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## **“Yoga's Impact on Cardiovascular Endurance: Enhancing Physical Strength and Well-being in Young Athletes”**

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### **Abstract**

This study examines how the ancient practice of yoga contributes to improving cardiac vascular endurance in humans. In our daily lives, we often inhale significant amounts of toxic air, coupled with irregular breathing patterns, which can lead to various illnesses, including cardiovascular endurance and fatigue. The research indicates that utilizing oxygen efficiently in the body can enhance the immune system and strengthen nerves and muscles. Certain yoga poses facilitate deep breathing, promoting gaseous exchange within the body. Pranayama, a vital breathing technique in yoga, is highlighted as particularly beneficial for overall health. The study focused on young athletes aged between 14-16, demonstrating that regular yoga practice enhances physical strength and improves cardiovascular endurance. These findings suggest that incorporating yoga into one's routine can prepare individuals, especially young athletes, for off-season sports activities while maintaining positive mental and physical well-being.

### **Introduction**

Blood and oxygen are pivotal for human health, influencing both physical endurance and immunity. The brain and heart rely on these elements in combination for optimal function. By measuring specific parameters, we can assess how they contribute to enhancing human capacity and strength. Following research study focused on sports has shown that simple yoga methods can significantly increase physical strength. External environmental factors often limit physical endurance, leading to fatigue. However, this research highlights that adopting pranayama can enhance cardiac vascular endurance, thus overcoming physical limitations.

Oxygen is the most important nutrient of all living organisms. One can live for weeks without food and for days without water but only for few minutes without oxygen. In the absence of oxygen all vital organs start degenerating. Of all organs brain requires the most oxygen. Mental sluggishness, depression, visual and auditory impairment are the result of O<sub>2</sub> deprivation to the brain. It is oxygen, which releases energy contained in the food. Therefore, it is vital to the organism.

Research conducted by Birkel DA and Edgren L. in (2000)(1) emphasized the crucial role of lung vital capacity in maintaining overall health. This aspect holds particular significance for individuals dealing with conditions such as asthma, heart ailments, and respiratory issues. Their study aligns with previous research indicating the beneficial impact of yoga on lung vital capacity.

In a separate investigation by Chaya MS, Kurpad AV, Nagendra HR, and Nagarathna R. (2006)(6), significant differences were observed in the Basal Metabolic Rate (BMR) between yoga practitioners and non-practitioners. The BMR of yoga practitioners was notably lower, by approximately 13% when adjusted for body weight ( $P < 0.001$ ). This study suggests a substantial reduction in BMR, likely associated with decreased arousal levels, resulting from long-term engagement in yoga, which involves a combination of stimulating and inhibitory practices.

In society, breathing is a very important aspect of any living being. Breathing is one of the chief mechanisms by which oxygen is supplied to the organic systems, tissues, and ultimately to cells, the basic unit of living organisms. Breathing also disposes of the waste in the cells and tissues, which turn into toxins, when accumulated.

‘Pranayama’, one of the ‘angas’ of ‘Ashtanga yoga’ is the practice and control of breathing. Pranayama is said to be the control of the ‘Prana’, the vitality or vital force of the body. In other words ‘Pranayama is said to be the control of the ‘Prana’, the vitality or vital force of the body. In other words ‘Pranayama’ is the control of ‘Oxygen’ in the body. Practitioners of ‘Pranayama’ and yogis claim that one can completely control all the forces of universe and the

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mind. Further, they also claim that one who practices pranayama will have good appetite, cheerfulness, handsome figure, good strength, courage, and enthusiasm, a high standard of health, vigor vitality and good concentration of mind. Nevertheless improper breathing resulting in diminished oxygen supply results in diminished mental ability, diminished organic efficiency and increased fatigue-both mental and physical.

Reciprocally, mental tension produces restricted breathing. A person confronted with perplexing problem, tends to lean forward, draw his arm together and bend his head down resulting in reduced lung capacity. Increased toxin in the muscles of the breathing apparatus due to increased focus and mental tension reduces lung capacity resulting in shallowness coupled with increased frequency of breath.

### **Significance of Pranayama**

Increasing complexity of modern life leads to bad breathing, which becomes a habit. Unless the process is reversed the problems are usually confounded. Therefore, it is necessary to become aware of the problem and recognize the need for cultivating good breathing habits. Once the awareness is created, the remedy could include deep breathing exercises, stretching of the muscles of respiratory apparatus and those activities, like sports, brisk walking, etc., which stimulate and / or induce deep breathing. 'Pranayama, one of the deep breathing exercise, holds the key to problems.

