

Exploring the Therapeutic Effects of Kapalbhathi Pranayama on Metabolic Fitness (MetF) and Bone Integrity (BI)

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Abstract: Objective: The present study was conducted with the objective to determine the therapeutic effects of Kapalbhathi Pranayama on Metabolic Fitness (MetF) and Bone Integrity (BI). Methods: Forty, university level girls between the age group of 19-25 years were selected. The subjects were purposively assigned into two groups: Group-A: Experimental ($n_1=20$); Group-B: Control ($n_2=20$). The subjects from Group-A: Experimental were subjected to a 4-weeks kapalbhathi pranayama. Statistical Analysis: Student t test for paired samples was utilized to compare the means of the pre-test and the post-test. Results: Significant differences were found in Maximal Oxygen Consumption (VO_{2max} ; $t=4.5033^*$), Blood Pressure (Systolic Blood Pressure; $t=6.725^*$, Diastolic Blood Pressure; $t=7.408^*$) and Blood Sugar (Fasting Blood Sugar; $t=8.432^*$, Post Prandial Blood Sugar; $t=4.207^*$) of university level girls. However, insignificant between-group differences were noted in Blood Lipid (Cholesterol; $t=0.319$, Triglycerides; $t=0.057$) and Bone Integrity ($t=1.7097$) of university level girls. Conclusion: Based on the analysis of the results obtained, we conclude that the experimental group subjected to 4-week training of Kapalbhathi Pranayama brought about significant difference in Maximal Oxygen Consumption (VO_{2max}), Blood Pressure and Blood Sugar, whereas insignificant differences were noted in Blood Lipid and Bone Integrity of university level girls.

Keywords: Yoga, Physiological Fitness, University Level Girls

1. Introduction

Our ancestors have made several invaluable contributions for the welfare of mankind. Yoga is one of them. Maharshi Patanjali Yoga Sutra is a universally accepted treatise on the subject of yoga. In Indian contemplation uni-lateral development of Personality has not been given any importance. Pranayamic breathing has been shown to be a beneficial clinical application in the treatment of psychological disorders as well as physiological diseases. Different forms of pranayama activate different branches of the autonomic nervous system effecting oxygen consumption, metabolism and skin resistance. Pranayamic breathing, characterized by brief breath retention, caused significant increases in oxygen consumption and metabolic rate while pranayamic breathing, characterized by long breath retention, caused lowering of oxygen consumption and metabolic rate [1]. This demonstrates that slow breathing enhances parasympathetic activation. In another study using breathing exercises mimicking pranayama, slow breathing over a period of three months was shown to improve autonomic

function while fast breathing did not have an effect on the autonomic nervous system [2]. Kapalbhathi Pranayama is a miraculous yoga breathing exercise, invented by Indian yogis thousands years ago, for complete body fitness. It affects even those diseases which are impossible to be cured by medicines like cancer, diabetes, asthma. Numerous patients have gained healthy and happy life by adopting it, in their daily life [3]. The ancient science of yoga makes use of the voluntary regulation of breathing to make respiration rhythmic and to calm the mind [4]. Pranayama may also affect the immune system. Inhibition of the sympathetic nervous system has been shown to enhance function of the immune system in several forms of meditation including mindfulness meditation and Transcendental meditation [5, 6]. This practice is called 'Pranayama'. It is an art of controlling the breath. It involves taking in breath, retaining it then exhaling it [7, 8]. Some studies have shown the various effects of Pranayama on young volunteers. The beneficial effects of six weeks practice of different pranayamas are well reported and have sound scientific basis [9]. Pranayam, the fourth step of ashtang yoga is an important component of yoga training. It is known that the regular practice of pranayama increases

parasympathetic tone, decreases sympathetic activity, improves cardiovascular and respiratory functions, decreases the effect of stress and strain on the body and improves physical and mental health [10, 11]. Different types of pranayama along with asanas produce different physiological responses in normal young individuals. 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 Kapalbhathi Pranayama to assess its efficacy with respect to metabolic fitness and Bone Integrity and as a result the present study was conducted to find out therapeutic effects of kapalbhathi pranayama on metabolic fitness and Bone Integrity.

