

**EFFECTS OF SHORT TERM PRACTICE OF BHASTRIKA PRANAYAMA ON METABOLIC FITNESS (METF) AND BONE INTEGRITY (BI)**

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**Abstract.** *Purpose:* The present study was conducted with the objective to determine the short term practice of bhastrika pranayama on Metabolic Fitness and Bone Integrity. *Material:* 30 university level females between the age group of 21-26 years were selected. The subjects were randomly matched and assigned into two groups: Group-A: Experimental ( $n_1=15$ ); Group-B: Control ( $n_2=15$ ). The subjects from Group-A: Experimental were provided to a 4-weeks bhastrika pranayama. *Statistical Analysis:* Student t test for paired samples was utilized to compare the means of the pre-test and the post-test. *Results & Conclusions:* Based on the analysis of the results obtained, we conclude that the significant differences were found in Metabolic Fitness (i.e., Maximal Oxygen Consumption ( $V_{O_2max}$ ) and blood pressure of University Level Girls. Insignificant between-group differences were noted in Blood Lipid, Blood Sugar and Bone Integrity of University Level Girls.

**Keywords:** Bhastrika Pranayama, Metabolic, Fitness, Bone Integrity.

**Introduction**

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 [8]. The physiological and psychological benefits of yoga have been demonstrated in several studies [1, 2, 3, 4]. Numerous researches clearly reveal that regular practice of yoga leads to enhancement in physical and physiological functions and human sports performance. Some reports show the benefits in both peripheral nerve function [5] as well as central neuronal processes [6, 7]. According to literature one can reveal that the very meaning of yoga is to achieve a balance within the internal and external environment, in this manner looking for to accomplish physical, spiritual and mental well-being. This is made possible through the practice of "Pranayama" or breathing exercises, "Asana" or specific postures, and Meditation [9]. It is a notion that regular practicing of yoga over a period of time guides to a decrease in muscular relaxation, physical and respiratory rate, along with calming of the mind, and decreased state of arousal [10, 11]. Growing number of evidences have claimed that yoga practices increases longevity, [12] has therapeutic [13] and rehabilitative effects. The beneficial effects of six weeks practice of different pranayamas are well reported and have sound scientific basis [14]. Yoga, which is a way of life, is characterized by balance, health, harmony, and bliss. [15]. By practicing yoga, a person is supposed to reach a state of mental equanimity, where responses to favorable or unfavorable external events are well under the individual's control, and responses are moderate in intensity [16]. The science of yoga is a powerful stream of knowledge, which enables the practitioners to achieve radiant physical health, serene mind, continues spiritual uplift, and creates the ability for harmonious social living [17]. Pranayam, the fourth step of ashtang yoga is an important component of yoga training [18]. The very meaning of yoga is to achieve a balance within the internal and external environment, thereby seeking to attain mental, spiritual and physical well-being. This is made possible through the practice of "Pranayama" or breathing exercises, "Asana" or specific postures, and Meditation [19]. It is thought that practicing yoga over a period of time leads to a decrease in respiratory rate, muscular relaxation along with calming of the mind, which might be interpreted at least partly as a decreased state of arousal [20-21]. But various studies show that respiratory parameters improve after yoga & pranayama. A significant increase in the vital capacity, tidal volume increase in expiratory and inspiratory pressures and breath's holding time [22]. Pranayama has immense therapeutic potential in a wide range of psychosomatic disorders, but there is currently lack of an adequate meta-analysis in relation to Bhastrika Pranayama to assess its efficacy with respect to Metabolic Fitness (MetF) and Bone Integrity (BI) and as a result the present study was conducted to find out therapeutic effects of Bhastrika Pranayama on Metabolic Fitness (MetF) and Bone Integrity (BI).

**Material and Methods**

**Subjects**

Thirty, university level women between the age group of 21-26 years were selected. The subjects were randomly matched and assigned into two groups: Group-A: Experimental ( $n_1=15$ ); Group-B: Control ( $n_2=15$ ).

Table 1.

*Distribution and Demographics of Subjects.*

Sample Size (N=30)			
Variables	Total (N=30)	Experimental group ( $n_1=15$ )	Control group ( $n_2=15$ )
Age	21.733±2.049	21.4±1.992	22.066±2.120
Body Height	5.39±1.748	5.346±1.407	5.433±1.988
Body Mass	54.226±3.240	53.186±2.405	55.266±3.695

**Methodology**

This study is designed as a retrospective cross-sectional study. The subjects from Group-A: Experimental were provided to a 4-week training of Bhastrika Pranayama. This lasted 4 weeks and consisted of daily sessions.

