6.0 STUDY II: CORRELATION BETWEEN BHRAMARI TIME AND PEFR

6.1 INTRODUCTION

Measurements of ventilatory function is useful for assessment of physical fitness in children and adults and also for diagnosis and follow up during management of conditions with increased airway resistance, such as asthma, chronic bronchitis, and emphysema (Petty, 2006). Yoga training improves lung function, strength of inspiratory and expiratory muscles as well as skeletal muscle strength and endurance of students (Mandanmohan, Jatiya, Udupa & Bhavanani, 2003). Several studies have shown that regular yoga practice increases the vital capacity, timed vital capacity, maximum voluntary ventilation, breath holding time and maximal inspiratory and expiratory pressures (Vedala, Mane & Paul, 2014). Yoga training has shown positive effect on improving lung function and exercise capacity in patients with chronic obstructive pulmonary disease (Raub, 2002). Yoga breathing exercises, as an adjunct treatment improves pulmonary functions in both normal volunteers (Mandanmohan, Jatiya, Udupa & Bhavnani, 2003) and in patients with bronchial asthma (Vedala, Mane & Paul, 2014). Pulmonary functions and diffusion capacity in patients of bronchial asthma before and after yogic intervention has shown increased respiratory stamina (Soni, et al. 2012).

Peak expiratory flow rate (PEFR), which is a measure of the maximum flow achieved during an expiration delivered with maximal force starting from the level of maximal lung inflation (Pedersen, 1997), is an essential measure in the evaluation of ventilator function. Various types of instruments including hand held mini PFR meters are available to
measure PEFR (Holcroft, Eisen, Sama & Wegman, 2003). A simple, but reliable, method of measuring the ventilator function of the lungs has long been sought.

With yoga being accepted for use in schools, there is a need for developing a scientifically acceptable standardized tool to assess the progress of their practices that can be used in yoga classes for children that keeps their interest going. Yoga lays emphasis on manipulation of breath (Pranayama) that contributes to positive neurophysiologic responses (Vialatte, Bakardjian, Prasad & Cichocki, 2009). Yogic breathing technique called Bhramari Pranayama (Bhpr) involves, producing a pulsating constant low pitch sound imitating the buzzing of a female bumble bee (Rajesh, Ilavarasu & Srinivasan, 2014). Bhramari time is a measure of the slow exhalation time while making a low pitched humming sound like that of a female honey bee. This has been used in our yoga based personality camps for children and adults over many years as a tool to assess the progress of the practices. The present study was designed to validate the acceptability of bhramari time by checking its correlation with PEFR in healthy South Indian Children.

6.2 MATERIALS AND METHODS

6.2.1 Subjects

Three hundred and eighty six healthy school children who attended yoga based Personality Development Camp in summer holidays in the serene campus of SVYASA University, Bengaluru were randomly selected from a pool of 625 children. Children with a history of asthma, a recent history of respiratory infection with or without persistent cough within the past two weeks and those with any major disability or illness were excluded from the study. Participants in this study had no formal training in yogic techniques.
6.2.2 Design and procedure

The study utilized a cross-sectional design. The procedure was performed in a spacious room during the morning hours between 9 to 11 AM between third to fifth days after the inauguration of the camp in the month of April after the child had acclimatized to the camp life. The children were assessed individually on PEFR and bhramari time.

6.2.3 Measurement

Demographic data

The weight (KG) was recorded using a standard electronic weighing scale. The participants were asked to remove as much outerwear as possible. Further they were asked to remove the shoes and step up onto the weighing scale and stand still over the center of the scale with body weight evenly distributed between both feet. Standing height (cm) was measured without shoes and without traction using standard scale.

Procedure for bhramari time measurement

The term Bhramari is Sanskrit word signifies a female bee. This is a pranayama technique wherein after a deep inhalation the participant exhales through the nasal airways with the mouth closed, emulating the buzzing of bumble bees in a constant low pitch (Rajesh, Ilavarasu & Srinivasan, 2014). Subjects sat on a comfortable cushion on the floor of the experimental room, in a crossed leg posture keeping the spine erect, with eyes-closed and practiced three rounds of Bhramari pranayama which was taught to them in the classes for three days. Before the child was taken up for the study. The purpose and technique of the Bhramari breathing time was up for the study, the test procedure was explained to the
child followed by a demonstration of the correct manner of performing. They were closely observed to ensure that they maintained the procedure correctly. Three trials were performed and the time duration of the exhalation was measured using a stop watch. The best of the three readings was taken as the final Bhramari Time (BHT).

**Procedure for PEFR Measurement**

A mini PEFR meter (Clement Clarke) was used to check the PEFR of these children. The purpose and technique of performing PEFR was explained along with a demonstration of the correct manner of performing the test. When subjects had understood the method and were able to perform correctly, they were made to give the test in the standing position. They were closely observed to ensure that they maintained an airtight seal between their lips and the mouthpiece of the instrument (Holcroft, Eisen, Sama & Wegman, 2003). The highest value of the three readings was recorded as the final PEFR value.

**Data analysis**

Pearson correlation test was used to examine the association between height, weight, PFR and BHT. Independent-samples t-tests were performed to compare groups.

**6.3 RESULTS**

Three hundred ninety one subjects who satisfied the inclusion and exclusion criteria were included in the study. Five students were excluded due to missing data. Final sample consisted of 229 boys and 157 girls. Table 6.1 shows the detailed demographic profile. Participants’ age ranged from 9 to 16 years with a mean age of 12.78 years (SD=1.69).
Table 6.1 Demographic details

<table>
<thead>
<tr>
<th>N</th>
<th>Age (±1.69)</th>
<th>Weight (Kg) (±11.70)</th>
<th>Height (cm) (±12.20)</th>
<th>PFR (l/min) (±62.75)</th>
<th>BHT (sec) (±4.98)</th>
</tr>
</thead>
<tbody>
<tr>
<td>386</td>
<td>12.78</td>
<td>43.39</td>
<td>149.80</td>
<td>291.30</td>
<td>13.13</td>
</tr>
</tbody>
</table>

Table 6.2 gives Distribution of Weight, Height, Peak Expiratory Flow Rate (PEFR) and Bhramari Time (BHT) in different Age groups. BHT, PEFR, height and weight increased progressively with age.

