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Physiological effect of *Bhastrika Pranayama* on Cardio-Pulmonary variables among healthy individuals - A Randomized Controlled Trial

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ABSTRACT

Background And Objectives: *Bhastrika Pranayama* boosts airflow into the body, which produces heat both physically and subtly, igniting both the body's and mind's internal fires. This fast-breathing *Pranayama* increases energy, cleanses and regenerates the lungs, tones the diaphragm, heart, and abdominal muscles, improves circulation. Hence, the objective of this study was to assess the physiological impact of *Bhastrika Pranayama* on healthy individuals using cardio-pulmonary variables. **Materials and Methods:** 110 healthy male and female participants between the ages of 18 and 25 were enrolled, and they were randomly divided into a control group and a *Pranayama* group. The parameters SpO2, SBP, DBP, HR, RR, and PEFR were noted for pre and post values for both groups were recorded. The parameters were measured using a peak flow metre, cardiac monitor, and pulse oximeter. The *Pranayama* group received *Bhastrika Pranayama* for 4 weeks whereas the control group received no intervention. **Result:** The *Pranayama* group showed a significant improvement in SpO2 ($p \leq 0.05$), RR ($p \leq 0.05$) and PEFR ($p \leq 0.05$) and a small reduction in SBP, DBP and HR. Whereas, no significant changes were observed in the control group. **Discussion:** Following 4-week of *Bhastrika Pranayama* shows improvement in PEFR, RR, and SpO2 while lowers HR, SBP, and DBP somewhat. The benefits of *Bhastrika Pranayama* in healthy people in terms of fitness-related health conditions, both in the short and long term, may also be revealed by future research.

Key words: *Bhastrika Pranayama, Blood pressure, Heart rate, Peak expiratory flow rate, Respiratory rate, SpO2.*

INTRODUCTION

One of the ancient Indian techniques that is still used today is *Yoga*. Since it is the science of holistic living, it should be applied in everyday life. It affects a person's physical, emotional, psychological, vital, mental, and spiritual well-being. The Sanskrit word *Yuj*, which means "to join," is the root of the word *Yoga*, which has the meanings "unity" or "oneness." *Yoga* is a technique for bringing the body, mind, and emotions into harmony. The practice of *Yoga* includes *Asana*, *Pranayama*, *Mudra, Bandha, Shatkarma*, and meditation.[1] *Yoga* is not merely physical, but also physio-psychological and psycho-spiritual in nature. It is a science that frees one's mind from its shackles in the physical world and directs it towards the soul.[2] Regular *Yoga* practice cultivates qualities of friendliness, compassion and more self-control while encouraging strength, endurance and flexibility.[3] The eight stages of *Yoga*: *Yama, Niyama, Asana*, *Pranayama*, *Pratyahara, Dharana, Dhyana* and *Samadhi*. *Yama* are rules for universal moral commandments, *Niyama* are the rules for the self-purification, *Asana* is physical posture which helps in purify the body and mind, *Pranayama* is conscious prolongation of inhalation, retention and exhalation, pratyahara brings the mind and sense

