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Effects of Yogic Breathing Techniques on Respiratory Function and Breathing Patterns at High Altitude

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Abstract

Background: *Practices involving resistive breathing have been shown to enhance endurance and performance in competitive athletes. However, there is still little research on how pranayama or yogic breathing techniques (YBP) might help professional athletes improve their respiratory endurance and performance.* ***Aim:*** *The objective of the current research was to assess how yoga breathing practices affected competitive athletes' respiratory function.* ***Methodology:*** *A total of 60 (30 male and 30 female) athletes were included and were divided into two groups; control and experimental. 30 individuals were randomly assigned in both the groups. The experimental group received daily instruction in yogic breathing techniques for one hour for six months. The control group received the same daily schedule (normal exercise). Various anthropometric measurements and spirometry measurements such as FVC, FEV1, PEFR, and the FEV1/FVC ratio both before and after yoga intervention in both the groups were measured.* ***Result:*** *The result showed significant increase in FVC level in control (3.51L) and experimental group (3.64L) P<0.05). A significant increase in FEV1 (3.43L) and PEF (534.18L/s) levels were also observed post-test of experimental groups (P<0.05), whereas the increase was non-significant in control group (P>0.05). Non-significant results were also observed in FEV1/FVC ratio in both control and experimental group (P<0.05).* ***Conclusions:*** *At high altitudes, yoga practices may beneficial for athletes in bringing about favorable psychological changes among low landers athletes.*

Keywords: *Athletes, High Altitude, Pranayama, Spirometer, Respiratory function, Yoga*

1. Introduction

In recent years, engaging in physical activity at High Altitudes has gained popularity. High-altitude exercise encompasses a range of activities, from leisurely hiking to competitive ultra-endurance events like foot races, mountain biking, cross-country skiing, and even team sports. However, traveling to high altitudes carries significant health risks. High Altitude (HA) poses a physiological challenge to individuals accustomed to lower altitudes. This challenge arises from a combination of reduced atmospheric pressure, leading to a decrease in oxygen levels, and cold temperatures, which collectively place stress on various physiological systems. Adapting strategies to enhance the performance and well-being of athletes in High-Altitude regions (above 3000 meters) remains a complex task in the field of HA physiology research. Besides concerns related to altitude and environmental factors impacting athlete safety, limited access to adequate medical care poses a substantial obstacle. To ensure safety, proper acclimatization becomes crucial for individuals journeying to elevated locations. Additionally, altitude training is believed to offer advantages for athletic performance, although the supporting evidence remains inconclusive [1].

Yogic practices, which encompass yoga, meditation, and pranayama, have gained global recognition as a specific system for promoting overall well-being, offering a wide range of applications. These practices are user-friendly and can be seamlessly integrated into one's daily routine. Their simplicity and accessibility have led to their widespread acceptance worldwide. Yoga is renowned for enhancing physical fitness, while meditation practices exert a positive influence on bodily and visceral functions through their impact on the mind. Yoga, as a form of exercise, is particularly effective in maintaining optimal health and has a profound impact on lung function [2,3]. Medical science believed that yogic practices play a significant role in preventing, managing, and rehabilitating various respiratory diseases. Within yogic practice, diverse asanas are employed to strengthen weak chest muscles surrounding the lungs. Yogic breathing techniques, as described in ancient texts like the sutras, outline different methods of breathing for specific purposes. Pranayama, which goes beyond simple breath control, is a potent yogic technique used to elevate the body's energy flow, known as "prana," to a higher frequency [4]. The four primary breathing techniques used in Pranayama are inhalation (Puraka), exhalation (Rechaka), internal breath retention (Antharkumbhaka), and exterior breath retention (Bahir kumbhaka) [5]. Three specific Pranayama techniques, also known as Yogic Breathing Practices (YBP), were used in this study: "Sectional breathing, Bhastrika breathing, and alternate nostril breathing with internal breath holding (Nadi Shodhana Pranayama with Anthar Kumbhaka) are all breathing techniques". Alternate nostril breathing has been shown to improve cardio-pulmonary function and lung vital capacity in healthy people [6]. It has been shown that it increases the lung's maximum ventilatory volume and vital capacity when used in conjunction with yogic bellows breathing. Additionally, when paired with voluntary internal breathing retention, it improves the body's tissues' access to oxygen [7]. The decline in baseline heart rate and respiratory rate is more apparent when Yogic Bellows Breathing is paired with other breathing exercises, indicating enhanced cardiac autonomic reactivity and parasympathetic activity [8]. By enhancing the use of the abdomen and diaphragm muscles and allowing for a more efficient filling and emptying of the respiratory system, sectional breathing methods increase thoraco-pulmonary compliances. This routine, when combined with personal awareness, aids in the correction of ineffective breathing patterns and increases lung Vital Capacity [9]. This research looked at how yoga breathing techniques affected healthy participants. In this research, yoga techniques will be used to improve pulmonary function and respiratory muscle endurance in competitive athletes. This exercise can improve inefficient breathing patterns and increases lung Vital Capacity when combined with personal awareness [9].

