiovascular regulation.[18]

Bhramari Pranayama, commonly known as Humming Bee Breathing, is a calming yogic breathing technique that involves deep inhalation followed by slow exhalation while producing a humming sound resembling that of a bee. During the practice, the ears are gently closed with the fingers to enhance awareness of the internal vibrations generated by the humming sound.[19] Bhramari Pranayama is believed to facilitate a meditative state by directing attention inward and harmonizing mental activity. The vibrations produced during exhalation exert a soothing effect on the nervous system, thereby reducing stress, promoting emotional balance, and enhancing relaxation there by improves autonomic regulation.

Although yogic breathing techniques have been shown to improve cardiovascular function and reduce blood pressure, evidence directly comparing the effects of Alternate Nostril Breathing and Bhramari Pranayama in individuals with primary hypertension is limited. Therefore, the present study was undertaken to compare the immediate effects of these two pranayama techniques on heart rate variability (HRV) and blood pressure in patients with primary hypertension.

II. METHODOLOGY

Participants with a pre-existing diagnosis of primary hypertension according to the Indian Guidelines on Hypertension (IGH-III), 2013, were recruited from SDM Yoga and Nature Cure Hospital, Shanthivana, Dharmasthala. A total of 214 hypertensive patients were screened, of whom 60 eligible participants (aged 25–50 years) of either sex with primary hypertension, with or without antihypertensive medication, were enrolled. Participants with ischemic heart disease, type 2 diabetes mellitus, and hypercholesterolemia[20] were included, whereas those with a history of Percutaneous Transluminal Coronary Angioplasty (PTCA), with or without stenting, Coronary Artery Bypass Graft (CABG) [21] surgery, and female participants during their menstrual cycle[22,23] were excluded. Ethical approval was obtained from the Institutional Ethics Committee of SDM College of Naturopathy and Yogic Sciences, and written informed consent was obtained from all participants before the intervention. The participants were randomly allocated using a computer-generated randomization sequence into two groups, with 30 participants in Group 1 and 30 participants in Group 2.

- *Demographic Characteristics of the Participants*

A total of 60 participants completed the study, with 30 participants each in Group 1 (ANB) and Group 2 (HBB). In Group 1, there were 19 males and 11 females, while Group 2 comprised 20 males and 10 females. The participants were aged between 25 and 50 years. In Group 1, the mean age of male participants was 38.38 ± 8.04 years and that of female participants was 42.27 ± 5.06 years. In Group 2, the mean age of male participants was 43.30 ± 6.13 years, whereas the mean age of female participants was 38.37 ± 7.85 years.

- *Assessment*

The assessments and interventions for both groups were conducted at Anveshana Research Laboratory, SDM Yoga and Nature Cure Hospital, Shanthivana. Heart rate variability (HRV) was recorded using electrocardiography (ECG) with the BIOPAC MP36 system in a standard bipolar limb lead II configuration before and after the 15-minute intervention. Each HRV recording was performed for 10 minutes under standardized conditions, with participants seated comfortably and instructed to remain relaxed and minimize movement throughout the recording period. The study assessed autonomic

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variables including blood pressure (BP), heart rate (HR), RR interval, root mean square of successive differences (RMSSD), NN50, pNN50, low-frequency (LF) power, high-frequency (HF) power, and the LF/HF ratio. These HRV parameters, encompassing both time-domain and frequency-domain measures, were selected to evaluate autonomic nervous system function. LF power was considered to represent sympathetic modulation, HF power as an indicator of parasympathetic activity, and the LF/HF ratio as a measure of sympathovagal balance[24].

- *Intervention*

Participants were randomly allocated into two groups, Group 1 (Alternate Nostril Breathing, ANB) and Group 2 (Humming Bee Breathing, HBB), using a computer-generated randomization method to minimize allocation bias. Both interventions were performed for 15 minutes with participants seated comfortably in a relaxed posture with eyes closed, spine and head upright, and hands in chin mudra. The ANB group practiced alternate nostril breathing using Nasikagra mudra, involving inhalation and exhalation alternately through each nostril in a systematic sequence[25]. The HBB group practiced humming bee breathing by inhaling through the nose and performing slow, controlled exhalation with a continuous humming sound while gently closing the ears[25]. Each breathing practice was continued for 15 minutes under guided supervision.

