###### **“Immediate effect of *Bhasthrika* & *Bhramari* *pranayamas* on autonomic and respiratory variables in healthy individuals”- A Randomized controlled trial.**

**Abstract:** ***Introduction:*** *Pranayamas,* one of the limbs of *Ashtanga yoga* . It involves manipulation of the breath and works as a dynamic bridge between the body and mind. Regular practices of *Pranayamas* have shown an increase in parasympathetic tone and a decrease in sympathetic activity. *Pranayamas* especially when done in a faster pace for a longer duration produce parasympathetic dominance in contrast to the short duration training which evokes a sympathetic activity. ***Material and Methods:*** Subjects of age 18-25 years who haven’t had any form of exposure towards yogic practices for the past 3 months were randomly recruited. A total number of 210 subjects were screened. Ninety subjects met inclusion criteria and were allocated randomly by using a computer generated randomization tool into 3 groups of 30 each. Group 1, Group 2 & Group 3 were assigned for the practice of *Bhasthrika, Bhramari & Breath Awareness* respectively. The data was collected for autonomic and respiratory variables by using polygraph (MP 36 Biopac Student Lab) at baseline, during & immediately after 5 mins of the practice for

each group. ***Observations and Results:*** The findings of the present study indicate that a significant increase in HR, RMSSD, LF, LF/HF ratio in all the three groups during the practice. However, interestingly an increase in HF was observed during *breath awareness* practice. Immediately following the practices, a significant reduction in HR, RMSSD, and HF were observed in all the three groups. However, NN50 increased significantly immediately following the practice as compared to the baseline levels following *Bhramari* and breath awarenessgroups. These findings suggest that all practices increase the sympathetic tone. Interestingly, *Bhrastrika* and *Bhramari Pranayama* practices increases the cardiac tone as indicated through NN50.

***Conclusion:*** The study investigated the immediate effects of *Bhasthrika , Bhramari* and breath awareness practices on autonomic and respiratory variables and concluded that there was an increase in HF during these practices which indicated an increase in cardiac tone. Short durations of *Bhastrika* and *Bhramari* *Pranayama* practices are therefore effective in physiological arousal among healthy individuals.

**Keywords** Pranayam; *Bhasthrika; Bhramari;Breath Awareness;* Heart rate variability.

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1. Introduction

The word “*Yoga*” comes from a Sanskrit root “*yuj*” which means union or yoke, to join and to direct and concentrate one's attention. [1,2] According to Patanjali yoga sutras, *Yoga* is a “union” of the mind, body and spirit. It is also understood as the science of the mind.[3] The holistic definition of *Yoga* is most relevant to the modern society where the matter-based paradigm has become the truth of the times. The aim of *Yoga* is to enhance the freedom to choose one’s way towards absolute freedom, which is freedom from tensions , stresses, diseases and miseries moving towards a positive and perfect health.[4] Since *Yoga* has been recognized as a form of mind body medicine having a holistic way of approach towards stress management, it can also be used as a technique to bring fitness and vigor to the physical body and also harness our emotions and expand our power of insight, vision, and analysis.[5] Physiologically, regular practice of *Yoga* help practitioners to become more resilient to stressful conditions and reduce several risk factors of various cardio-respiratory diseases. Muscle strength, flexibility, blood circulation and oxygen uptake as well as hormone functions have been shown to be improved by practicing *Pranayamas* (yogic breathing techniques) and *Asanas* (yogic postures) which form an integral part of the practice of yoga. In addition, meditation has also shown to help stabilize the autonomic nervous system by shifting towards a parasympathetic dominance.[6] *Yoga* plays a key role not only in improving mental health and quality of life in the treatment of a number of disorders.[7] but also lets its practitioners gain physical strength and a calming effect on the mind.[8] Yogic philosophies can be divided into four main branches viz; *Bhakti yoga, Karma yoga, Jnana yoga, and Ashtanga yoga.*[9] Of these, *Ashtanga yoga* is an eightfold path to awareness and enlightenment, consisting of eight limbs.[1,10] These limbs comprise of ethical principles for living a meaningful and purposeful life; serving as a prescription for moral and ethical conduct and self-discipline, they direct attention towards one's health while acknowledging the spiritual aspects of one's nature. [11] *Pranayamas,* one of the limbs of *Ashtanga yoga* [12,13] given by Maharishi Patanjali is considered to be much more important than asanas to attain sound health.[14,15] It involves manipulation of the breath and works as a dynamic bridge between the body and mind.[16] Pranayama consists of three phases “*Puraka*” (inhalation) considered as the first phase; “*Kumbhaka*” (retention) as the second phase and “*Rechaka*” (exhalation) as the third phase which can be either fast or slow.[17] The nasal cycle is an ultradian rhythm consisting of phases of breathing cycles and is characterized by the alternating potency of the left and right nares, with a periodicity of 2 to 8 hours.[18] The versions of breathing in a nasal cycle vary from single nostril breathing to bellow breathing .[17] The Autonomic Nervous system also known as the visceral or involuntary nervous system functions without a conscious and voluntary control and influences the activities of most of the organ systems in the body. It innervates cardiac muscles, smooth muscles and various other endocrine as well as exocrine glands. The ANS therefore makes a significant contribution to homeostasis by regulating blood pressure, gastro intestinal responses to food, contraction of the urinary bladder, focusing of the eyes, and by maintenance of body temperature.[19] Regular practices of *Pranayamas* have shown an increase in parasympathetic tone and a decrease in sympathetic activity which in turn decreases the effect of stress and strain on the body thereby improving cardio-vascular and respiratory functions.[20,21,22] Previous studies have demonstrated that different types of *Pranayamas* (including *Bhasthrika* and *Bhramari*) produce divergent effects and different physiological benefits[23,24,25] in specific ways .[26] *Pranayamas* especially when done in a faster pace for a longer duration produce parasympathetic dominance in contrast to the short duration training which evokes a sympathetic activity. [27] Heart rate variability (HRV) is a parameter used to assess the autonomic nervous system activity which is computed from the continuous ECG recordings and by analyzing the variability in the intervals between sinus rhythm heart beats (R-R intervals). [28] HRV is also used to assess the tonicity of autonomic balance in the body ,[29] and risks of sudden death are associated with a decreased HRV. It has been reported that HRV shows a favorable influence by yogic practices.[30] The conscious cortical regulation of brainstem respiratory centers influences the cardiovascular centers and brings about changes in HRV.[31] There have been many scientific studies on yoga and its longitudinal effects on physical function along with a phenomenal and ever increasing popularity of *Pranayama* in the past few years. There has however been a lack of studies done on the immediate effects of *Bhastrika*  and *Bhramari Pranayamas*.

