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RESEARCH ARTICLE

Effect of Pranayama on respiratory endurance in young adults

Angesh Harish Bagade[1], Megha Shrikrishna Bhonde[1], Nitin Babanrao Dhokane[2]

[1]Department of Physiology, Lakhiram Agrawal Memorial Government Medical College, Raigarh, Chhattisgarh, India, [2]Department of Physiology, Government Medical College, Nagpur, Maharashtra, India

Correspondence to: Megha Shrikrishna Bhonde, E-mail: megha.bagade83@gmail.com

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ABSTRACT

Background: Pranayama is an integral part of Yoga with proven health benefits. Pranayama involves controlled breathing exercises and isometric contraction of respiratory muscles which have a major role in strengthening the respiratory muscles and improving respiratory endurance. **Aims and Objectives:** The present study was undertaken to find out whether the practice of Pranayama regularly for a significant duration increases respiratory endurance. **Materials and Methods:** Maximum respiratory pressures (maximum expiratory pressure [MEP] and maximum inspiratory pressure [MIP]), breath holding time after expiration (BHTe) and after inspiration (breath holding time after inspiration [BHTi]) were recorded and 40 mmHg test was performed in 53 subjects before start of study and after 12 weeks of Pranayama practice. The descriptive statistics were used, i.e. mean and standard deviation for describing the parameters. Paired *t*-test was used to compare the MEP, MIP, BHTe, BHTi, and 40 mmHg test results before and after study. $P < 0.05$ was considered statistically significant. **Results:** There was a significant increase in MEP and MIP by 37% and 26%, respectively ($Z = 28.19$, $P < 0.001$ for MEP and $Z = 19.06$, $P < 0.001$ for MIP). BHTe and BHTi also showed statistically significant increase by 38% and 46%, respectively ($Z = 32.24$, $P < 0.001$ for BHTe and $Z = 32.33$, $P < 0.001$ for BHTi). 40 mmHg test showed a 50% increase after 12 weeks training. **Conclusion:** The current study indicates that practice of Pranayama regularly increases the strength of respiratory muscles and improves respiratory endurance.

KEY WORDS*:* Pranayama; Maximum Respiratory Pressures; Breath Holding Time; Respiratory Endurance

INTRODUCTION

Yoga is a science practiced in India for thousands of years. Many studies have shown that it produces consistent physiological changes with proven health benefits.[1,2] Yoga is designed to balance physical, mental, emotional, and spiritual well-being in an individual. It includes gentle stretching of muscles and breathing exercises with wide range of classical Asanas and Pranayama practices.[3]

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Pranayama is an integral part of Yoga. It is a Yogic technique in which breathing is controlled voluntarily. There are various methods of Pranayama, mostly characterized by breath holding at the end of maximal inspiration or maximal expiration and slowing of the respiratory rate.[4]

Pranayama involves regulated breathing exercises which require a person to hold his breath, thereby maintaining isometric contraction of respiratory muscles. Furthermore, some Pranayamas require forceful respiration. Both these types of breathing exercises may help to strengthen the respiratory muscles, thereby increasing respiratory endurance.

Various studies have proved the beneficial effects of Pranayama on the respiratory system not only in healthy individuals but also in patients of respiratory and cardiac diseases like bronchial

asthma.[5,6] In our previous study, we found that Anulom Vilom Pranayama helps in regulation of autonomic functions by strengthening the parasympathetic response.[7]

It needed to be found out whether regular practice of Pranayama improves respiratory endurance and to what extent. Respiratory pressures, breath holding time, and 40 mmHg test are simple, non-invasive, and easily reproducible tests without any complications which can be used to test respiratory endurance. Hence, we used these tests in the present study to find out whether Pranayama improves respiratory endurance in young adults. The results of this study would help to emphasize the role of Pranayama in improving respiratory endurance and importance of regular Pranayama practice.

MATERIALS AND METHODS

The study was carried out in a reputed medical college in Bhopal. For the present study, 53 healthy young volunteers in the age group of 20–40 years were selected randomly from the non-teaching staff of the college. 28 male and 25 female volunteers were selected. The ethical committee was informed about the nature of the current study and a permission to conduct the study was obtained. The nature of the study was explained and written informed consent was taken from the subjects before the procedure.

