Trend of the effects of four varieties of yoga bhastrika pranayama on physical efficiency index

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background and Study Aim: The objective of the study was to find out the Trend of the effects of four varieties of dynamic yogic breathing call as Bhastrika Pranayama on physical efficiency measured by Harward Step Test. The study was design to find out significant difference between measures of performance (Physical Efficiency Index) for four treatments (four verities of Bhastrika pranayama). Also to find out interaction between particular trials and treatments (linear, quadratic & cubic component for overall trend).

Material/Methods: Total of 40 students were selected as subjects. Age of the Subjects was ranged from 17 to 25 years. All the subjects were divided randomly in to four groups i.e. 10 in each group. Practice of Bhastrika Pranayama was considered as Independent variables and Physical Efficiency Index was considered as dependent variables. To find out the trend of the effects of four varieties of Bhastrika Pranayama on Physical Efficiency Index, trend analysis with multiple treatments was used at 0.05 level of Significance.

Results: Insignificant difference was found between measures of performance for treatments (significant trend for treatments), between trials and treatments interaction and between cubic component for overall trends (all $p>0.05$). Significant difference ($p<0.05$) was found between measures of performance for treatments (significant trend for trials), also between linear component for overall trends ($p<0.05$) and between quadratic component for overall trends.

Conclusions: Study revealed that all the four varieties of Bhastrika Pranayama practices proved to be equal in bringing out change in Physical Efficiency Index.

Key words: yoga practices • Bhastrika Pranayama • Physical Efficiency Index

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Background

Classical Indian yoga provides the earliest, comprehensive account of relaxation and its broader connection to mind-body states. It is a set of practical methods based on the experience of individual practitioners. These practices may be directed to various parts of the human body, or they may involve the muscles, breath, energies, emotions, or the mind in general. In practice, yoga relies on a specific, step-by-step approach [1]. There have been many studies on physical yoga and its effects on physical function but only few related to pranayama, the breathing exercises [2–7]. According to Hathapradipika of Svatmarama [8], there are eight Varieties of Pranayama, of which Bhastrika is one. In Sanskrit, Bhastrika means bellows. This Pranayama is called Bhastrika because it is characterized by incessant and quick expulsions of breath in all its varieties, imitating the actively hissing belloes of a village smith. Whether in these expulsions both the nostrils are used

Classical Indian yoga – yoga is the name of one of the six hindu traditional orthodox philosophical schools, but in our article we refer to Yoga Sutras of Patanjali – widely regarded as the compiler of the formal Yoga.

Pranayama – the specific yogic breathing exercises meaning extension of the life force. The word is composed of two Sanskrit words, prāna means life force, or vital energy or the breath, and ayāma, means to extend or draw out.

Bhastrika – a kind of yogic pranayama, a breathing technique through the nose, where breathing is forcible and with equal time for inhalation and exhalation.

Kapalabhati – the yogic system of body cleansing techniques, the technique of Kapalabhati involves short and strong forceful exhalations and inhalation happens automatically.

Harvard Step Test – a type of cardiac stress test developed by Brouha et al. (1943) in the for detecting and/or diagnosing fitness, and ability to recover after a strenuous exercise after steps for 5 minutes or until exhaustion.

Dynamic suryanamaskar – Surya Namaskara is an ancient system of Indian exercise and depends of level of practice it includes the regular routine of twelve physical yogic poses or prayer of twelve yogic poses known as Sun Salutation.

as in the first two varieties, or only one nostril is used as in the last two varieties, is all immaterial, quick succession of forceful expirations is the most prominent feature of every type of Bhastrika. Hence, the name. Swami Kuvalayananda [1] described four varieties of Bhastrika Pranayama. These are as follows: First variety – The first part of this variety is identical with Kapalabhati. After a number of exhalations, this number being determind by the strength of the individual. The second part of this variety, deepest possible Puraka is made as air is inhaled through both the nostril. It is desirable that the process of Puraka should cover at least eight seconds. Puraka is followed by Kumbhaka. Rechaka is be done through left nostril. Second variety – This variety is considered in its two parts separately. Starting with the first part which corresponds to Kapalbhati. In second part of this variety, Puraka is done through always from the right nostril, Puraka is followed by Kumbhaka, whereas that to be used for exhalation is invariably the opposite one. Third variety – It is desirable to consider the variety in two parts, the first part corresponding to Kapalabhati.In this variety Kapalabhati is done from one nostril only (right nostril). In second part the deep inhalation is to be done through the right nostril in every odd round and through the left nostril in every even round, Puraka is followed by Kumbhaka, the deep exhalation being effected invariably through the opposite nostril. Fourth variety- In this variety, the first part differs from others. The technique may be as; quick inspiration through the right nostril is immediately followed by quick expiration through the left nostril. This is followed by the deepest possible inspiration through the right nostril, the necessary retention of breath and the final expiration through the left nostril, which completes the second part of that round and also the round itself. Then the second round commences with quick inspiration through left nostril and expiration through the right nostril.