Hence, the present study has been therefore undertaken to evaluate the immediate effects of *Bhastrika* and *Bhramari* *Pranayamas* on autonomic and respiratory variables amongst healthy individuals.

2. Experimental Section / Material and Methods

Subjects of age 18-25 years who haven’t had any form of exposure towards yogic practices for the past 3 months were randomly recruited from the SDM College of Naturopathy & Yogic Sciences, Ujire, Belthangady (Taluk) D.K (District), Karnataka (State). A total number of 210 subjects were screened. Ninety subjects met inclusion criteria and were allocated randomly by using a computer generated randomization tool into 3 groups of 30 each. Group 1, Group 2 & Group 3 were assigned for the practice of *Bhasthrika, Bhramari* & Breath Awareness respectively. The data was collected at baseline, during & immediately after 5 mins of the practice for each group.

 3. Results and Discussion

The data obtained following *Pranayamas* were analyzed for normal distribution and variance using Shapiro-wilk test with SPSS (Version 21.0). The pre, during and post data of the three groups were analyzed using Repeated measures analyses of Variance (RMANOVA), Bonferroni adjustment with post-hoc analysis.

Data of all three autonomic and respiratory variables were found to be normally distributed. The results of the pre, during and post comparisons for the 3 groups are detailed below:

**3.1 Heart rate and Heart Rate variability (HRV) :**

**Bhasthrika pranayama:**

Time domain and frequency domain analysis of HRV indicate a significant reduction in NN50 (p≤0.01) , pNN50 (p≤0.05), during the practice of *Bhastrika Pranayama* and there is also a reduction in RMSSD (p≤0.05), NN50(p≤0.01),VLF(p≤0.001), immediately following *Bhastrika* *Pranayama*. An increase in, VLF (p≤0.001) & LF/HF (p≤0.05)during the practice was observed. However, pNN50 (p≤0.05) increased significantly immediately after *Bhasthrika* *Pranayama*. These findings suggest that *Bhastrika* *Pranayama* caused sympathetic tone to be elevated during and immediately after the practice.

**Bhramari pranayama:**

Time domain and frequency domain analysis of HRV indicate a significant reduction in Respiration rate (p≤0.001), Mean RR (p≤0.001), VLF(p≤0.05) , and HF(p≤0.01) during the practice and an increase in HR(p≤0.001),RMSSD(p≤0.001), LF(p≤0.01) & LF/HF(p≤0.05) during *Bhramari* *Pranayama*. However, a significant increase was seen in Mean RR (p≤0.001) immediately after practicing *Bhramari* *Pranayama*. These finding suggest an elevated sympathetic tone with *Bhramari*  *Pranayama*.

