*Original Contribution*

# A Study of Short-term Breathing Exercises on Different Cardio-Respiratory Parameters

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Cardiorespiratory health is one of the critical parameters for improving endurance. Breathing exercises in the form of various Pranayama have a significant effect on cardiorespiratory health. To assess the effect of breathing exercises in the form of various pranayamas on cardiorespiratory parameters in people living with sedentary lifestyles. This longitudinal study was done on 30 subjects aged 25 to 35 years. Participants performed Bhastrika, Kapalbhati, Anulomvilom and Bhamri Pranayama with prayers and warm-up for 10 to 40 minutes, progressively increasing over one year. The average daily duration in the initial 3 months was 15 minutes; in the next three months, it was 23 minutes. The average daily duration in the last 6 months was 34 minutes. Cardiorespiratory functions were assessed using Spiro Excel machine spirometer and Mercury sphygmomanometer (Diamond) at the time of enrolment and the end of 1 year of the study. A paired t-test, using statistical software, was used to analyze parameters. In males and females, significant change is observed in pulse rate, systolic blood pressure and diastolic blood pressure. In pulmonary function test parameters, non-significant change was observed in forced expiratory volume in 1 sec ($FEV_1$) and forced vital capacity (FVC); other parameters, i.e., $FEV_1$ as percentage of FVC in % [$FEV_1$ (%)], peak expiratory flow rate in L/s (PEFR) and Minute Ventilation Volume (MVV) L/min showed significant change in males and females. Breathing exercises in the form of various Pranayama positively affect cardiorespiratory health, and further studies are recommended in the diseased population.

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**Key words:** Cardiorespiratory health, Pranayamas, Spirometry

## Introduction

PRanayama literally means to expand Prana (vital force). ‘Prana’ means breathing process, and ‘Vyama’ means exercise. This breathing exercise is known to affect cardiorespiratory health positively. Prana (vital force) provides energy to different organs and controls critical life processes. Vyama represents a voluntary effort to maintain. Nowadays, people all over the world practice pranayama regularly[1]. Yogic techniques are recognized to impact people’s heart, respiratory, and mental health. Cardiorespiratory health is one of the critical parameters for the improvement of endurance. Endurance depends on oxygen uptake during any activity[2,3]. If the cardiorespiratory health is good, oxygen uptake would be better, thereby improving endurance. Pulmonary function test parameters are one of the fitness parameters used in individuals' fitness assessment. Blood pressure is influenced by respiration in a variety of ways. The effects of respiratory sinus arrhythmia modulate arterial blood pressure through a mechanical coupling to the systemic venous and arterial circulations within the thorax and respiratory-induced variations in intrathoracic pressure[4]. Regular practice of rhythmic slow breathing has increased baroreflex sensitivity, reduced chemoreflex activation, and decreased systolic, diastolic, and mean blood pressure and heart rate variations in hypertensive patients[5]. A positive effect is also observed on the elasticity of the lungs, rib cage, and respiratory muscle. An effect on hypercapnic ventilatory sensitivity was also observed[1]. Previously, various authors have assessed the role of various yoga asanas on cardiorespiratory health[6,7]. Authors have found positive effects on respiratory health as well as on cardiac health[6,8].

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This effect was not observed on all parameters[4,7]; some showed non significant change[9]. Most of the studies were cross-sectional, and the duration ranged from two to five months[1,3,4,8]. In the present study, we have taken systolic, diastolic, and pulse rates as the cardiac parameters because these are the major factors responsible for morbidity and mortality worldwide. Systolic pressure depends on cardiac output, diastolic blood pressure depends on total peripheral resistance, and both systolic and diastolic blood pressure is used for grading hypertension[10]. Hypertension is considered to be accountable for various end-stage organ diseases, and controlling hypertension is the aim of different treatment modalities[10]. Heart rates are considered predictors of cardiac health[11]. Respiratory parameters studied were FVC, $FEV_1$, $FEV_1$/FVC ratio (%), PEFR and MVV. Spirometry interpretation depends on FVC, $FEV_1$, $FEV_1$/FVC ratio (%) and PEFR parameters. It helps whether the pattern is obstructive or restrictive[12]. MVV is the primary parameter that may be directly affected by breathing exercises, as MVV depends on the strength of the respiratory muscles[13]. This is one of the longitudinal studies where the effect of breathing exercises (pranayamas) on sedentary adults was studied over 12 months. Further, we had yet to come across any such studies in this region of the world. Since breathing exercises were done for 10 to 40 minutes progressively increased over one year, we have used short-term breathing exercises. The study aimed to assess the effect of short-term breathing exercises on different cardio-respiratory parameters. Thus, this study helped to know whether breathing exercises in various pranayamas are practical in improving cardiorespiratory parameters in people living with sedentary lifestyles.