- *Data Extraction and Analysis*

Heart rate was calculated in beats per minute from the R waves of the QRS complexes obtained from successive R–R intervals of digitized ECG recordings. The recorded data were visually inspected offline, and only artifact-free segments were included for analysis. Heart rate variability (HRV) frequency-domain analysis was performed using Fast Fourier Transform (FFT), and the power spectrum components, including low-frequency (LF: 0.04–0.15 Hz), high-frequency (HF: 0.15–0.40 Hz), and LF/HF ratio, were analyzed and expressed in normalized units. The extracted data were tabulated and analyzed using IBM SPSS version 21.0. Descriptive statistics, including mean, median, and standard deviation, were calculated, and normality of pre- to post-intervention changes was assessed using the Shapiro–Wilk test. Statistical significance was considered at $p < 0.05$ with 95% confidence intervals.

III. RESULTS

A total of 60 participants of both sexes, aged 25–50 years, were recruited for this comparative randomized controlled trial. Among male participants, the mean age was 38.38 ± 8.04 years in Group 1 and 43.30 ± 6.13 years in Group 2. Among female participants, the mean age was 42.27 ± 5.06 years in Group 1 and 38.37 ± 7.85 years in Group 2.

The baseline anthropometric characteristics of the participants were comparable between the two groups. The mean height, weight, and body mass index (BMI) in Group 1 were 165.90 ± 8.80 cm, 74.80 ± 9.80 kg, and 27.09 ± 2.20 kg/m², respectively. In Group 2, the corresponding values were 165.66 ± 8.03 cm, 75.83 ± 10.38 kg, and 27.56 ± 2.88 kg/m², respectively.

The mean pre-test and post-test systolic blood pressure (SBP) in Group 1 decreased from 137.67 ± 12.62 mmHg to 122.60 ± 12.41 mmHg**,** while in Group 2 it decreased from 134.53 ± 16.54 mmHg to 124.73 ± 16.56 mmHg**;** statistical analysis revealed a significant reduction in SBP within both groups **(**$p < 0.05$**).** Similarly, diastolic blood pressure (DBP) decreased from 87.53 ± 11.50 mmHg to 79.87 ± 9.32 mmHg in Group 1 and from 86.00 ± 9.38 mmHg **to** 80.53 ± 8.79 mmHg in Group 2, with both groups demonstrating significant reductions following the intervention **(**$p < 0.05$**).** The mean RR interval in Group 1 increased significantly from 815.03 ± 98.28 ms at baseline to 862.43 ± 90.12 ms after intervention **(**$p < 0.05$**),** whereas Group 2 showed a marginal, non-significant change from 861.77 ± 186.56 ms to 858.77 ± 115.92 ms **(**$p > 0.05$**).** Mean heart rate decreased from 77.93 ± 9.21 bpm to 73.17 ± 7.39 bpm in Group 1 and from 78.77 ± 7.79 bpm to 72.67 ± 6.90 bpm in Group 2, with both groups showing significant reductions **(**$p < 0.05$**).** The RMSSD values increased significantly from 38.06 ± 19.96 ms to 43.78 ± 21.41 ms in Group 1 and from 28.94 ± 13.96 ms to 35.39 ± 14.45 ms in Group 2 **(**$p < 0.05$**),** indicating enhanced parasympathetic modulation. Similarly, NN50 increased from 20.63 ± 16.31 to 24.86 ± 18.21 in Group 1 and from 13.46 ± 10.04 to 32.94 ± 24.18 in Group 2, while pNN50 increased from 7.88 ± 9.75% to 10.90 ± 10.39% in Group 1 and from 3.43 ± 3.54% to 8.08 ± 5.94% in Group 2; both parameters showed significant improvements following intervention **(**$p < 0.05$**).** The mean LF power decreased significantly from 55.15 ± 17.31 nu to 49.76 ± 19.76 nu in Group 1 and from 62.86 ± 18.82 nu to 51.23 ± 18.41 nu in Group 2 **(**$p < 0.05$**).** In contrast, HF power increased significantly from 44.03 ± 17.90 nu to 47.94 ± 19.44 nu in Group 1 and from 46.75 ± 12.69 nu to 74.09 ± 10.88 nu in Group 2 **(**$p < 0.05$**).** The LF/HF ratio showed a significant reduction from 2.21 ± 3.95 to 1.52 ± 1.66 in Group 1 and from 1.41 ± 0.58 to 0.97 ± 0.42 in Group 2 **(**$p < 0.05$**),** suggesting a shift toward enhanced parasympathetic modulation and improved sympathovagal balance following the interventions.