Significance of the study

The present study has been undertaken to examine the effects of bhastrika pranayama on the Physical Efficiency

Objectives

1. To find out significant difference between measures of performance (Physical Efficiency Index) for four treatments (Four varieties of Bhastrika Pranayama).
2. To find out significant difference between four trials resulting from four treatments (four verities of Bhastrika Pranayama).
3. To find out interaction between trials and treatments.
4. To find out Linear, Quadratic and Cubic components for overall trend.
5. To find out Linear, Quadratic and Cubic components of the group X trial interaction.

Hypothesis

1. There shall not be any significant difference between measures of performance (Physical Efficiency Index) for four treatments (Four varieties of Bhastrika Pranayama).
2. There shall not be any significant difference between four trials resulting from four treatments (four varieties of Bhastrika Pranayama).
3. There shall not be any significant interaction between trials and treatments.
4. There shall not be any significant Linear, Quadratic and Cubic components for overall trend.
5. There shall not be any significant Linear, Quadratic and Cubic components of the group X trial interaction.

Material and Methods

Forty students were selected as subjects. Age of the Subjects was ranged from 17 to 25 years. All the subjects were divided randomly in to four groups i.e. 10 in each group. Practice of Bhastrika Pranayama was considered as Independent variable and Physical Efficiency Index was considered as dependent variable. Physical Efficiency Index was measured by Harward Step Test. Subjects stepped up and down 30 times per minute on the bench of 20 inches height. The stepping exercise continued for 5 minutes. After the completion of stepping, pulse rate was counted between 1–1.5, 2–2.5, 3–3.5 minutes after the exercise. Score of Physical Efficiency Index was computed using the formula:

$$\text{PEI} = \frac{\text{Duration of Exercise in seconds} \times 100}{2 \times \text{Sum of Pulse Counts in Recovery}}$$

Experimental design

The randomized block design (special case of randomized block design i.e. repeated measures design) was used for the study. Bhastrika Pranayama was treated as independent variable. Physical Efficiency Index was treated as dependent variable. Varieties of Bhastrika Pranayama were treated as blocking variable. For the purpose of the study four varieties of Bhastrika Pranayama were included. The experiment treatment was conducted for 56 Days (8 weeks). Observations were taken after every two weeks treatment. Study was done according the Department of Physical Education, Benares Hindu University ethical rules. The students-volunteers were informed about the study.

Experimental treatment (Bhastrika Pranayama)

Day	Schedule				Time
	Experimental Group-1 (1st Variety of Bhastrika)	**Experimental Group-2 (2nd Variety of Bhastrika)**	**Experimental Group-3 (3rd Variety of Bhastrika)**	**Experimental Group-4 (4th Variety of Bhastrika)**	
1st day	Preliminary Yogic Exercises --- Practice of 1st Variety of Bhastrika Pranayama (3 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 2nd Variety of Bhastrika Pranayama (3 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 3rd Variety of Bhastrika Pranayama (3 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 4th Variety of Bhastrika Pranayama (3 rounds × 3sets) --- Relaxation Posture	5 minutes --- 10 minutes --- 5 minutes
	Same schedule was repeated for two weeks				
(FIRST OBSERVATION WAS TAKEN)					
15th day	Preliminary Yogic Exercises --- Practice of 1st Variety of Bhastrika Pranayama (4 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 2nd Variety of Bhastrika Pranayama (4 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 3rd Variety of Bhastrika Pranayama (4 rounds × 3 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 4th Variety of Bhastrika Pranayama (4 rounds × 3 sets) --- Relaxation Posture	5 minutes --- 15 minutes --- 5 minutes
	Same schedule was repeated for two weeks				
(SECOND OBSERVATION WAS TAKEN)					
29th day	Preliminary Yogic Exercises --- Practice of 1st Variety of Bhastrika Pranayama (4 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 2nd Variety of Bhastrika Pranayama (4 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 3rd Variety of Bhastrika Pranayama (4 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 4th Variety of Bhastrika Pranayama (4 rounds × 4 sets) --- Relaxation Posture	5 minutes --- 20 minutes --- 5 minutes
	Same schedule was repeated for two weeks				
(THIRD OBSERVATION WAS TAKEN)					
43th day	Preliminary Yogic Exercises --- Practice of 1st Variety of Bhastrika Pranayama (5 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 2nd Variety of Bhastrika Pranayama (5 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 3rd Variety of Bhastrika Pranayama (5 rounds × 4 sets) --- Relaxation Posture	Preliminary Yogic Exercises --- Practice of 4th Variety of Bhastrika Pranayama (5 rounds × 4 sets) --- Relaxation Posture	5 minutes --- 25 minutes --- 5 minutes
	Same schedule was repeated for two weeks				
(FOURTH OBSERVATION WAS TAKEN)					