Table 6.2: Distribution of Weight, Height, Peak Flow Rate and Bhramari Time in different Age groups

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>Weight (Kg) (±)</th>
<th>Height (Cm) (±)</th>
<th>PFR (L/min) (±)</th>
<th>BHT (Sec) (±)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>26.75±4.53</td>
<td>135.30±11.75</td>
<td>216.00±33.73</td>
<td>9.60±2.84</td>
</tr>
<tr>
<td>10</td>
<td>32</td>
<td>31.82±7.85</td>
<td>134.45±8.52</td>
<td>236.25±44.44</td>
<td>11.00±2.95</td>
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<tr>
<td>11</td>
<td>46</td>
<td>35.74±8.31</td>
<td>140.33±8.41</td>
<td>262.39±44.93</td>
<td>12.59±4.42</td>
</tr>
<tr>
<td>12</td>
<td>71</td>
<td>39.40±9.40</td>
<td>145.43±9.92</td>
<td>271.30±50.99</td>
<td>12.78±4.79</td>
</tr>
<tr>
<td>13</td>
<td>93</td>
<td>46.96±11.37</td>
<td>152.27±8.92</td>
<td>295.65±51.92</td>
<td>12.91±5.27</td>
</tr>
<tr>
<td>14</td>
<td>71</td>
<td>47.10±9.46</td>
<td>156.04±8.36</td>
<td>317.83±56.28</td>
<td>14.17±5.14</td>
</tr>
<tr>
<td>15</td>
<td>45</td>
<td>52.95±8.27</td>
<td>161.27±9.56</td>
<td>334.09±63.33</td>
<td>14.14±5.41</td>
</tr>
<tr>
<td>16</td>
<td>18</td>
<td>51.30±9.92</td>
<td>161.56±5.65</td>
<td>357.78±79.52</td>
<td>15.28±5.95</td>
</tr>
</tbody>
</table>

Table 6.3 shows the zero-order correlations on all variables. As hypothesized, BHT was significantly and positively correlated with PEFR ($r=.35$, $p<0.01$), Height ($r=.29$, $p<0.01$), Weight($r=.17$, $p<0.01$) and Age ($r=.22$, $p<0.01$). Further, PEFR had significant positive correlation with Height ($r=.64$, $p<0.01$), Weight ($r=.53$, $p<0.01$) and Age ($r=.53$, $p<0.01$).

Table 6.3: Pearson Correlation between Bhramari Time, Peak Flow Rate, Height, Weight and Age (N=386)

<table>
<thead>
<tr>
<th></th>
<th>PFR</th>
<th>Height</th>
<th>Weight</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>BHT</td>
<td>.35**</td>
<td>.29**</td>
<td>.17**</td>
<td>.22**</td>
</tr>
<tr>
<td>PFR</td>
<td></td>
<td>.64**</td>
<td>.52**</td>
<td>.53**</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td>.74**</td>
<td>.68**</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td>.57**</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
Independent-samples t-tests were performed to determine whether statistically significant differences existed in height, weight, PFR and BHT between boys and girls. Table 6.4 shows the gender differences. The average values of BHT for all age groups ranged from 3 to 34 seconds for boys and 5 –26 seconds for girls. The PEFR values for boys ranged between 160 – 510 L/min and girls between 160 –410 L/min. Gender wise analysis has shown no difference in any variable except on PEFR. Boys scored significantly higher in PEFR than girls.

| Table 6.4 Comparison of boys and girls on all variables |
|-------------|-----|-----|-----|-----|-----|-----|
| Gender  | N   | Weight | Height | PEFR | BHT | Age |
| Boys    | 229 | 43.39±12.43 | 149.91±13.15 | 297.60±66.69** | 13.18±5.31 | 12.66±1.69 |
| Girls   | 157 | 43.37±10.56  | 149.64±10.67  | 282.10±55.45  | 13.06±4.48  | 12.97±1.68  |

**p=0.02. Boys had higher PEFR than girls.

**Figure 6.1: Comparison of boys and girls on Weight**
Figure 6.2: Comparison of boys and girls on Height

![Graph comparing height of boys and girls.]

Figure 6.3: Comparison of boys and girls on PEFR

![Graph comparing PEFR of boys and girls.]

p=0.02
All the variables except PEFR, did not show significance.
6.4 DISCUSSION

This study sets out to examine the relationship between PEFR and Bhramri Time among school children in order to establish the utility of this yogic tool for use in mass programs and by individuals as a test of their progress in the practice of yoga. The significant relationship between Bhramri Time and PEFR confirmed our primary hypothesis. Further, the relationship between Bhramri Time and Anthropometric data also has shown significance. Height had the strongest relationships with other variables. Overall, the study showed that in healthy children PEFR (Ebomoyi & Iyawe, 2005) and BHT significantly increases with height, weight and age, which has shown the relation of PEFR with height, weight and chest circumference of other studies.

PEFR is a measure of a dynamic factor during exhalation as it takes into account the rate of movement of air in and out of the lungs and is considered the best single index of ventilatory function (Pedersen, 1997). Unfortunately, it is time consuming, fatiguing, difficult to obtain acceptable data by novices and needs a good instrument (although simple and portable). BHT is a useful test that is cost effective as it needs no instruments and acceptable while teaching yoga to children in a school or a camp environment because of the playful nature of the test that promotes self encouragement to continue the practices.

Limitations of the study

Potential limitations of this research must also be considered. We have used only PEFR using a mini PEFR instrument which is a measure of forced expiratory volume in first second (FEV$_1$) while BHT is a measure of slow vital capacity (SVC). It would have been ideal to compare all measures of lung function using a spirometer to establish the utility of
the BHT. Secondly, the sample included was healthy young children in a yoga camp environment which may be difficult to generalize for all children and adults.

