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Effect of Short-Term Practice of Anulom Vilom Pranayama on Cardiorespiratory Metrics in Healthy Adults

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Abstract: ***This study aimed to evaluate the effects of a 3-weeks Anulom Vilom Pranayama regimen on cardiovascular and respiratory parameters in 50 healthy adults aged 18–58 years. Under the supervision of a certified yoga instructor, the participants were asked to practice pranayama for 20 min daily in the morning. A semiautomatic blood pressure monitoring instrument was used to measure blood pressures including systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR). Respiratory function tests, including forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), FEV_1/FVC ratio, and peak expiratory flow rate (PEFR), were assessed with a portable digital spirometer. The study found significant reductions in HR (mean difference: -11.51 bpm, p<0.001), SBP (mean difference: -9.58 mmHg, p<0.001), and DBP (mean difference: -6.51 mmHg, p<0.001) following the intervention. Additionally, significant improvements were observed in FVC (pre: 3.43 L, post: 3.66 L), FEV_1 (pre: 2.88 L, post: 3.24 L), FEV_1/FVC ratio (pre: 84.22%, post: 88.51%), and PEFR (pre: 427.80 L/min, post: 461.20 L/min). The results showed that short training in Anulom Vilom Pranayama is beneficial and brings about positive changes in the cardiovascular and respiratory systems of healthy individuals. These effects may be due to the increased parasympathetic control of the heart and changes in the hypothalamic-pituitary-adrenal axis. These results provide insight into the possibility of using this Pranayama technique as a complementary technique to promote cardiovascular and respiratory health.***

Keywords: Anulom Vilom Pranayama (AVP), Systolic Blood pressure (SBP), Diastolic Blood pressure (DBP), Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV_1), Peak Expiratory Flow Rate (PEFR), healthy adults.

1. Introduction and Literature Review

Rapid technological advancements in the modern era have significantly contributed to the rise in acute stress. Faster technological developments and heightened competitive environments have also paid for it. Acute stress episodes elicit temporary elevations in sympathetic nervous system activity, which not only augments performance, but also triggers the hypothalamic-pituitary-adrenal axis. This dual effect underscores the complex physiological responses to stressors in modern milieu. Long-term exposure to stress causes increased levels of sympathetic activity over extended periods and changes in the hypothalamic-pituitary-adrenal axis baseline. These alterations provoke physiological reactions and affect cardiovascular function, thermoregulation, respiration patterns, and the concentrations of particular hormones in the bloodstream. The effects on these variables are specific; heart rate, blood pressure, respiratory rate, plasma catecholamines, and corticosteroids are increased. Increased cardiovascular morbidity and mortality rates are associated with prolonged sympathetic overactivity (Pal et al., 2004) [1]. Cardiorespiratory function is a critical marker for overall health and fitness. Its assessment encompasses numerous measurements, such as heart rate, blood pressure (both systolic and diastolic), respiratory rate, FVC, FEV_1, FEV_1/FVC ratio, and PEFR. Many therapeutic approaches, such as Pranayama, have shown a significant link to both mental and physical health. Pranayama, a traditional Indian breathing technique used by yoga practitioners for many years, has recently gained attention for its potential to address heart-related and other physiological conditions. Pranayama is a Sanskrit word made up of the two parts; “Prana” and “Yama”. ‘Prana’ Elucidates as vigor or vital energy, life force or power or breath. Fundamentally, it is the subtle energy that bleeds through the body along the energy channels or Nadis (Pawar et al., 2023) [2]. Yama is referred to as regulation, control, discipline, or restrain of prana. Thus, pranayama is translated as the control of life force energy or breath control. It is a collection of several kinds of “yogic breathing practices” utilized to affect the prana flow in the entire body to promote mental, spiritual, physical, and emotional well-being (Pankaj Patidar & Kanchan Yadav, 2023) [3]. Pranayama is the ultimate practice of which is an instrumental tool to bring harmony and balance in the body, mind and heart. According to (Prakash et al., 2022) [4]. Anulom Vilom Pranayama (AVP), also known as alternate nostril breathing, is a yogic breathing technique that involves systematically alternating left and right nostrils. This practice is believed to balance the flow of energy through the body's subtle channels or Nadis and harmonize the functioning of the left and right hemispheres of the brain. (A. Sharma, 2022) [5] mentioned that 'Anulom Vilom' Pranayama tries to balance two bodily energies called 'Ida' and 'Pingala' which control 'prana' flow. The term 'Anulom' actually means ‘in sequence,’ whereas 'Vilom' means 'reverse.’ It is performed by breathing through different nostrils while sitting in a cross-leg position.