Statistical analysis

In our study we have applied statistics and we especially intended to find out significant difference between: – measures of performance (Physical Efficiency Index), – four treatments (four varieties of Bhastrika Pranayama), – four trials resulting from four treatments, – trials and treatments interactions (Tables 1, 2). Also to find out linear component for overall trend, quadratic component for overall trend and cubic component for overall trend, to find out linear components of the group X trial interaction, quadratic components of the group X trial interaction and cubic components of the group X trial interaction [9–11]. Trend analysis with multiple treatments was applied at 0.05 level (Figures 1, 2).

Table 1. Descriptive statistics of Physical Efficiency Index (in seconds) in relation to four different trials and four different treatments.

Trials	Treatments	N	Mean	Std. deviation	Minimum	Maximum
Trial One	Bhastrika Variety One	10	85.8000	4.93964	80.00	93.00
	Bhastrika Variety Two	10	86.2000	5.22388	76.00	93.00
	Bhastrika Variety Three	10	86.1000	7.06242	76.00	97.00
	Bhastrika Variety Four	10	86.7000	4.32178	79.00	92.00
	Total	**40**	**86.2000**	**5.27792**	**76.00**	**97.00**
Trial Two	Bhastrika Variety One	10	87.5000	4.64878	81.00	95.00
	Bhastrika Variety Two	10	88.2000	4.87169	79.00	95.00
	Bhastrika Variety Three	10	87.8000	6.84430	78.00	99.00
	Bhastrika Variety Four	10	88.8000	3.99444	82.00	94.00
	Total	**40**	**88.0750**	**5.01990**	**78.00**	**99.00**
Trial Three	Bhastrika Variety One	10	89.3000	4.47338	83.00	96.00
	Bhastrika Variety Two	10	90.4000	5.37897	80.00	97.00
	Bhastrika Variety Three	10	89.9000	6.29727	79.00	100.00
	Bhastrika Variety Four	10	90.9000	3.81372	87.00	97.00
	Total	**40**	**90.1250**	**4.91563**	**79.00**	**100.00**
Trial Four	Bhastrika Variety One	10	91.8000	4.91709	87.00	99.00
	Bhastrika Variety Two	10	93.2000	4.58984	84.00	99.00
	Bhastrika Variety Three	10	92.2000	5.97774	83.00	104.00
	Bhastrika Variety Four	10	93.9000	3.47851	89.00	99.00
	Total	**40**	**92.7750**	**4.70944**	**83.00**	**104.00**

Results

Trend analysis (Trial means with different treatments)

It is evident from Table 3 that the four treatment means (Bhastrika 1, Bhastrika 2, Bhastrika 3, Bhastrika 4) did not differ significantly since F value of.161 was found lower than the required value with 3, 36 df at 0.05 level of significance.

Table 4 revealed that the four trials means (T1, T2, T3, T4) was found significant since F value of 192.135 was found higher than the required value with 3, 108 df at 0.05 level of significance.

It is revealed from Table 5 that interaction between trials and treatments was found insignificant since F value of.416 was found lower than the required value with 9, 108 df at 0.05 level of significance.

Linear component for overall trend

Table 6 revealed that linear component for overall trend was found significant since F value 275.791 was found higher than the required value with 1, 36 df at 0.05 level of significance.