2. Methods

Forty, university level girls of Department of Physical Education (T), Guru Nanak Dev University, Amritsar between the age group of 19-25 years (Mean ± SD: age 22.025±1.954yrs, height 5.305±1.431 ft, body mass 55.7±2.593 kg) volunteered to participate in the study. The subjects were purposively assigned into two groups:

- Group-A: Experimental (n₁=20)
- Group-B: Control (n₂=20)

All the subjects were informed about the objective and protocol of the study. Distribution and demographics of

subjects are brought forth in table-1.

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

- Maximal oxygen uptake (V_{O2}max) was used as a measure of cardiopulmonary fitness and was assessed by a maximal running test on a treadmill. Maximal oxygen uptake was scaled relative to body weight (mL.min⁻¹.kg^{-2/3}).
- 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 measured in supine posture by Sphygmomanometer. Two reading were taken 5 minutes apart and the mean of two was taken as the basal blood pressure.
- 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) in anteroposterior view was measured by dual-energy X-ray absorptiometry (DXA) using a Hologic QDR 1500W (Bedford, MA, USA).

Table 1. Distribution and demographics of subjects.

Variables	Total (N=40)	Experimental group (n ₁ =20)	Control group (n ₂ =20)
Age	22.025±1.954	22.15±1.899	21.9±2.049
Body Height	5.305±1.431	5.285±1.386	5.325±1.482
Body Mass	55.7±2.593	55.4±2.370	56±2.828

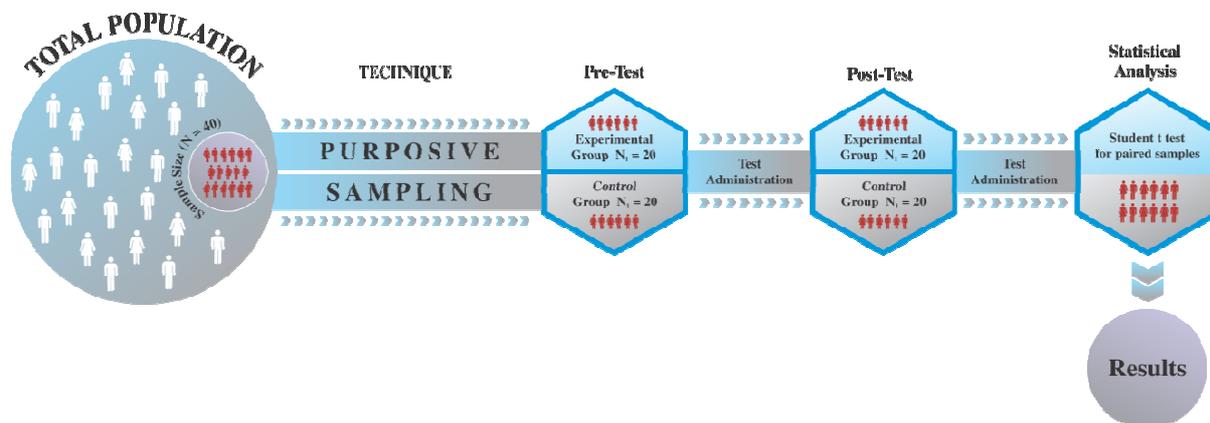


Figure 1. Study design.

Table 2. Experimental treatment.

4-Weeks Kapalbhathi Pranayama Training Programme			
Weeks	Schedule	Time	Duration
1 st Week	Preliminary Yogic Exercises	5 Minute	20 Minute
	Practice of KapalbhathiPranayama (9 Rounds X 1 Set)	10 Minute	
	Relaxation Posture	5 Minute	
2 nd Week	Preliminary Yogic Exercises	5 Minute	25 Minute
	Practice of Kapalbhathi Pranayama (9 Rounds X 2 Set)	15 Minute	
	Relaxation Posture	5 Minute	

4-Weeks Kapalbhathi Pranayama Training Programme			
Weeks	Schedule	Time	Duration
3 rd Week	Preliminary Yogic Exercises	5 Minute	30 Minute
	Practice of Kapalbhathi Pranayama (9 Rounds X 3 Set)	20 Minute	
	Relaxation Posture	5 Minute	
4 th Week	Preliminary Yogic Exercises	5 Minute	35 Minute
	Practice of Kapalbhathi Pranayama (9 Rounds X 4 Set)	25 Minute	
	Relaxation Posture	5 Minute	



Figure 2. Subjects performing kapalbhathi pranayama.

