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Effect of 6-week *Anulom-Vilom Pranayama* and *Bhastrika Pranayama* Yoga Training Intervention on Respiratory Parameters among High School Students of Punjab

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ABSTRACT

Aim: The present study aimed to examine the effect of 6-week *Anulom-Vilom* and *Bhastrika Pranayama* practices on selected respiratory parameters among school students in rural Punjab.

Materials and Methods: A quasi-experimental pre-test–post-test design was employed. A total of 20 healthy male students aged 13–16 years from Wheat Field School, Punjab, were randomly selected as participants. The intervention consisted of 6 weeks of structured pranayama training. Respiratory parameters, including vital capacity (VC), expiratory VC (EVC), and expiratory reserve volume (ERV), were measured using the Minispir Portable USB Spirometer. Data were statistically analyzed using GraphPad online software.

Results: Post-intervention analysis revealed a statistically significant improvement in pulmonary function parameters. *Anulom-Vilom Pranayama* practice produced marked increases in VC (3.28 > 2.26) and EVC (2.37 > 2.26), while *Bhastrika Pranayama* showed a positive effect on ERV (2.60 > 2.26).

Conclusion: The findings indicate that regular *Pranayama* practice, specifically *Anulom-Vilom* and *Bhastrika*, significantly enhances pulmonary function among adolescents, and thus be recommended as a preventive and promotive health strategy to improve lung efficiency and reduce the risk of future respiratory disorders.

1. INTRODUCTION

The word yoga means “union”: union of mind, body, and spirit – the union between us and the intelligent cosmic spirit of creation “the oneness of all things”.^[1] Hence, *Pranayam*, “control of *prana*” is not just breathing exercises. Through *Pranayam*, you use the breath to affect the constellation of energy that is your body-mind (Tony *et al.*, 2000). The word *prāṇāyāma* is derived from two Sanskrit roots – *prāṇa*, meaning “vital force” or “life energy,” and *āyāma*, meaning “extension” or “control.”^[2] Thus, *prāṇāyāma* refers to the regulation or expansion of vital energy through conscious breath control. In classical yoga philosophy, *prāṇāyāma* constitutes the fourth limb of *Aṣṭāṅga Yoga* as delineated by Patañjali’s *Yoga Sūtras*.^[3] It is a disciplined

breathing technique involving mindful awareness, rhythm, and mental concentration, aimed at harmonizing physiological and psychological processes. The term “yogic breathing” – a contemporary translation of *prāṇāyāma* – has gained increasing prominence in scientific and yogic literature for its documented effects on stress reduction, cardiorespiratory efficiency, and emotional regulation.^[4,5]

The psychological benefit of an exercise depends on its ability to improve the health of the individual performing it. The fourth element of the Eight-Fold Path of yoga is *Pranayam*, which emphasizes the regulation of breath and vital energy to promote harmony between body and mind. Yoga is the controlled use of “vital force” or “cosmic energy” through focus and conscious breathing.^[6] It is a system inherited from ancient Indian tradition, denoting a holistic “lifestyle” that aims to develop an individual’s physical, mental, and emotional dimensions.^[7] Kuvalayanandaji provided a comprehensive message for humanity, integrating ancient yogic principles with modern science

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to promote wellness and self-realization.^[8] Both the human personality and the human soul are addressed in his vision of yoga as a complete science of life. The system of wellness ensures freedom from disease, natural enhancement of physiological efficiency, mental discipline, and emotional transformation.^[9] A person's adaptability refers to the ability of joints to move through their full range of motion. The growth and strength of the muscles surrounding the joints are influenced by flexibility, which can be improved through systematic stretching, particularly after physical activity.^[10,11] Stretching when the muscles are warm and supple helps increase flexibility and reduces the risk of injury, thereby promoting both physical resilience and psychological well-being.

The five principles of yoga are relaxation, physical exercise (*asanas*), *pranayam* (breathing control), nourishing diet, and positive thinking and meditation, *pranayam* are yogic breathing techniques that increase the capacity of lungs. *Pranayam* is the control of inspiration and expiration.^[12] The inspiration of prana-vayu is "*shwasa*" and expiration is "*prashwasa*" and cessation of both is characteristic of *pranayam*. *Pranayam* improves overall performance of the body. The regular practice of *pranayama* increases chest wall expansion and almost all lung functions. The beneficial effect of different *pranayama* is well reported and has sound scientific basis.^[13] *Pranayama* makes efficient use of abdominal and diaphragmatic muscles and improves the respiratory apparatus.^[14] Yoga strengthens the respiratory musculature due to which chest and lungs inflate and deflate to the fullest possible extent, and muscles are made to work to the maximal extent.^[15]