Quadratic component for overall trend

Table 6 revealed that quadratic component for overall trend was found significant since F value 5.824 was found higher than the required value with 1, 36 df at 0.05 level of significance.

Cubic component for overall trend

Table 6 also revealed that cubic component for overall trend was found insignificant since F value.724 was found lower than the required value with 1, 36 df at 0.05 level of significance.

Linear components of the trends for the treatment groups

Table 7 revealed that linear components of the trends for the four treatment groups was found insignificant since the F value of.559 was found lower than the required value with 3,36 df at 0.05 level of significance (No linear component of the group X trial interaction was found).

Table 2. Statistics Showing Normality of Data [Physical Efficiency Index (PEI)] in Four Varieties (V1, V2,V3, V4) of Bhastrika Pranayama(BP) in Relation to Four Trials.

Trial 1				
Measures	BP-V1	BP-V2	BP-V3	BP-V4
Skewness	.454	–.937	.077	–.519
Std. Error of Skewness	.687	.687	.687	.687
Kurtosis	–1.461	.443	–.983	–.395
Std. Error of Kurtosis	1.334	1.334	1.334	1.334

Trial 2				
Measures	BP-V1	BP-V2	BP-V3	BP-V4
Skewness	.415	–.469	–.110	–.143
Std. Error of Skewness	.687	.687	.687	.687
Kurtosis	–.941	.029	–.546	–1.050
Std. Error of Kurtosis	1.334	1.334	1.334	1.334

Trial 3				
Measures	BP-V1	BP-V2	BP-V3	BP-V4
Skewness	.144	–.720	–.215	.517
Std. Error of Skewness	.687	.687	.687	.687
Kurtosis	–1.189	–.129	–.297	–1.354
Std. Error of Kurtosis	1.334	1.334	1.334	1.334

Trial 4				
Measures	BP-V1	BP-V2	BP-V3	BP-V4
Skewness	.494	–.824	.504	.105
Std. Error of Skewness	.687	.687	.687	.687
Kurtosis	–1.512	.177	.649	–1.413
Std. Error of Kurtosis	1.334	1.334	1.334	1.334

Table 3. Significant difference between measures of performance for four treatments (significant trend for treatments).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Treatment Factor	48.819	3	16.273	.161*	.922
Error	3642.625	36	101.184		

* Insignificant at 0.05 level; F-Value required to be significant at 3, 36 df=2.87.

Table 4. Significant difference between four Trials (Significant trend for trials)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
factor1	954.669	3	318.223	192.135*	.000
Error (factor1)	178.875	108	1.656		

* Significant at 0.05 level; F-Value required to be significant at 3, 108 df=2.69.

