EFFECT OF PRANAYAMA AND BANDHA PRACTICES ON SELECTED PHYSIOLOGICAL VARIABLES AMONG ADOLESCENT GIRLS

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Abstract

Yoga breathing is considered as an intermediary between the mind and body which owes great potentials and comprehensive utilization of the prana system. As the pranayama and bandhas have vital role in the yogic breathing practices, the investigator analyzed the effect of pranayama and bandha practices on selected physiological variable among adolescence girls. To achieve this purpose, three groups of twenty adolescent girls each were randomly selected as subjects and named as 'bandha group', (BG) 'pranayama group' (PG) and 'combined group' (CG). BG and PG underwent selected bandha and Pranayama practice respectively whereas CG underwent the combination of both pranayama and bandha practice for six weeks. The selected subjects were tested before (pre test) and after (post tests) the practice period on the selected variables for the research work and were statistically treated by applying ANACOVA and Scheffe's Post Hoc test. The result of this study was proved that selected bandha and pranayama practice could make significant changes on the physiological functions among adolescent girls. Daily practice of yoga is one of the prime and easiest ways to maintain the physiological functions, attain physical fitness and free from diseases especially among adolescent girls.

KEY WORDS: *Yoga, Pranayama, Bandha, Physiology, Adolescent Girls.*

INTRODUCTION

Yoga is a spiritual technique and system of philosophy, but it is also the oldest and most thoroughly tested form of physical and mental exercise known as humanity. Yoga breathing is considered an intermediary between the mind and body. Yoga breathing owes their great potentials to prana. Regular practice of yoga breathing gives maximum benefits through complete and comprehensive utilization of the prana system **(Nancy, 1986).**

Yoga science of breathing is called pranayama. Oxygen is the most vial nutrient to our body. It is essential for the integrity of the brain, nerves, glands and internal organs. It is a systematic exercise of respiration, which makes the lungs stronger, improves blood circulation makes the man healthier and bestows upon him the boon of a long life. It aids the respiratory system function at its best whereby the life force can be activated and regulated in order to go beyond one's normal boundaries or limitations and attain a higher state of vibratory energy **(Iyengar, 1981).**

Bandha is a lock, meaning a closing off part of the interior body. These techniques speed up the raise of Kundalini energy, which allows the experience of higher states of consciousness. Bandhas thus direct the energy flow (prana) inside the body so that blockages of dammed up and repressed energy are alleviated, areas starved of prana are nourished, and the life force energy (prana) which leak out because of dissipative habits are harmonized, activated, and integrated **(Ravishankar, 2004).**

Peak expiratory flow rate (PEFR) is the maximum flow rate generated during a forceful exhalation, starting from full lung inflation. The peak expiratory flow rate measures how fast a person can breathe out (exhale) air. The number of movements indicative of inspiration and expiration per unit time is respiratory rate. Exercise increases the number, while rest diminishes it. The lower the resting respiratory rate, healthier the person is (Menon, 1984). Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inspiration. It is equal to the inspiratory reserve volume plus the tidal volume plus the expiratory reserve volume which are an invaluable tool in assessing the functional ability of the breathing system **(Nancy, 1986).**

Breathing consists of a regular rhythmic contraction and relaxation of the diaphragm. Breath can be hold voluntarily for a while. Holding the breath during inhalation causes the air drawn inside the lungs gets more chance of mixing with stale air in those pockets. As more time is made available for air mixing, stagnant stale air is removed and supply of fresh air goes inside those pockets. Similar action takes place during exhalation also. The overall effect of these actions is that entire surface of alveoli, or air sacs inside the lungs gets larger amount of fresh air **(Morehouse, 1986).**