2. Materials And Methods

In this research, a total of 60 competitive athletes (30 males and 30 females) from Burdwan University, West Bengal, India was recruited, with ages ranging from 17 to 23 years. On average, they had 6.29 ± 2.9 years of experience in the sport and engaged in daily practice sessions lasting 40 minutes. The participants were divided into two groups: the Control group, made up of people who did not practice yoga, and the Experimental group, made up of participants who received yoga interventions, such as pranayama, yoga asanas, and other yogic practices. Prior to the study's start, participants' medical histories were examined for evidence of allergies, respiratory conditions, past diagnoses of asthma or exercise-induced bronchoconstriction (EIB), as well as any respiratory symptoms they may have had while exercising or just after. Inclusion criteria for the study required participants to engage in sports at the national or international level and practice for a minimum of 4 hours per day. Exclusion criteria encompassed current or former smoking habits, the use of any medication at the time of testing, and the presence of any medical conditions. All participants, age 18 or older, provided written informed permission, and the study was approved by the institution's ethical committee. Parents or legal guardians were asked for informed permission for kids under the age of 18.

Procedure of Training Schedule:

The two groups used in the present study were the experimental set and the control set. The people in the control group weren't yoga practitioners. In comparison, the experimental group included individuals who participated in a yoga intervention that included daily yoga practice for 30 minutes, six days per week, for a period of four months. Pre-testing and post-testing were done as part of the research. Information on several breathing exercises, including their timing and order, is presented in Table 1. Both groups had routine pulmonary function tests (PFTs), anthropometric and body composition assessments, and PFTs before and after the yoga intervention. These measurements were performed using either a calibrated, computerized pneumotachograph spirometer (Jaeger Master scope PC; Jaeger; Hochberg, Germany) or a spirometer (Model 2130; Sensor Medics; Yorba Linda, CA).

Table 1

Yoga intervention		
Regular Physical Training	Total repetition	Total duration
Stretching and running exercises	5times	20 min
Endurance building exercises	5times	20 min
Yoga Training (Yoga Group)		

Nadi Shodhana Pranayama	10times	10 mins
Bhastrika Pranayama	5times	10 mins
Vibhagiya Pranayama	10times	10 mins
Anthar kumbhaka	10times	10 mins

Anthropometric and Body Composition Measurements

The Anthropometric Standardization Reference Manual's recommendations were followed for measuring the participants' heights using a stadiometer (Wunder SA. Bl. srl A 200) while they were standing up straight and feet [16]. According to the manufacturer's instructions, the electrical impedance body composition analyzer TANITA BC-420MA was used to determine body measurements such weight, a percentage of fat-free mass, the percentage of muscle mass, the percentage of fat mass, and BMI.