Pranayama insists on nasal breathing. Nasal breathing has many advantages. Nasal breathing filters out impurities, warms the air to desired level of temperatures to facilitate efficient gaseous exchange, moisturizes the air and finally but most importantly, through sense of smell detects poisonous gases that may injure the health of the organism. Pranayama also insists on rhythmic, deep and slow breathing. Irregularities in the breathings may disrupt of other organic system including that of the brain. Pranayama helps re-establish regular breathing pattern, natural relaxed rhythms of body and mind. Deep breathing also increases absorption of Oxygen (Prana) enhancing dynamism, vitality and general wellbeing.

Forced inspiration of pranayama forces open unused alveoli, thus increasing surface area for gaseous exchange. Kumbhaka, the holding of breath, increases the intra-alveolar pressure, thus enhancing oxygen uptake by the blood. Secondly when the ventilator rate is consciously increased, oxygen absorption increases. Kapalabhati, a hyper ventilation technique, increases ventilator rate from 5 mm per minute to 50-60 mm per minute, increasing O<sub>2</sub> levels in the blood. Increased O<sub>2</sub> levels in the arterial blood through the chemo receptors located in the carotid bodies of carotid arteries in the neck regulate not only rate and rhythm of respiration but also that of heart. Forced inspiration, holding and expiration, alternate pressures in the thoracic and abdominal cavities thus milking venues blood into those cavities much more efficiently.

### **Review of Literature**

Reviews for the present study can be classified under different heads, focusing on yoga and pranayama. A study by Ray US, Pathak A, Tomer OS. *Hatha yoga practices: Energy expenditure, respiratory changes and intensity of exercise*. There is evidence that yoga practice can improve cardiovascular endurance.

Another study by Udupa et al (1972) showed a significant improvement respiratory function with lowered rate of respiration, increased expansion of the chest, vital capacity and breath holding time among 12 young normal volunteers.

A study by Sirohishowed a significant improvement in forced vital capacity among 20-40 years old male subjects. Vital capacity is directly related to maximum volume of O<sub>2</sub> uptake (VO<sub>2</sub> (max)), which in turn is related to higher cardio-vascular endurance. Therefore, improved vital capacity should result in improved cardio-vascular endurance. There have been no research which link pranayama to cardio-vascular endurance (fitness).

The vital capacity of the lungs is a critical component of good health. Vital capacity is an important concern for those with asthma, heart conditions, and lung ailments as well as to those who smoke. It is also equally important to those who have no known lung problems. Health studies have concluded that pulmonary function is a long-term predictor for overall survival rates. It is, therefore, essential to be involved in physical activity or sports, which help in

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achieving better lung function. Better lung function is directly related to cardio-vascular fitness level.

Proponents of Yoga have long claimed that yogic practice and pranayama help increase vital capacity. Very few empirical studies have supported these claims. Therefore, the purpose of the study was to investigate the effects of yogic practice and pranayama on forced vital capacity and cardio-vascular endurance among children

There are very few studies, which have investigated effects of practice of ‘Pranayama’ and/or yoga on various physiological parameters and few studies have investigated effects of life-style modification involving pranayama on such diverse parameters as anxiety and depression, exercise tolerance, heart rate, aerobic threshold and O<sub>2</sub> consumption, oxidation stress, vital capacity, blood pressure, blood lactate, blood sugar and lipid profile.

Heart rate and blood pressure are regulated by autonomic nervous system. Bhargava et al, (1988) have shown that four week of ‘Nadinshodhan-Pranayama’ resulted in reduced heart rate and blood pressure. Therefore they suspected that ‘Pranayama’ alter autonomic responses probably by increasing vagal tone and decreasing sympathetic discharges. Telles et al, (1996) have also shown that pranayama (Surya analoma and viloma) has sympathetic stimulating effect. Telles et al (1994) had earlier investigated the effect of pranayama on metabolism and autonomic activities. They suspected the increase in metabolism could be due to increased sympathetic discharge to adrenal medulla. A study by Damodaran et al (2002) also suggested decrease in sympathetic activity, associated with yoga practice.

Involving ‘Pranayama’ Ray et al (2001) have also shown relatively lower sympathetic activity among their yoga treatment group compared to control group.

There is couple of studies investigating effect of yoga based on lifestyle modification (asana and ‘pranayama’) on oxidative stress. One such study by Yadav et al (2005) in their pre- and post-test non- randomized single group design found that the serum concentration of thibaituric acid reactive substances (TBARS), an indicator of oxidative stress, decreased significantly. Their study suggested that the yoga based low cost lifestyle intervention reduces oxidative stress.