Adolescence is a Latin word means "to grow up" is a transitional stage of physical and mental human development generally occurring between 12 years and 19years. Adolescence is a transitional stage of physical and mental human development generally occurring between puberty and legal adulthood. Dramatic changes in the body, a development in a person's psychology and transitions through one's academic career being occurs in this period. It is generally regarded as an emotionally intense and often stressful period. Yoga physiology is the study of how the body reacts and adapts to yogic exercise, in both the long and short term to a routine **(Smith, 2007).**

OBJECTIVE OF THE STUDY

As the pranayama and bandhas have vital role in the yogic practices, the investigator was interested to analyze the physiological changes among adolescent girls due to selected yogic breathing practices. The objective of the study was to find out the effect of pranayama and bandha practices on selected physiological

variables such as forced vital capacity, peak expiratory flow rate, resting respiratory rate, breathing holding time among adolescent girls.

MATERIALS AND METHODOLOGY

Three groups of twenty adolescent girls each were randomly selected as subjects from Coimbatore district schools and named as 'bandha group', 'pranayama group' and 'combined group'. Their mean age, height and weight were 16.93 years, 156.3 centimeters and 46.57 kilograms respectively. Pranayama and bandha practice was planned, administered and scheduled based on the results of the pilot study. The data on dependent variables such as Peak expiratory flow rate, Forced vital capacity, Respiratory rate and Breath holding time were collected by means of Wright Peak flow meter, Wet Spiro-meter, Number of breath rate/min and Nostril clip respectively. The selected groups underwent the practice in the morning session only for three option days and six weeks in total. The selected subjects were tested before (pre test) and after (post tests) the practice period on the selected variables for the research work and were statistically treated by applying ANACOVA and Scheffe's Post Hoc test. The details of practice is shown in the following table-I.

Table-I
DETAILS OF PRACTICE

Group	Practice	Procedure	Weeks Alternative	Duration			Total Duration
				Inhalation (In Sec.)	Holding (In Sec.)	Exhalation (In Sec.)	
Pranayama Group (Mon, Thur, Sun)	Pranayama	1.Anuloma Viloma 2.Sectional Breath 3.Ujjayi Pranayama 4.Surya Bhedana 5.Chandra Bhedana 6.Kapalabhati 7.Bhastrika 8.Bhramari	I & II	5	Nil	5	20 Min
			III & IV	5	10	20	25 Min
			V & VI	5	20	20	30 Min
Bandha Group (Tues, Fri, Sun)	Bandhas	1. Jalandhara: Inhale and hold 2. Udyana: Exhale and hold 3. Moola: Exhale and hold 4. Tri Bandha: Combination of all	I & II	Slowly	As long as possible	Slowly	20 Min
			III & IV	slowly			25 Min
			V & VI	slowly			30 Min
Combined Group (Wed, Sat, Sun)	Pranayama & Bandhas	Three Pranayamas sequentially	I & II	5	Nil	5	10 Min
			III & IV	5	10	20	15 Min
			V & VI	5	20	20	20 Min
		Tri-Bandha	I & II	Slowly	As long as possible	Slowly	10 Min
			III & IV	Slowly			10 Min
			V & VI	Slowly			10 Min

RESULTS AND DISCUSSIONS

The computation of ANCOVA and Post Hoc test were presented in the following tables.

Table II

ANALYSIS OF COVARIANCE ON FORCED VITAL CAPACITY

Test	Bandha	Pranayama	Combined	Source of variance	Sum of squares	Df	Mean squares	Obtained f
Pre Test Mean	2.14	2.09	2.07	between	0.40	2	0.200	0.06
				within	204.00	57	3.58	
Post Test Mean	2.76	2.795	3.20	between	31.03	2	15.52	4.30*
				within	205.90	57	3.61	
Adjusted Post Test Mean	2.73	2.80	3.22	between	37.04	2	18.52	32.32*
				within	32.092	56	0.57	
Mean Diff	0.62	0.705	1.13					

