

Effects of Chandra-Nadi Pranayama on metabolic fitness and bone integrity

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Abstract. The purpose of this study was to investigate the effects of Chandra-Nadi Pranayama on metabolic fitness (MetF) and bone integrity. Thirty eight, university level girls, aged between 21-26 years were selected. The subjects were purposively assigned into two groups: Group-A, Experimental ($n_1=19$); Group-B, Control ($n_2=19$). The subjects from Group-A were subjected of 4 weeks of Chandra-Nadi Pranayama. Student t test for paired samples was utilized to compare the means of the pre-test and the post-test. Based on the analysis of the results obtained, we conclude that the significant differences were found in metabolic fitness (i.e., Maximal Oxygen Consumption) at university level girls. Insignificant between-group differences were noted in blood lipid and blood glucose level, blood pressure and bone integrity.

Key words: *Chandra-Nadi Pranayama, metabolic fitness, bone integrity.*

Introduction

Yoga was collated, coordinated and systematized by Patanjali in his classical work, the yoga sutras, which consists of 185 terse aphorisms (1). It is also an important part of Hindu asceticism and a vital part of any yoga practice. Pranayama is derived from two Sanskrit words, namely, prana, which means vital force or life energy, ayama means to prolong (2). Versions of pranayama vary from single nostril breathing to belly breathing. Pranayama consists of three phases: puraka (inhalation), kumbhaka (retention) and rechaka (exhalation) that can be either fast or slow. Pranayama is known to improve pulmonary function (3) and cardiovascular profile (4). A Buteyko breathing device, which mimics pranayama, was shown to improve symptoms and reduce bronchodilator use in asthma patients (5). Pranayama has also been shown, over time, to reduce oxygen consumption per unit work (6). Thus pranayama and meditation as a natural way of cleansing breath has been suggested as a route to healthy body and mind (7). When completed through the left nostril alone the practice is called Chandra Anuloma Viloma Pranayam which means a heat dissipating or cooling liberating practice (8-10). Recent studies have reported differential physiological and psychological effects produced by exclusive right and left nostril breathing. (11-14). So many studies conducted to evaluate the effect of Pranayama and yoga, in normal volunteers, on cardio-respiratory efficiency (15) and bone metabolism (16) have resulted in a significant improvement in numerous physiological systems. While another study conducted on normal healthy individuals had resulted in an improvement in lean body mass and a reduction in fat skin fold thickness (17) after yogic practices. In an interventional research involving 98 subjects found fasting blood sugar (FBS), serum total cholesterol, low density lipoproteins (LDL), very low density lipoproteins (VLDL), the ratio of total cholesterol to HDL-C, and total triglycerides were significantly lower, and HDL-C significantly higher (18). There is currently lack of an adequate meta-analysis in relation to Chandra-Nadi Pranayama to assess its efficacy with respect to metabolic fitness (MetF) and bone integrity and as a result the present study was conducted to find out therapeutic effects of Chandra-Nadi Pranayama on metabolic fitness (MetF) and bone integrity.

Material and Method

Subjects. Thirty eight, university level girls between the age group of 21-26 years were selected. The subjects were purposively assigned into two groups: group A, experimental group ($n_1=19$) and group B, control group ($n_2=19$). Distribution and demographics of subjects are presented in table I.

Methodology. This study was designed as a retrospective cross-sectional study. The subjects from group A were subjected to a 4 week training of Chandra-Nadi Pranayama.

This lasted 4 weeks and consisted of daily sessions. Maximal oxygen uptake (VO_{2max}) 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 ($mL \cdot min^{-1} \cdot kg^{-1}$). 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 (L_2-L_4) in anteroposterior view was measured by dual-energy X-ray absorptiometry (DXA) using a Hologic QDR 1500W (Bedford, MA, USA).

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.