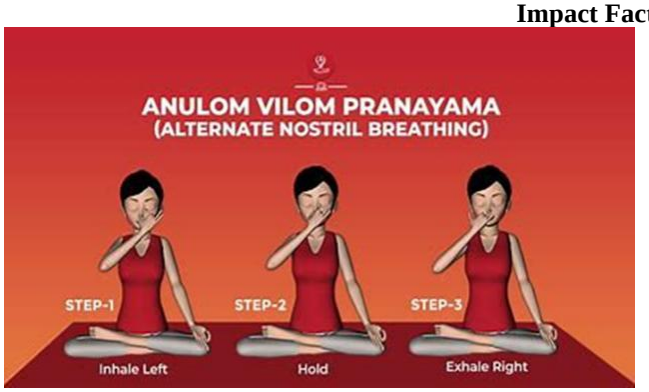


Figure 1: Anulom viloma Pranayama
Source: (D. Sharma, 2021)[6]

Repeated Nadisuddhi rapidly reduces heart rate and blood pressure (Malhotra et al., 2022) [7]. A study focusing on hypertensive patients found that 10 min of AVP led to a significant reduction in systolic and diastolic blood pressure and improved manual dexterity and eye-hand coordination (Telles et al., 2013) [8]. Another study found that 15 minutes of AVP enhanced performance in vigilance tests and lowered systolic blood pressure (Telles et al., 2017) [9]. However, some Investigations have revealed differential effects based on the nostril employed; right nostril breathing is associated with increased oxygen consumption, systolic blood pressure, and cutaneous vasoconstriction, indicative of sympathetic stimulation (Telles et al., 1996) [10]. Conversely, left nostril breathing (Chandra Nadi Pranayama) was found to induce an immediate decrease in heart rate and blood pressure in patients with hypertension (Bhavanani et al., 2012) [11]. Mixed results were obtained in another study, in which instant effects of Anulom Vilom Pranayama on cardiovascular and pulmonary parameters were observed. The results revealed that heart rate was significantly reduced in the Pranayama group along with an improvement in peak expiratory flow rate; however, blood pressure did not show any significant changes (Sharma Neha N. and Khyati Shah, 2022) [12]. Hence, this study was designed to determine the effect of short-term practice of Anulom Vilom Pranayama on cardiorespiratory metrics in healthy adults.

2. Materials and Methods

The present investigation employed a quantitative experimental research methodology. The study protocol was approved by the Ethical Committee (IEC) of SMIMER, Surat. A cohort of 50 healthy adults aged between 18 and 58 years was randomly selected based on the criteria that participants had no prior exposure to Anulom Vilom Pranayama and did not have any respiratory or cardiovascular disorders. Their age, height, and weight were recorded. All subjects were healthy, did not have any cardiorespiratory diseases, and were not taking any medications. All participants were nonsmokers and had the same socioeconomic status. Participants who were non-smokers and of the same socioeconomic status were included in the study. The aim and objective of the study were explained to each participant and consent was obtained from all participants. Baseline records (which served as controls) of SBP (mmHg), DBP (mmHg), forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC Ratio and PEFR (L/min) were calculated on the first day before starting the AVP or Alternate Nostril Breathing (ANB) session. They performed AVP practice for 3 weeks. Each AVP session lasted 20 min and was conducted under the guidance of a certified yoga instructor. Training sessions were scheduled in the early morning hours, with an empty stomach. They were directed to sit in an easy and steady posture (either in a lotus posture, that is, Padmasana, or a comfortable sitting posture, that is, Sukhasana) with the head, neck, and trunk upright and in a straight line and keep the body stationary during the practice of ANB in a calm and quiet room. ANB was performed using the following steps with some modifications (Raghuraj et al., 1998) [13], (Shrivastava et al., 2005) [14]. The volunteer was asked to close one of his/her nostrils (say right nostril) by his thumb and slowly breathe in up to maximum, through left nostril

1) He/she was asked to close his other nostril (left) by his/her ring finger and open the right nostril to exhale slowly up to maximum
2) They were then instructed to inhale through the same right nostril (with the left nostril closed) and then to open the left nostril and exhale, as stated above.

These three steps completed one cycle of Anulom Vilom Pranayama (AVP). By the end of the 3rd week, all the parameters were recorded again.

2.1 Measurement of Parameters

- Blood Pressure: Systolic and diastolic blood pressures were measured using a citizen semi-automatic blood pressure monitor.
- Pulmonary Function: Lung function parameters were assessed using a MIR Spirobank portable digital spirometer. The participants performed standard spirometry maneuvers, including forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV_1/FVC ratio, and peak expiratory flow rate (PEFR).

