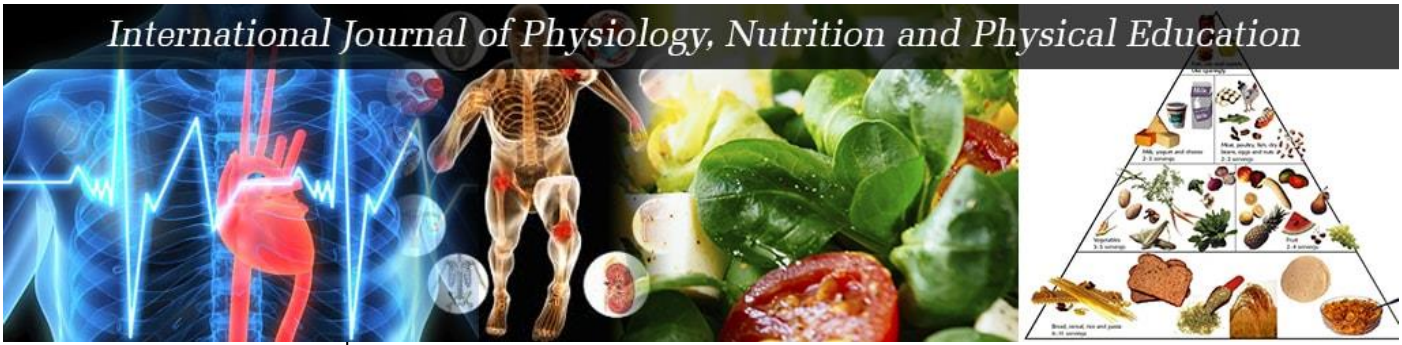

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Effect of pranayama on pulmonary functions of pre-adolescent boys

Sujit Singh and Amit Banerjee

Abstract
Background: According to the traditional wisdom of yoga, pranayama is the key to bringing about psychosomatic integration and harmony. It has been proven beyond doubt that pranayama is very important means for preventing and curing many ailments. Pranayama brings several physiological changes in the body.
Aim: The aim of the present study is to investigate the effects of ten weeks pranayama training on selected pulmonary functions of pre-adolescent boys.
Method: For the purpose of the study 30 male students were selected randomly as subjects from Jawahar Navodaya Vidyalaya, Banipur, North 24 Parganas, West Bengal, India. Age of the students ranges from 11 to 13 years. All the subjects were divided randomly in to experimental and control groups equally. Experimental group received pranayama training for ten weeks. Data were collected before and after ten weeks of training. Peak expiratory flow rate was measured by peak flow meter and respiratory rate was measured by palpation of chest movement for one minute.
Result: ANCOVA was applied to calculate the collected data at 0.05 level of significance and to identify the significance difference on experimental and control groups the mean critical difference was used as a post-hoc test. Significant difference was found between experimental and control groups on peak expiratory flow rate and respiratory rate.
Discussion: After ten weeks of pranayama training experimental group improved significantly on peak expiratory flow rate and respiratory rate.
Conclusion: From the above result it was concluded that ten weeks of pranayama training had a significant positive effect on pulmonary functions of pre-adolescent boys.

Keywords: Peak expiratory flow rate, respiratory rate, pranayama

Introduction

"In the beginning there is a breath (the first inhale of a new born). In the end there is a breath (last exhale in the moment of death). In between breath is always present. Without breath, there cannot be life"

When people talk about pranayama they generally mean those yogic practices which involve some kind of manipulation of breathing activity. But when one looks at the tradition of yoga, one finds that the concept of pranayama has a much greater depth and width and its techniques include vast array of very suitable elements apart from simple manipulation of breathing activity.

Pranayama is a Sanskrit word alternately translated as "extension of prana or breath control". The word pranayama is composed from two Sanskrit words Prana and Ayama. When we deal with concept of pranayama the term Prana refers breathing activity and Ayama means restrain, control or conscious manipulation. But if we study pranayama in its more essential and deeper aspect, the term Prana indicates the energy responsible for all the life activities in the human being, pranic energy responsible life or life force. The term Ayama means the expansion, stretch, regulation of these pranic activities. Thus the word pranayama in this context meaning the process through one can get acquainted with the whole field of pranic activity with a view to gain a complete control over it. Patanjali in his yoga sutras (ch. 2, sutras 49-51) describes pranayama as the controlled intake and outflow of breath in a firmly established posture.

It has been proven beyond doubt that pranayama is very important means for preventing and curing many ailments. Pranayama brings several physiological changes in the body.