The circumference of the waist was measured using a measuring tape, with 0.1 cm increments. After a normal exhale, the length between the top of the crest of the iliac spine and the last rib was measured using a flexible anthropometric tape [16]. To calculate the waist-to-height ratio, the person's height was multiplied by their waist circumference. Based on the strategy employed in prior studies, an ABSI (body shape index) was also computed [17].

Respiratory Function Parameters

Spiro metric Measurements

Respiratory function parameters were assessed using ZAN®messgeraete GmbH spirometry, following the guidelines established by the European Respiratory Society, at room temperature, and administered by the same investigator. Prior to each measurement, spirometry equipment was calibrated. Participants were given a 15-minute rest period before the measurements and were informed about the procedure. To ensure accuracy, subjects were instructed to perform a powerful, rapid forced expiration challenge immediately after taking a maximum forced inhalation. During this maneuver, flow and volume curves were monitored on the screen to ascertain whether subjects were exerting sufficient effort during both inhalation and exhalation. For everyone, at least three technically sound measurements were conducted, and the highest recorded value was considered the baseline measurement. The following respiratory parameters were measured using spirometry: Peak Expiratory Flow (PEF) in liters per second (L/s), FEV1(Forced Expiratory Volume in One Second) in liters (L) and Forced Vital Capacity (FVC) in liters (L) in both the experimental (yoga practitioners) and the control group (sedentary individuals) [10].

Statistical Analysis

Software from SPSS Inc., USA, was used to evaluate the data once it was collected. To test if the data followed a normal distribution, the data were evaluated. Standard deviation (S.D.) and mean were determined for quantitative data. Each statistic is provided as a mean S.D. A comparison of mean values was carried out using an unpaired t-test to determine the significance of differences between the two groups. P >0.05 was used to define statistical significance for all two-tailed statistical tests.

3. Results and Discussion

A total of 60 participants were included in the study. Table 2 represents the demographic distribution of males and females in both the control and experimental groups.

Table 2

Demographic details				
Variables	**Control**		**Experimental**	
	Male (n=15)	**Female (n=15)**	**Male (n=15)**	**Female (n=15)**
Age	18.8±3.29	19.13±2.53	18.28±3.51	19.66±4.18
Weight (Kgs)	59.26±9.31	49.25±6.29	57.66±7.15	48.91±6.34
Height (m)	1.65±0.04	1.60±0.03	1.65±0.08	1.61±0.05
BMI (Kgm^{-2})	22.52±3.38	18.94±2.59	21.68±2.71	19.56±3.29

- BMI: Body Mass Index

In both the control and experimental groups, the average age of both males and females were similar (18.8±3.29 vs 18.28±3.51 for males and 19.13±2.53 vs 19.66±4.18 for females). Average level of weight and height were also observed to be similar in both the groups, i.e., 59.26±9.31Kgs for males and 49.25±6.29Kgs for females in control group whereas 57.66±7.15 and 48.91±6.34Kgs for male and females respectively in experimental group. BMI levels were higher in males of control group

(22.52±3.38Kgm-2 vs 21.68±2.71Kgm-2) and in females of experimental group (19.56±3.29Kgm-2 vs 18.94±2.59Kgm-2).

Table 3

Pre and post-test level of FVC, FEV1, PEFR and FEP1/FVC ratio of both the control and experimental group

Variables	Control		Sig	Experimental		Sig
	Pre	Post		Pre	Post	
FVC	3.48±0.29	3.51±0.38	0.003*	3.51±0.34	3.64±0.21	0.00*
FEV1	3.27±0.23	3.28±0.27	0.14*	3.35±0.39	3.43±0.26	0.00*
PEFR	511.53±27.16	521.58±31.09	0.031*	519.18±32.94	534.18±24.16	0.00*
FEV1/FVC	0.94	0.95	0.094	0.93	0.96	0.00*