Despite these limitations, the present study confirmed our primary hypothesis i.e. BHT correlated positively with PEFR. To our knowledge, this is the first study to understand the relationship between BHT and PEFR. BHT can be enhanced by training. Practice of yoga based breathing practice can increase pulmonary function which in turn leads to enhancement of BHT (Vedala, Mane & Paul, 2014). Our study suggests that BHT can be recommended for use in mass camps as an acceptable scientifically validated yogic tool in young population to assess the progress of their practices in each class. Studies comparing BHT with other variables of lung function may be carried out in future to confirm the validity and reliability of this observation.
7.0 STUDY III: COMPARISON OF PHYSICAL FITNESS IN ADOLESCENT SENIOR YOGA PRACTITIONERS WITH NON-PRACTITIONERS

7.1 INTRODUCTION

Previous studies have shown that yoga training enhances an individual's physical fitness. The aim of this study was to investigate the differences in physical fitness of healthy children who regularly practice yoga and those who do not practice yoga. It was hypothesized that children who regularly practiced yoga would have better physical fitness with higher strength, flexibility and ventilator function compared to those children who did not do yoga.

7.2 SUBJECTS AND METHODS

7.2.1 Participants

This study evaluated 110 competitive yoga children who had practiced yoga at least once weekly for a minimum of two months within the past 6 months (Thomas, Friedmann, Ross, & Bevans, 2012), and 110 age, gender, weight-matched healthy yoga motivated children who were naive (control group).

7.2.2 Design and procedure

The study utilized a cross-sectional design.

The participants in the yoga group were recruited from an International Yoga competition (HIMALAYA) organized by S-VYASA Yoga University. The control group was recruited from the children who registered for Yoga based Personality Development Camp (YPDC)
in summer holidays in the serene campus of SVYASA University. Children with a history of asthma, a recent history of respiratory infection with or without persistent cough within the past two weeks and those with any major disability or illness were excluded from the study.

7.2.3 Measures

**Anthropometric data and Ventilatory Function were similar to study1.**

**Sit-and-reach test** (SAR) used to measure spinal flexibility, has been shown to have positive correlation with hamstring flexibility (Baltaci, Un, Tunay, Besler & Gerçeker, 2003). The subject sits on the floor with his legs extended towards the SAR apparatus with the sole of the foot touching the board. Participant then bends forward to his maximum capacity pushing the indicator with his fingers keeping the elbows straight (Tekur, Singphow, Nagendra, & Raghuram, 2008). The distance covered is then measured in centimeters.

**Hand grip strength**

Hand grip strength of both hands was measured using hand grip dynamometer (Lafayette Instrument, U.S.A). Subjects were encouraged to perform maximal contractions keeping their arm extended at shoulder level, horizontal to the ground (Madanmohan, Mahadevan, Balakrishnan, Gopalakrishnan & Prakash, 2008). The test was repeated three times at intervals of 15 seconds independently in both hands and the maximum value obtained was recorded.
**Data analysis**

Levene’s test for equality of variances was used for all variables to determine the variance. Independent-samples t-tests were performed to determine whether statistically significant differences existed in anthropometry, spinal flexibility, hand grip strength and ventilatory function between Yoga and control groups.

**7.3 RESULTS**

Except for weight and PEFR, the assumption of homogeneity of variance was met for all other variables. Table 7.1 and 7.2 show comparison between the two groups and the gender differences respectively. There was no significant difference in the age, height and weight between the two groups (Table 7.1). A sub group analysis (Table 7.2) also showed non-significant difference in the age, height and weight between boys and girls in the two groups. The lung capacity as measured by PEFR was significantly better (p=0.002) in children who practiced yoga. Spinal flexibility as measured by SAR was significantly better in yoga than non yoga group (p=.001). Muscular fitness as measured by hand grip strength, the girl yoga practitioners had scored significantly higher when compared with non practitioners. Further, there was no significant difference in handgrip strength between boys groups.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td><strong>t</strong></td>
</tr>
<tr>
<td>Age</td>
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<td>12.87</td>
<td>1.31</td>
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<td></td>
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<td>12.82</td>
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<td>20.31</td>
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</tbody>
</table>

*Adjusted because variances were not equal.

Abbreviations: PEFR- peak expiratory flow rate, SAR- sit and reach, HGS- hand grip strength. Note: Fitness was better in children who practiced yoga than those who did not.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
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<td>1.40</td>
<td>0.833</td>
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<td>5.810</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>60</td>
<td>19.22</td>
<td>4.431</td>
<td>3.072</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>60</td>
<td>16.77</td>
<td>4.304</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Adjusted because variances were not equal; PEFR- peak expiratory flow rate
Figure 7.1: Comparison of age between yoga and non yoga practitioners

Figure 7.2: Comparison of height between yoga and non yoga practitioners

Figure 7.3: Comparison of weight between yoga and non yoga practitioners
Figure 7.4: Comparison of PFR between yoga and non yoga practitioners
Figure 7.5: Comparison of Hand Grip (R) between yoga and non yoga practitioners

![Bar chart showing comparison of hand grip (R) between yoga and non yoga practitioners for total, boys, and girls.]

Figure 7.6: Comparison of Hand Grip (R) between yoga and non yoga practitioners

![Bar chart showing comparison of hand grip (R) between yoga and non yoga practitioners for total, boys, and girls.]

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7.4 DISCUSSION

This cross sectional cohort study compared the physical fitness of 110 adolescent students (50 boys, 60 girls) in age range of 12 to 13 years who were adept yoga competitors with 110 yoga naïve healthy students who were motivated to learn yoga. The results indicated that Yoga practitioners did exhibit higher physical fitness compared to yoga naïve children. Gender analysis showed that girls who practiced yoga had higher levels of physical fitness compared to non practitioners. Further, boys who practiced yoga had higher levels of physical fitness on all domains except handgrip strength than yoga naïve boys.