Bhattacharya et al (2002) investigated further the effect of ‘Yogic Breathing’ on oxidative status among young healthy males. In their randomized control group pre- and post-

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test design found that the free radicals were significantly reduced among the treatment group. They concluded that yogic breathing exercise (pranayama) not only help relieving the stresses of life but also improve antioxidant levels.

Birkel DA, Edgren L. (2000) investigated the effects of yoga postures and breathing exercises on vital capacity. A total of 287 college students, 89 men and 198 women served as subjects. Subjects were taught yoga poses, breathing techniques, and relaxation in two 50-minute class meetings for 15 weeks. The researchers measured vital capacity determinants over time for smokers, asthmatics, and those with no known lung disease near the beginning and end of two 17-week semesters. The study showed a significant improvement in vital capacity across all categories over time. Since there was no control group in the study, it is not known whether these findings were the result of yoga poses, breathing techniques, relaxation, or other aspects of exercise in the subjects' life. However, these findings are consistent with other research studies reporting the positive effect of yoga on the vital capacity of the lungs.

The investigator came across only one study which investigated cardio respiratory endurance using 'Harvard Step Test'. The study by Madanmohan, Udupa K, Bhavanani A.B., Shatapathy C.C., Sahai A. (2004) reported the effects of yoga training on cardiovascular response to exercise and the time course of recovery after the exercise. Cardiovascular response to exercise was determined by Harvard step test. Heart rate (HR) and blood pressure response to exercise were measured in supine position before exercise and at 1, 2, 3, 4, 5, 7 and 10 minutes after the exercise. Rate-pressure product [ $RPP = (HR \times SP)/100$ ] and double product ( $DoP = HR \times MP$ ), which are indices of work done by the heart were also calculated. Exercise produced a significant increase in HR, systolic pressure, RPP & DoP and a significant decrease in diastolic pressure. After two months of yoga training, exercise-induced changes in these parameters were significantly reduced. It was concluded that after yoga training a given level of exercise leads to a milder cardiovascular response, suggesting better exercise tolerance.

Most of these and other reports on effects of Yoga are uncontrolled case reports or cohort studies with significant methodological limitations. Most of the studies were not randomized, had inadequately described Yoga or control regimens, did not control (experimentally or statistically) confounding factors, the criterion measure was not reliable and the data were not

appropriately addressed. Secondly, most of the studies have focused their attention on adults or aged or on those with some ailments. None of the studies, that scholar came across have looked into the effects of pranayama on children or youth.

### **Objectives**

1. To investigate into the effects of pranayama on cardio-vascular endurance among boys, under the age of 14 to 16.
2. To study the impact of pranayama on cardio-vascular activities among boys.

### **Limitations:**

1. The study is limited by the measurement of cardio-vascular endurance as measured by Harvard step of test.
2. Sincere effort in the practice of pranayama by the participants during the treatment sessions is assumed.

### **Delimitations:**

1. The study is delimited to normal healthy boys in the age group of 14- to 16-year age group.
2. The study is limited to effects of pranayama only and no other yoga practice.

### **Significance of the study**

If pranayama is found to be beneficial in improvement of cardio-vascular endurance, its practice may be combined with sports training. During monsoons, when physical activity on children is hampered by rain, practice of pranayama may be continued within the confines of classrooms of schools. Such a practice may help maintain cardio-vascular endurance during 'Off-season' of sports training.

### **Definition of terms:-**

1. **Pranayama:** *Pranayama comes from root word Prana, it means life force. In ordinary terms it means Breath or respiration but unlike it has a deep meaning it means the all permeating universal cosmic energy. Primarily though Prana is equated to the breathing process of inhaling and exhaling it constitutes many other manifestations*
2. **Cardio-vascular endurance:** The ability of the cardiovascular and respiratory systems to supply oxygen and the muscles to use oxygen in prolonged dynamic exercise.

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## EXPERIMENTAL METHODS

The review of literatures reveals that Pranayama and Yoga postures have positive effect on whole host of health related physiological parameters. However, the results of research related to cardiovascular are somewhat conflicting and research on Vital capacity are scanty. The purpose, of the study was to investigate in to the effect of Pranayama on the development of cardiovascular fitness and vital capacity among school boys

In order to realize the objective a pre and post randomized control group design was set up. Subjects for the experimental, treatment intervention, test protocols for criterion measures and statistical techniques are described as follows.

## SUBJECTS

Total of 60 high school boys of age 14 to 16 years from Government High School, Chandargi, Karnataka were randomly selected for the study. All subjects had volunteered for the study. All subject were normal and were of same age.