Anulom-Vilom sometimes referred to as alternate nostril breathing, it is one of the fundamental breathing techniques used in Yoga. *Bhastrika Pranayam* is often known as "Yogic Breath of Fire," a technique that involves quick inhalations and exhalations. The current study will be helpful to understand how *Pranayam* has been shown to be helpful to enhance physical health, which it improves lung function, boost immunity, and reduces the risk of respiratory chronic diseases. *Pranayam* practice into a school's wellness program could have positive effects on student's physical and mental health, potentially leading to improve academic performance and overall well-being. *Pranayam* is a Yogic breathing technique, which has been practiced for centuries to promote physical, mental, and spiritual well-being. As it was widespread, there was limited scientific evidence on its effects on respiratory parameters. This study aims to investigate the impact of "*Anulom-Vilom Pranayam*" and "*Bhastrika Pranayam*" on respiratory parameters, including vital capacity (VC), force VC (FVC), expiratory VC (EVC), and expiratory reserve volume (ERV) among high school students.

2. OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- i. To assess the effect of *Anulom-Vilom Pranayama* on VC, EVC, FVC, and ERV among high school students in Punjab.
- ii. To assess the effect of *Bhastrika Pranayama* on VC, EVC, FVC, and ERV among high school students in Punjab.

3. RESEARCH METHODOLOGY

The present study adopted a true quasi-experimental pre-test–post-test research design to examine the effects of *Anulom-Vilom* and *Bhastrika Pranayama* on selected respiratory parameters among school students. A total of 20 ($n = 20$) male students from Wheat Field School, Punjab, aged 13–16 years, were randomly selected as subjects for the study. The participants were randomly divided into two equal groups: Group A (n

$= 10$) practiced *Anulom-Vilom Pranayama*, while Group B ($n = 10$) practiced *Bhastrika Pranayama* for a duration of 6 weeks. The selection of the techniques was guided by their feasibility, safety, and proven reliability in previous scientific studies on pulmonary function enhancement. Accordingly, the following variables were identified for testing: VC, EVC, Forced VC (FVC), and ERV. The 6-week *pranayama* training intervention served as the independent variable, while the aforementioned respiratory function parameters constituted the dependent variables. All respiratory assessments were conducted in the Human Performance Laboratory using a Minispir Portable USB Spirometer, which ensured precise and standardized measurement of pulmonary functions. The intervention protocols were administered during the morning sessions, under the direct supervision of the investigators, ensuring adherence, accuracy, and participant safety. The study followed an identical training schedule for both groups, differing only in the specific *pranayama* technique practiced. Pre-test and post-test measurements were recorded for all participants to evaluate the comparative effects of *Anulom-Vilom* and *Bhastrika Pranayama* on respiratory performance (Table 1).

After the collection of relevant data, to know the effect of *Pranayam* on respiratory parameter among high school students of rural Punjab, t-test was employed on mean of pre- and post-tests with the help of Graphpad (online software). The level of significance was set at 0.05%.

4. RESULTS AND INTERPRETATION OF DATA

The findings of the study present a comparative analysis of the pre-test and post-test scores for the two experimental groups – Group A (*Anulom-Vilom Pranayama*) and Group B (*Bhastrika Pranayama*) – over a 6-week intervention period. Statistical analysis was performed using the paired t-test to assess within-group differences between pre- and post-test means. The level of significance was set at $P < 0.05$, with a table value of $t = 2.26$ for $df = 9$.

4.1. Group A: *Anulom-Vilom Pranayama*

The results indicate that *Anulom-Vilom* training had a statistically significant effect on certain pulmonary parameters. The mean value of VC increased from 2.65 to 2.85, with a calculated t-value of $3.28 > 2.26$, suggesting a significant improvement following the 6-week intervention. Similarly, the mean of EVC improved from 2.61 to 2.89, with a calculated t-value of $2.37 > 2.26$, which also indicates a significant enhancement in respiratory performance. In contrast, FVC demonstrated an increase from 2.56 to 2.66; however, the calculated t-value ($0.78 < 2.26$) indicates that this improvement was not statistically significant. Likewise, ERV increased marginally from 0.24 to 0.31, with a calculated t-value of $0.75 < 2.26$, denoting a non-significant change. These findings reveal that *Anulom-Vilom Pranayama* effectively enhanced the subjects' VC and EVC, but no significant improvement was observed in FVC or ERV (Table 2 and Figure 1).