Comparisons

These results are consistent with previous studies which have shown long-term effect of yoga practice on minimum muscular fitness (Gharote, 1975), lung function (Vedala, Mane & Paul, 2014), skeletal muscle strength and endurance of children (Mandanmohan, Jatiya,
Study by Chen et al investigated the effect of yoga exercise on the health-related physical fitness of unhealthy school-age children. Results showed significant improvement in BMI, flexibility, muscular strength, and cardiopulmonary fitness following seventh week training and 2 weeks of self-practice at home (Chen et al, 2009). Another 12-week community-based yoga interventional study provided preliminary evidence for the benefits of yoga on HRQL, physical fitness and Physical activity level in pediatric cancer out-patients (Wurz, Chamorro-Vina, Guilcher, Schulte & Culos-Reed, 2014).

**Mechanisms**

In normal exercises, flexibility programs or in sports, one aims to develop the strength of the muscle through contraction of the muscle. In Yoga, in contrast, the muscle is stretched fast or slow in a systematic manner with greater emphasis on relaxation and maintenance with ease. In Yoga, the effortless stretch of the skeletal muscle offers a global control (Srinivasan, 2011) while in exercises, only certain muscles pertaining to that sport are activated in preference to most others.

Basic yogic postures involve sustained isometric contraction of the shoulder, chest and arm muscles which may be possible reason for improvement in the handgrip strength (Mandanmohan, Jatiya, Udupa & Bhavanani, 2003). Further most of the forward bending posture helps to enhance spine flexibility and hamstring muscle. Consequent improvement in the spine flexibility and hamstring muscles can explain the significant increase in measure of sit and reach in yoga practicing children. Furthermore, one of main component of yoga practice is pranayama. Previous report suggests short term and long term pranayama practice enhance ventilatory functions as measured by spirometry (Joshi, Joshi,
& Gokhale, 1992; Murthy, et al. 1983). This may explain the difference in airway resistance and strength of expiratory muscle seen in PEFR, between yoga trained and yoga naive children.

**Limitations**

Potential limitations of this research must also be considered. It may be difficult to generalize the results of this study as both groups were motivated to do yoga. Secondly, we have used only PEFR using a mini PEFR instrument; it would have been ideal to compare all measures of lung function using a spirometer. Further nutritional status and physical activity level which can influence the physical fitness were not measured.

**Strengths**

To our knowledge, this is the first study that has compared physical fitness in yoga trained children as compared to untrained ones. The majority of the current researchers have mainly focused on the effects of short-term and long-term yoga programs. The present study is, perhaps, the first in which physical fitness of children compared between yoga practitioners and non practitioners. Although motivation remains an important factor (Manjunath & Telles, 1999) that may influences the performance, this didn’t appear to be a factor in the current study as both groups were motivated to practice yoga.

**Conclusion**

Alarming health trends are emerging, signifying that schools need to renew and inflate their role in providing and encouraging physical activity for our nation’s young people. Importantly, physical inactivity regulates the risk features of lifestyle-related chronic
diseases and conditions and may track through adulthood. This study has shown children who practice yoga have seemed to have higher physical fitness than non practitioners. Hence we recommend that yoga be introduced at school level in order to improve physical fitness and ventilatory functions of students. Environmental factors such as availability of play ground, tools and financial constrain are not an issue for yoga practice.
8.0 STUDY IV: EFFECT OF INTENSIVE SHORT TERM YOGA PROGRAM ON PHYSICAL FITNESS

8.1 INTRODUCTION

Yoga in its original form consists of a system of physical, psychological and ethical practices (Nagarathna & Nagendra, 2001). The popularity of yoga is evident with emerging interest and research in its therapeutic applications. The estimated prevalence of practicing Yoga has increased in many countries (Barnes, Powell-Griner, McFann & Nahin, 2004; Siegel & Barros, 2009). Earlier studies have shown positive effects of Yoga training in enhance minimum muscular fitness (Gharote, 1976), skeletal muscle strength and endurance of students (Mandanmohan, Jatiya, Udupa & Bhavanani, 2003). Further, a recent study has shown yoga training improves lung function, increases vital capacity, timed vital capacity, maximum voluntary ventilation, breath holding time and maximal inspiratory and expiratory pressures (Vedala, Mane & Paul, 2014). A recent literature suggests that yoga improves children’s physical well being that promotes mental well-being (Hagen & Nayar, 2014). Hence present evaluate the effect of short term intense yoga program on physical fitness.

8.2 SUBJECTS AND METHODS

8.2.1 Participants

One hundred and three healthy school children of both genders in age range of 10-16 years who attended yoga based Personality Development Camp in summer holidays in the serene campus of SVYASA University, Bengaluru, were randomly selected from a pool of 630 children.
Inclusion Criteria

- Normal health status
- Both genders,
- Age ranging between 12 to 16 years.

Exclusion criteria

- Major sensory disabilities such as deafness or blindness,
- Major neurological disabilities,
- History of psychiatric diseases,
- Children with a history of asthma, a recent history of respiratory infection with or without persistent cough within the past two weeks,
- Taking any medication.

8.2.2 Design and Procedure

This was a single armed pre-post design. All children were the participants of a ten day residential yoga based personality development camp organized during summer holidays in the month of April. Eligible participants underwent intense yogic training for a period of ten days. Detail program schedule is added in the appendix-1.

8.2.3 Measurements

*Anthropometric data, Ventilatory Function, Flexibility, BHT and Kraus-Weber test* were similar to previous studies.
8.2.4 Intervention

**Yoga based Personality Development Camp (YPDC)**

YPDC consisted of training in different yoga based techniques for approximately eight hours a day, for 10 days. It included specialized yoga module for overall personality development such as Yogāsanas, breathing practices, eye-cleansing techniques, meditation, emotional culturing sessions, Vedic chanting, and yogic games. Further, the training also included guided relaxation and Cyclic Meditation (CM). Detail program schedule is added in the appendix-1

**Data analysis**

Since the data on physical fitness postures was a categorical variable, McNemar’s test and single sample proportion test were performed.