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under control, *Dharana* is concentration on a single point, *Dhyana* is meditation and *Samadhi* is the super consciousness. *Prana* is a Sanskrit word that implies life force, vitality, energy, or vigour. *Ayama* is an acronym for prolonging, regulation, restraint, and control. The practice of *Pranayama* uses a variety of techniques to deliberately, rhythmically, profoundly move and expand the breathing system. It is made up of a slow, continuous flow of inhalation (*Puraka*), exhalation (*Rechaka*), and breath retention (*Kumbhaka*).[4] In the yogic method, *Pranayama* has been given a very significant role and is said to be considerably more crucial for maintaining good health than *Yoga Asanas*.[5] *Yoga* and *Pranayama* increase oxygen consumption, boost blood flow,[6] and shift the body towards the parasympathetic side, which brings about tranquilly. According to studies, *Pranayama* aids in the thalamic level processing of sensory data.[7] Swami Muktibodhananda explores the different ways to practice *Kumbhaka* in his book Light on *Hatha Yoga*, which describes how marvellous perfection is attained. Those who are knowledgeable practice different *Kumbhaka* to achieve them. *Surya Bedha, Ujjayi, Seetkari, Sheetali, Bhastrika, Bhramari, Moorchha,* and *Plavini* are the eight *Kumbhaka*. *Bhastrika* has a major physiological impact on the heart and brain. *Bhastrika* increases the compression and decompression on the brain, stimulating the flow of cerebral fluid and giving the brain a rhythmic massage. The heart and blood are stimulated by the diaphragm and lungs' rhythmic pumping. Each cell's accelerated rate of gas exchange and blood circulation generate heat and "wash out" waste gases. The respiratory center is stimulated by sympathetic nerves when hyperventilation starts to happen, but because more carbon dioxide is being released, the centre becomes relaxed and hyperventilation does not happen. Hyperventilation would occur if exhalation were to become less than inhalation. Inhalation and exhalation must therefore stay equal in *Bhastrika*. The diaphragm's quick and rhythmic movement stimulates the visceral organs as well, which has a massaging effect on the entire body. Thus, *Bhastrika* practice warms the sinuses and nasal passages, removing mucus and boosting resistance to colds and all respiratory illnesses.[8] Hence, the current study is undertaken to understand the outcome of *Bhastrika Pranayama* intervention on cardio-pulmonary variable among healthy individuals.

Aims and Objectives

The objectives and aims of this study was to assess the physiological impact of *Bhastrika Pranayama* on healthy individuals using cardio-pulmonary variables.

To evaluate the cardio-pulmonary changes following *Bhastrika Pranayama* among healthy individuals such as

- SpO2
- Systolic BP
- Diastolic BP
- Respiratory rate
- Heart rate
- Peak expiratory flow rate

Materials and Methods

This is a randomized controlled trial pre-post-study design. It was conducted at Alvas College of Naturopathy and Yogic Sciences, Moodabidri, Mangaluru, Dakshina Kannada, Karnataka. After obtaining a legally signed written consent, participants of healthy individual both male and female genders, age 18 to 25 years, who were willing to participate, joined the study. Subjects with Weak individual, Systemic illness, Tobacco chewing, under medication and those who under neurological or psychological disturbances were eliminated from the study. 110 healthy individuals were chosen for the study based on the inclusion and exclusion criteria. The illustration of study plan is shown in figure 1. Alvas College of Naturopathy and Yogic Sciences' ethical committee authorized the study.

Ethical Considerations

The study's purpose and the participants' rights as research subjects were explained to them. For individuals who couldn't comprehend English, an informed consent form was given in their native language, Kannada, and explained. Each subject

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received enough time to read the information sheet and have all of their enquiry. It was explained to them that they had the right to leave the study at any moment and that they had to be willing to take part voluntarily. By signing an informed consent form, each subject indicated their willingness to take part in the study. The institution's ethical committee has given the approvement for the project with the ethical clearance registration certificate no. ACNYS/IECHS/2021/79.

CTRI Registration number - CTRI/2022/09/045627

Assessments

Baseline and post assessment were done from both groups using the following assessment tools:

Pulse oximetry:

SPO2 was recorded with the help of pulse oximetry. The index finger of the subject will be plugged into silicon hole of the fingertip pulse oximeter (Nellcor N-20) which will not be too tight (which would constrict the circulation) or too loose (may fall off or let other light in).[9]

Cardiac monitor:

Systolic blood pressure (SBP) and diastolic blood pressure (DBP), respiratory rate (RR), and heart rate (HR) were measured by using Automatic non-invasive patient cardiac monitor EFFICA CM10 a phillips model, Manufactured by Philips Medical System, MA01810 USA.[10]