Table I. Distribution and demographics of subjects

Sample Size (N=38)			
Variables	Total (N=38)	Experimental group (n ₁ =19)	Control group (n ₂ =19)
Age (Years)	21.947 \pm 1.972	21.736 \pm 2.130	22.157 \pm 1.833
Body Height (Meters)	5.352 \pm 0.137	5.357 \pm 1.261	5.347 \pm 1.504
Body Mass Weight (Kg)	56.263 \pm 2.446	53.368 \pm 2.191	55.157 \pm 2.733

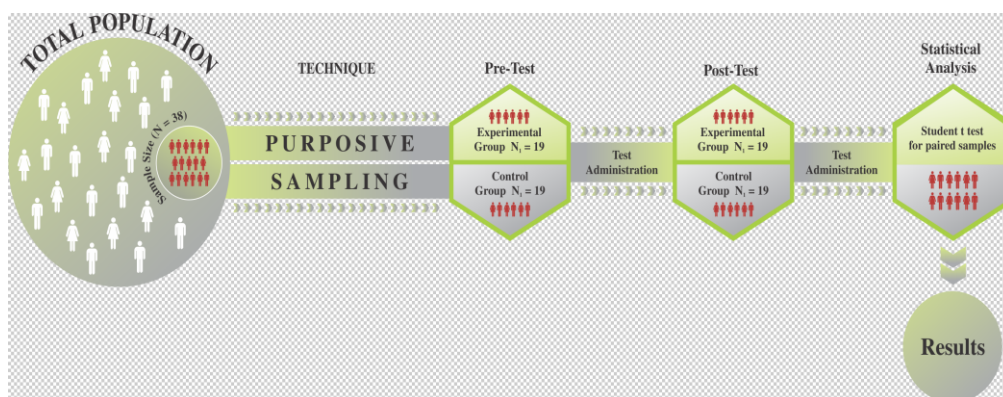


Figure 1. Study Design

Table II. Experimental treatment

4-Weeks Chandra-Nadi Pranayama Training Programme			
Weeks	Schedule	Time (minute)	Duration (minute)
1 st Week	Preliminary Yogic Exercises	5	20
	Practice of Chandra-Nadi Pranayama (9 Rounds X 1 Set)	10	
	Relaxation Posture	5	
2 nd Week	Preliminary Yogic Exercises	5	25
	Practice of Chandra-Nadi Pranayama (9 Rounds X 2 Set)	15	
	Relaxation Posture	5	
3 rd Week	Preliminary Yogic Exercises	5	30
	Practice of Chandra-Nadi Pranayama (9 Rounds X 3 Set)	20	
	Relaxation Posture	5	
4 rd Week	Preliminary Yogic Exercises	5	35
	Practice of Chandra-Nadi Pranayama (9 Rounds X 4 Set)	25	
	Relaxation Posture	5	

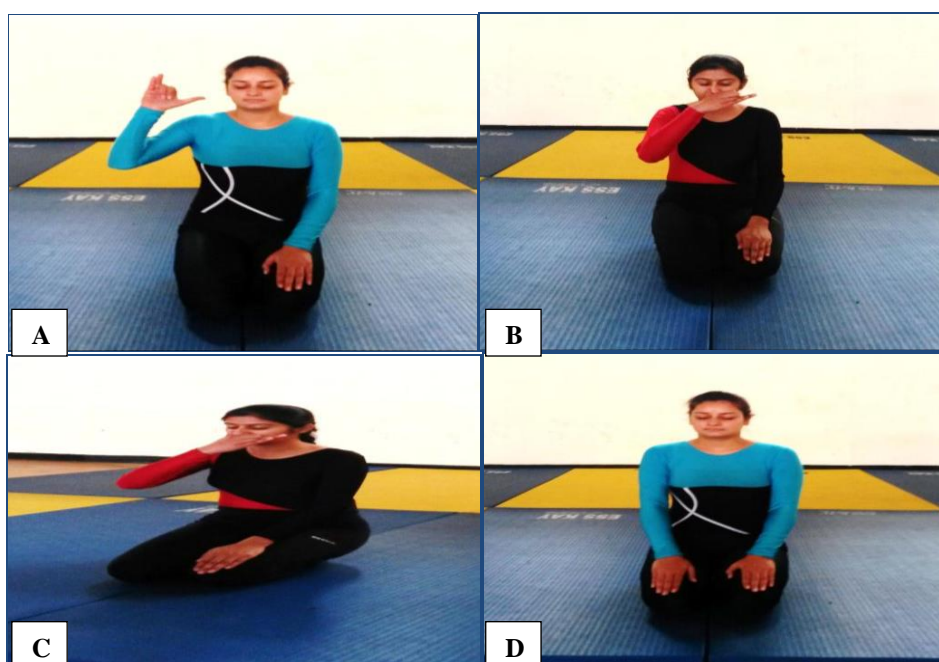


Figure 2. Subjects performing Chandra-Nadi Pranayama

Results

The results of Metabolic Fitness (MetF) (i.e., Maximal Oxygen Consumption-VO₂max), blood lipid, blood pressure and blood sugar) in Experimental and Control group (n=19 each) before (Pre) and after (Post) 4-weeks Chandra-Nadi (left nostril) Pranayama Training Programme (experimental group only) in university level girls are presented in table III.