- Maximal oxygen uptake (VO<sub>2</sub>max) was used as a measure of fitness of cardiopulmonary system and was assessed by a running test at maximal pace on a treadmill. Maximal oxygen uptake was scaled relative to body weight (mL . min<sup>-1</sup>.kg<sup>-2/3</sup>).
- Blood samples (10 ml) for the determination of lipid profiles were obtained. All of biochemical tests have been done with serum samples.
- Blood pressure was assessed by Sphygmomanometer.
- The blood sugar levels were measured by Digital Glucometer (ACCU-CHEK, Sr no-GN20606850 manufactured by Roche Diagnostics India Pvt. Ltd, Mumbai).
- Bone mineral density (BMD) of lumbar spine (L2-L4) was assessed by dual-energy X-ray absorptiometry (DXA) with the help of a Hologic QDR 1500W (Bedford, MA, USA).

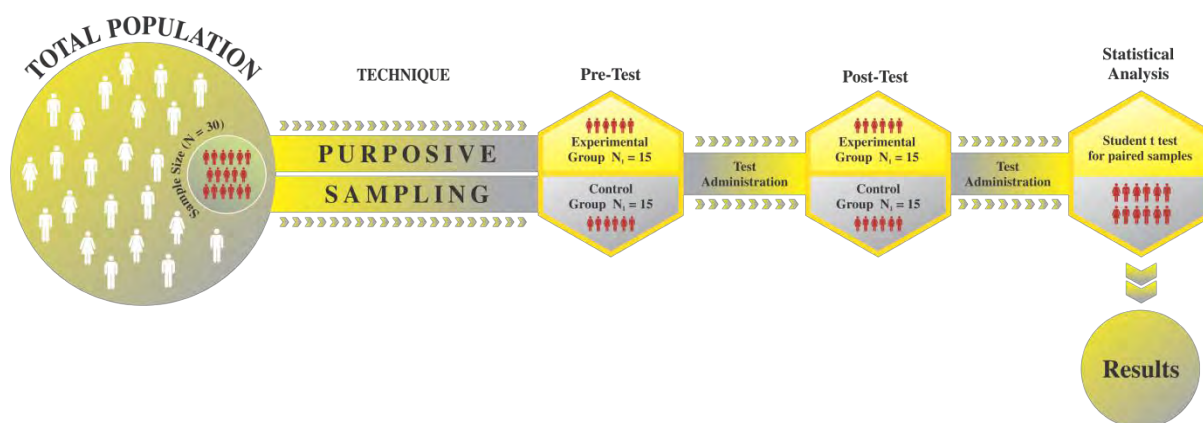


Fig.1. Study Design.

Table 2

Experimental Treatment.

4-Weeks Bhastrika Pranayama Training			
Weeks	Schedule	Time	Duration
1 <sup>st</sup> Week	Preliminary Yogic Exercises	5 Minute	20 Minute
	Practice of Bhastrika Pranayama (9 Rounds X 1 Set)	10 Minute	
	Relaxation Posture	5 Minute	
2 <sup>nd</sup> Week	Preliminary Yogic Exercises	5 Minute	25 Minute
	Practice of Bhastrika Pranayama (9 Rounds X 2 Set)	15 Minute	
	Relaxation Posture	5 Minute	
3 <sup>rd</sup> Week	Preliminary Yogic Exercises	5 Minute	30 Minute
	Practice of Bhastrika Pranayama (9 Rounds X 3 Set)	20 Minute	
	Relaxation Posture	5 Minute	
4 <sup>rd</sup> Week	Preliminary Yogic Exercises	5 Minute	35 Minute
	Practice of Bhastrika Pranayama (9 Rounds X 4 Set)	25 Minute	
	Relaxation Posture	5 Minute	



Fig. 2. Subjects Performing Bhastrika Pranayama.

**Statistical Analyses**

Data are expressed as the mean ± SD. Student t test for paired samples was utilized to compare the means of the pre-test and the post-test.

**Results**

Table 3

Mean values (±SD) and Paired Sample t-test of Metabolic Fitness (MetF) (i.e., Maximal Oxygen Consumption ( $V_{O_2max}$ ), Blood Lipid, Blood Pressure and Blood Sugar) in Experimental and Control group (n=15 each) before (Pre) and after (Post) 4-weeks Bhastrika Pranayama Training Programme (Experimental group only).