Subjects who were non-smokers, non-alcoholic and those who did not use drugs of any kind were selected for the study. The subjects had similar dietary habits and physical and mental activities. Before the study, subjects were clinically examined and were not found to be having any significant abnormalities. None of the subjects had any Yoga training and did not involve in athletics or sports. Since the parameters were tested in the same subjects before and after the intervention, each subject acted as his or her own control.

Before the start of the study, subjects were familiarized with the test procedures. For each test, practice trials were administered until we were satisfied that the subjects understood and performed the task correctly. Control readings were taken approximately 2 h after a light breakfast and 30 min of rest. It was ensured that the subjects were comfortable and relaxed during the procedure. Maximum expiratory pressure (MEP) and maximum inspiratory pressure (MIP), breath holding time at end-expiration (BHTe), and breath holding time at end-inspiration (BHTi) were recorded, and 40 mmHg test was performed for all the volunteers at rest which formed the control readings.

MEP and MIP were measured using a handheld digital manometer specifically for respiratory pressure measurement - the micro respiratory pressure meter manufactured by MDSpiro. The MIP and MEP reflect the respiratory muscles' ability to generate force during a short quasi-static contraction. MIP and MEP measurements are conducted with a manometer that measures mouth pressure and these depend on the motivation and coordination of the subject.[8]

BHTe was determined by noting the maximum time (in seconds) for which the subject could hold his breath after breathing out fully, i.e. at residual volume. Similarly, BHTi was determined after taking in a full breath. It was ensured that there was no hyperventilation before breath holding. Care was taken to see that the subjects did not make any chest or abdominal movement during the breath holding. A noseclip was used to prevent nasal breathing.

40 mmHg test was conducted by asking the subjects to take in a full breath and blow against the mercury column to the pressure of 40 mmHg, maintaining it as long as possible. The time (in seconds) for which the subject could maintain the mercury level at 40 mmHg was noted.

For each parameter, three readings were taken at intervals of 5 min and the best out of the three efforts were noted.

After determining the control readings, the subjects were trained to perform seven Pranayamas by a trained Yoga teacher. Each session lasted for about 45 min. The details of these Pranayamas are available in most of the standard books of Yoga.[9] The sequence and the durations for the various Pranayamas are mentioned in Table 1.

The subjects were instructed to perform the above-mentioned Pranayamas daily for 12 weeks under the supervision and guidance of the Yoga teacher. All the parameters measured before the study was remeasured after completion of 12 weeks. The observations and the significance of their changes were not discussed with the subjects at any time during the study to avoid bias.

The data entry was done in MS-Excel, and the analysis was done by SPSS-IS software. The descriptive statistics were used, i.e. mean and standard deviation (SD) for describing the parameters. We used paired *t*-test to compare the MEP, MIP, BHTe, BHTi, and 40 mmHg test before and after study, i.e. before and after the practice of Pranayama daily for 12 weeks. $P < 0.05$ was considered statistically significant.

Table 1. Sequence and duration of Pranayamas performed by the subjects

Pranayama	Duration (min)
Bhastrika	5
Kapalbhati	5
Anulom Vilom	5
Bahya Pranayam	5
Bhramari Pranayama	5
Udgeet Pranayama	5
Pranav Pranayama	5

RESULTS

The results of the study are expressed as mean ± SD (n = 53) and depicted in Table. 2.

In our study, we found that before the practice of Pranayama, the MEP and MIP were 90.75 ± 5.31 mmHg and 70.71 ± 5.17 mmHg, respectively. After the training program of 12 weeks, there was a highly significant increase in both MEP and MIP which increased to 124.26 ± 6.74 mmHg and 89.58 ± 5.01 mmHg, respectively (Z = 28.19, $P < 0.001$ for MEP and Z = 19.06, $P < 0.001$ for MIP).

BHTe was 32.48 ± 1.55 s before training which increased significantly to 44.8 ± 2.31 s after training (Z = 32.24, $P < 0.001$). BHTi was 63.01 ± 3.38 s before training and 91.87 ± 5.55 s after training, the increase being statistically significant (Z = 32.33, $P < 0.001$).