4.2. Group B: *Bhastrika Pranayama*

The comparative findings for *Bhastrika Pranayama* reveal a different pattern of improvement. The mean VC increased from 2.48 to 2.52, with a calculated t-value of $0.46 < 2.26$, indicating a statistically non-significant change. Similarly, EVC increased from 2.48 to 2.52 ($t = 0.46 < 2.26$), and FVC improved from 2.38 to 2.52 ($t = 0.96 < 2.26$), neither reaching statistical significance. However, a marked improvement was observed in ERV, which increased from 2.07 to 2.27 with a t-value of $2.60 > 2.26$, indicating a statistically significant enhancement following 6 weeks of *Bhastrika* practice.

After the 6-week intervention, comparative analysis of the two experimental groups revealed distinct outcomes. Group A (*Anulom-Vilom*) exhibited significant improvements in VC and EVC, while FVC and ERV did not change significantly. Conversely, Group B (*Bhastrika*) showed significant enhancement only in ERV, with no significant improvement in VC, EVC, or FVC (Table 3 and Figure 2).

These findings suggest that *Anulom-Vilom Pranayama* is more effective in improving the overall lung capacity and expiratory control, whereas *Bhastrika Pranayama* primarily benefits expiratory reserve, possibly due to its dynamic and forceful breathing pattern. Both techniques, however, contribute to improved pulmonary efficiency and can serve as effective respiratory training modalities for adolescents.

5. DISCUSSION

Optimal respiratory function and cardiovascular endurance are fundamental components of overall health and athletic performance. In recent years, yogic interventions, particularly pranayama practices, have gained increasing recognition as effective strategies for improving physiological efficiency and physical endurance. These practices not only enhance respiratory mechanics but also contribute to improved concentration, stress regulation, and overall well-being. The present study sought to evaluate the impact of *Anulom-Vilom Pranayama* and *Bhastrika Pranayama* on selected pulmonary parameters among school-aged boys. The results demonstrated that *Anulom-Vilom Pranayama* led to a significant improvement in VC and EVC, while *Bhastrika Pranayama* significantly improved ERV. These findings indicate that the nature and intensity of specific *Pranayama* techniques can produce distinct physiological outcomes. *Anulom-Vilom*, a slower and rhythmically controlled breathing practice, emphasizes alternate nostril breathing and promotes parasympathetic activation, thereby enhancing lung elasticity and ventilatory efficiency.^[16]

Conversely, *Bhastrika Pranayama* involves rapid, forceful inhalations and exhalations that engage respiratory muscles dynamically, improving expiratory strength and reserve volume through repeated stimulation of the diaphragm and intercostal muscles.^[17] The improvement in VC among the *Anulom-Vilom Pranayama* group aligns with previous studies suggesting that sustained yogic breathing promotes alveolar ventilation, increases thoracic compliance, and enhances oxygen diffusion.^[18] The EVC also showed a significant increase following *Anulom-Vilom Pranayama*, consistent with evidence that slow and deep breathing exercises strengthen both inspiratory and expiratory musculature, thereby improving the efficiency of air exchange. In contrast, neither group exhibited significant improvement in FVC, suggesting that while *Pranayama* improves voluntary control and lung expansion; its effect on forced respiratory maneuver may be limited over short-term interventions. A longer training duration or a combined approach with aerobic activity might be required to observe substantial FVC gains. The significant increase in ERV observed in the *Bhastrika Pranayama* group supports the view that high-velocity breathing enhances expiratory efficiency through repetitive muscular engagement and reduction of residual air in the lungs. Such findings have practical implications for improving ventilatory endurance and may be beneficial for athletes engaged in sports requiring high aerobic output.

Overall, the results corroborate earlier findings that regular *Pranayama* practice improves pulmonary function, enhances respiratory muscle tone, and can serve as an effective preventive measure against respiratory dysfunctions. Integrating *Pranayama* into daily fitness routines and physical education programs may contribute to improved

physical performance, emotional balance, and long-term respiratory health. Moreover, given its non-invasive and cost-effective nature, *Pranayama* can be a valuable adjunct therapy for managing respiratory conditions and promoting holistic well-being among both clinical and healthy populations.

6. CONCLUSION

Yogic practices usually lead to vagal tone stimulation, resulting decrease in sympathetic tone, thus they induce a decrease in systolic and diastolic blood pressure and in heart rate as well. Yoga practice has multiple physiological credits including a decrease of blood pressure, increased respiratory rate, increased heart rate, and improved autonomic nervous para-sympathetic cardiovascular system by sympathetic functions, respiratory modulating activities, decreases the effect of stress and strain of body, and improves physical and mental health. Hence, it is believed that the practice of yoga can also result in changes in perception, attention, and cognition, such as increased performance of verbal memory and memory scores.