- *Summary of Between-Group Comparison*

Between-group comparison of gain scores using the Mann–Whitney U test demonstrated significant differences between the Alternate Nostril Breathing (Group 1) and Humming Bee Breathing (Group 2) groups for systolic blood pressure (SBP) **(**$p = 0.003$**),** diastolic blood pressure (DBP) **(**$p = 0.044$**),** NN50 **(**$p < 0.001$**),** and high-frequency (HF) power **(**$p = 0.007$**).** No significant between-group differences were observed for mean RR interval, mean heart rate (HR), RMSSD, pNN50, low-frequency (LF) power, or LF/HF ratio **(**$p > 0.05$**).** Effect size analysis using Cohen's *d* revealed a large effect of Alternate Nostril Breathing on SBP and a moderate effect on DBP and mean RR interval, whereas Humming Bee Breathing

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demonstrated large effects on NN50, mean HR, and LF/HF ratio, along with moderate effects on SBP, DBP, and LF power. The remaining autonomic variables showed small or negligible effect sizes, indicating comparable effects of both interventions on autonomic regulation.

Overall, both breathing interventions were effective in improving cardiovascular and autonomic function. However, Alternate Nostril Breathing produced greater reductions in systolic and diastolic blood pressure**,** whereas Humming Bee Breathing resulted in greater improvements in parasympathetic indices, particularly NN50 and HF power**,** indicating a stronger influence on cardiac autonomic modulation.

IV. DISSUCSION

The present study demonstrated that a single 20-minute session of Alternate Nostril Breathing (ANB) and Humming Bee Breathing (HBB) produced significant improvements in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate variability (HRV) in individuals with primary hypertension. Both interventions resulted in a significant reduction in SBP **(**$p < 0.001$**),** accompanied by improvements in HRV indices, indicating enhanced cardiac autonomic regulation [26, 27]. These findings suggest that both breathing techniques promote a shift toward parasympathetic dominance while attenuating sympathetic activity, thereby contributing to improved cardiovascular function[28].

The reduction in blood pressure observed following ANB may be explained by its modulatory effect on autonomic nervous system activity. SBP is primarily influenced by cardiac output, whereas DBP is largely determined by peripheral vascular resistance. Slow, controlled breathing has been shown to enhance baroreflex sensitivity, improve vagal tone, and reduce sympathetic outflow, leading to a decrease in heart rate and systemic vascular resistance[29]. In addition, the alternating pattern of nasal airflow during ANB has been proposed to facilitate autonomic balance through neural pathways linking the nasal mucosa with hypothalamic autonomic centers. This coordinated modulation of sympathetic and parasympathetic activity may underlie the observed reductions in blood pressure and the concurrent improvements in HRV.

Similarly, HBB elicited significant reductions in blood pressure and favorable changes in HRV[30]. The prolonged humming during exhalation promotes slow, rhythmic breathing, enhances vagal activation, and may increase nitric oxide release within the nasal passages, improving endothelial function and vascular relaxation[31]. Together, these physiological responses may contribute to reduced vascular resistance, enhanced parasympathetic modulation, and improved cardiovascular autonomic regulation in individuals with primary hypertension.

The time-domain indices of heart rate variability (HRV), including the R–R interval, RMSSD, NN50, and pNN50**,** are widely recognized as markers of cardiac parasympathetic (vagal) modulation. In the present study, the Alternate Nostril Breathing (ANB) group demonstrated an increase in the mean R–R interval following the intervention, whereas the Humming Bee Breathing (HBB) group showed a slight decrease; however, the between-group difference was not statistically significant. Both interventions produced significant increases in RMSSD**,** NN50**,** and pNN50 **(**$p < 0.05$**),** indicating enhanced vagal activity and improved parasympathetic regulation of cardiac function.