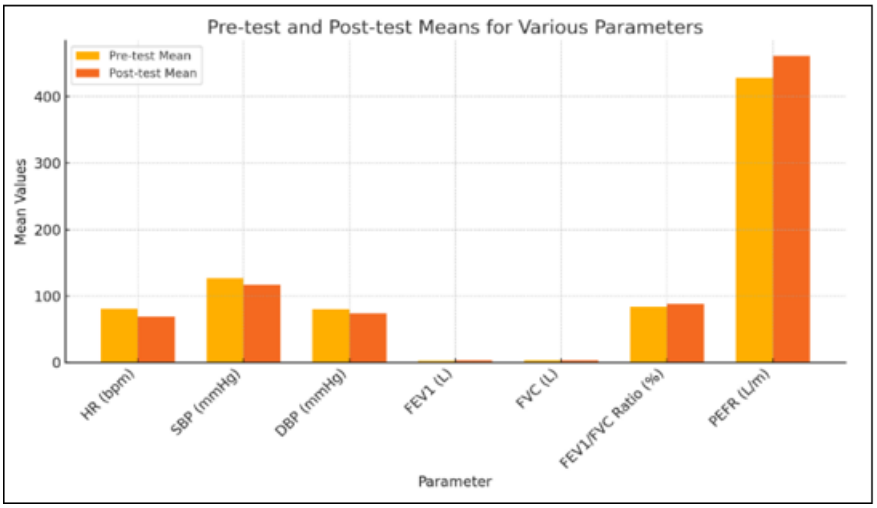
2.2 Data Analysis

Statistical analysis was performed using SPSS version 25 software. Data collected before and after the practice of "Anulom Vilom Pranayama are expressed as mean ± standard deviation. For intragroup comparisons, paired Student's t-test was used. A p-value of 0.05 was established as the threshold for statistical significance.

3. Tables & Graph

Table 1: Cardiorespiratory Metrics before and after the practice of Anulom Vilom Pranayama

Parameter	Before Pranayama	After Pranayama	Mean Difference	t- Value	p-value
HR (bpm)	80.61 ± 6.31	69.1 ± 4.89	-11.51	-13.93	0.00
SBP (mmHg)	126.51 ± 5.24	116.92 ± 6.57	-9.588	-14.17	0.00
DBP (mmHg)	80.35 ± 4.28	73.84 ± 5.65	-6.51	-13.61	0.00
FEV_1 (L)	2.88 ± 0.49	3.24 ± 0.52	0.36	13.32	0.00
FVC (L)	3.43 ± 0.61	3.66 ± 0.54	0.23	9.06	0.00
FEV_1/FVC Ratio (%)	84.22 ± 6.06	88.51 ± 5.04	4.29	8.11	0.00
PEFR (L/m)	427.8 ± 53.5	461.2 ± 50.98	33.4	18.34	0.00



Graph 1: Cardiorespiratory parameters before and after the practice of Anulom Vilom Pranayama

4. Results

In the study group, the participants ranged in age from 22 to 58 years, with an average age of 44.5 years. Heights ranged from 1.50 meters to 1.85 meters, averaging 1.70 meters. Weights varied more significantly, from 47.0 kg to 128.0 kg, with an average weight of 73.4 kg. The relatively high standard deviation of 14.13 kg points to substantial diversity in body weights. The BMI values ranged from 19.1% to 37.4%, with an average of 25.32%. A standard deviation of 3.76% indicates a moderate variation in BMI.

The mean paired difference (post-test minus pre-test) in heart rate (HR) is -11.51 bpm, with a standard deviation of 5.89 bpm and a standard error of 0.82 bpm. The 95% confidence interval ranges from -13.16 bpm to -9.85 bpm. The t-value is -13.93 (df = 50), with a p-value of 0, indicating a statistically significant reduction in HR post-intervention. The accompanying figure demonstrates this decrease in the mean HR. The mean systolic blood pressure (SBP) prior to the intervention is 126.51 mmHg (SD = 5.24 mmHg, SEM = 0.73 mmHg), decreasing to 116.92 mmHg post-intervention (SD = 6.57 mmHg, SEM = 0.92 mmHg). The mean paired difference in SBP is -9.58 mmHg (SD = 4.83 mmHg, SEM = 0.67 mmHg), with a 95% confidence interval ranging from -10.94 mmHg to -8.23 mmHg. The t-value is -14.17 (df = 50), with a p-value of 0, indicating a statistically significant reduction in SBP following the intervention.