Results of 40 mmHg test showed a statistically significant increase from 36.32 ± 1.89 mmHg before training to 54.62 ± 2.41 mmHg after completion of training program (Z = 43.50, $P < 0.001$).

DISCUSSION

The present study was of 12 weeks duration which was of sufficient intensity and duration to elicit significant changes in all the parameters.

In the present study, the MEP and MIP were found to be considerably increased in the subjects after Pranayama training. We found that there was an approximate 37% increase in MEP posttraining ($P < 0.001$). Furthermore, MIP increased by approximately 26% after Pranayama training ($P < 0.001$).

Respiratory pressures are specific and sensitive indices of respiratory muscle strength, and they are easy to measure and reproducible and do not produce any complications.[10] Chen and Kuo have reported that inspiratory muscle endurance is greater in physically active men than sedentary men.[11] Black and Hyatt found that the values of maximum respiratory pressures were altered even before the appearance of any significant changes in other pulmonary function tests.[12] Hence, evaluation of these pressures can be of great physiological and clinical significance. In our study, various Pranayamas, especially Bhastrika, Kapalabhati, and Bahya Pranayama, are involved forceful respiratory efforts which increase the strength of the respiratory muscles. Kapalabhati Pranayama involves forceful expiration with passive inspiration which makes maximum use of diaphragm and abdominal muscles, thus strengthening them. Bahya Pranayama involves holding the breath at residual volume after forceful expiration. This requires isometric contraction of expiratory muscles which increases the endurance of these muscles.

Table 2: Comparison of MEP, MIP, BHTe, BHTi, and 40 mmHg test before and after practice of Pranayama

Parameter	Before training	After training
MEP	90.75±5.31*	124.26±6.74*
MIP	70.71±5.17*	89.58±5.01*
BHTe	32.48±1.55*	44.8±2.31*
BHTi	63.01±3.38*	91.87±5.55*
40 mmHg test	36.32±1.89*	54.62±2.41*

Values are expressed as mean±SD (n=53); *P<0.001. MEP: Maximum expiratory pressure, MIP: Maximum inspiratory pressure, BHTe: Breath holding time at end-expiration, BHTi: Breath holding time at end-inspiration, SD: Standard deviation

BHTe and BHTi both increased significantly after the training program. BHTe and BHTi increased by approximately 38% and 46%, respectively ($P < 0.001$). BHT depends on initial lung volume, training, and willpower of the subject. Our findings are consistent with Madanmohan *et al*. who found that BHTe and BHTi significantly increased by 39% and 40%, respectively, after 12 weeks Yoga training.[13] Similar findings were reported by Nayar *et al*. where BHTi increased significantly from 54 s to 106 s.[14] During Pranayama, a person consciously and consistently controls his respiration by overriding respiratory stimuli. This results in greater ability to control one's own respiration. Various Pranayamas involve forceful respiration as well as maintaining the respiratory muscles in sustained isometric contraction. Furthermore, practice of Pranayama may lead to alteration in responsiveness of medullary respiratory centers as well as central and peripheral chemoreceptors increasing respiratory endurance and BHT. Studies have shown that practice of Anulom Vilom Pranayama (alternate nostril breathing) and Ujjayi Pranayama influences autonomic functions favorably.[15,16]

After Pranayama training, there was a significant improvement in 40 mmHg test results by approximately 50% ($P < 0.001$). This test measures the respiratory endurance as it involves isometric contraction of respiratory muscles to hold the breath while maintaining a constant pressure. Similar findings were reported by Madanmohan *et al*. who found that 40 mmHg test results increased by approximately 46% indicating an improvement in cardiorespiratory endurance.[13]

A number of studies have proved the beneficial effects of Pranayama on respiratory functions. Joshi *et al*. have reported that Pranayam training improves ventilatory functions in the form of increase in forced expiratory volume (FEV), FEV in one second, and peak expiratory flow rates.[4] Many investigators have found that Yoga training increases the vital capacity and improves lung functions in subjects.[17-20]

In this study, we closely monitored and supervised the Pranayama training program. Tests were carried out

in a controlled setting with emphasis on accuracy and reproducibility. However, the application of the findings may be limited by the sample size. There is a scope for similar studies to be carried out with larger study groups.