**Breath Awareness :**

Time domain and frequency domain analysis of HRV indicate a significant reduction in Respiration (p≤0.01) during and an increase in Mean RR(p≤0.05) & LF/HF(p≤0.01) immediately after practicing breath awareness. These finding suggest an elevated Para sympathetic tone with areath awareness*.*

**Post-tests in between groups**

A significant reduction in Respiratory rate (F(2,87)=42.707;p=0.000) was observed in *Bhramari* *Pranayama* as compared to *Bhastrika* and breath awareness, pNN50 (F(2,87)=6.839;p=0.002) was observed in *Bhasthrika* *Pranayama* as compared to *Bhramari* and breath awareness, VLF (F(2,87)=25.191;p=0.000) seen in *Bhramari Pranayama* as compared to *Bhasthrika* and breath awareness, and LF (F(2,87)=7.444;p=0.001) in breath awareness as compared to *Bhasthrika* and *Bhramari*.

A significant increase in NN50 was observed (F(2,87)=7.046;p=0.001) was observed in breath awareness as compared to *Bhasthrika* and *Bhramari* *Pranayamas* ; HF (F(2,87)=7.444;p=0.001) compared to *Bhasthrika* and *Bhramari* *Pranyamas*; and LF/HF (F(2,87)=4.816;p=0.10) in *Bhramari Pranayama* as compared to *Bhasthrika* andbreath awareness.The groups mean values ±SD for Low frequency (LF), High frequency (HF), LF/HF ratio, NN50, pNN50, Hear Rate, Respiratory Rate, Mean RR and RMSSD values for normal healthy volunteers following the intervention of all three pranayamas are given in the table-1, table-2 nd table-3 individually.

 DISCUSSION

*In Bhasthrika pranayama :*Time domain and frequency domain analysis of HRV indicate a significant reduction in NN50(p≤0.01), pNN50 (p≤0.05), during the practice of *Bhastrika pranayama* and there is also a reduction in RMSSD(p≤0.05),NN50(p≤0.01),VLF(p≤0.001), immediately following *Bhastrika pranayama.* An increase in, VLF (p≤0.001) & LF/HF (p≤0.05) during the practice was observed. However, pNN50(p≤0.05) increased significantly immediately after *Bhasthrika pranayama*. These findings suggest that *Bhastrika pranayama* caused sympathetic tone to be elevated during and immediately after the practice.

In *Bhramari pranayama*: Time domain and frequency domain analysis of HRV indicate a significant reduction in Respiration rate (p≤0.001), Mean RR (p≤0.001), VLF(p≤0.05) , and HF(p≤0.01) during the practice and an increase in HR(p≤0.001),RMSSD(p≤0.001), LF(p≤0.01) & LF/HF(p≤0.05) during *Bhramari pranayama.* However, a significant increase was seen in Mean RR (p≤0.001) immediately after practising *Bhramari pranayama.* These finding suggest an elevated sympathetic tone with *Bhramari pranayama.*

In Breath Awareness :Time domain and frequency domain analysis of HRV indicate a significant reduction in Respiration(p≤0.01) during and an increase in Mean RR(p≤0.05) & LF/HF(p≤0.01) immediately after practicing breathawareness*.* These finding suggest an elevated para sympathetic tone with breathawareness*.*

**When compared with the Post-tests in between groups :**

A significant reduction in Respiratory rate (F(2,87)=42.707;p=0.000) was observed in *Bhramari pranayama* as compared to *Bhastrika* andbreathawareness , pNN50 (F(2,87)=6.839;p=0.002) was observed in *Bhasthrika pranayama* as compared to *Bhramari* andbreathawareness*,* VLF (F(2,87)=25.191;p=0.000) seen in *Bhramari pranayama* as compared to *Bhasthrika* andbreathawareness*,* and LF (F(2,87)=7.444;p=0.001) in *Breath awareness* as compared to *Bhasthrika* and *Bhramari.*

A significant increase in NN50 was observed (F(2,87)=7.046;p=0.001) was observed in breathawareness as compared to *Bhasthrika* and *Bhramari pranayamas* ; HF (F(2,87)=7.444;p=0.001) compared to *Bhasthrika* and *Bhramari pranyamas;* and LF/HF (F(2,87)=4.816;p=0.10) in *Bhramari pranayama* as compared to *Bhasthrika* andbreathawareness.