The mean diastolic blood pressure (DBP) prior to the intervention was 80.35 mmHg, with a standard deviation of 4.28 mmHg and a standard error of the mean of 0.6 mmHg. Following the intervention, the mean DBP decreased to 73.84 mmHg, with a standard deviation of 5.65 mmHg and a standard error of the mean of 0.79 mmHg. Table 1 illustrates the paired-sample correlations between DBP before and after the Anulom Viloma Pranayama intervention. The correlation coefficient was 0.798, indicating a strong positive correlation between the pre-test and post-test DBP measurements. The p-value (Sig.) of 0 suggests that this correlation is highly statistically significant. The mean FEV_1 also exhibited an increase from 2.88 liters to 3.24 liters, with a corresponding standard deviation increase from 0.49 to 0.52, indicating a consistent improvement across the group. The mean FVC also demonstrated an increase from 3.43 liters to 3.66 liters. This improvement suggests that the participants experienced an increase in their lung capacity, which is crucial for overall respiratory health. As indicated in the table, there was a notable improvement in the FEV_1/FVC ratio, a key measure of pulmonary function, following the Anulom Vilom Pranayama practice. The mean FEV_1/FVC ratio before practice was 84.22%, which increased to 88.51% after practice. There is also a significant improvement in Peak Expiratory Flow Rate (PEFR), a measure of how quickly an individual can exhale air, following the practice of Anulom Vilom Pranayama. Before the practice, the PEFR values ranged from 250 L/m to 520 L/m with a mean of 427.80 L/m, whereas post-practice, these values increased to a range of 310 L/m to 540 L/m with a mean of 461.20 L/m.

5. Discussion

The results of our study clearly indicate a significant impact of the three-week practice of Anulom Vilom Pranayama (AVP) on heart rate and blood pressure, including both systolic blood pressure (SBP) and diastolic blood pressure (DBP). The results from Dandekar 2013) [15] corroborate our findings, as they observed a significant decrease in SBP following the short-term practice of Anulom Vilom Pranayama. Although the precise mechanisms remain

unclear, they postulated that practice influences the autonomic nervous system, resulting in enhanced parasympathetic control of the heart. Similarly, (Upadhyay et al., 2023) [16] explored the effects of the Nadi Shodhana and Bhramari Pranayama techniques on heart rate variability and blood pressure in hypertensive patients. They found that a 20 min practice of Nadi Shodhana and Bhramari Pranayama reduced the heart rate variability along with a significant change in auditory reaction time. According to them, the practice of Nadi Shodhana or Bhramari Pranayama both reduces blood pressure and improves the reaction time in patients with essential hypertension. The exact mechanism of reducing HR, SBP & DBP is unclear but (Casikar, 2017) [17] proposed a mechanism underlying the effect of Nadi Shodhana Pranayama in reducing blood pressure. The authors posited that the reduction in blood pressure may be attributed to the breathing technique, which stimulates the olfactory nerves in the roof of the nasal cavity. This stimulation was then transmitted to the olfactory bulbs in the cribriform plate. The olfactory bundle connects to the frontal brain region, which is linked to the hypothalamus. The hypothalamus regulates hormone levels. During perceived stress, serotonin receptors in the hypothalamus, along with the splanchnic pathway, regulate stress. Respiratory dysregulation causes a face lock in olfactory signals, thereby preventing proper signals from entering the hypothalamus. This results in disorganized hypothalamic information, leading to hypothalamic-pituitary-adrenal dysfunction. Regulated breathing in Nadi Shodhana Pranayama is believed to regulate the HPA axis and reduce blood pressure.

The results of our study also showed improvements in pulmonary function parameters. A notable increase in Forced Vital Capacity (FVC) was observed, indicating an enhancement in lung volume capacity. Simultaneously, a significant rise in Forced Expiratory Volume in the first second (FEV_1) was noted, suggesting enhanced airflow. An increase in the FEV_1/FVC ratio potentially indicates an overall improvement in lung function. Additionally, a significant rise in Peak Expiratory Flow Rate (PEFR) was observed, leading to improved airway function. These comprehensive improvements in multiple lung function metrics suggest a positive effect on respiratory health. A study by (Devi, 2019) [18] reported comparable findings when examining the effects of short-term Pranayama practice, including Anulom Vilom, on pulmonary function tests. Their research demonstrated significant increases in FVC, FEV_1, PEFR, and other related parameters following two months of regular practice. These results suggest that Anulom Vilom may contribute to enhanced lung capacity and airflow. Although this study did not isolate the specific effects of Anulom Vilom, it provides evidence supporting the broader benefits of yogic breathing techniques on pulmonary function.

6. Conclusion

This study aimed to determine the effects of a three-week Anulom Vilom Pranayama practice on cardiovascular and respiratory parameters in 50 healthy adults aged 18–58 years. Participants practiced 20 min of daily Pranayama under the supervision of a certified yoga instructor. After the intervention, the study found significant reductions in heart rate, systolic blood pressure, and diastolic blood pressure. The forced vital capacity, forced expiratory volume in the first second, FEV_1/FVC ratio, and peak expiratory flow rate were also significantly improved. The short-term practice of Anulom Vilom Pranayama may lead to improved cardiovascular and respiratory function in adults, possibly through parasympathetic control of the heart and hypothalamic-pituitary-adrenal axis regulation.

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