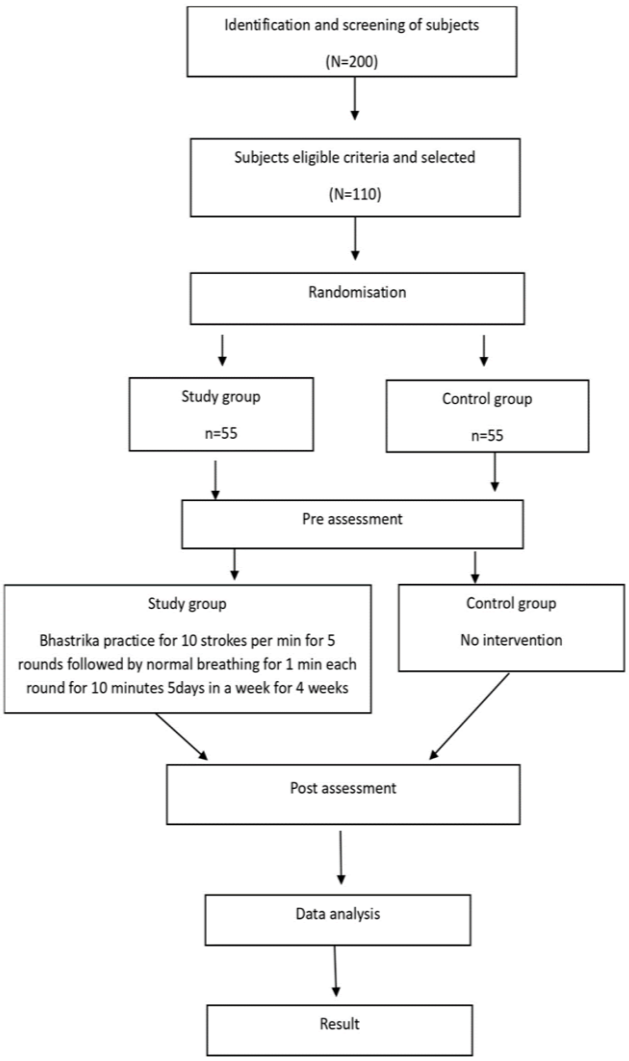
Peak flow meter:

Peak expiratory flow rate was measured by using mini wright peak flow meter (obtained from clement Clarke international Ltd, U.K) the subject were asked to take a deep breath and then blow out as hard as possible, in a short sharp blast through the mouth piece of peak flow meter and the resulting flow rate will be recorded by taking an average of three reading.[11]

Interventions

- The subject will be instructed to sit in a comfortable meditative posture like *Padmasana* or *Ardha Padmasana* or *Vajrasana* with hand resting on the knee in either chin or *Jnana Mudra.*

Figure 1: Illustration of study plan.



- Keeping the head and spine straight by closing eye and relax the whole body.
- The subject has to take a deep breath in and out quickly and forcefully through the nose without strain.
- Immediately afterwards breath in with same force.
- Forceful inhalation results from fully expanding the abdominal muscle and forceful exhalation from firm contraction of the abdominal muscles, do not strain.
- During inhalation, the diaphragm descends and the abdomen moves outward.
- During exhalation, the diaphragm moves upward and the abdomen inward.

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- The movement should be slightly exaggerated.
- Continue to breath in this manner, counting 10 breaths.
- After 10 breaths take a deep breath in and out slowly, this is one round.
- Keep the eye closed and concentrate on the breathing (Table-1).

Table 1: Method of *Bhastrika* practice for 4 weeks.

Bh as	NB	Bh as	NB	Bh as	NB	Bh as	NB	Bh as	NB
1m in	1m in	1m in	1m in	1m in	1m in	1m in	1m in	1m in	1m in

10 min

Bhas = Bhastrika, NB = Normal Breathing

Data analysis

The data was visually inspected for manual typographic errors. The shapiro-wilk's test for normality showed that the data was normally distributed. Paired samples t-test was used to assess within group differences. ANCOVA was performed to assess between group changes controlled for their respective baseline values. Levene's test for equality of variances were performed.