**8.3 RESULTS**

In a study to find out the effect of a 10 days’ Personality Development Camp (PDC), various physical and physiological variables were studied. Table 8.1 shows the results of paired sample t-test for Peak Flow Rate, Bhramari Time, and Sit and Reach. All the three variables showed significant improvement (p<0.001). Both Peak Flow Rate, and Bhramari Time had high effect sizes; Sit and Reach showed moderate effect size. This shows that yoga has beneficial effect on various physical and ventilatory variables.
Table 8.1: Paired sample t-test between pre and post assessment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre</th>
<th>Post</th>
<th>t-value</th>
<th>% change</th>
<th>Effect Size</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
<td>(df)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Flow Rate</td>
<td>312.65±60.31</td>
<td>346.08±68.58</td>
<td>8.48</td>
<td>10.69</td>
<td>0.84</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(101)</td>
<td>(101)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhramari Time</td>
<td>11.98±3.86</td>
<td>15.9±5.03</td>
<td>8.29</td>
<td>32.72</td>
<td>0.82</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(101)</td>
<td>(101)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit and Reach</td>
<td>34.92±7.12</td>
<td>36.9±6.68</td>
<td>6.96</td>
<td>5.67</td>
<td>0.69</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(101)</td>
<td>(101)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.1: PEFR value before and after ten days intense yoga program

![PEFR Chart](image-url)
Figure 8.2: BHT value before and after ten days of intense yoga program

Figure 8.3: Sit and Reach value before and after ten days of intense yoga program
McNemar's Chi-squared test showed that all variables of minimum muscular fitness K-WT2, K-WT3, and K-WT5, improved with statistically significance at p<0.001 except K-WT1 that showed non significant change (p= 0.182). K-WT4 and K-WT6 were also significant at p<0.01. These shows except for the first physical test, all others were significantly improved. Analyzing the total score, number of people who were successful in passing the test (pass in all the six tests) were 19 (29.23%). A single sample proportion test showed that this frequency was statistically significant compared to the post test count 46 (70.77%), p<0.001 (z= 4.195).

8.4 DISCUSSION

The aim of the study was to evaluate the effect of 10 days of yoga program on various physical and physiological variables. Physical variables consisted of KW test for minimal muscular fitness with a set of six physical tests, and ‘sit and reach test for flexibility, Ventilatory function tests included Peak flow rate and Bhramari rate. The overall results showed improvement in all the variables. Thus, this prospective study experimentally validates the finding of the previous cross sectional cohort study (Study III, chapter 7) which showed significantly higher physical fitness in long term Yoga practitioners as compared to yoga naive students. This also shows that even a short term practice of ten day’s can make a difference for these healthy urban children who had poor muscular fitness as a cohort.

Comparisons

Current study results are in line with the previous studies on yoga which have reported enhanced physical fitness as a result of the practice of yoga way of life. Previous studies have shown significant improvement in physical fitness in healthy (Chen et al, 2009) and
unhealthy children (Wurz, Chamorro-Vina, Guilcher, Schulte & Culos-Reed, 2014) following yoga intervention. Previous research has shown long-term effect of yoga practice on minimum muscular fitness (Gharote, 1975), lung ventilatory function (Vedala, Mane & Paul, 2014) and muscle strength and endurance of children (Mandanmohan, Jatiya, Udupa & Bhavanani, 2003).

**Mechanisms**

*Alternate Stretch and relax*

In Yoga, the muscle is stretched – fast or slow – in a systematic manner which enhances all skeletal muscles undergo stretch, thus, providing a global control (Srinivasan, 2011). Most of the forward bending postures helped to improve the spine flexibility and hamstring muscles. Possible mechanisms for the significant increase in sit and reach and KW-T6 measures following 10 days of intense yoga program, may be the similarity of KW-T6 with the set of asanas practiced during 10 days YPDC program. Studies have shown that yogic sun salutation and a few physical postures (Shalabhasan, Naukasana, Navasana, Uttana Padasana, Padahastasana, Halasana etc) enhances the strength, endurance and flexibility of the abdominal muscles, back muscles and hamstring muscle. As Kraus-Weber test measures the fitness of these spinal muscles and yoga asanas involve stretches of spine in almost all postures, this test appears to be a good measure to assess the benefits of yoga. It is interesting to note that this test could pick up the changes after ten day’s of practice which was also seen in the comparative study which compared long term yoga practitioners and yoga naïve children.

One of the main components of yoga practice during the camp was the practice of pranayama. Previous reports have already shown the short term and long term benefits of
pranayama practice that had enhanced all components of ventilatory functions as measured by spirometry (Joshi, Joshi, & Gokhale, 1992; Murthy, et al. 1983). Our results on PEFR and bhramari time support these results. This benefit could be traced to improved strength of the muscles involved in respiration and reduced airway resistance after yoga.

Limitations

It may be difficult to generalize the results of this study as the study group was motivated to do yoga. Secondly, we have used only PEFR using a mini PEFR instrument; it would have been ideal to compare all measures of lung function using a spirometer. Further, this experiment was a pre-post design which has its own limitations with many confounding factors.

Strengths

To our knowledge, this is the first study that has evaluated the effect of short term intense yoga training on physical fitness. Further, the current research has measured used the standard tools of physical fitness.