**Methods**

The longitudinal study was conducted in the Department of Physiology A.R.M.C.H and R.C. Solapur. Thirty subjects in the age group of 25 to 35 years were enrolled for the study. Subjects were enrolled from relatives of the various patients attending OPD. The study was conducted only after approval of the institutional ethics committee. Written informed consent was obtained from the participant for enrolment in the study.

The exclusion criteria for the patients were as follows: i) History suggestive of any acute infection, ii) History of chronic respiratory disease, iii) History of cardiac disease, iv) History of Diabetes, v) History of Drug intake is known to affect respiratory function, vi) Examination findings are suggestive of pre-existing respiratory or cardiac disease, vii) Chest and abdominal pain for any cause, viii) Oral or facial pain exacerbated by the mouthpiece, ix) Smokers and x) Subject doing regular exercise or yoga practice.

Socioeconomic status was asked using a modified Kuppuswamy scale based on the education of the head of the family, occupation, and monthly income[14].

Participants were enrolled to do Pranayama as follows. Standard instruction was followed for these pranayamas. The breathing exercise duration is shown in Table I.

Table I: Breathing exercise duration

| Sl. No. | Exercise | Duration |
|---|---|---|
| | Prayer followed by some warm-up exercise | 10 minutes |
| | Bhastrika pranayama | 2 minutes initially increased to 5 minutes |
| | Kapal Bhati pranayama | 2 minutes initially increased to 5 minutes |
| | Anulom Vilom Pranayama | 2 minutes initially increased to 5 minutes |
| | Bhramari pranayama | 2 minutes initially increased to 5 minutes |

All breathing exercises were done initially for approximately 10 minutes, which were increased to 40 minutes subsequently. In the initial three months, each Pranayama was for 2 minutes, which was increased to approximately 3 minutes in the next three months. In the last six months, it was approximately 4 to 5 minutes. Initially, they were given training, and frequent phone interaction was conducted with them to ensure compliance. The average daily duration in the initial 3 months was

15 minutes; in the next three months, it was 23 minutes. The average daily duration in the last 6 months was 34 minutes.

*For pulmonary function test*

i) Spiro Excel machine spirometer was used. All the subjects were familiar with the instrument and the test procedure. The tests were performed in a sitting position. The subjects were asked to take full inspiration, followed by as much rapid and forceful expiration as possible in the mouthpiece. Three consecutive readings were recorded, and the best reading among the three will be selected. Ii) PFT parameters were acceptable if they fell within and between the maneuver acceptability criteria. Guidelines given in the joint statements on lung function testing of the American Thoracic Society (ATS) and the European Respiratory Society (ERS) were followed[15,16]. iii) PFT parameters studied were forced vital capacity (FVC), forced expiratory volume in 1 s ($FEV_1$), FEV1 as a percentage of FVC in % [$FEV_1$ (%)], peak expiratory flow rate in L/s (PEFR), and Minute Ventilation Volume (MVV) L/min.

The standard method measured Blood pressure using a mercury sphygmomanometer (Diamond).

All parameters were recorded between 9 and 10 AM to avoid circadian variations.

All subjects were instructed to maintain uniform dietary habits and do the same yoga training daily.

Data would be compiled using Microsoft Excel sheets for anthropometric and cardio-respiratory parameters. Statistical analysis was done using statistical software. Numerical variables were summarized by mean and SD (normally distributed). The numerical variables were tested using a paired t-test. The Chi-square test was used to compare the frequency of normal spirometry patterns before and after the exercise program. A p-value less than 0.05 were considered to be statistically significant.

**Results**

This study was done with 30 healthy subjects of either sex (Male = 15, Female = 15) and mean age 30.23±4.23 years. All the healthy subjects had a sedentary lifestyle. All the subjects were doing their duties in the government, private office, business, or housewife, which does not involve physical activity. Out of 15 males, 12 were working at various government or private office posts, and three were doing their own business. Of 15 females, 10 were homemakers, and five were assigned to different government or private office positions. All subjects will be instructed to keep uniform dietary habits. A number of subjects based on socioeconomic class are shown in Table II. Most subjects were in the lower middle or upper lower class[14]. Characteristics of the subjects are shown in Figure 1. The cardiorespiratory pattern is shown in Table III and Table IV. In males and females, significant changes are observed in pulse rate, systolic blood pressure and diastolic blood pressure.