Table F-ratio at 0.05 level of confidence for 2 and 57 (df) =3.23. *Significant

Table III

SCHEFFE'S POST HOC TEST SCORES ON FORCED VITAL CAPACITY

Means				Required C I
Bandha	Pranayama	Combined	Mean difference	
2.73	2.80	-	0.07	0.28
2.73	-	3.22	0.49*	0.28
-	2.80	3.22	0.42*	0.28

***** Significant

BAR DIAGRAM ON ORDERED PRE, POST AND ADJUSTED POST TEST MEANS ON FORCED VITAL CAPACITY

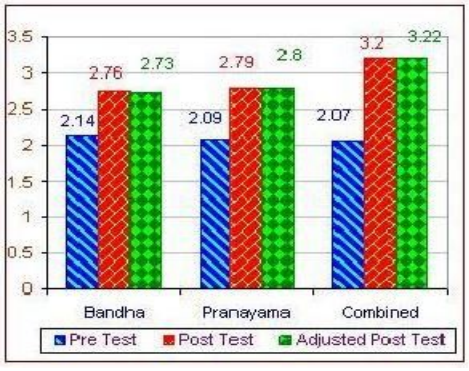

Figure 1

DISCUSSION ON THE FINDINGS OF FORCED VITAL CAPACITY

From the result of analysis of covariance on forced vital capacity among selected groups, it was observed that the obtained 'F' value of 32.32 was greater than the table value of 3.23 with 2 and 57 degrees of freedom. From the post hoc analysis, it was clear that the combined group improved the forced vital capacity due to the effect of six weeks of combined (bandha and pranayama) practice. This study was in accordance with the study done by Sivapriya and Others (2010) to create awareness in the health benefits of pranayama and showed significant increase in PEFR, FVC, and FEV.

Table IV

ANALYSIS OF COVARIANCE ON PEAK EXPIRATORY FLOW RATE

Test	Bandha	Pranayama	Combined	Source of variance	Sum of squares	Df	Mean squares	Obtained f
Pre Test Mean	1.34	1.3	1.31	between	0.01	2	0.007	0.51
				within	0.72	57	0.01	
Post Test Mean	2.42	2.405	2.76	between	1.59	2	0.79	29.69*
				within	1.52	57	0.03	
Adjusted Post Test Mean	2.42	2.40	2.75	between	1.58	2	0.79	29.12*
				within	1.524	56	0.03	
Mean Diff	1.08	1.105	1.45					

Table F-ratio at 0.05 level of confidence for 2 and 57 (df) =3.23. *Significant

Table V

SCHEFFE'S POST HOC TEST SCORES ON PEAK EXPIRATORY FLOW RATE

Means				Required C I
Bandha	Pranayama	Combined	Mean difference	
2.42	2.40	-	0.01	0.13
2.42	-	2.75	0.34*	0.13
-	2.40	2.75	0.35*	0.13

* Significance

BAR DIAGRAM ON ORDERED PRE, POST AND ADJUSTED POST TEST MEANS ON PEAK EXPIRATORY FLOW RATE

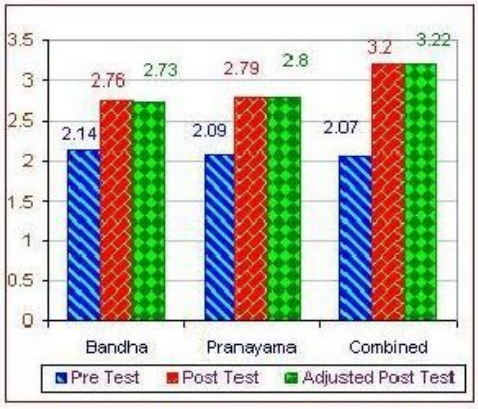

FIGURE 2

DISCUSSION ON THE FINDINGS OF PEAK EXPIRATORY FLOW RATE

The result of analysis of covariance of peak expiratory flow rate among selected groups showed that the obtained 'F' value of 29.12 was greater than the table value of 3.23 with 2 and 57 degrees of freedom. From the post hoc analysis, it was clear that the combined group improved the peak expiratory flow rate due to the effect of six weeks of combined (bandha and pranayama) practice. The study was in accordance with **Rajakumar (2010)** who analyzed the impact of yogic practices and physical exercises on selected physiological variables among the intercollegiate soccer players and revealed that yogic practice group showed significant improvement when compared to the other two groups.