3. Statistical Analyses

Statistical analyses were performed using the Statistical Package for the Social Sciences for Windows version 16.0 software (SPSS Inc., Chicago, IL). Data is expressed as the

mean \pm SD. Student t test for paired samples was utilized to compare the means of the pre-test and the post-test. The level of significance was set at 0.05.

4. Results

Table 3. Mean values (\pm 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 ($n=20$ each) before (pre) and after (post) 4-weeks kapalbhathi pranayama training programme (experimental group only).

Parameters	Group	Pre-Test	Post-Test	t-value	p-value	
Maximal Oxygen Consumption (V_{O_2max})	Experimental	33.74 \pm 2.28	34.70 \pm 1.53	4.5033*	0.0002	
	Control	22.67 \pm 0.46	22.47 \pm 0.28	1.870	0.076	
Blood Lipid	Cholesterol	Experimental	153.96 \pm 12.08	154.12 \pm 11.93	1.023	0.319
		Control	158.34 \pm 9.94	158.37 \pm 9.98	0.876	0.391
	Triglycerides	Experimental	146.26 \pm 1.79	146.49 \pm 1.66	2.023	0.057
		Control	135.88 \pm 9.29	135.91 \pm 9.25	0.010	0.991
Blood Pressure	Systolic Blood Pressure	Experimental	117.45 \pm 1.57	118.75 \pm 1.16	6.725*	0.0001
		Control	125.85 \pm 3.44	126.75 \pm 2.17	1.338	0.196
	Diastolic Blood Pressure	Experimental	75.35 \pm 2.08	77.95 \pm 2.37	7.408*	0.0001
		Control	83.50 \pm 2.31	84.35 \pm 1.79	1.669	0.111
Blood Sugar	Fasting Blood Sugar	Experimental	96.15 \pm 1.42	97.80 \pm 1.32	8.432*	0.0001
		Control	85.70 \pm 2.94	86.40 \pm 3.44	0.782	0.443
	Post Prandial Blood Sugar	Experimental	128.30 \pm 4.60	130.65 \pm 4.40	4.207*	0.0005
		Control	133.85 \pm 3.99	134.65 \pm 2.85	0.627	0.537

4.1. 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 33.74 \pm 2.28 & 34.70 \pm 1.53

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 22.67 \pm 0.46 & 22.47 \pm 0.28. The t-value in case of experimental group was 4.5033* and for control group it was 1.870. 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-weeksKapalbhati Pranayama Training Programme since, the calculated value of ($t=4.5033^*$) is greater than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.2. Cholesterol

The Mean and Standard Deviation values (\pm SD) of Cholesterol of pre-test and post-test of experimental group were 153.96 ± 12.08 and 154.12 ± 11.93 respectively. However, the Mean and Standard Deviation (\pm SD) values of Cholesterol of pre-test and post-test of control group were 158.34 ± 9.94 and 158.37 ± 9.98 . The t-value in case of experimental group was 1.023 and for control group it was 0.876. Insignificant between-group differences were noted in Cholesterol in the experimental group before (Pre) and after (Post) subjected to 4-weeksKapalbhati Pranayama Training Programme since, the calculated value of ($t=1.023$) is less than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.3. Triglycerides