## TREATMENT PROTOCOL

The entire treatment group underwent the pranayama as follows:

- Anuloma Viloma
- Kapalbhati
- Nadishod
- Ujjai
- Uddana Bandha
- Bramari

The above pranayama practices were taught to and practiced by treatment group every day for one and half hours (7:00 to 8:30 AM) for forty eight (90) days, excluding Sunday and holidays.

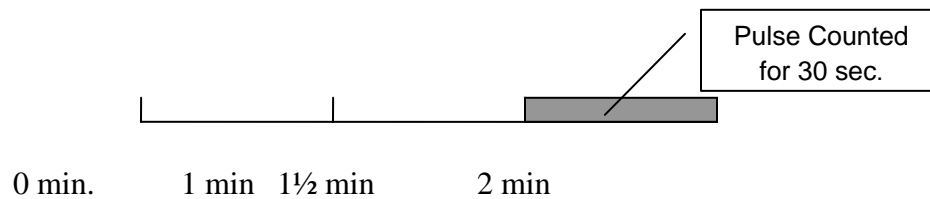
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### Measurement Protocol:

All subjects including those in the control group were measured before the start and at the end of pranayama treatment as follows.

**Harvard step-test:** The Harvard step test, developed by Brouha for the purpose of measuring physical fitness for muscular work and the ability to recover from work was used for the purpose of physical fitness assessment.

The subject stepped up and down on a 18”-stool for three minutes at the rate of one step per two seconds. Upon completion of three minutes exercise they were asked to be seated and pulse was measured as follows.



The following formula was used to compute in the physical fitness index

**Formula** : 
$$\frac{180 \times 100}{5.5 \times (\text{Total pulse count after the exercise})}$$

### STATISTICAL ANALYSIS:

Gain scores of physical fitness was obtained by subtracting pre-test scores out of post-test scores. The gain scores of ‘Physical Fitness’ were independently subjected to independent groups-test’.

## RESULTS

The purpose of the study was to investigate into the influence of pranayama (yogic) on physical fitness. Pre-test and post-test, scores were converted to gain score which were subjected to ‘Independent Groups t-test’. Results of the analysis are furnished in the following sections.

### Analysis of Physical Fitness Index Scores

It may be observed in table 1 that the control group had higher pre-test scores on physical fitness than the experimental group. However after the treatment the experimental group had higher post-test scores. The pre-test and post-test gain score data are represented in figure 3 and 4 respectively

Table 1. Mean, Standard Deviations and Standard Errors of Means of Pre-test, Post-test and Gain Scores of Physical Fitness Index Score of Control and Experimental Groups

(N =30 ea).

Variable	Treatment condition	Mean	Std. Dn	Std Error of Man
Pre-Test	Expt.	49.416	4.031	0.736
	Cont.	52.130	5.889	1.075
Post-Test	Expt	53.716	4.913	0.897
	Cont	52.113	5.456	0.996
Gain Score	Expt	4.300	2.721	0.496
	Cont.	-0.0227	5.731	1.046

The post-test and gain scores of the physical fitness index were subjected

Independent scores samples t-test the results of which are furnished in Table -2

Table-2. Result of t-test for equality means of post- test

And gains scores of physical fitness Index scores.

Variables	Obtained t – values	Df	p-value	Mean difference
Post-test	1.196	58	0.237	1.603
Gain scores	3.732	58	0.000	4.323

It may be observed in the table the pre-test and gain scores between experimental and control group reached significance level at  $\alpha=.05$ . However the difference between experimental and the control group and post-test scores was not significant.