Similarly, the frequency-domain measures of HRV, including low-frequency (LF) power, high-frequency (HF) power, and the LF/HF ratio**,** demonstrated significant changes following the interventions. Both ANB and HBB resulted in significant reductions in LF power and the LF/HF ratio**,** along with a significant increase in HF power **(**$p < 0.05$**).** These changes are consistent with a shift in autonomic balance toward greater parasympathetic modulation and reduced sympathetic influence, suggesting that both breathing techniques acutely improve cardiac autonomic regulation in individuals with primary hypertension[32].

Comparison of the gain scores between groups using Cohen's *d* analysis and Mann–Whitney U testing revealed a greater reduction in SBP and DBP following ANB compared with HBB. This greater blood pressure-lowering effect of ANB may be attributed to its ability to promote autonomic balance through alternating stimulation of sympathetic and parasympathetic pathways, resulting in enhanced cardiovascular regulation. Both interventions produced significant improvements in HRV parameters, indicating increased parasympathetic modulation following practice.

However, HBB demonstrated a more pronounced increase in HF power**,** a frequency-domain marker predominantly associated with parasympathetic activity. This effect may be related to the prolonged expiratory phase and humming-induced vibrations during Bhramari practice, which can enhance vagal modulation.[32] Therefore, while ANB may have a greater influence on blood pressure regulation, both ANB and HBB appear to be effective in improving cardiac autonomic function in individuals with primary hypertension. HBB may provide additional benefits through enhanced parasympathetic activation, particularly reflected by the greater increase in HF power. These findings suggest that both pranayama techniques can be considered effective complementary interventions for improving autonomic balance and cardiovascular regulation in primary hypertension.

V. CONCLUSION

The present study demonstrated that both Alternate Nostril Breathing (ANB) and Humming Bee Breathing (HBB) produced immediate beneficial effects on autonomic cardiovascular regulation in individuals with primary hypertension. Both practices resulted in reduced sympathetic activity and a shift in sympathovagal balance toward enhanced vagal modulation, as evidenced by improvements in heart rate variability parameters.

The findings suggest that HBB may be particularly effective in enhancing heart rate variability through increased parasympathetic activity, whereas ANB may have a greater effect on reducing blood pressure parameters, including systolic and diastolic blood pressure. Therefore, both pranayama techniques may serve as simple, non-invasive, and cost-effective complementary approaches for improving autonomic balance and supporting blood pressure management in individuals with primary hypertension.

These findings highlight the potential clinical application of slow breathing practices as an adjunctive strategy for cardiovascular health promotion. Further studies with larger sample sizes and long-term follow-up are required to determine the sustained effects of these interventions on hypertension management and cardiovascular risk reduction.