Table VI

ANALYSIS OF COVARIANCE ON BREATH HOLDING TIME

Test	**Bandha**	**Pranayama**	**Combined**	**Source of variance**	**Sum of squares**	**Df**	**Mean squares**	**Obtained f**
Pre Test Mean	26.60	26.65	26.55	between	0.10	2	0.050	0.01
				within	1176.30	57	20.64	
Post Test Mean	32.10	31.65	36.00	between	228.90	2	114.45	5.14*
				within	1270.35	57	22.29	
Adjusted Post Test Mean	32.10	31.60	36.05	between	237.54	2	118.77	50.52*
				within	131.645	56	2.35	
Mean Diff	5.50	5	9.45					

Table F-ratio at 0.05 level of confidence for 2 and 57 (df) =3.23. *Significant

Table VII

SCHEFFE'S POST HOC TEST SCORES ON BREATH HOLDING TIME

Means				**Required C I**
Bandha	**Pranayama**	**Combined**	**Mean difference**	
32.10	31.60	-	0.50	1.21
32.10	-	36.05	3.95*	1.21
-	31.60	36.05	4.45*	1.21

*Significant

BAR DIAGRAM ON ORDERED PRE, POST AND ADJUSTED POST TEST MEANS ON BREATH HOLDING TIME

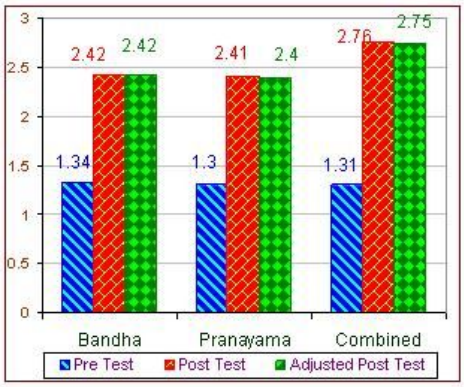

FIGURE 3

DISCUSSION ON THE FINDINGS ON BREATH HOLDING TIME

The result of analysis of covariance of breath holding time among selected groups showed that the obtained 'F' value of 50.52 was greater than the table value of 3.23 with 2 and 57 degrees of freedom. From the post hoc analysis, it was clear that the combined group improved the breath holding time due to the effect of six weeks of combined (bandha and pranayama) practice. The study was in accordance with **Madanmohan (2002)** studied the effect of yoga training and proved that yoga practice for 12 weeks results in significant reduction in visual and auditory RTs and significant increase in respiratory pressures, breath holding times and HGS.

Table VIII
ANALYSIS OF COVARIANCE ON RESTING RESPIRATORY RATE

Test	Bandha	Pranayama	Combined	Source of variance	Sum of squares	Df	Mean squares	Obtained f
Pre Test Mean	22.30	22.4	22.50	Between	0.40	2	0.200	0.06
				Within	204.00	57	3.58	
Post Test Mean	19.40	19.35	17.85	Between	31.03	2	15.52	4.30*
				Within	205.90	57	3.61	
Adjusted Post Test Mean	19.49	19.35	17.76	Between	37.04	2	18.52	32.32*
				Within	32.092	56	0.57	
Mean Diff	2.90	3.05	4.65					

Table F-ratio at 0.05 level of confidence for 2 and 57 (df) =3.23. *Significant

Table IX
SCHEFFE'S POST HOC TEST SCORES ON RESTING RESPIRATORY RATE

Means				Required C I
Bandha	Pranayama	Combined	Mean difference	
19.49	19.35	-	0.14	0.60
19.49	-	17.76	1.73*	0.60
-	19.35	17.76	1.59*	0.60