RESULTS

Analysis for within group changes in Experimental group indicated a significant increase in SpO2 ($p \leq 0.05$), RR ($p \leq 0.05$) and PEFR ($p \leq 0.05$) and a significant reduction was observed in DBP ($p \leq 0.05$). Whereas, no significant changes were observed in the control group. Between group changes performed using analysis of covariance for variables of interest adjusted for their respective baseline values indicated a significant difference in SpO2 ($F_{(1,107)}=140.75$, $p \leq 0.05$, $p\eta^2 = 0.57$), RR ($F_{(1,107)}=18.25$, $p \leq 0.05$, $p\eta^2 = 0.146$), and PEFR ($F_{(1,107)}=71.14$, $p \leq 0.05$, $p\eta^2 = 0.399$). Near significant changes were observed for HR ($F(1,107)=10.20$, $p=0.02$, $p\eta2 = 0.049$), SBP ($F_{(1,107)}=3.43$, $p=0.07$, $p\eta^2 = 0.031$) and DBP ($F_{(1,107)}=3.440$, $p=0.06$, $p\eta^2 = 0.031$). Table-2. The graphical representation of each parameters shown in figure 2-7.

Table 2: Table representing the cardio-pulmonary variables in Mean±SD before and after the intervention.

	Experimental group		Control Group	
	Pre (Mean±SD)	**Post (Mean±SD)**	**Pre (Mean±SD)**	**Post (Mean±SD)**
SpO2	97.2 ± 1.06	98.55 ± 0.57[a b]	97.27 ± 1.18	97.16 ± 1.10
SBP	116.29 ± 7.41	115.75 ± 6.6	117.02 ± 7.6	117.02 ± 7.56
DBP	71.6 ± 6.46	70.9 ± 5.71[a b]	71.24 ± 6.09	71.09 ± 6.14
RR	16.36 ± 2.7	17.20 ± 1.93[a b]	16.84 ± 2.67	16.80 ± 2.55
HR	75.89 ± 5.99	75.15 ± 5.19[b]	73.85 ± 5.82	73.71 ± 5.67
PEFR	305.82 ± 62.17	326.65 ± 51.13[a b]	303.82 ± 62.49	303.18 ± 61.3

Table mentioning the results of within and between group comparisons through paired samples t-test and analysis of covariance and the average (Mean±SD) values of the assessments.

[a]within group comparisons, level of significance $p \leq 0.05$

[b]Between group comparisons, level of significance $p \leq 0.05$

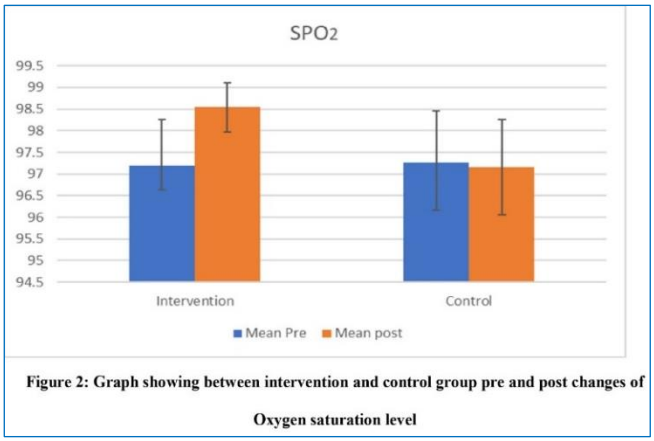

Figure 2: Graph showing between intervention and control group pre and post changes of Oxygen saturation level

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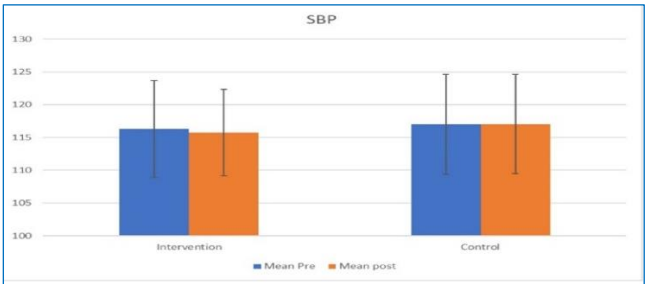