Table III. Mean values (±SD) and Paired Sample t-test of Metabolic Fitness (MetF) Blood Lipids, Blood Pressure and Blood Sugar before (Pre) and after (Post) 4-weeks of Chandra-Nadi Pranayama Training Programme

Parameters	Group	Pre-Test	Post-Test	t-value	p-value	
Maximal Oxygen Consumption (VO ₂ max) (ml/min/kg)	Experimental	33.847±1.987	34.405±1.867	3.8541*	0.0012	
	Control	29.584±5.179	28.153±5.514	1.7327	0.1002	
Blood Lipid level	Cholesterol (mmol/L)	Experimental	153.947±10.532	154.147±10.404	1.0274	0.3178
		Control	153.105±10.470	152.200±10.331	0.5554	0.5854
	Triglycerides (mmol/L)	Experimental	146.867±1.435	146.805±1.432	1.6950	0.1083
		Control	143.232±6.663	143.121±6.728	1.5971	0.1276
Blood Pressure	Systolic Blood Pressure (mmHg)	Experimental	116.26±1.59	116.84±1.61	1.6026	0.1264
		Control	115.32±1.63	114.74±3.66	0.7342	0.4723
	Diastolic Blood Pressure (mmHg)	Experimental	75.21±1.90	75.79±2.84	1.0467	0.3091
		Control	75.89±2.02	76.47±2.46	0.9028	0.3785
Blood Glucose level	Fasting Blood Glucose (mg/dL)	Experimental	95.74±1.91	96.37±2.19	1.6449	0.1173
		Control	95.84±1.42	96.32±2.26	1.2063	0.2433
	Post Prandial Blood Glucose (mg/dL)	Experimental	127.05±1.18	127.53±1.12	1.3400	0.1969
		Control	126.16±1.50	126.21±2.15	0.1044	0.9180

*Significantly ($p < 0.001$) different from the respective 'Pre' value

Maximal Oxygen Consumption (VO₂max). The results of Metabolic Fitness (MetF) in Experimental group and Control group are shown in Table III. The mean and standard deviation (±SD) values of VO₂max of pre-test and post-test of Experimental group were 33.847±1.987ml/min/kg and 34.405±1.867 ml/min/kg, respectively. However, the mean and standard deviation (±SD) values of VO₂max of pre-test and post-test of Control group were 29.584±5.179 ml/min/kg and 28.153±5.514 ml/min/kg. The t-value in case of experimental group was 3.8541* and for control group it was 1.7327.