CONCLUSION

In our study, we have found a significant improvement in all the respiratory parameters that were tested. We conclude that the practice of Pranayama significantly improves maximum respiratory pressures, BHT, and 40mmHg test results and is extremely useful in improving lung functions and respiratory endurance. The results of our study may be used to emphasize the role of Pranayama in strengthening respiratory muscles and improving respiratory endurance, and regular practice of Pranayama may prove to be a step in the direction of a healthy lifestyle.

REFERENCES

1. Bharshankar JR, Bharshankar RN, Deshpande VN, Kaore SB, Gosavi GB. Effect of yoga on cardiovascular system in subjects above 40 years. Indian J Physiol Pharmacol 2003;47:202-6.
2. Iyengar BK. Light on Yoga. London: George Allen and Unwin Ltd; 1968. p. 243-5.
3. Gowtham L, Vasanthi B, Jayshree N, Ambika, Jacob M. Effects of yoga in type 2 diabetes mellitus with hypertension: Alteration in RBC morphology as a marker for oxidative stress. Indian J Physiol Pharmacol 2018;62:51-8.
4. Joshi LN, Joshi VD, Gokhale LV. Effect of short term 'pranayam' practice on breathing rate and ventilatory functions of lung. Indian J Physiol Pharmacol 1992;36:105-8.
5. Mahour J, Verma P. Effect of ujjayi pranayama on cardiovascular autonomic function tests. Natl J Physiol Pharm Pharmacol 2017;7:391-5.
6. Kondam A, Chandrasekhar M, Punita P, Varadharaju B, Suresh M, Karthik S. Combined effects of pranayama and suryanamaskar on dynamic spirometric values in normal young subject. Natl J Physiol Pharm Pharmacol 2015;5:79-84.
7. Dhanavijay AD, Bagade AH, Chaudhary AK, Sadawarte S, Dhokane N. Alternate nostril breathing and autonomic function in healthy young adults. IOSR J Den Med Sci 2015;14:62-5.
8. Nambiar VK, Ravindra S. Maximal respiratory pressures and their correlates in normal Indian adult population: A cross-sectional study. Int J Physiother Res 2015;3:1188-96.
9. Ramdeo S. Pranayama Rahasya. Haridwar: Divya Prakashan; 2011. p. 34-55.
10. Madanmohan, Jatiya L, Udupa K, Bhavanani AB. Effect of yoga training on handgrip, respiratory pressures and pulmonary function. Indian J Physiol Pharmacol 2003;47:387-92.
11. Chen H, Kuo C. Relationship between respiratory muscle function and age, sex and other factors. J Appl Physiol 1989;66:943-8.
12. Black LF, Hyatt RE. Maximal respiratory pressures: Normal values and relationship to age and sex. Am Rev Respir Dis 1969;99:696-702.
13. Madanmohan, Thombre DP, Balakumar B, Yanan TK, Thakur S, Krishnamurthy N, Chandrabose A. Effect of yoga training on reaction time, respiratory endurance and muscle strength. Indian J Physiol Pharmacol 1992;36:229-33.
14. Nayar HS, Mathur RM, Sampathkumar R. Effect of yogic exercises on human physical efficiency. Ind J Med Res 1975;63:1369-76.
15. Mason H, Vandoni M, Debarbieri G, Codrons E, Ugargol V, Bernardi L. Cardiovascular and respiratory effect of yogic slow breathing in the yoga beginner: What is the best approach? Evid Based Complement Alternat Med 2013;2:743504.
16. Lee CM, Ghiya S. Influence of alternate nostril breathing on heart rate variability in non-practitioners of yogic breathing. Int J Yoga 2012;5:66.
17. Bhole MV, Karambelkar PV, Gharote ML. Effect of yoga practices on vital capacity. Ind J Chest Dis 1970;12:32-5.
18. Birkel DA, Edgren L. Hatha yoga: Improved vital capacity of college students. Altern Ther Health Med 2000;6:55-63.
19. Makwana K, Khirwadkar N, Gupta HC. Effect of short term yoga practice on ventilatory function tests. Indian J Physiol Pharmacol 1988;32:202-8.
20. Yadav RK, Das S. Effect of yogic practice on pulmonary functions in young females. Indian J Physiol Pharmacol 2001;45:493-6.

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