Parameters		Group	Pre-Test	Post-Test	t-value	p-value
Maximal Oxygen Consumption ( $V_{O_2max}$ )		Experimental	33.24±2.38	34.48±1.63	5.145*	0.0001
		Control	22.66±0.40	22.48±0.29	1.5730	0.1380
Blood Lipid	Cholesterol	Experimental	159.26±10.74	159.33±10.77	1.375	0.190
		Control	154.25±12.25	154.44±12.07	0.9242	0.3710
	Triglycerides	Experimental	146.56±1.90	146.76±1.71	1.462	0.165
		Control	135.82±8.72	135.83±8.69	1.450	0.168
Systolic Blood Pressure		Experimental	117.13±1.60	118.60±1.24	6.204*	0.0001
		Control	125.93±3.45	126.40±2.23	0.5191	0.6118

Parameters		Group	Pre-Test	Post-Test	t-value	p-value
Blood Pressure	Diastolic Blood Pressure	Experimental	75.47±2.00	78.13±2.13	6.324*	0.0001
		Control	83.33±2.55	84.13±1.88	1.1687	0.2620
Blood Sugar	Fasting Blood Sugar	Experimental	95.07±2.79	96.53±3.11	1.3291	0.2051
		Control	85.47±3.07	86.40±3.62	0.8750	0.3963
	Post Prandial Blood Sugar	Experimental	124.20±3.17	125.67±2.66	1.0822	0.2975
		Control	133.53±4.29	135.00±3.00	0.9644	0.3512

### Maximal Oxygen Consumption ( $V_{O_2max}$ )

The results of Metabolic Fitness (MetF) in group (Experimental) and group (Control) are shown in Table-3. The Mean and Standard Deviation ( $\pm$ SD) values of Maximal Oxygen Consumption ( $V_{O_2max}$ ) of pre-test and post-test of experimental group were 33.24±2.38 & 34.48±1.63 respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Maximal Oxygen Consumption ( $V_{O_2max}$ ) of pre-test and post-test of control group were 22.66±0.40 & 22.48±0.29. The t-value in case of experimental group was 5.145\* and for control group it was 1.5730.

Significant between-group differences were noted in Maximal Oxygen Consumption ( $V_{O_2max}$ ) in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=5.145^*$ ) is greater than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

### Cholesterol

The Mean and Standard Deviation values ( $\pm$ SD) of Cholesterol of pre-test and post-test of experimental group were 159.26±10.74 and 159.33±10.77 respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Cholesterol of pre-test and post-test of control group were 154.25±12.25 and 154.44±12.07. The t-value in case of experimental group was 1.375 and for control group it was 0.9242.

Insignificant between-group differences were noted in Cholesterol in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=1.375$ ) is less than tabulated value of  $t_{0.05} (14) = 2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

### Triglycerides

The mean and standard deviation values of Triglycerides of pre and post-test of experimental group were 146.56±1.90 and 146.76±1.71 respectively. However, the mean and standard deviation values of Triglycerides of pre and post-test of control group were 135.82±8.72 and 135.83±8.69. The t-value in case of experimental group was 1.462 and for control group it was 1.450.

Insignificant between-group differences were noted in Triglycerides in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=1.462$ ) is less than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

### Systolic Blood Pressure

The Mean and Standard Deviation ( $\pm$ SD) values of Systolic Blood Pressure of pre-test and post-test of experimental group were 117.13±1.60 & 118.60±1.24 respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Systolic Blood Pressure of pre-test and post-test of control group were 125.93±3.45 & 126.40±2.23. The t-value in case of experimental group was 6.204\* and for control group it was 0.5191.

Significant between-group differences were noted in Systolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=6.204^*$ ) is greater than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

### Diastolic Blood Pressure

The Mean and Standard Deviation ( $\pm$ SD) values of Diastolic Blood Pressure of pre-test and post-test of experimental group were 75.47±2.00 & 78.13±2.13 respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Diastolic Blood Pressure of pre-test and post-test of control group were 83.33±2.55 & 84.13±1.88. The t-value in case of experimental group was 6.324\* and for control group it was 1.1687.

Significant between-group differences were noted in Diastolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=6.324^*$ ) is greater than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4-week period were noted in the control group.

**Fasting Blood Sugar**

The Mean and Standard Deviation ( $\pm$ SD) values of Fasting Blood Sugar of pre-test and post-test of experimental group were  $95.07 \pm 2.79$  &  $96.53 \pm 3.11$  respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Fasting Blood Sugar of pre-test and post-test of control group were  $85.47 \pm 3.07$  &  $86.40 \pm 3.62$ . The t-value in case of experimental group was 1.3291 and for control group it was 0.8750.