Significant between-group differences were noted in $V_{O_2\max}$ in the experimental group before (Pre) and after (Post) subjected to 4-weeks Chandra-Nadi (left nostril) Pranayama training programme since, the calculated value of ($t=3.8541^*$) is greater than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Cholesterol (mmol/L). The mean and standard deviation values (\pm SD) of serum cholesterol of pre-test and post-test of experimental group were 153.947 ± 10.532 and 154.147 ± 10.404 , respectively. However, the mean and standard deviation (\pm SD) values of serum cholesterol of pre-test and post-test of control group were 153.105 ± 10.470 and 152.200 ± 10.331 . The t-value in case of experimental group was 1.0274 and for control group it was 0.5554. Insignificant between-group differences were noted in serum cholesterol in the experimental group before (Pre) and after (Post) subjected to 4 weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.0274$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Triglycerides (mmol/L). The mean and standard deviation values (\pm SD) of serum triglycerides of pre-test and post-test of experimental group were 146.867 ± 1.435 and 146.805 ± 1.432 , respectively. However, the mean and standard deviation (\pm SD) values of serum triglycerides of pre-test and post-test of control group were 143.232 ± 6.663 and 143.121 ± 6.728 . The t-value in case of experimental group was 1.6950 and for control group it was 1.5971. Insignificant between-group differences were noted in serum triglycerides in the experimental group before (Pre) and after (Post) subjected to 4 weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.6950$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Systolic Blood Pressure (mmHg). The mean and standard deviation (\pm SD) values of Systolic Blood Pressure of pre-test and post-test of experimental group were 116.26 ± 1.59 and 116.84 ± 1.61 , respectively. However, the mean and standard deviation (\pm SD) values of Systolic Blood Pressure of pre-test and post-test of control group were 115.32 ± 1.63 and 114.74 ± 3.66 . The t-value in case of experimental group was 1.6026 and for control group it was 0.5191. Insignificant between-group differences were noted in Systolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4 weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.6026$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Diastolic Blood Pressure (mmHg). The Mean and Standard Deviation (\pm SD) values of Diastolic Blood Pressure of pre-test and post-test of experimental group were 75.21 ± 1.90 and 75.79 ± 2.84 respectively. However, the mean and standard deviation (\pm SD) values of Diastolic Blood Pressure of pre-test and post-test of control group were 75.89 ± 2.02 and 76.47 ± 2.46 . The t-value in case of experimental group was 1.0467 and for control group it was 0.9028. Insignificant between-group differences were noted in Diastolic Blood Pressure in the experimental group before (Pre) and after (Post) subjected to 4-weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.0467$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Fasting Blood Glucose (mg/dL). The Mean and Standard Deviation (\pm SD) values of Fasting Blood Glucose of pre-test and post-test of experimental group were 95.74 ± 1.91 and 96.37 ± 2.19 , respectively. However, the mean and standard deviation (\pm SD) values of Fasting Blood Sugar of pre-test and post-test of control group were 95.84 ± 1.42 and 96.32 ± 2.26 . The t-value in case of experimental group was 1.6449 and for control group it was 1.2063. Insignificant between-group differences were noted in Fasting Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4 week Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.6449$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

Post Prandial Blood Glucose (mg/dL). The mean and standard deviation (\pm SD) values of Post Prandial Blood Glucose of pre-test and post-test of experimental group were 127.05 ± 1.18 and 127.53 ± 1.12 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 126.16 ± 1.50 and 126.21 ± 2.15 .

The t-value in case of experimental group was 1.3400 and for control group it was 0.1044. Insignificant between-group differences were noted in Post Prandial Blood Sugar in the experimental group before (Pre) and after (Post) subjected to 4 weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.3400$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