### Estimated Marginal Means of Physical Fitness

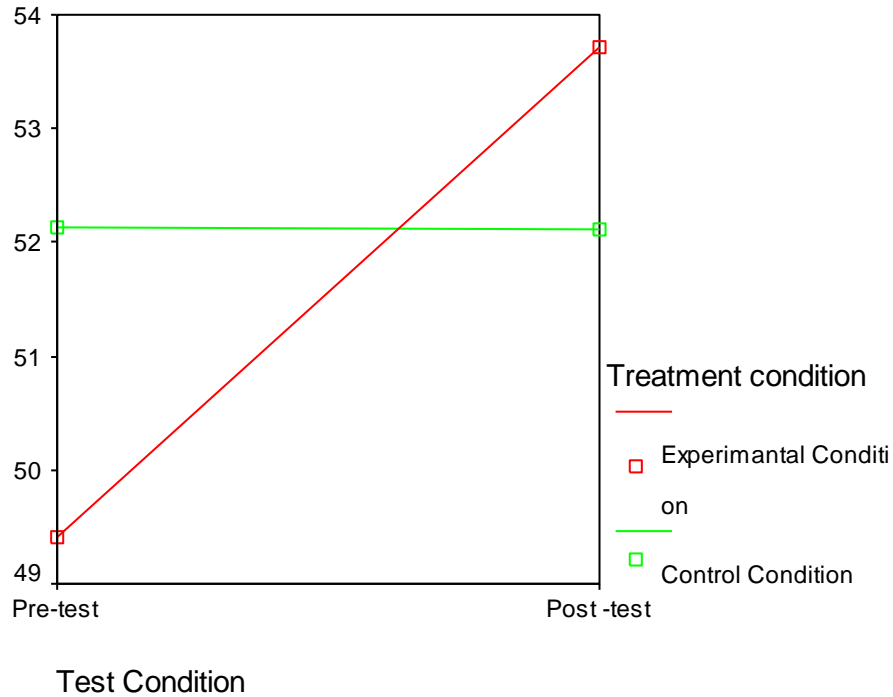


Figure 1. Physical Fitness pre-test and post -test scores of experimental and control groups

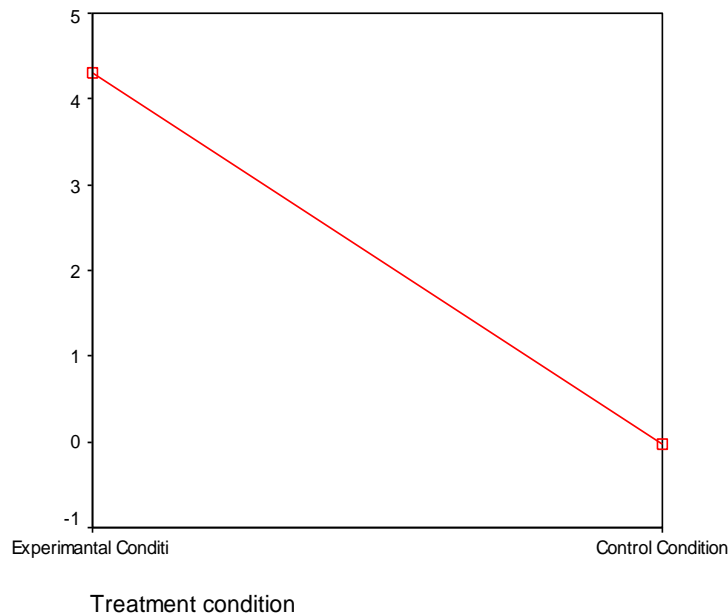


Figure 2. Physical fitness gain scores of experimental and control groups

It may be noted here that the physical fitness scores of control group did in fact reduced during the post-test, while that of the experimental group significantly increased. Hence, it may be anticipated that the gain scores analysis would result in significant gain in physical fitness by the experimental group compared to that of the control group.

Therefore, it may be observed, in table-4 that the gain scores analysis confirmed significant gain of 4.323 by the experimental group over the control group. Hence the second hypothesis, which stated that practice of pranayama would enhance cardio-vascular endurance accepted.

## RESULTS

The results of analyses of physical fitness index scores supported hypotheses. Subjects who took part in pranayama significantly improved their physical fitness as anticipated. The findings are consistent with other published research studies reporting positive effects of pranayama on cardio-vascular physical fitness to date.

## DISCUSSION

Results of the present investigation reiterated results of the earlier studies. The cardio-vascular endurance of school boys improved after six weeks of yogic practices including pranayama while the boys in the control group showed no improvement. The values of control group of boys, who did not participate in yogic practices showed no gain. As envisaged by some of the research reports, the sympathetic discharges among the boys of treatment condition was reduced. As expected the forced inspiration and retention (rechaka and kumbhaka) of pranayama forced open the dormant alveoli increasing the lungvolume, the vital capacity.

## CONCLUSION

Pranayama improves cardio-vascular endurance of all the boys who practiced pranayama for three months. Practicing yoga by the students regularly in schools can be helpful not only to maintain the good health but also improves concentration among students. Yoga helps in shaping a good personality.

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## RECOMMENDATIONS

1. The present study suggests health benefits of yoga and pranayama for school boys. Therefore, irrespective of their participation in sports, the yogic practices including pranayama may be taught to both boys and girls in schools.
2. The present study involved normal boys only. Therefore similar study be undertaken involving young school girls.
3. Similar study may be undertaken in combination with sports training/ conditioning or with cardio-vascular training.

## ACKNOWLEDGMENTS

The study is conducted at the Karnataka Chandargi Sports Residential School, involving students, which aids in coordinating the research efforts.

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