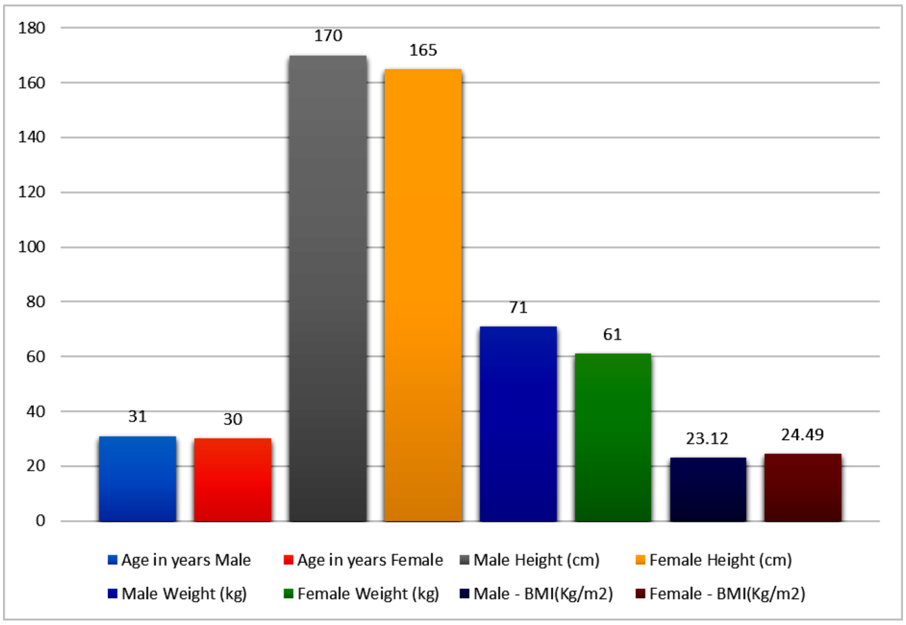


Figure 1: Characteristics of the subjects (Male = 15, Female = 15)

In pulmonary function test parameters, non-significant change was observed in $FEV_1$ and FVC. $FEV_1$ (%), PEFR and MVV showed significant changes in males and females. Normal spirometry pattern was observed in nine subjects and six subjects in males and females, respectively, before the short-term breathing exercise program. With one year of the program, this number was significantly increased in both sexes (Table V).

Table II: Socioeconomic status of subjects as per modified Kuppuswamy scale

| Socioeconomic class | Male (n=15) | Female (n=15) |
|---|---|---|
| I - upper | 0 | 0 |
| II - upper middle | 0 | 0 |
| III - lower middle | 9 | 8 |
| IV- upper, lower | 6 | 7 |
| V - lower | 0 | 0 |

Table III: Cardiovascular parameters in male subjects (n=15) and female subjects (n=15)

| Parameters | Before short-term breathing exercises Male n=15 | After short-term breathing exercises Male n=15 | Before short-term breathing exercises Female n=15 | After short-term breathing exercises Female n=15 |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | Mean±SD | Mean±SD |
| Pulse rate (beats per minute) | 80.46±2.71 | 72.86±2.86* | 77.41±3.73 | 71.22±1.98* |
| Systolic BP (mm Hg) | 125.6±2.79 | 120.13±5.30* | 123.1±3.13 | 118.23±4.21* |
| Diastolic BP (mm Hg) | 83.73±2.27 | 76.53±2.45* | 81.23±2.98 | 75.11±1.93* |

*- $p<0.01$- very significant

Table IV: Pulmonary function parameters in male subjects (n=15) and female subjects (n=15)

| Parameters | Before short-term breathing exercises (Male n=15) | After short-term breathing exercises (Male n=15) | Before short-term breathing exercises (Female n=15) | After short-term breathing exercises (Female n=15) |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | Mean±SD | Mean±SD |
| $FEV_1$ (L) | 3.12±0.53 | 3.11±0.31 | 2.22±0.56 | 2.38±0.54 |
| FVC (L) | 3.51±0.35 | 3.48±0.65 | 2.57±0.65 | 2.60±0.71 |
| $FEV_1$/FVC RATIO (%) | 88.3±11.23 | 94.56±12.34* | 87.3±12.70 | 93.5±14.7* |
| PEFR (L/sec) | 7.53±2.12 | 6.34±1.43* | 5.54±1.67 | 6.34±1.43* |
| MVV (L/min) | 103.61±5.12 | 115.16±6.13* | 82.66±4.14 | 105.86±5.87* |