The science of pranayama teaches us haw to reduce respiratory and heart rate, while increasing the quantum of oxygen drawn in and decreasing the outflow of breath. This can be as minimal as two or three cycles per minute. When the respiratory rate is thus lowered, the metabolic rate of the body also reduces. The body is brought to a state of temporary hibernation. All the cells are rested, and relaxation is ensured. The sympathetic overdrive is reduced, with consequent energy conservation. In pranayama the mind is kept attentive so that the rhythm of the breathing is regulated. The frontal brain which is the seat of intellectual activity is made quiet. Complete neuro-physiological relaxation occurs.

Based on previous literature the present study is an attempted to find out the effect of pranayama on pulmonary functions of pre adolescent boys.

2. Methodology

2.1 Subject

For the purpose of the study 30 boys were selected randomly as subject from Jawahar Navodaya Vidyalaya (JNV), Banipur, North 24 Parganas, West Bengal, India. Age of the subjects ranges between 11 to 13 years.

2.2 Design of the study

For the experimental procedure all the subjects were divided in to two equal groups, experimental and control group (15 subjects in each group). Experimental group received specific pranayama training for 10 weeks, and control did not receive any treatment.

2.3 Variables studied

1. Peak expiratory flow rate
2. Respiratory rate

2.4 Criterion measures

1. Peak expiratory flow rate was measured by peak flow meter, scores recorded in units of liters per minute (L/min).
2. Respiratory rate was measured by palpation of chest movement for one minute.

2.5 Training programme

The training programme was included three pranayama i.e. Nadi Sodhana, Chandra Bhedana and Bhramari. The training was given for ten weeks (weekly five days). The duration of training period was 45 minutes per day.

2.6 Collection of Data

Data were collected twice, immediately before the commencement of training programme and after the termination of training programme.

2.7 Statistical procedure

ANCOVA was applied as a statistical tool to analyze the collected data at 0.05 level of significance and in case of existence of significant difference, the Post Hoc test was used in order to investigate the existence of significant difference between the paired group's means.

3. Result & Discussion

Table 1: Descriptive Statistics on Peak Expiratory Flow Rate of Control Group in Pre-Test and Post-test

	Pre-Test	**Post-Test**
Sample size	15	15
Arithmetic mean	330.0000	333.3333
Variance	5942.8571	7352.3810
Standard deviation	77.0899	85.7460
Standard error of the mean	19.9045	22.1395

Table 2: Descriptive Statistics on Peak Expiratory Flow Rate of Experimental Group in Pre-Test and Post-Test

	Pre-Test	**Post-Test**
Sample size	15	15
Arithmetic mean	346.0000	378.6667
Variance	3197.1429	2712.3810
Standard deviation	56.5433	52.0805
Standard error of the mean	14.5994	13.4471

Table 3: Analysis of Variance of Experimental and Control Group on Peak Expiratory Flow Rate

Group	**Source of Variance**	**Sum of Squares**	**DF**	**Mean Squares**	**F- ratio**	**p value**
Pre-Test	Between	1920.0000	1	1920.0000	0.420	P = 0.522
	Within	127960.0000	28	4570.0000		
Post-test	Between	15413.3333	1	15413.3333	3.063	P = 0.091
	Within	140906.6667	28	5032.3810		

*Significant at 0.05 level of confidence

The table value required for significance at 0.05 level of confidence for df (1, 28) = 4.20

Table 4: Analysis of Covariance of Experimental and Control Group on Peak Expiratory Flow Rate

Adjusted Post-test Means		**Source of Variance**	**Sum of Squares**	**DF**	**Mean Squares**	**F-ratio**	**P value**
Experimental Group	**Control Group**						
370.9255	341.0745	Between	6584.319	1	6584.319	8.428*	0.007
		within	21092.722	27	781.212		

*Significant at 0.05 level of confidence

The table value required for significance at 0.05 level of confidence for df (1, 27) = 4.21