*Bhastrika Pranayama* involves forceful contraction of respiratory muscles and abdominal muscles. Earlier studies have also demonstrated an elevated heart rate immediately following *Bhastrika pranayama* suggesting an increase in sympathetic[32] activity. *Bhastrika pranayama* is found effective in decreasing BP and increasing HR immediately. Mullur Lata et.al study shown Increase MEP and PEFR immediately after *Bhastrika pranayama*.[33] In our study also it shows increased sympathetic activity and HRV indicate a significant reduction during the practice and there is also a reduction seen immediately after *Bhastrika pranayama*.

The phenomenon of *Bhastrika* simultaneously increasing the heart rate and decreasing blood pressure can be attributed to the duration of inhibitory neural impulses by activating pulmonary stretch receptors, which brings about withdrawal of sympathetic tone in blood vessels of skeletal muscle leading to widespread vasodilatation, thus causes decrease in peripheral resistance and thus DBP. [32]

Raghuraj et al have reported that *Nadishuddi* reduces sympathetic activity while *Kapalabhati* produces sympathetic stimulation. As like *Nadishuddi*, In our study there was significant HRV indicate a significant reduction in Respiration during and an increase in immediately after practicing breathawareness. These finding suggest an elevated para sympathetic tone with breathawareness.[34]

 In *Bhramari Pranayama* there is humming sound produced during exhalation by keeping fingers on ears and eyes.[35]The vibrations and sound produced during this exercise causes increased conduction of impulses in vestibulcohclear nerve. This eventually by virtue of its connection to the cerebellum and other extrapyramidal tract improves the performance output. During *Omkar* recitation, the first pronunciation A creates the vibrations, which affect on the spinal cord to increase it's efficiency.[36,37] affecting intermediolateral grey column.[38]

The second pronunciation U creates the vibrations in the throat and affects the Thyroid Glands, while the last pronunciation M, brings the vibrations to the brain, thereby activating the brain centres as a result of which, the efficiency of a brain increases.[36] As our study is concerned with performance output we decided to have longer M part as it is going to affect the brain activity.[36,37]In our study we observed HRV indicate a significant reduction in Respiration during. However, a significant increase seen immediately after practicing *Bhramari pranayama.* These findings suggest an slightly elevated sympathetic tone with *Bhramari pranayama.*

Results from a study by Madanmohan et al[34] shows that regular practice of breathing exercises (pranayama) increases parasympathetic tone, decreases sympathetic activity, improves cardio-vascular and respiratory functions, decreases the effect of stress and strain on the body and improves physical and mental health.[39] In yoga tradition, it is taught that different *Pranayamas* have different effects. Raghuraj et al have studied the acute effect of fast and slow *Pranayamas* on heart rate variability [40] while, Telles and Desiraju have demonstrated the heart rate changes during the performance of different *Pranayamas*.

**Table 1**:

**Showing HRV & respiratory rate measures in *Bhasthrika Pranayama*. Values are group mean ±S.D.**

|  |  |  |  |
| --- | --- | --- | --- |
| VARIABLES | PRE | DURING | POST |
| HR | 84.23±8.05 | 87.62±11.44 | 82.74±7.29 |
| RESP | 15.60±1.27 | 17.77±1.11 c  | 15.71±1.14 |
| MEAN RR | 725.34±4.14 | 719.49±111.39 | 736.89±65.42 |
| RMSSD | 51.27±52.95 | 78.41±66.90 | 39.14±32.19 y |
| NN50 | 77.73±68.76 | 36.53±45.38 a | 47.97±43.35 x |
| PNN50 | 16.50±15.38 | 7.20±8.58 b | 10.24±9.69 y |
| VLF | 28.11±14.33 | 59.45±\_21.69 c | 54.08±24.26 z |
| LF | 55.44±19.04 | 65.63±\_20.87 | 61.47±15.26 |
| HF | 44.56±19.04 | 34.37±20.87 | 38.54±15.26 |
| LF/HF | 1.99±2.09 | 3.98±4.59 b | 2.07±1.38 |

Note : a= <0.01, b= <0.05, c= <0.001 ; x=<0.01 , y=<0.05 , z= < 0.001

**Table 2 :**

**Showing HRV & respiratory rate measures in *Bhramari Pranayama.* Values are group mean ±S.D.**

|  |  |  |  |
| --- | --- | --- | --- |
| VARIABLES | PRE | DURING | POST |
| HR | 82.88±9.86 | 89.62±6.53 c | 82.19±9.69 |
| RESP | 15.34±1.85 | 11.69±\_25.26 c | 14.72±1.85 |
| MEAN RR | 734.25±91.01 | 685.16±48.72 c | 746.35±94.41 z |
| RMSSD | 47.34±34.57 | 103.26±59.62 c | 46.08±32.12 |
| NN50 | 86.40±63.05 | 84.03±45.19 | 87.70±70.73 |
| PNN50 | 18.32±14.32 | 16.30±9.09 | 19.04±16.17 |
| VLF | 28.85±17.47 | 17.00±13.67 b | 31.28±20.87 |
| LF | 56.58±20.12 | 70.37±16.97 a | 60.03±20.48 |
| HF | 43.42±20.14 | 29.63±16.97 a | 39.97±20.48 |
| LF/HF | 2.33±3.25 | 5.02±6.51 b | 2.93±3.96 |