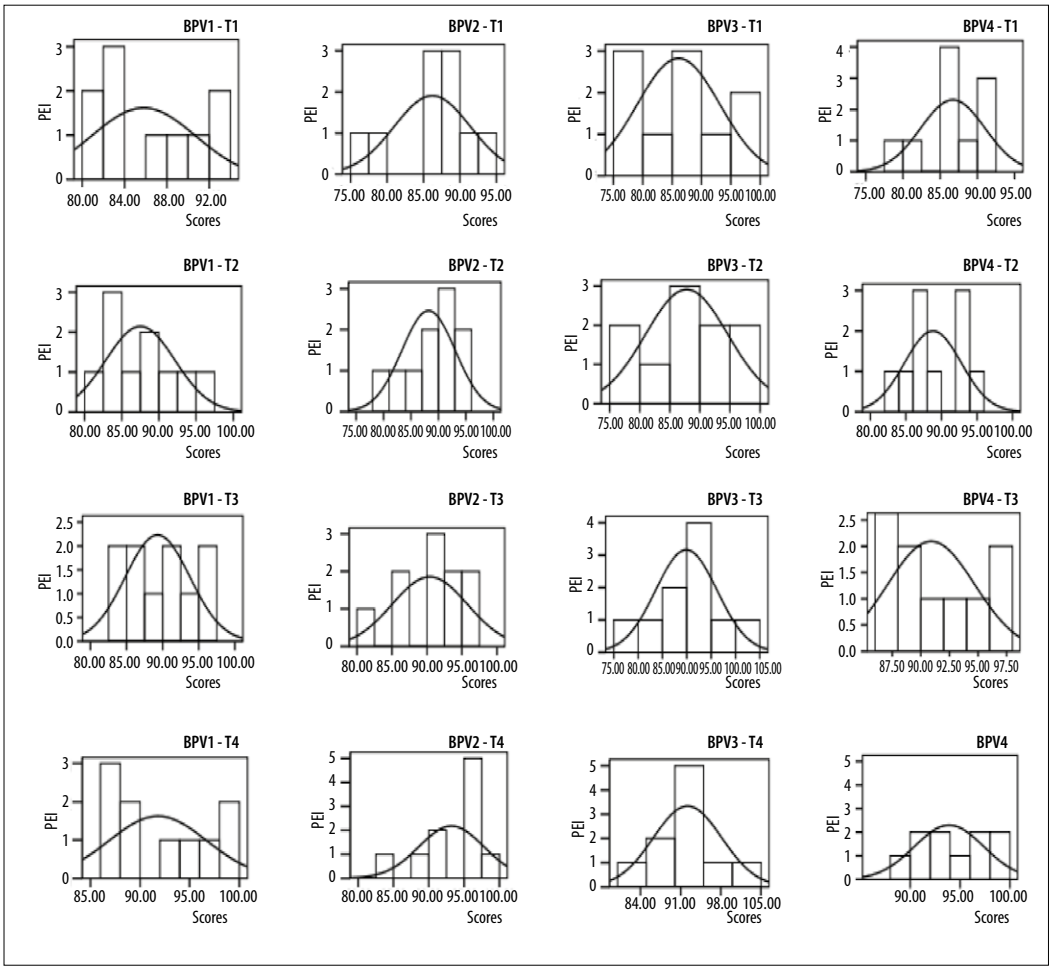

Figure 1. Graphical Representations of Normality of Data [Physical Efficiency Index (PEI)] in Four Varieties of Bhastrika Pranayama (BPV1, BPV2, BPV3, BPV4) in Relation to Four Trials (T1, T2, T3, T4).

Table 5. Interaction between Trials and treatments.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Factor1 * Treatments	6.206	9	.690	.416*	.924
Error (factor1)	178.875	108	1.656		

* Insignificant at 0.05 level; F-Value required to be significant at 9, 108 df=2.69.

Table 6. Linear, quadratic and cubic component for overall trend.

Source	factor1	Type III Sum of Squares	Df	Mean Square	F	Sig.
factor1	Linear	948.301	1	948.301	275.791*	.000
	Quadratic	6.006	1	6.006	5.824*	.021
	Cubic	.361	1	.361	.724	.400
Error (factor1)	Linear	123.785	36	3.438		
	Quadratic	37.125	36	1.031		
	Cubic	17.965	36	.499		

* Significant at 0.05 level; F-Value required to be significant at 1, 36 df=2.87.

Table 7. Linear, quadratic and cubic components of the group X trial interaction (differences among the linear, quadratic and cubic components of the trends for the treatment groups).

Source	factor1	Type III Sum of Squares	Df	Mean Square	F	Sig.
factor1 * Treatments	Linear	5.764	3	1.921	.559	.646
	Quadratic	.119	3	.040	.038	.990
	Cubic	.324	3	.108	.216	.884
Error(factor1)	Linear	123.785	36	3.438		
	Quadratic	37.125	36	1.031		
	Cubic	17.965	36	.499		