Conclusion

In summary, the findings of this study confirm that yoga based intervention is associated with several benefits in physical fitness in school-aged children. Yoga based activities that stress the cardiovascular and respiratory systems have the greatest psycho-physical benefits. Hence we recommend that yoga be introduced at school level in order to enhance psycho-physical functions of students.
Suggestions for future work

upcoming studies should endeavor to support the evidence with a more meticulous design, apt sample size, long term follow-up to evaluate maintenance, use of objective measures of the overall activity, BMI, growth parameters, diet monitoring and assessment tools that would explain the underlying pathway. Also future studies should take account of the expenses of implementation issues and carry out cost effectiveness analyses to further inform future public health strategies in this topic.
9.0 STUDY V: IMMEDIATE EFFECT OF TRADITIONAL PHYSICAL PRACTICE YOGIC SQUAT ON COGNITIVE ABILITY

9.1 INTRODUCTION

Exercise and physical training are known as promoters of several alterations, and among them, cardiorespiratory benefits, increase in the mineral bone density and decrease in the risk for chronic-degenerative diseases. Recent year the relationship between exercise and cognitive performance is a highly topical area of scientific inquiry (Tomporowski, Davis, Miller & Naglieri, 2008). An emerging body of multidisciplinary literature has documented the beneficial influence of physical activity engendered through aerobic exercise on selective aspects of brain function (Antunes et al., 2006). Several studies have observed an improvement in the cognitive functions with the exercise practicing. Many studies have been conducted to test the potentially beneficial effects of physical activity on cognition has shown a strong correlation between the increasing aerobic capability and the improvement in the cognitive functions (Drollette et al., 2014; Scudder, Drollette, Pontifex & Hillman, 2012). Studies assessed the effects of acute bouts of physical activity on adults’ shown significant enhancement on cognitive performance (Nanda, Balde & Manjunatha, 2013). Three groups of studies were constituted on the basis of the type of exercise protocol employed. Each group was then evaluated in terms of information-processing theory. It was concluded that submaximal aerobic exercise performed for periods up to 60 min facilitate specific aspects of information processing; however, extended exercise that
leads to dehydration compromises both information processing and memory functions (Tomporowski, 2003).

Yogic squat is a physical practice of worship, in which devotees hold earlobes between thumb and forefinger with hands crossed in front of the chest and perform squats. Common belief is that these practices will endeavourers’ success in all aspect of life. This is done 18 or 108 or 1008 times. Traditionally this practice has been used as a form of punishment in schools. Even though there is no reference in traditional scriptures, this practice has been passed down through the auricular tradition (karna paramparā) over ages and is practiced even today with great faith. This account of the origin of the practice is supported by tracing of the Sanskrit word Dhorbikaranam which literally means “hands on ears”. It is also known as Baski in Kannada, Yetham in Malayalam, Thoppukaranam in Tamil, and Kaan Pakad or Dorbi Karn in Hindi.

Pranic Healing Master Choa Kok Sui has introduced a practice in the United States called super brain yoga. Practice consists of using the thumb and a finger to apply pressure to each earlobe while doing knee bends and taking breaths. The practice is believed to activate acupressure energy points for the brain, eyes, forehead, mouth, ovary, parotid, temple, and testes congregated around the area of the ear as well as the pads of the thumb and forefinger which are believed to correspond to the brain, and the pineal and pituitary glands (Sui, 2005). Testimonial on Super Brain Yoga - a similar practice using the thumb and a finger to apply pressure to each earlobe while doing knee bends and taking breaths - show increased class participation, concentration, improved quality of academic performance and social skills in a sample of US school students (Koterba, 2007; Sui, 2005).
Scientific validation of the practice is in its initial stages. A recent study on immediate effect of 108 rounds of yogic squat on emerging adults has shown a significant improvement in selective attention and state mindfulness. Further state anxiety reduced significantly after the yogic squat. As no formal research study is available on yogic squat. Hence, this study sought to understand the traditional worship practice on selective attention in a sample of adolescence.

9.2 MATERIALS AND METHODS

9.2.1 Subjects

Eight three healthy school children of both genders in age range of 13-16 years who attended yoga based Personality Development Camp in summer holidays in the serene campus of SVYASA University, Bengaluru, were randomly selected from a pool of 540 children. All reported having a normal or corrected vision. Those who had any history of psychological illness, heart disease, renal failure, recent surgery, joint pain, or any other debilitating condition, any major disability or illness and unwillingness to participate in the study were excluded from the study.

9.2.2 Design and procedure

All children were the participants of a ten day residential yoga based personality development camp organized during summer holidays in the month of April. Eligible participants underwent familiarization on the practice of yogic squats for a period of seven days. They were also familiarized with procedure of assessment tools. A randomized self-as-control within subjects design was implemented. All sessions was conducted in a spacious room on 8th and 9th day of the camp after the child had acclimatized with practice.
All participants underwent two condition experimental condition (yogic squat) and control session (walking) for 10 min. All sessions were conducted at the same time (4-5pm) on two different days to avoid diurnal variation. Further subjects were assigned sessions randomly to avoid practice effect. Instructions and assessments were done at group level by the researcher.

9.2.3 Measurement

Digit Letter Substitution Test (DLST)

The DLST performance depends on selective attention and working memory. The DLST worksheet consists of a 8 rows × 12 columns array of random digits 1–9. Subjects are seated comfortably with the worksheet upside down until the start of the test. Subjects were instructed to make their own choice of letter substitution strategy, whether horizontally, vertically, or selecting each particular digit randomized in the array one at a time. They were instructed to substitute as many target digits as possible in the specified time of 90 seconds. Each test was timed on a standard stopwatch. Because the tests were administered with such a short intervening time interval, immediately before and after an sessions of only 10 minutes, different worksheets and coding was used for each test, with different digit–letter pairing in the key and differently randomized arrays of digits on the worksheet. Scoring the DLST counts both the total number of substitutions attempted, and the number of wrong substitutions. Net score is obtained by deducting the latter from the former. DLST has used for similar design and validated for the Indian population (Pradhan, & Nagendra, 2009; Pradhan & Derle, 2012).
9.2.4 Intervention

9.2.4.1 Experimental condition

Participants practiced 10 min yogic squat with specific hand position. The procedure for squat was a modified form of the Mayo Clinic's practice. Instructions are as follows: Stand with your feet slightly apart, greater than shoulder width and toes pointing ahead. The hands cross over each other (left over right), maintaining a gentle pressure holding the earlobes throughout with thumb in front and the finger to the back. Slowly descend, bending through hips, knees, and ankles, and stopping when knees reach a 90° angle. Then return to the starting position. Keep the back in a neutral position and abdominal muscles tight. Do not flatten the curve of the lower back or arch back. Keep knees centered over feet while going down. Do not let knees roll inward or outward. Keep movements smooth and controlled with normal breathing. The subjects were told that they could rest if they were too exhausted to continue the practice.