\*p < 0.05, \*\*p < 0.01 and \*\*\*p < 0.001

**Table:3 Showing HRV & respiratory rate measures in *Breath Awareness*. Values are group mean ±S.D.**

|  |  |  |  |
| --- | --- | --- | --- |
|  VARIABLES | PRE | DURING | POST |
| HR | 82.84±10.11 | 83.4±4.21  | 80.15±9.21  |
| RESP | 15.9±1.31 | 14.87±1.93 **a** | 15.89±1.12 |
| MEAN RR | 740.34±89.83 | 735.93±75.76 | 767.92±90.28 **b** |
| RMSSD | 56.89±36.37 | 100.98±125.53 | 52.35±26.61 |
| NN50 | 97.87±85.43 | 108.77±72.98 | 99.90±2.31 |
| PNN50 | 21.48±20.01 | 24.62±16.79 | 22.49±17.58 |
| VLF | 29.82±14.08 | 23.69±16.04 | 36.36±19.42 |
| LF | 48.037±17.19 | 46.99±22.23 | 53.94±19.34 |
| HF | 51.96±17.19 | 53.00±22.24 | 46.04±19.33 |
| LF/HF | 1.19±0.89 | 1.51±1.76 | 1.70±1.45 **a** |

Note : a= <0.01, b= <0.05, c= <0.001 ; x=<0.01 , y=<0.05 , z= < 0.001

**Table 4: Showing Post Tests of between 3 Groups**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Bhasthrika | Bhramari | Breath Awareness | pŋ2 |
| HR | 82.74±7.29 | 82.19±9.69 | 80.15±9.21 | .034 |
| RESP | 15.71±1.14 | 14.72±1.85\*\*\* | 15.89±1.12 | .495 |
| MEAN RR | 736.89±65.42 | 746.35±94.41 | 767.92±90.28 | .029 |
| RMSSD | 39.14±32.19 | 46.08±32.12 | 52.35±26.61 | .025 |
| NN50 | 97.97±43.35  | 87.70±70.73 | 99.90±2.31 | .139 |
| PNN50 | 10.24±9.69\*\* | 19.04±16.17 | 22.49±17.58 | .136 |
| VLF | 54.08±24.26 | 31.28±20.87\*\*\* | 36.36±19.42 | .367 |
| LF | 61.47±15.26 | 60.03±20.48 | 53.94±19.34\*\*\* | .146 |
| HF | 38.54±15.26 | 39.97±20.48 | 46.04±19.33\*\*\* | .146 |
| LF/HF | 2.07±1.38 | 2.93±3.96\* | 1.70±1.45 | .100 |

\*p<0.01, \*\*p<0.05 and \*\*\*p<0.001

**Figure 1: Trial profile**



**Figure 2:** **HRV spectrum obtained by FFT analysis**



**Figure 3: Schematic representation of ECG (Electrocardiogram)**



**Figure 4: Measuring Heart rate variability**



**Figure 5:** **calculating Heart rate variability**

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**Graphical representation of the results between all the 3 groups**

**Graph 1:** **Showing the changes in heart rate**



**Graph 2: Showing the changes in Respiratory rate**

**Graph 3: Showing the changes in Mean RR**



**Graph 4: Showing the changes in RMSSD**



**Graph 5: Showing the changes in NN50**



**Graph 6: Showing the changes in PNN50**



**Graph 7: Showing the changes in VLF**



**Graph 8: Showing the changes in LF**



**Graph 9: Showing the changes in HF**



**Graph 10: Showing the changes in LF/HF**



4. Conclusions

The study investigated the immediate effects of *Bhasthrika, Bhramari* and breathawareness practices on autonomic and respiratory variables and concluded that there was an increase in HF during these practices which indicated an increase in cardiac tone. Short durations of *Bhastrika* and *Bhramari* *Pranayama* practices are therefore effective in physiological arousal among healthy individuals.

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04

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**Number of Figures /Graphs in the paper/article ---05 Figures / 10 Graphs-----------**

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