The Mean and Standard Deviation values (\pm SD) of Triglycerides of pre-test and post-test of experimental group were 146.26 ± 1.79 and 146.49 ± 1.66 respectively. However, the Mean and Standard Deviation (\pm SD) values of Triglycerides of pre-test and post-test of control group were 135.88 ± 9.29 and 135.91 ± 9.25 . The t-value in case of experimental group was 2.023 and for control group it was 0.010. Insignificant between-group differences were noted in Triglycerides in the experimental group before (Pre) and after (Post) subjected to 4-weeks Kapalbhati Pranayama Training Programme since, the calculated value of ($t=2.023$) is less than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.4. 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 117.45 ± 1.57 & 118.75 ± 1.16 respectively. However, the Mean and Standard Deviation (\pm SD) values of Systolic Blood Pressure of pre-test and post-test of control group were 125.85 ± 3.44 & 126.75 ± 2.17 . The t-value in case of experimental group was 6.725^* and for control group it was 1.338. Significant between-group differences were noted in Systolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4-weeks Kapalbhati Pranayama Training Programme since, the calculated value of ($t=6.725^*$) is less than tabulated value

of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.5. 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 75.35 ± 2.08 & 77.95 ± 2.37 respectively. However, the Mean and Standard Deviation (\pm SD) values of Diastolic Blood Pressure of pre-test and post-test of control group were 83.50 ± 2.31 & 84.35 ± 1.79 . The t-value in case of experimental group was 7.408^* and for control group it was 1.669. Significant between-group differences were noted in Diastolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4-weeksKapalbhati Pranayama Training Programme since, the calculated value of ($t=7.408^*$) is less than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.6. 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 96.15 ± 1.42 & 97.80 ± 1.32 respectively. However, the Mean and Standard Deviation (\pm SD) values of Fasting Blood Sugar of pre-test and post-test of control group were 85.70 ± 2.94 & 86.40 ± 3.44 . The t-value in case of experimental group was 8.432^* and for control group it was 0.782. Significant between-group differences were noted in Fasting Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4-weeks Kapalbhati Pranayama Training Programme since, the calculated value of ($t=8.432^*$) is less than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

4.7. 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 128.30 ± 4.60 & 130.65 ± 4.40 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 133.85 ± 3.99 & 134.65 ± 2.85 . The t-value in case of experimental group was 4.207^* and for control group it was 0.627. Significant between-group differences were noted in Post Prandial Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4-weeks Kapalbhati Pranayama Training Programme since, the calculated value of ($t=4.207^*$) is less than tabulated value of $t_{.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

Table 4. Mean values (\pm SD) and paired sample t-test of bone integrity in experimental and control group (n=20 each) before (pre) and after (post) 4-weeks kapalbhathi pranayama training programme (experimental group only).

Parameters	Group	Pre-Test	Post-Test	t-value	p-value
Bone Integrity	Experimental	1.133 \pm 0.019	1.125 \pm 0.008	1.7097	0.1036
	Control	1.148 \pm 0.024	1.149 \pm 0.021	0.2239	0.8252