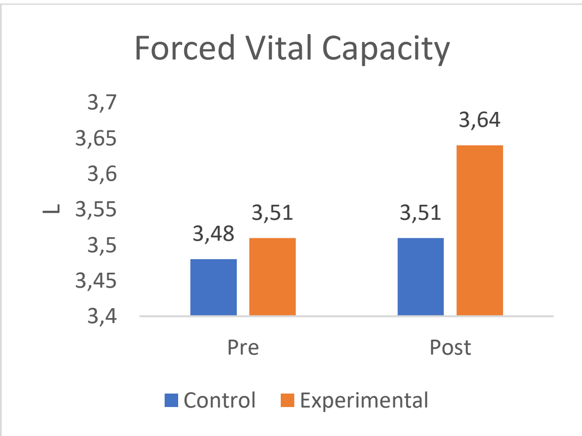
***** Means significant

- FVC: Forced Vital Capacity
- FEV: Forced Expiratory Volume
- PEF: Peak Expiratory Flow

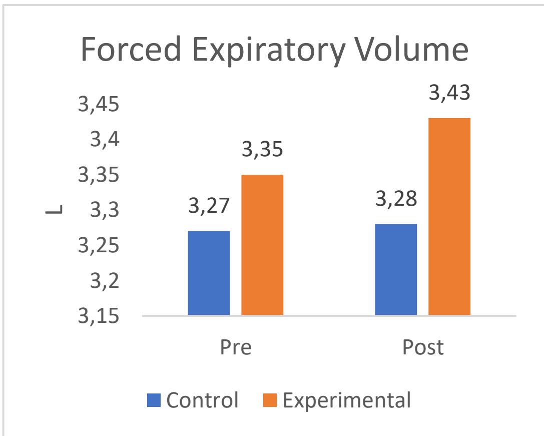
Table 3 represents the pre- and post-test level of FVC, FEV1, PEFR and FEV1/FVC ratio of both the control and experimental group. A significant difference in FVC levels were observed in post-test in both groups (P<0.05) (fig 1a).

In pre- and post-test comparison of FEV1 levels, a non-significant difference was observed in control group (P>0.05), whereas the difference was statistically significant in experimental group (P<0.05) indicating an increase in FEV1 level in experimental group with yoga intervention (fig 1b).

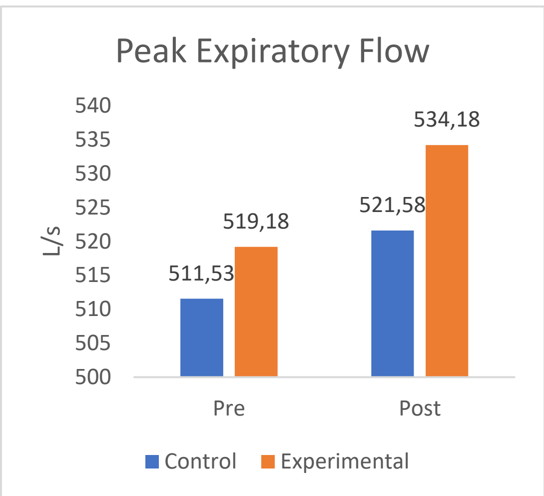
Similar findings were also recorded in PEFR levels in both groups (fig 1c). In FEV1/FVC ratio, significant improvement in experimental group was observed (P<0.05) as compared to the control group (P<0.05) (fig 1d).