Practice of short "*Kumbhak Pranayama*" at a slow rate increases oxygen consumption and metabolic rate. Practice of *Pranayama* also had been referred treatment for anxiety disorders as it attenuates cardiac autonomic responses. Finally, *Anulom-Vilom Pranayama* improves the VC and EVC, while *Bhastrika Pranayama* improves the ERV among the high school students of rural Punjab.

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8. AUTHOR CONTRIBUTIONS

All authors contributed to the study's design, data collection, analysis, and manuscript preparation, and approved the final version.

9. FUNDING

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10. ETHICAL APPROVALS

Conducted in accordance with academic and ethical standards.

11. CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this paper.

12. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

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Table 1: Six-week pranayama training protocol

Anulom-vilom pranayam training (Group-A)				Bhastrika pranayam training (Group-B)			
Week	Day	Duration	No. of Reps	Week	Day	Duration	No. of Reps
One	Mon–Sat	8 min/day	15–17	One	Mon–Sat	8 min/day	15–17
Two	Mon–Sat	8 min/day	15–17	Two	Mon–Sat	8 min/day	15–17
Three	Mon–Sat	8 min/day	15–17	Three	Mon–Sat	8 min/day	15–17
Four	Mon–Sat	8 min/day	20–25	Four	Mon–Sat	8 min/day	20–25
Five	Mon–Sat	8 min/day	25–30	Five	Mon–Sat	8 min/day	25–30
Six	Mon–Sat	8 min/day	25–30	Six	Mon–Sat	8 min/day	25–30

Table 2: Descriptive statistics of *Anulom-Vilom Pranayama*

Variable	Pre-test mean	Post-test mean	Pre-test SD	Post-test SD	t-value
Vital capacity	2.65	2.85	0.74	0.47	3.28
Expiratory vital capacity	2.61	2.89	0.46	0.46	2.37
Force vital capacity	2.56	2.66	0.34	0.63	0.78
Expiratory reserve volume	0.24	0.31	0.06	0.05	0.75

SD: Standard deviation. Significant at $P < 0.05$

Table 3: Descriptive statistics of *Bhastrika Pranayama*

Variable	Pre-test mean	Post-test mean	Pre-test SD	Post-test SD	t-value
Vital capacity	2.48	2.52	0.55	0.5	0.46
Expiratory vital capacity	2.48	2.52	0.55	0.5	0.46
Force vital capacity	2.38	2.52	0.59	0.37	0.96
Expiratory reserve volume	2.07	2.27	0.5	0.35	2.60

SD: Standard deviation. Significant at $P < 0.05$

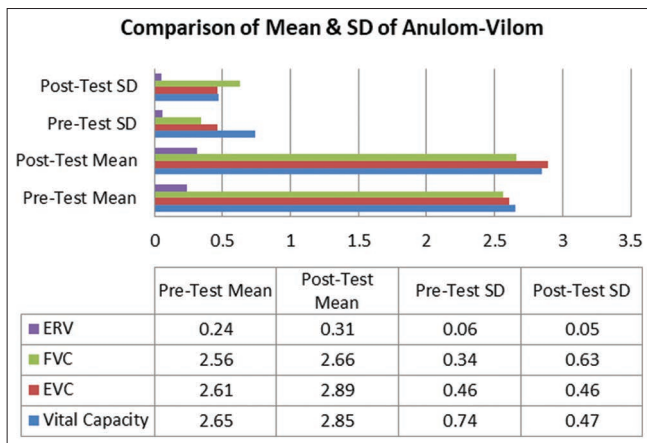


Figure 1: Graphical representation of descriptive statistics of *Anulom-Vilom Pranayama*

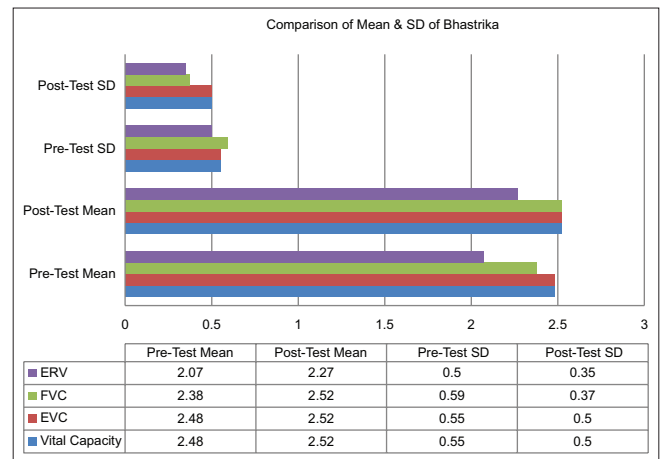


Figure 2: Graphical representation of descriptive statistics of *Bhastrika Pranayama*