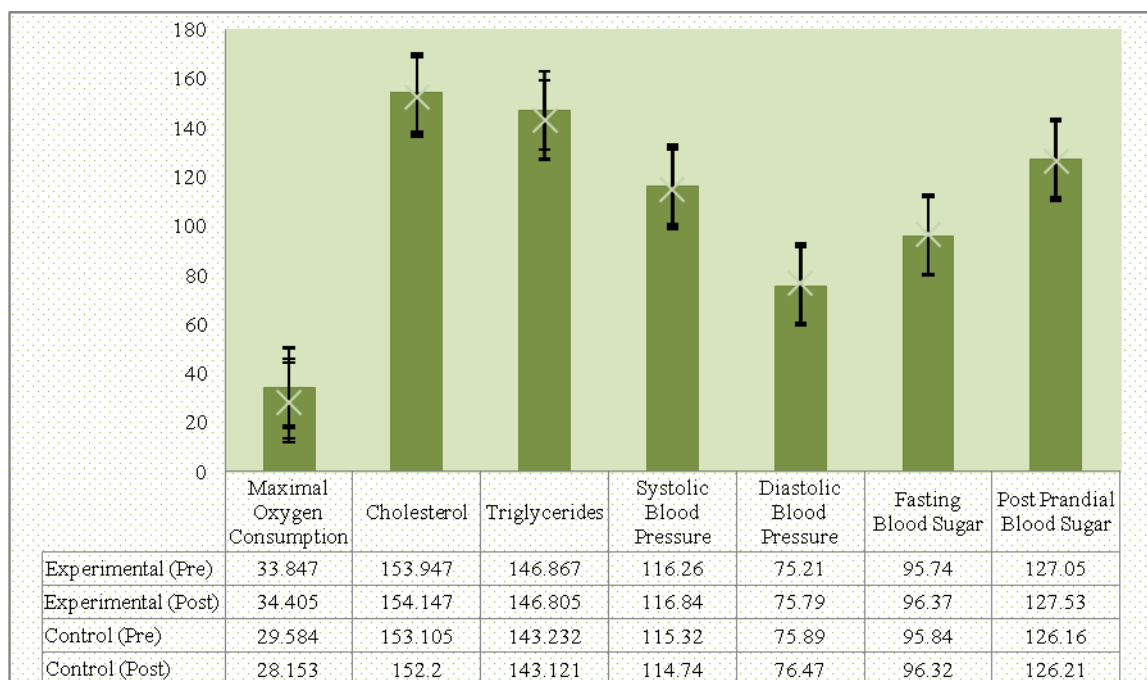


Figure 3. Mean values of Metabolic Fitness (MetF) in Experimental and Control group

Table IV. Mean values (\pm SD) and Paired Sample t-test of Bone Integrity in Experimental and Control group

Parameters	Group	Pre-Test	Post-Test	t-value	p-value
BMD (mg/cm^2)	Experimental	1.1384 \pm 0.0189	1.1305 \pm 0.0154	1.6410	0.1182
	Control	1.1421 \pm 0.0237	1.1384 \pm 0.0229	0.8765	0.3923

*Significantly ($p < 0.001$) different from the respective 'Pre' value

Bone Integrity. The mean and standard deviation (\pm SD) values of BMD (mg/cm^2) of pre-test and post-test of experimental group were 1.1384 \pm 0.0189 and 1.1305 \pm 0.0154 respectively. However, the mean and standard deviation (\pm SD) values of Bone Integrity of pre-test and post-test of control group were 1.1421 \pm 0.0237 and 1.1384 \pm 0.0229. The t-value in case of experimental group was 1.6410 and for control group it was 0.8765. Insignificant between-group differences were noted in Bone Integrity in the experimental group before (Pre) and after (Post) subjected to 4 weeks Chandra-Nadi (left nostril) Pranayama Training Programme since, the calculated value of ($t=1.6410$) is less than tabulated value of $t_{0.05} (18) = 2.10$ 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.

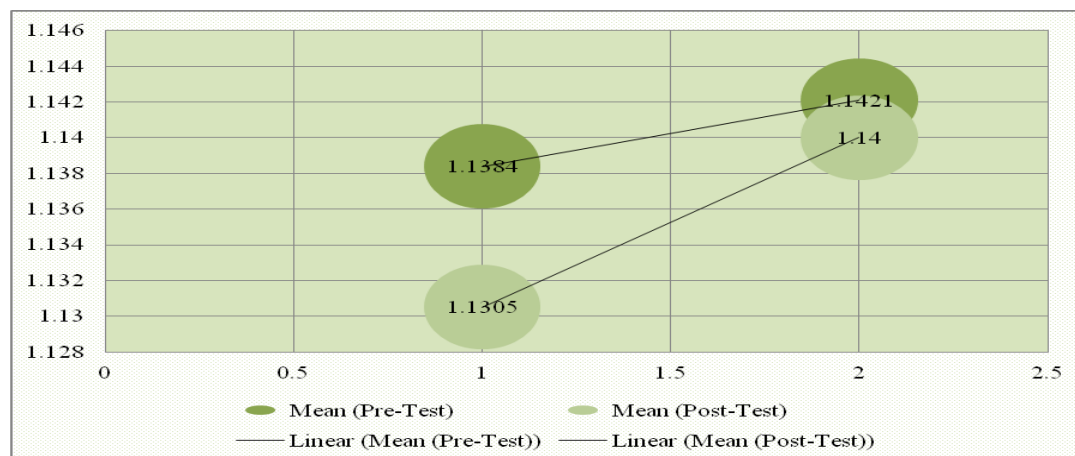


Figure 4. Mean values of BMD (mg/cm²) in Experimental and Control group

Conclusion

Based on the analysis of the results obtained, we conclude that the significant differences were found in metabolic fitness (i.e., Maximal Oxygen Consumption) at university level girls. Insignificant between-group differences were noted in blood lipid and blood glucose level, blood pressure and bone integrity.

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