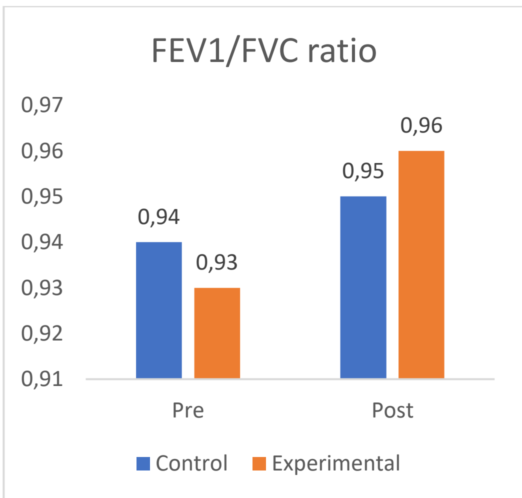
a)



b)



c)



d)

Figure 1. Pre- and post-test level of control and experimental group, a) FVC, b) FEV, c) PEF and d) FEV1/FVC ratio

Findings

The purpose of the current study was to understand the effects of yogic breathing techniques such as Nadi Shodhana Pranayama with Anthar kumbhaka, Bhastrika Pranayama and Vibhagiya Pranayama along with regular physical training on respiratory capacity at high altitudes. Sixty competitive athletes between the ages of 17 and 23 were divided into control and experimental groups. Lung capacity parameters were be measured using Spirometer Lung Exercise Respiratory Exerciser. After four months of yoga intervention, there was a noticeable difference in the level of FVC, FEV, PEF and FEV1/FVC ratio in athletes competing at high altitude.

In the current study, participants who practiced yoga had substantially greater pulmonary function values than sedentary subjects who did not practice yoga. When compared with participants of control group, the experimental group had higher pulmonary functions. The average FVC was found to be 3.64L for yoga practitioners and 3.51L for control group participants in post-test. An increase in FEV levels were also observed in yoga group as compared to the control. Similar outcomes were also observed in PEF and FEV1/PVC ratio, i.e., higher in experimental group.

According to Prakash et al. [11] sedentary people had lower mean FVC values than yoga practitioners, who had a mean FVC value of 98. These findings are consistent with the results of the current research. FVC significantly increased following pranayama practice, according to Joshi et al.'s research [12]. Furthermore, Yadav and Das [13] found that participants who had participated in yoga activities for 12 weeks had significantly higher FVC. According on how long you practice yoga, your FVC values will alter. When compared to sedentary individuals, yoga practitioners' scores for the second test under investigation, %FEV1, were significantly higher. According to prior studies [14] greater FEV1 was found in yoga practitioners when research participants and sedentary participants were compared. Pranayama exercises help to increase lung compliance by removing airway secretions and serving as a potent physiological stimulus to produce prostaglandins and lung surfactant into the alveolar gaps [15].

According to Vedala et al., people who practiced yoga had considerably greater pulmonary function values than inactive subjects who didn't do yoga. When compared to participants who were sedentary, the yoga group had superior pulmonary function status. The average FVC was found to be 109.1 for yoga practitioners and 86.8 for inactive individuals. This clearly demonstrated that the participants who had been practicing yoga for the previous six months had higher FVC values than the sedentary subjects [16].

According to Udupa et al.'s research, pranayama also teaches the respiratory centres how to hold their breath for extended periods of time. Longer expirations and effective utilization of the abdominal and diaphragmatic muscles are more important. In terms of essential capacity, this act teaches the respiratory system to empty and fill more thoroughly and effectively [17].

After practicing pranayama, asthmatic patients showed a considerable improvement in their FVC, FEV1, maximal voluntary breathing, and PEFR, according to Soni et al. [18].

There were no discernible differences across the genders in any group. Due to the small sample size, results comparisons by age were not done. The goal of the current research was to track the improvement in lung function over time. Spirograms were taken with a dry rolling seal spirometer. This study's disadvantage is that it doesn't explain how long the positive benefits will last or when they will start to be noticeable. Further investigation is needed to determine the population that is most benefited by yogic breathing techniques and any physiological changes that may have occurred in the respiratory musculature.