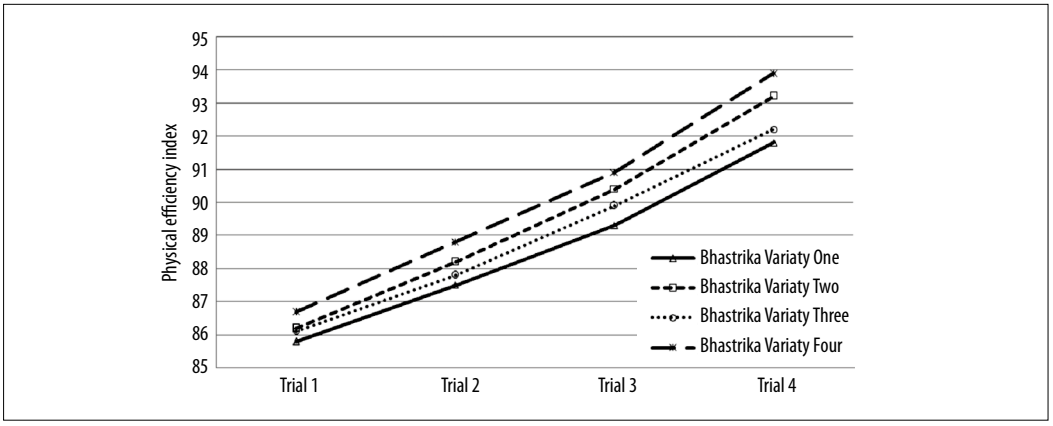

Figure 2. Trend of the Effects of Four Experimental Treatments (Four Varities of Bhastrika Pranayama) in Relation to Physical Efficienty Index.

Quadratic components of the trends for the treatment groups

Table 7 also revealed that quadratic components of the trends for the four treatment groups was found insignificant since the F value of.038 was found lower than the required value with 3,36 df at 0.05 level of significance (No quadratic component of the group X trial interaction was found).

Cubic components of the trends for the treatment groups

Table 7 also revealed that cubic components of the trends for the four treatment groups was found insignificant since the F value of.216 was found lower than the required value with 3,36 df at 0.05 level of significance (No cubic component of the group X trial interaction was found).

Discussions

Makwana K et al. [12] conducted a study with the objective to find out the effect of short term yoga practice on ventilator function tests. Physiological changes associated with yoga training caused improvements in ventilator functions of the lungs including a prolongation of breath holding times. Joshi LN et al. [13] conducted a study with the objective to find out the effect of short term 'Pranayama' practice on breathing rate and ventilatory functions of lungs. Changes in cardiorespiratory and metabolic intensity by the practice of pranayamas and meditation were reported. Choudhary R and Stec K [14] conducted a study to find out the effect of dynamic suryanamaskar on vital capacity. Dynamic Suryanamaskar practice proved to be effective in the improvement of vital capcity. Stec K and Choudhary R [15,16] conducted a study to find out the effect of dynamic suryanamaskar on negative breath holding capacity. The results indicate that in the beginning, at least two intervals (two weeks each) together are sufficient to bring change in Negative Breath Holding Capacity. Stec K & Choudhary R [16] conducted a study to find out the effect of dynamic suryanamaskar on physical efficiency index. Experimental treatment found effective for the improvement of PEI. Choudhary R & Saggu GSS [17] conducted a study on the trend of effect of pracchardana and vidharna on Positive Breath Holding Capacity. Significant trend of the effect of experimental treatment was found on positive breath holding capacity. Stec K, Choudhary R & Kulmatycki [18] conducted a study with the objective to determine the

effects of Dynamic Surya Namaskar (sun salutations) on Differential Chest Circumference. the study shows that the effect of dynamic Surya Namaskar remains for two weeks even after a pause in treatment but the achieved performance decreases significantly after four weeks of rest (mean difference =1.525). Choudhary R, Mehrotra A, Narayan S [19] conducted a study with the objective to study the trend of effect of pracchardana and vidharna on Negative breath holding capacity. Significant trend of the effect of experimental treatment was found on negative breath holding capacity. Present study revealed that all the four varieties of Bhastrika Pranayama practices proved to be equal in bringing out change in Physical Efficiency Index (Insignificant difference was found between measures of performance, $p>0.05$). Linear component was found significant in bringing out change in Physical Efficiency Index (linear trend was found significant, $p<0.05$). Quadratic component also proved to be effective in bringing out change in Physical Efficiency Index (Quadratic trend was found significant, $p<0.05$). Cubic trend was found insignificant ($p>0.05$). Present study also supports the earlier conducted studies.

Conclusions

Insignificant difference ($p>0.05$) was found between measures of performance for treatments (significant trend for treatments).

Significant difference ($p<0.05$) was found between measures of performance for treatments (significant trend for trials).

Insignificant ($p>0.05$) Interaction between Trials and treatments was found.

Significant difference ($p<0.05$) was found between linear component for overall trends.

Significant difference ($p<0.05$) was found between quadratic component for overall trends.

Insignificant difference ($p>0.05$) was found between cubic component for overall trends.

Insignificant difference ($p>0.05$) was found between linear components of the trends for treatment groups.

Insignificant difference ($p>0.05$) was found between quadratic components of all the trends for the four treatments groups.

Insignificant difference ($p>0.05$) was found between cubic components of the trends for treatment groups.

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