*- $p<0.05$- significant

Table V: Frequency of normal spirometry pattern in male subjects (n=15) and female subjects (n=15)

| Pattern of spirometry | Before short-term breathing exercises Male n=15 | After short-term breathing exercises Male n=15 | Before short-term breathing exercises Female n=15 | After short-term breathing exercise Female n=15 |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) |
| Normal spirometry pattern | 09 (60.0) | 12 (80.0)* | 06 (40.0) | 09 (60.0)* |

*- $p<0.05$- significant

**Discussion**

In the present study, study subjects had done breathing exercises in the form of Pranayama for 12 months. Significant improvement in form and a significant decrease in pulse rate, diastolic blood pressure, and systolic blood pressure were observed both in males and females. In pulmonary function assessment, $FEV_1$ and FVC showed non-significant change, while FEV/FVC ratio, PEFR, and MVV showed significant change. Various authors have found results similar to our study; various studies are cross-sectional with varied durations[4,6]. This study results are comparable to those of longitudinal studies with a duration of eight days to 12 weeks[2,4,8,9]. In this study, a particular form of Pranayama was focused on. In our study, subjects did Bhastrika, Kapalbhati, Anulom Vilom and Bhamri Pranayama for 30 minutes to 40 minutes for about 12 months. Various mechanisms for cardiovascular effects have been explained in the literature[14,15,16,17]. These are decreased sympathetic tone and the associated increase in parasympathetic tone[17]. Slow breathing exercises have been known to cause an increase in vagal tone and increase baroreflex sensitivity[9]. These exercises are known to relieve stress. It causes the autonomic nervous system to reset with decreased adrenalin-mediated sympathetic activity and peripheral resistance[18,19]. Slow deep breathing increases baroreflex sensitivity by stimulating the medullary cardio-inhibitory area. This leads to a reduction in sympathetic activity that inhibits the tonic discharge of the vasoconstrictor nerves and excites the vagal innervations of the hear[20]. All these cause neural and nonneural tissue to fire together, which is also called synchronization. This synchronization is seen in the heart, lungs, limbic system, and cortex[1,16,19]. All these effects were responsible for decreased pulse rate and blood pressure, as observed in the present study. Positive effects are also observed in diseased conditions like hypertension[5] and they are also recommended as primary preventive measures. What are the mechanisms for respiratory function improvement? Deep breathing exercises cause an increase in the elasticity of the lungs and rib cage and have a positive effect on respiratory muscle efficiency. Further pulmonary stretch receptors get stimulated, resulting in reflex relaxation of the smooth muscle of the larynx and the tracheobronchial tree[1]. The release of surfactant and prostaglandin is also considered to be responsible for this[21,22]. Various studies have observed that Yogic breathing exercises affect hypoxic and hypercapnic chemosensitivities. The stepwise approach that starts from the stimulation chemoreceptor and the mechanoreceptor that ultimately activates various parts of the brain controlling respiration, the cerebellum and the limbic system has been described in the literature[22]. All these mechanisms cause improvement in respiratory function. In addition, one of the positive aspects of this study was duration. The duration of this study was comparatively long, which was one of the factors for improvement in cardiac and respiratory function. In some studies, non significant effects were observed for which duration was one of the factors[4,23]. Another factor was whether breathing exercises/pranayama sessions were supervised or unsupervised. Our sessions were not supervised. However, training was given to them, and frequent interactions were done with them for compliance[8].

*Limitation of the study*

The sample size was smaller, and all samples were healthy. We recommend further studies with larger sample sizes and various diseased populations. Dietary habits should have been taken into account in the study period. Comparisons based on socioeconomic status were not made as the sample size was small, and this was not the study's primary objective. Further, though we had frequent interaction for compliance, all sessions were not supervised since it was not practically possible.

**Conclusion**

Thus, we can summarize the breathing exercises must be advocated as a part of a healthy lifestyle and should be considered part of a training program for various individuals with sedentary lifestyles.

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