4. Conclusion

At high altitude, hypoxic, and simulated altitude situations, yoga, breathing techniques, and meditation have shown to have positive benefits on the physiological, metabolic, and psychological parameters. Prior to rising to HA, regular yoga practice is quite helpful for HA acclimatization. The results of the current research are consistent with past results that suggested training in resistive breathing might improve lungs capacity. The results revealed that practicing yoga improves autonomic reaction, oxygen diffusion, and decreases anxiety in competitive athletes. It also suggests that yoga lowers airway resistance, enhances lungs endurance, and improves the number of breaths per stroke. However, there aren't many studies addressing these advantageous impacts in genuine HA settings, and further research is required in this area. Future research is necessary to comprehend the performance enhancements and genuine changes in the respiratory muscles.

Conflicts of interest

The author(s) declared no have conflict of interest concerning this work, authorship, and/or publications of this paper.

References:

1. Khodaee M, Grothe HL, Seyfert JH, VanBaak K. Athletes at high altitude. Sports health. 2016 Mar;8(2):126-32.
2. Akhtar P, Yardi S, Akhtar M. Effects of yoga on functional capacity and well-being. International journal of yoga. 2013 Jan;6(1):76.
3. Arbe A. That new tranquilizer called yoga. Medical Times. 1972 Sep 1;100(9):170-passim.
4. Muktibodhananda S, Saraswati SS. Hatha yoga pradipika. Munger, Bihar: Yoga publication trust; 2009.
5. Saraswati SS. Asana pranayama mudra bandha. Munger, Bihar: Yoga publi cation trust; 2002.
6. Singh S, Gaurav V, Parkash V. Effects of a 6-week nadi-shodhana pranayama training on cardio-pulmonary parameters. Journal of Physical Education and Sports Management. 2011;2(4):44-7.
7. Bal BS. Effect of anulomvilom and bhastrika pranayama on the vital capacity and maximal ventilatory volume. Journal of Physical Education and Sport Management. 2010 Jul;1(1):11-5.
8. Veerabhadrappa SG, Herur A, Patil S, Ankad RB, Chinagudi S, Baljoshi VS, Khanapure S. Effect of yogic bellows on cardiovascular autonomic reactivity. Journal of cardiovascular disease research. 2011 Oct 1;2(4):223-7.
9. Nagarathana R, Nagendra HR. Yoga for promotion of positive health. Banga lore: Swami Vivekananda Yoga Prakashana; 2010.
10. Polgar G. Pulmonary function tests in children. The Journal of pediatrics. 1979 Jul;95(1):168-70.
11. Prakash S, Meshram S, Ramtekkar U. Athletes, yogis and individuals with sedentary lifestyles; do their lung functions differ? Indian journal of physiology and pharmacology. 2007 Jan 20;51(1):76
12. Joshi LN, Joshi VD, Gokhale LV. Effect of short term'Pranayam'practice on breathing rate and ventilatory functions of lung. Indian J PhysiolPhamscol; 1992; 36 (2): 105. 1992;108.
13. Yadav RK, Das S. Effect of yogic practice on pulmonary functions in young females. Indian journal of physiology and pharmacology. 2001 Oct 1;45(4):493-6.
14. Makwana K, Khirwadkar N, Gupta HC. Effect of short-term yoga practice on ventilatory function tests. Indian J PhysiolPharmacol. 1988 Jul 1;32(3):202-8.
15. Joshi LN, Joshi VD, Gokhale LV. Effect of short term'Pranayam'practice on breathing rate and ventilatory functions of lung. Indian J PhysiolPhamscol; 1992; 36 (2): 105. 1992;108.
16. Vedala SR, Mane AB, Paul CN. Pulmonary functions in yogic and sedentary population. International journal of yoga. 2014 Jul;7(2):155.
17. Udupa KN, Singh RH, Settiwar RM. Studies on the effect of some yogic breathing exercises (Pranayams) in normal persons. The Indian journal of medical research. 1975 Aug;63(8):1062-5.
18. Soni R, Singh S, Singh KP, Gupta M. Effect of pranayama on pulmonary function test in asthamatic patients. Indian J PhysiolPharmacol2006; 52:150.