Insignificant between-group differences were noted in Fasting Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=1.3291$ ) is less than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

**Post Prandial Blood Sugar**

The Mean and Standard Deviation ( $\pm$ SD) values of Post Prandial Blood Sugar of pre-test and post-test of experimental group were  $124.20 \pm 3.17$  &  $125.67 \pm 2.66$  respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Post Prandial Blood Sugar of pre-test and post-test of control group were  $133.53 \pm 4.29$  &  $135.00 \pm 3.00$ . The t-value in case of experimental group was 1.0822 and for control group it was 0.9644.

Insignificant between-group differences were noted in Post Prandial Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=1.0822$ ) is less than tabulated value of  $t_{0.05} (14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4- week period were noted in the control group.

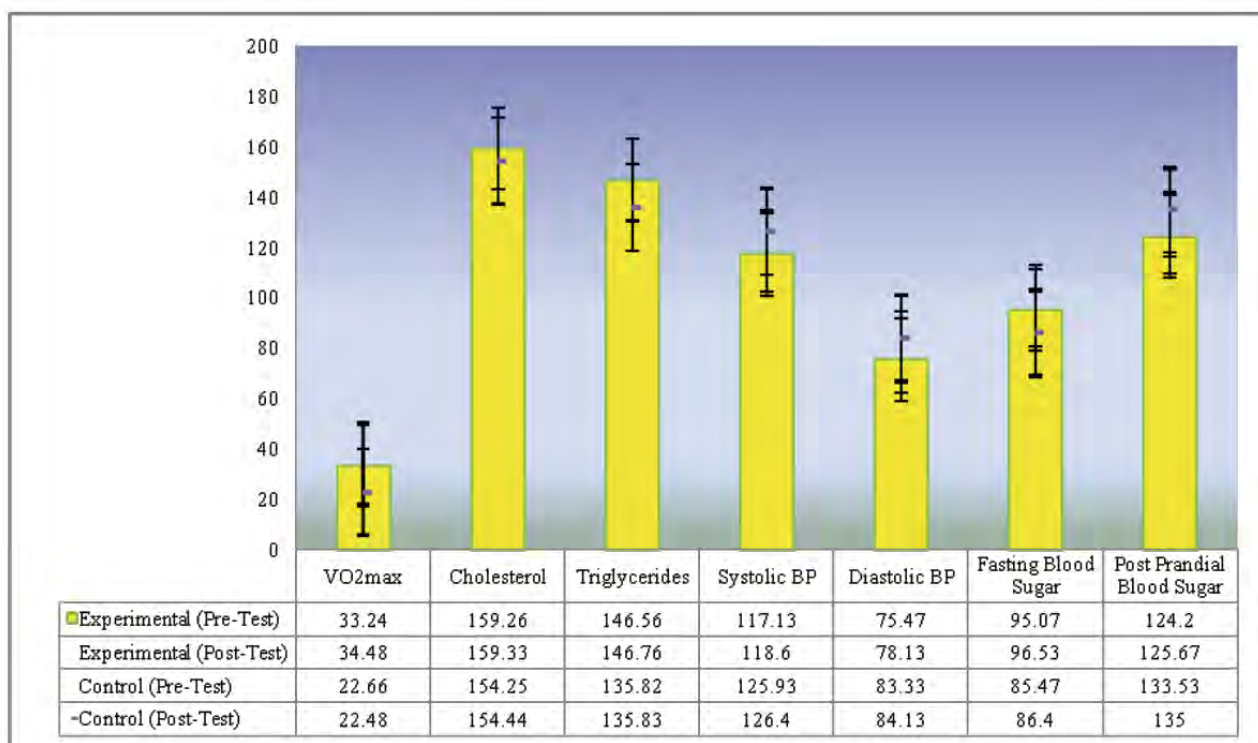


Fig. 3. Mean values of Metabolic Fitness (MetF) (i.e., Maximal Oxygen Consumption ( $V_{O_2max}$ ), Blood Lipid and Blood Sugar) in Experimental and Control group ( $n=15$  each) before (Pre) and after (Post) 4-weeks Bhastrika Pranayama Training Programme (Experimental group only).

Table 4.

Mean values ( $\pm$ SD) and Paired Sample t-test of Bone Integrity in Experimental and Control group ( $n=15$  each) before (Pre) and after (Post) 4-weeks Bhastrika Pranayama Training Programme (Experimental group only).