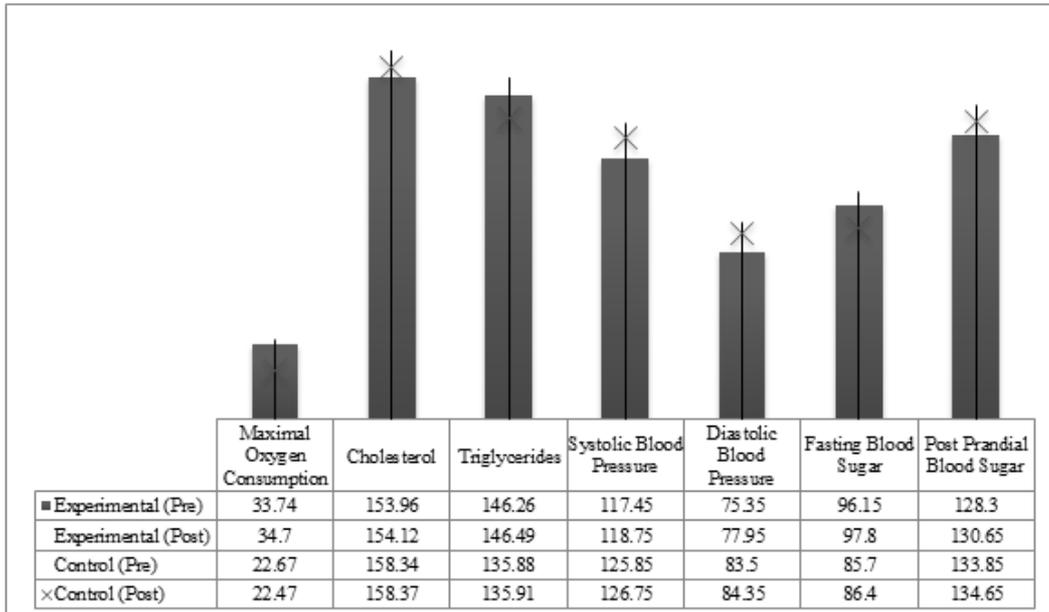


Figure 3. Mean values of metabolic fitness (MetF) (i.e., maximal oxygen consumption (v_{o2max}), blood lipid, blood pressure and blood sugar) in experimental and control group (n=20 each) before (pre) and after (post) 4-weeks kapalbhathi pranayama training programme (experimental group only).

4.8. Bone Integrity

The Mean and Standard Deviation (\pm SD) values of Bone Integrity of pre-test and post-test of experimental group were 1.133 \pm 0.019 & 1.125 \pm 0.008 respectively. However, the Mean and Standard Deviation (\pm SD) values of Bone Integrity of pre-test and post-test of control group were 1.148 \pm 0.024 & 1.149 \pm 0.021. The t-value in case of experimental group was 1.7097 and for control group it was 0.2239. Insignificant

between-group differences were noted in Bone Integrity in the experimental group before (Pre) and after (Post) subjected to 4-weeks Kapalbhathi Pranayama Training Programme since, the calculated value of (t=1.7097) is less than tabulated value of $t_{0.05} (19) = 2.09$ for the selected degree of freedom and level of significance. However, no significant changes over that 4-weeks period were noted in the control group.

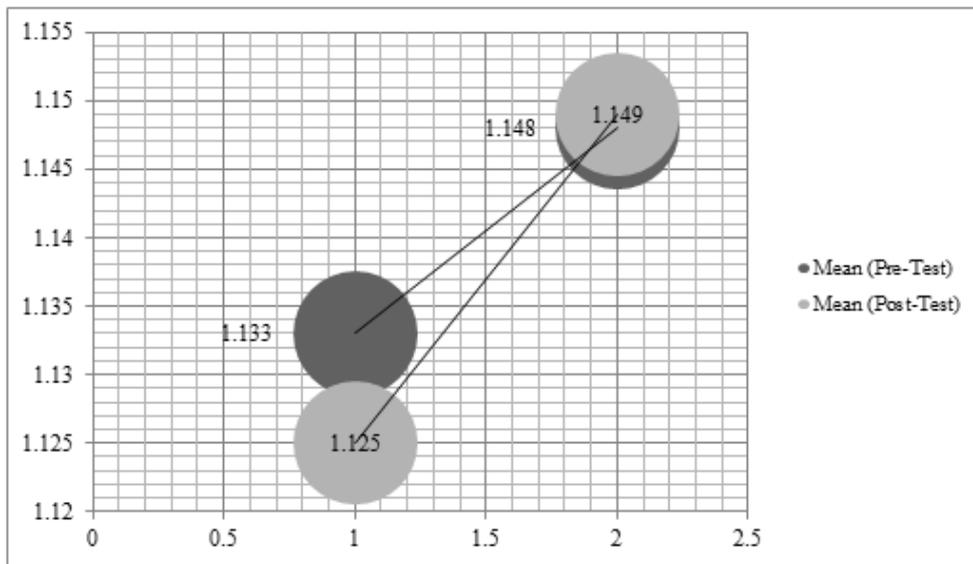


Figure 4. Mean values of bone integrity in experimental and control group (n=20 each) before (pre) and after (post) 4-weeks kapalbhathi pranayama training programme (experimental group only).

5. Conclusion

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} , Blood Pressure and Blood Sugar) of University Level Girls. Insignificant between-group differences were noted in Blood Lipid and Bone Integrity of University Level Girls.

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