Figure 9.1: Procedure of Practice yogic squat
9.2.4.2 Control condition

Subjects were asked to walk at their own pace along a 30-m long yoga hall. Subjects were asked to walk from end to end, covering as much ground as they could during the 10 minutes, without running. Every 60 s, subjects were given feedback on time progression and were encouraged to keep on normal pace of walking along with normal breathing. The subjects were told that they could rest if they were too exhausted to continue the test. They were asked to keep silent and have normal pace of walking along with normal breathing. After the 10 minute duration, they were asked to occupy their respective places for post assessment.

9.3 RESULTS

Mean values and standard deviation for total scores, wrong substitutions, and net scores on all tests are given in Table 9.1.
Table 9.1: Comparison of Yogic Squat and Walking Session on DLST scores

<table>
<thead>
<tr>
<th></th>
<th>Yogic Squat (YS)</th>
<th>Walking</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Variable</td>
<td>Pre</td>
<td>Post</td>
<td>% change</td>
<td>p value</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>DLST TOTAL SCORE</td>
<td>50.82±11.26</td>
<td>57.71±9.928</td>
<td>13.56</td>
<td>&lt;0.001</td>
<td>50.63±10.653</td>
<td>55.24±9.821</td>
</tr>
<tr>
<td></td>
<td>DLST ERROR SCORE</td>
<td>0.23±0.548</td>
<td>0.08±0.356</td>
<td>-63.16</td>
<td>0.039</td>
<td>0.25±0.713</td>
<td>0.11±0.494</td>
</tr>
<tr>
<td></td>
<td>DLST NET SCORE</td>
<td>50.59±11.208</td>
<td>57.63±9.892</td>
<td>13.91</td>
<td>&lt;0.001</td>
<td>50.37±10.59</td>
<td>55.13±9.912</td>
</tr>
<tr>
<td></td>
<td>DLST TOTAL SCORE</td>
<td>48.08±11.993</td>
<td>55.79±10.833</td>
<td>16.03</td>
<td>&lt;0.001</td>
<td>48±11.009</td>
<td>53.35±9.98</td>
</tr>
<tr>
<td></td>
<td>DLST ERROR SCORE</td>
<td>0.19±0.445</td>
<td>0.08±0.404</td>
<td>-55.56</td>
<td>0.200</td>
<td>0.38±0.89</td>
<td>0.15±0.618</td>
</tr>
<tr>
<td></td>
<td>DLST NET SCORE</td>
<td>47.90±11.984</td>
<td>55.71±10.772</td>
<td>16.31</td>
<td>&lt;0.001</td>
<td>47.63±10.837</td>
<td>53.21±10.131</td>
</tr>
<tr>
<td></td>
<td>DLST TOTAL SCORE</td>
<td>54.57±9.05</td>
<td>60.34±7.948</td>
<td>10.58</td>
<td>&lt;0.001</td>
<td>54.23±9.114</td>
<td>57.83±9.112</td>
</tr>
<tr>
<td></td>
<td>DLST ERROR SCORE</td>
<td>0.29±0.667</td>
<td>0.09±0.284</td>
<td>-70</td>
<td>0.109</td>
<td>0.09±0.284</td>
<td>0.06±0.236</td>
</tr>
<tr>
<td></td>
<td>DLST NET SCORE</td>
<td>54.29±8.949</td>
<td>60.26±7.953</td>
<td>11</td>
<td>&lt;0.001</td>
<td>54.14±9.101</td>
<td>57.77±9.091</td>
</tr>
</tbody>
</table>

Table 9.1 shows gender wise description of DLST score for Yogic Squat and Walking group. Both the group have improved but the within group change was more pronounced in Yogic squat group.
Figure 9.2: Gender wise DLST scores of Yogic Squat and Walking group

Figure 9.3: Total DLST scores of Yogic Squat and Walking group
9.4 DISCUSSION

In the present study, we have evaluated the immediate effect of yogic squat as compared with Walking on Digit Letter Substitution Task. Both the groups showed the same trend as well degree of statistical significance. However, the changes were pronounced higher in Yogic Squat session than in Walking session. Total DLST score improved more in YS session, both significant (p<0.001). Though error reduced in both the sessions, they were not statistically significant; the reduction again was found to be better in YS session. Because of this the Net DLST scores results’ trend remained the same as DSLT total score.

A gender difference analysis revealed no difference in the patter of measured variables and the trends remained similar as the total score, except for in the YS session, males showed better improvement in DLST Total score, whereas Females showed better reduction in errors compared to males. The impact of this trend was reflected in the DLST Net score, in which females were found to fair better than males. A very similar trend was again observed in the Walking session.

As per our knowledge there is no previous reports specific to YS on cognitive functions in children. The mechanism underlying the enhancement is not known. Previous study on adult has shown significant enhancement of mindfulness and reduction in anxiety following YS. We hypothesize that improvement in substitution task may be due to enhancement of present moment awareness and reduction in anxiety level which usually influences cognitive task.

The study is limited by the small sample size, and the lasting effect of intervention was not assessed. Future studies should incorporate various assessment methods to capture changes while performing the task and intervention to understand underlying mechanism.
10.0 DISCUSSION ON ALL FIVE STUDIES AND CONCLUSIONS

10.1 DISCUSSION
The overall aim of the study was to explore the effect of yoga on physical fitness among adolescents. Five studies were conducted to evaluate the above aim.

An urgent need for physical fitness program has been illustrated in the first study, which records a failure rate of 71% on KW test in urban children (10-16 years) of both genders. The current statistics on the prevalence of poor muscular fitness in urban children reported in many studies (Raja, Gupta, Bodhke, & Girish, 2014) is alarming. This indicates the effect of sedentary life styles of these school going children and points to the present societal value of bread making and not man making education. This study has also shown a clear relationship between maximum physical fitness and pulmonary function test (PEFR) that suggests a possibility of using this simple had held apparatus to assess pulmonary function as one of the important predictors of ventilatory physical fitness.