Figure 3: Graph showing between intervention and control group pre and post changes of Systolic blood pressure

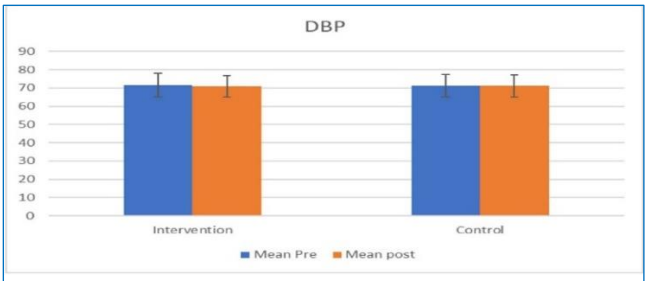

Figure 4: Graph showing between intervention and control group pre and post changes of Diastolic blood pressure

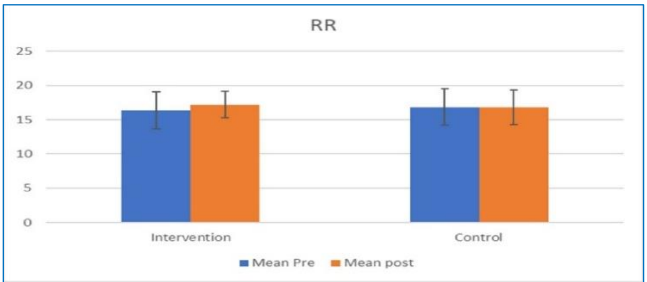

Figure 5: Graph showing between intervention and control group pre and post changes of Respiratory rate

Figure 6: Graph showing between intervention and control group pre and post changes of Heart rate

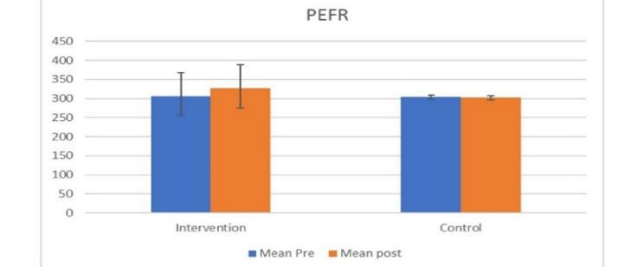

Figure 7: Graph showing between intervention and control group pre and post changes of Peak expiratory flow rate

Discussion

The present study shows there were significant improvement in SpO2, RR, and PEFR and a small reduction in HR, SBP & DBP after 4 weeks of intervention in the study group who practice *Bhastrika Pranayama*. Over the course of the trial, there were no changes in the above-mentioned parameters in the control group. The difference in SpO2, RR, and PEFR was shown to be statistically significant when comparing the post-training final findings of all the parameters between the study group and control group.

Thus, comparing with few other Studies, the report of some authors like Pramanik T, et. al. (2009) & Das Payel (2017), highlighted the *Pranayama* activates pulmonary stretch receptors, leading to vasodilation and decreased diastolic blood pressure by inhibiting sympathetic tone in skeletal muscle blood vessels after immediate practice of slow pace *Bhastrika.*[12] Another study done on short term practice of *Pranayama* on autonomic function by Riyanka Chail & Anjusha B (2019) suggest that there was a significant decrease in HR, SBP & DBP, possibly due to increase in vagal tone and a decreasing cardiac sympathetic activity.[13] Study for 40 days of *Pranayama* training on hypertensive subjects by Prashant K J *et al.* (2019) suggested that regular practice of *Pranayama* helps to reduce the BP, PR, and RR, indicating an effect on the cardiovascular reflex control system.[14] According to a brief overview of *Pranayama* published in 2006 by Jerath *et al.* suggested that *Pranayamic* breathing help the activation of stretch receptors in the lungs and stretching of fibroblasts in the connective tissue, enhances inhibitory neural impulses and hyperpolarization current, leading to increased parasympathetic dominance, and a decrease in blood pressure, heart rate, and oxygen consumption.[15] After 6 weeks of *Yoga* practice harmonizes the sympathetic and parasympathetic nervous systems, increases inhibitory neuronal impulses and reduces peripheral resistance and diastolic blood pressure.[16]