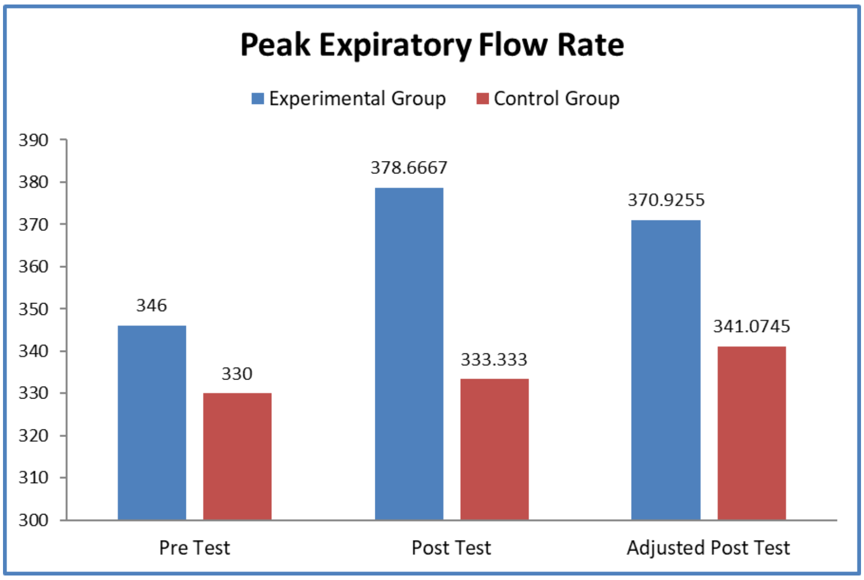

Fig 1: Comparison of means of peak expiratory flow rate scores between experimental and control group in pre-test, post-test and adjusted post-test phases

Table 5: Fisher's Least Significance Difference (LSD) Post Hoc Test for the Difference between the Adjusted Post-test Means on Peak Expiratory Flow Rate

Group	Adjusted Means	Mean Difference	Critical Difference
Experimental Group	370.9255	29.8510*	20.9222
Control Group	341.0745		

*Significant at 0.05 level

There was no significant difference observed (p>0.05) on peak expiratory flow rate between experimental and control group in pre-test and post-test phases (table-3). However a significant difference observed (*p*<0.05) on peak expiratory flow rate between experimental and control group in adjusted post-test means (table-4) and further this result also supported by the post hoc test result as the mean difference was found greater than the critical difference (table-5).This proved that there is no significant difference between experimental and control group at the time of pre-test, indicated that the groups are homogeneous as the process of randomization was successful.

Table 6: Descriptive Statistics on Respiratory Rate of Control Group in Pre-Test and Post-test

	Pre-Test	Post-Test
Sample size	15	15
Arithmetic mean	16.2667	16.8000
Variance	4.0667	4.1714
Standard deviation	2.0166	2.0424
Standard error of the mean	0.5207	0.5273

Table 7: Descriptive Statistics on Respiratory Rate of Experimental Group in Pre-test and Post-test

	Pre-Test	Post-Test
Sample size	15	15
Arithmetic mean	15.5333	13.4667
Variance	6.4095	4.4095
Standard deviation	2.5317	2.0999
Standard error of the mean	0.6537	0.5422

Table 8: Analysis of Variance of Experimental and Control Group on Respiratory Rate

Group	Source of Variance	Sum of Squares	DF	Mean Squares	F- ratio	p value
Pre-Test	Between	4.0333	1	4.0333	0.770	P = 0.388
	Within	146.6667	28	5.2381		
Post-Test	Between	83.3333	1	83.3333	19.423*	P < 0.001
	Within	120.1333	28	4.2905		

*Significant at 0.05 level of confidence
The table value required for significance at 0.05 level of confidence for df (1, 28) = 4.20

Table 9: Analysis of Covariance of Experimental and Control Group on Respiratory Rate

Adjusted Post-test Means		Source of Variance	Sum of Squares	DF	Mean Squares	F-ratio	P value
Experimental Group	Control Group						
13.4943	16.7723	Between	78.433	1	78.433	17.751*	<0.001
		within	119.298	27	4.418		

*Significant at 0.05 level of confidence
The table value required for significance at 0.05 level of confidence for df (1, 27) = 4.21