***** significant

BAR DIAGRAM ON ORDERED PRE, POST AND ADJUSTED POST TEST MEANS ON RESTING RESPIRATORY RATE

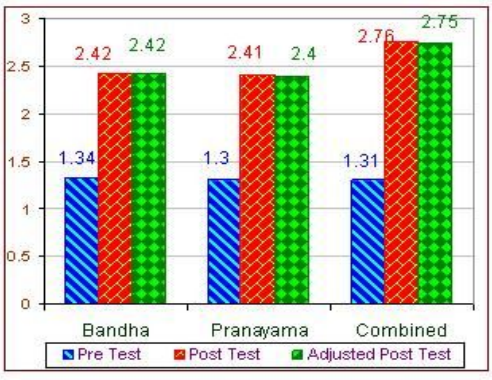

Figure-4

DISCUSSION ON FINDINGS OF RESTING RESPIRATORY RATE

The result of analysis of covariance of resting respiratory rate among selected groups showed that the obtained 'F' value of 50.52 was greater than the table value of 3.23 with 2 and 57 degrees of freedom. From the post hoc analysis, it was clear that the combined group improved the resting respiratory rate due to the effect of six weeks of combined (bandha and pranayama) practice. The study was in accordance with Varun, Monica, Shakuntala, Basvarajaih (2008) who analysed physiology of anuloma viloma pranayama and revealed that yoga significantly dropped the resting respiratory rate.

CONCLUSION

These practices help to boost, harmonise and refine the flow of Prana, thereby helping to maintain and enhance health. It is concluded that the present study had shows that selected bandha and pranayama practice had greater effect on physiological functions among the participants, which is very encouraging and significant.

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Movement Patterns Analyzed With the Fast Fourier Transform

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Abstract

A new methodological assessment using the Fast Fourier Transform was created to compare the frequency patterns of the gait of the different subject groups. Three different groups were examined in this study. These groups were: control patient group (CP), senior group (S), and sport student group (SS). All subjects walked at their individual speed by holding at both sidebars to get comparable movement patterns. A motion analysis was investigated with three infrared cameras at a frequency of 100Hz by Lukotronic System (LUKOtronic Lutz-Kovacs-Electronics OEG, Innsbruck, Austria). Eleven reflected markers were placed at the backside of the subjects. These placement of the markers were: shoulder left, shoulder right, sternum, hip left, hip right, knee left, knee right, ankle left, ankle right, heel left, and heel right. The scalar product of the distance between shoulder and ankle was investigated using a Fast Fourier Transform. To amplify the higher harmonical frequencies, the distance data was differentiated with respect to time two times. To be independent of individual walking speed, the frequency data was normalized afterwards. The area under the first peak (fundamental frequency) and the nine following peaks (higher harmonical frequencies) were measured. Means of the ten areas were calculated and compared to the three different groups. The quality of movement (MQ) was applied to the Fast Fourier Transform of the ankle-data. The S-group and the SS-group showed resembled patterns and data with the difference of higher peaks at the beginning and a higher gradient between the first peaks for the seniors. The S-group showed by far the lowest values. Particularly this group exhibits a high variability compared to the SS-group and the CP-group. It could be concluded that the application of this new methods (FFT movement patterns) will add to the biomechanics of the gait analysis as to stereotyped the gait of different group patterns and classify them with respect to their patterns as a finger thump.

Keywords: *Motion Analysis, Pathological Gait, Fast Fourier Transform*

Introduction

Walking is one of the naturally movements of the humans. Human walking could be described as a cycle of forward motions based on biomechanical values. Wiedmer (1992) showed that the objective of human walking is a forward motion of the centre of gravity in balance under lowest energy input. The gait analysis is a