In the study, Budhi *et al.* (2019) found that healthy people who practiced *Bhastrika Pranayama* for one month had significantly higher FVC, FEV1, PEFR, and

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MVV values than those who exercised regularly. This suggests that a single session of *Bhastrika Pranayama* can activate prior unventilated lung areas, support respiratory muscle strength, while fast and slow *Pranayama* can lead to improvements in pulmonary functioning after 12 weeks of practice, according to Garg S. et al. (2017).[17] According to Arulmozhi *et al.* (2018), practicing *Pranayama* for 12 weeks helped in improving respiratory muscle strength by significantly increasing the maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), which changed their lung function in chronic asthmatics subjects[18] while also increasing chest expansion and peak expiratory flow rate in healthy individuals by Ankad RB, *et al.* (2011) also reported.[19] *Pranayama* can help to regulate the sympathetic and parasympathetic nervous systems, according to a study by Priyanka S, *et al.* (2021). *Pranayama* that corrects breathing irregularities and relaxes the respiratory system to encourage bronchial dilatation which helps in strengthening the muscles that control inhalation and exhalation.[20] After practicing *Pranayama* for 12 weeks and engaging in aerobic activity, Pathak R, *et al.* (2023) reported a significant improvement in FVC, FEV1, FEV1/FVC, and PEFR. However, the *Pranayama* group had better improvement than the aerobic exercise group.[21] Another study by Mayura Patila, et al. (2023) suggests that doing *Bhastrika* and *Suryabhedan Pranayama* for 12 weeks results in statistically significant improvements in PFT parameters including FVC, FEV1, and PEFR.[22] In agreement with another study, *Pranayama* intervention considerably raises blood oxygen saturation (SpO2), according to Vrinda Gokhle *et al.* (2018) findings. *Yoga* exercise raises oxygen saturation levels, possibly as a result of better blood circulation.[23] Another study by Rutuja and Rasika in 2022 revealed that practicing *Yogasana* increases the oxygen saturation level, indicating that it helps in supplying oxygen to all of the body's organs and maintaining their optimal functioning properly. With an increase in blood oxygen levels, the heart will beat more quickly, blood flow to the muscles and the lungs will increase, and small blood vessels will widen to get more oxygen into the body.[24]

According to the results of the current study, *Bhastrika Pranayama* improves SpO2, RR, and PEFR statistically significant while also a bit lowering HR, SBP and DBP in healthy individuals. With reference to earlier studies, the current study clearly demonstrates that by practicing *Bhastrika Pranayama* improves cardio-pulmonary function by strengthening respiratory muscles, accelerating blood flow and increasing carbon dioxide release, leading to improved gas exchange and relaxation of the respiratory centre, as well as activation of the parasympathetic system. Hence, single *Bhastrika Pranayama* can be suggested for therapeutic benefits of cardio-pulmonary disorders.

CONCLUSION

According to the study findings, practicing *Bhastrika Pranayama* for 4 weeks resulted in a considerable improvement in SpO2, RR, and PFFR as well as a slight reduction in heart rate, SBP, and DBP in healthy people. Additionally, *Bhastrika Pranayama* is excellent in enhancing cardio-pulmonary function. This ancient form of medicine is becoming more and more well-liked as a clinical field because of its availability, safety and affordability. It may be suggested as replacement for standard therapy for respiratory illnesses, part of our lifestyle and for the avoidance of cardio-pulmonary issues. *Yoga* and *Pranayama* have the ability to assist the nations in coping with global challenges.

Limitations and Future directions of study

The limitations of the study are the selection of healthy individuals as subjects and a shorter intervention period compared to previous research. Hence, Further studies are necessary to evaluate the exact physiological effects and underlying mechanisms of *Bhastrika Pranayama* in subjects with cardio-pulmonary disorders. Such studies require a larger sample size, advanced techniques, and a longer intervention period than previous studies.

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