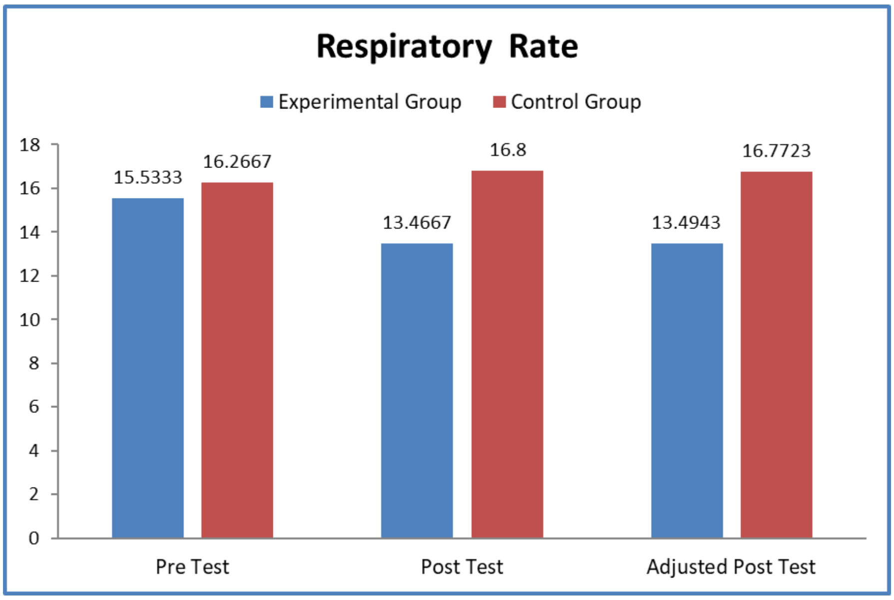

Fig 2: Comparison of means of respiratory rate scores between experimental and control group in pre-test, post-test and adjusted post-test phase

Table 10: Fisher's Least Significance Difference (LSD) Post Hoc Test for the Difference between the Adjusted Post-test Means on Respiratory Rate

Group	Adjusted Means	Mean Difference	Critical Difference
Experimental Group	13.4943	3.2780*	1.5733
Control Group	16.7723		

*Significant at 0.05 level

There was no significant difference observed (p>0.05) on respiratory rate between experimental and control group in pre-test phase (table-8). However a significant difference observed (*p*<0.05) on respiratory rate between experimental and control group in post-test and adjusted post-test means (table-8 &9) and further this result also supported by the post hoc test result as the mean difference was found greater than the critical difference (table-10).

This proved that there is no significant difference between experimental and control group at the time of pre-test, indicated that the groups are homogeneous as the process of randomization was successful.

3.1 Discussion on Peak Expiratory Flow Rate

Result of the present study clearly shows that peak expiratory flow rate significantly improved after ten weeks of pranayama training. Previous research literature also agreed with this fact. Nagireddy & Devananda (2018) [17] found that peak expiratory flow rate improved after six weeks of pranayama training in college students. Shasi Kant (2017) [18] found similar result, from the findings he concluded that cardiorespiratory variables (included Peak expiratory flow rate) of basketball players improved after three weeks of pranayama training. The findings of Dinesh *et al.* (2015) [7] also supported current findings. They examined the comparative effect of twelve weeks of slow and fast pranayama training on pulmonary function in adult healthy volunteers. They found both fast and slow pranayama training is beneficial for peak expiratory flow rate. Kartik *et al.* (2014) [6] concluded that yogic practice (included pranayama & suryanamaskar) improved peak expiratory flow rate. Panwar *et al.* (2012) investigated effect of pranayama on pulmonary test of young healthy student. They concluded that pranayama has positive physiological benefits on respiratory system as evident by improved pulmonary function (peak expiratory flow rate also included as variables).

Peak expiratory flow rate denotes the force of exhalation. It is an expression of effort by respiratory muscles and the state of relaxation of the bronchial tree. Peak expiratory flow rate is higher when bronchi are relaxed dilated and respiratory system is working efficiently.

Pranayama helps in bringing the sympathetic and parasympathetic nervous system in harmony. Through prayanayamic breathing participants can influence the nervous system. Pranayama may allow bronchi-dilatation by correcting abnormal breathing patterns and reducing muscle tone of respiratory muscles. Pranayama cleanses airway secretions, acts as a major physiological stimulus for the release of lung surfactant and prostaglandins into alveolar spaces which increases lung compliance.

An increase in peak expiratory flow rate is associated with decreased resistance of airways and increased strength of the respiratory musculature.

3.2 Discussion on Respiratory Rate

Result of the present study clearly shows that respiratory rate significantly improved after ten weeks of pranayama training. Previous research literature also agreed with this fact. Shasi Kant (2017) [18] found similar result, from the findings he concluded that cardiorespiratory variables (included respiratory rate) of basketball players improved after three weeks of pranayama training. Upadhyay *et al.* (2008) [11] studied effect of alternate nostril breathing on cardiorespiratory functions in healthy young adults and from the findings they concluded that the training have a positive effect on cardiorespiratory functions (included respiratory rate as one of the variable).

Practice of voluntary breath retention involves voluntary cessation of breathing and slowing down the speed of breathing, aiding a practitioner to gain control over the pneumotaxic center and influencing the pontine areas of the brain stem. Control over these areas facilitates the practitioner to prolong the breath holding time after following inspiration.

4. Conclusions
These findings are in accordance with earlier findings suggest that pranayama training improve the pulmonary functions pre-adolescent boys.

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