REFERENCES

[1]. Naish Jeannette, Court Denise Syndercombe. Medical sciences. 2nd ed. Saunders; 2014. p. 562.
[2]. Special Article, Indian Guidelines on Hypertension – III. J Clin Prev Cradiol 2013;3:128-161
[3]. Lawes C, Hoorn S, Rodgers A. Global burden of blood-pressure-related disease, 2001. The Lancet. 2008; 371:1513-1518.
[4]. Gupta R. Trends in hypertension epidemiology in India. Journal of human hypertension. 2004 Feb;18(2):73.
[5]. Gupta R, Gupta VP. Hypertension epidemiology in India: lessons from Jaipur heart watch. Current science. 2009 Aug 10:349-55.
[6]. Das SK, Sanyal K, Basu A. Study of urban community survey in India: growing trend of high prevalence of hypertension in a developing country. International journal of medical sciences. 2005;2(2):70.
[7]. Joint National Committee on the Prevention Detection. Evaluation and Treatment of High Blood Pressure. The sixth report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure (JNC VI). Arch Intern Med 1997;157:2413-46
[8]. Nicoll R, Henein MY. Hypertension and lifestyle modification: how useful are the guidelines?2010 ;879-880
[9]. Chen ST, Maruthur NM, Appel LJ. The effect of dietary patterns on estimated coronary heart disease risk: results from the Dietary Approaches to Stop Hypertension (DASH) trial. Circulation: Cardiovascular Quality and Outcomes. 2010 Sep;3(5):484-9.
[10]. Craddick SR, Elmer PJ, Obarzanek E, Vollmer WM, Svetkey LP, Swain MC. The DASH diet and blood pressure. Current atherosclerosis reports. 2003 Nov 1;5(6):484-91
[11]. Bhatt SP, Arafath TK, Guleria R. Non-pharmacological management of hypertension.2007
[12]. Taneja DK. Yoga and health. Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine. 2014 Apr;39(2):68.
[13]. Han Y, Han M, Lee S, Sarkar AM, Lee YK. A framework for supervising lifestyle diseases using long-term activity monitoring. Sensors. 2012 May;12(5):5363-79.
[14]. Bijlani RL, Vempati RP, Yadav RK, Ray RB, Gupta V, Sharma R, Mehta N, Mahapatra SC. A brief but comprehensive lifestyle education program based on yoga reduces risk factors for cardiovascular disease and diabetes mellitus. Journal of Alternative & Complementary Medicine. 2005 Apr 1;11(2):267-74.
[15]. P Lavie. Rediscovering the importance of nasal breathing in sleep or, shut your mouth and save your sleep .J Laryngol Otol. 1987 Jun;101(6):558-63.
[16]. Malhotra V, Tandon OP, Patil R, Sen TK, Lobo SW, Nagamma T, Rahul A, Singh A, Motani S, Choudhary A. Suryanadi Anuloma Viloma Pranayama Modifies Autonomic Activity of Heart. JOY: the journal of yoga. 2009 Mar 1;8(1).
[17]. Telles S, Nagarathna R, Nagendra HR. Breathing through a particular nostril can alter metabolism and autonomic activities. Indian Journal of Physiology and Pharmacology. 1994 Apr;38:133.
[18]. Srivastava RD, Jain N, Singhal A. Influence on alternate nostril breathing on cardiorespiratory and autonomic functions in healthy young adults. Indian journal of physiology and pharmacology. 2005;49(4):475.
[19]. Swami Satyanada Saraswathi. Asana Pranayama mudra bandha. 4th/17th reprinted. Bihar; Yoga publications trust, Munger; 2008.
[20]. Sujatha T, Judie A. Effectiveness of a 12-week yoga program on physiopsychological parameters in patients with hypertension. International Journal of Pharmaceutical and Clinical Research. 2014;6(4):329-35.
[21]. Rossi G, Seccia T, Gallina et al. Prospective appraisal of the prevalence of primary aldosteronism in hypertensive patients presenting with atrial flutter or fibrillation (PAPPHY Study): rationale and study design. Journal of Human Hypertension. 2012; 27(3):158-163.
[22]. Yildirir A, Kabakci G, Akgul E et al. The effects of menstrual cycle on cardiac autonomic innervation as

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26aug544

assessed by heart rate variability. Journal of the American College of Cardiology. 2002;39:208.

[23]. Princi T, Parco S, Accardo A et al. Parametric evaluation of heart rate variability during the menstrual cycle in young women. Biomedical Sciences Instrumentation. 2005; 41:340-345.

[24]. Taskforce. Heart rate variability: standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Circulation 1996;93(5):1043–65.

[25]. Saraswati SS. Introduction to yoga in Asana, Pranayama, Mudra and Bandha. : Yoga Publication Trust; 2012. 385-390

[26]. Franklin SS. Systolic blood pressure: it's time to take control. American journal of hypertension. 2004 Dec 1; 17(S3):49S-54S.

[27]. Hainsworth R. Circulatory responses from lung inflation in anesthetized dogs. American Journal of Physiology-Legacy Content. 1974 Feb 1; 226(2):247-55.

[28]. Eccles R. Nasal airflow in health and disease. Acta oto-laryngologol. 2000 Jan 1; 120(5):580-95.

[29]. Ganong WF. Review of MedicalPhysiology. 22nd ed. Boston, Mc Graw Hill 2005; 605

[30]. Kuppusamy M, Kamaldeen D, Pitani R, Amaldas J. Immediate effects of Bhramari pranayama on resting cardiovascular parameters in healthy adolescents. Journal of clinical and diagnostic research: JCDR. 2016 May; 10(5):CC17.

[31]. Keel CA, Neil E, Joels N. Blood groups In: Samson Wright's applied physiology, 13th ed. Oxford UK; Oxford University Press 1996; 46.

[32]. 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. Medical hypotheses. 2006 Jan 1; 67 (3):566-71.