Parameters	Group	Pre-Test	Post-Test	t-value	p-value
Bone Integrity	Experimental	$1.13 \pm 0.028$	$1.146 \pm 0.023$	1.464	0.165
	Control	$1.15 \pm 0.027$	$1.14 \pm 0.026$	0.159	0.876

**Bone Integrity**

The Mean and Standard Deviation ( $\pm$ SD) values of Bone Integrity of pre-test and post-test of experimental group were  $1.13\pm 0.028$  &  $1.146\pm 0.023$  respectively. However, the Mean and Standard Deviation ( $\pm$ SD) values of Bone Integrity of pre-test and post-test of control group were  $1.15\pm 0.027$  &  $1.14\pm 0.026$ . The t-value in case of experimental group was 1.464 and for control group it was 0.159.

Insignificant between-group differences were noted in Bone Integrity in the experimental group before (Pre) and after (Post) subjected to 4-week Bhastrika Pranayama Training Programme since, the calculated value of ( $t=1.464$ ) is less than tabulated value of  $t_{0.05}(14)=2.1448$  for the selected degree of freedom and level of significance. However, no significant changes over that 4-week period were noted in the control group.

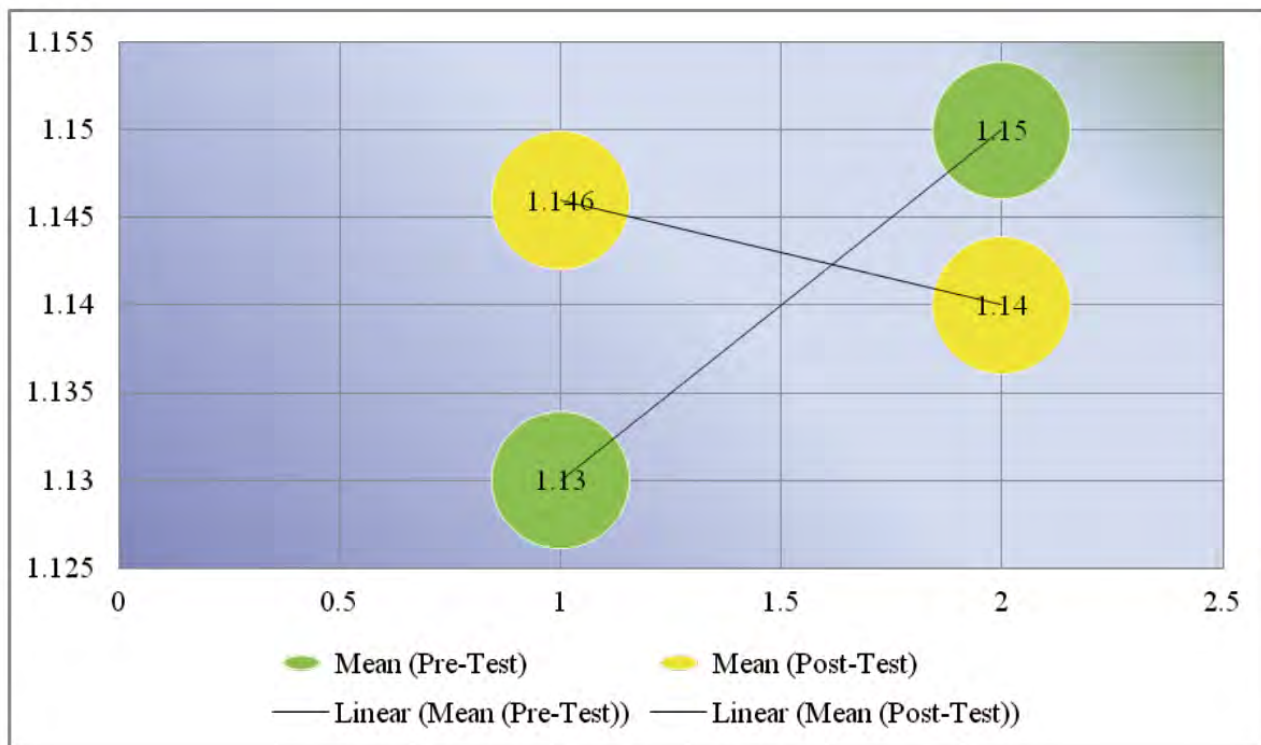


Fig. 4. Mean values of Bone Integrity in Experimental and Control group ( $n=15$  each) before (Pre) and after (Post) 4-weeks Bhastrika Pranayama Training Programme (Experimental group only).

### Conclusions:

Based on the analysis of the results obtained, we conclude that the significant differences were found in Metabolic Fitness (MetF) (i.e., Maximal Oxygen Consumption ( $V_{O_2max}$ ) and blood pressure of University Level Girls. Insignificant between-group differences were noted in Blood Lipid, Blood Sugar and Bone Integrity of University Level Girls.

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