These results point to an urgent need for strategies to handle the issue of physical fitness in all schools on a routine basis. Apart from establishing physical fitness training programs in schools, it is necessary to continuously assess their progress. For this simple yet informative tool is required to assess their muscular fitness and pulmonary function. The second study has shown Bhramari Time as a potential alternative to PEFR measurement. The strong correlation indicates that Bhramari Time can be fruitfully utilized in all schools to measure and monitor their pulmonary function. Hence this study has given a good tool to be used in schools across the country.
Among all the existing modalities of physical fitness, yoga seems to be a promising intervention. Unlike other methods like physical exercises, yoga postures and other techniques involve systematic training of muscular strength and endurance. Muscle tone is gradually built up and prepares the system for long lasting performance. This was the key highlight of the third study in which physical strength, flexibility and pulmonary functions were shown to be better in a cohort of practitioners of yoga compared to novices.

The above mentioned distinguishing feature of higher performance in various variables of muscular strength, flexibility and pulmonary function in yoga practitioners has been evaluated by a prospective experimental design in the fourth study. A 10 days residential yoga program reinforced the results of the earlier cohort study of yoga practitioners and novices.

In the fifth study, we have shown the cognitive benefit of yoga which gives support to the well known fact that a physically fitness training can improve the cognitive abilities (Drollette et al., 2014; Scudder, Drollette, Pontifex & Hillman, 2012). We looked at a traditional practice of yogic squat for its effect on the cognitive abilities. This study brings out the richness of traditional practices that were used in schools and homes to achieve overall personality development of children. This study promotes use of such methods rooted in traditional culture for physical fitness. Also this study opens up the doors for further research to understand underlying mechanism.

Yoga has various facets; the very philosophy asserts the existence of human being in many layers or koshas. According to this famous model from taitriya upanishad(Chinmayananda, 1992; Nagendra, 2010), there are five layers starting with annamaya kosha or the gross physical body. The next subtler layer, pranamaya kosha which hosts all the nadis (channels/meridians
and facilitate the flow of prana the vital force; manomaya kosha is the layer of emotional conditioning, and the vijnanamaya kosha, the sheath of discrimination; finally in the row of expansiveness is the anandamaya kosha, the layer of bliss. The matter based paradigm of the modern society has just cherished the gross annamaya kosha, while totally neglecting the subtler aspects that modulate the grosser layers. However, the next obvious question would be how are we going to translate these philosophical concepts into practical techniques?

Figure 10.1 Pancha kosa model
Yoga Personality Development Camp (YPDC) is a 10 day structured camp which includes yoga training for approximately 8-10 hours a day. The camp aims at improving all aspects of personality including physical, mental, intellectual, and spiritual development. Based on the concept of *pancha kosha*, various sessions like asana session, *pranayama* session, Gita chanting session, creativity hour, devotional session, yoga based games, and dramas to portray the life of ideal personalities from epics and history are incorporated (Appendix-1). The whole course is structured in such a way that all the aspects of five *koshas* are well nurtured.

The practice of the whole yoga program gradually leads to refinement at all levels. Physical body becomes stronger and disease free, the pranic imbalances are removed, emotional stability is achieved, thinking and discriminative power enhances, and the ability to remain in deeper layers of silence is naturally achieved.

The ability to consciously slow down the uncontrolled mental processes (Intrusive rewinding thoughts) and use the mind optimally according to the demand criteria of the environment is called as mastery (*chitta vrtti norodhah*). In the state voluntary mastery (yoga state of existence), there is no unwanted expenditure of energy, and the available resources are optimally utilized to harness the best.

Asanas are performed in two ways dynamic (*Haṭha Yoga School*) and static (*Patañjali School*). The dynamic method involves moving in and out of the final position. This school uses the speed, repetitions, and maintenance with strength (Isometric) and often jerks for performance. The objective of this school is predominantly to shatter the laxity, lethargy and *tamas* in general. Whereas in the static method the final position is reached and maintained for some length of time (Nagarathna & Nagendra, 2001). Maintenance for longer duration with ease is the key factors.
The objective is to gain mastery over the pairs of opposite and conquer the body consciousness. Usually a muscle is activated by a group of nerve fibers that send volley of electrical impulses arising from the brain to act in a coordinated and smooth fashion. There are also many fibers that take information back to the brain regarding the status of the muscle. This feedback provides information to the brain regarding the stretch of the muscle, how fast it stretches and how long the stretch is maintained. All these three aspects of muscle activity could be accomplished in the practice of āsanas (Srinivasan, 2011).

This paves the way to higher creativity, intelligence and other skills. This also gives an opportunity to soften the emotions and culture the emotional stresses, which adolescents usually undergo can be avoided. This again strengthens the discriminative ability and makes a person resistance to any intellectual assault. Overall, this gives a person a wholesome character and living. Each person thus growing, no doubt is bound to realize his purpose of life, which is higher liberation and freedom (spiritual health) in a very natural course.

Overall, the whole study brings to lime light the current situation of physical fitness in young adolescents in the country and offers methods of evaluating and techniques of implementing physical fitness in our educational setups. Thus, this study has far reaching influence to propose recommendations to policy makers and wide spread implementation of yoga program as means of physical fitness across educational setups.
10.2 INTEGRATION OF KEY FINDINGS

Figure 10.2: Study overview

- **Variables**
  - Study 1: KW- Test & PEFR
  - Study 2: Bhramari Time & PEFR
  - Study 3: PEFR, Sit & Reach, Handgrip
  - Study 4: PEFR, Bhramari Time, Sit & Reach, KW- Test
  - Study 5: DLST

- **Outcomes**
  - Poor fitness and pulmonary function in adolescent population
  - Bhramari Time is an alternate to PEFR
  - Better fitness in long term yoga practitioners than the yoga naive
  - 10 days’ of YPDC improved fitness
  - Yogic Squat enhances cognitive ability

- **Physical Fitness**
  - Minimum Physical Fitness
  - Bhramari Time Vs PEFR.
  - Fitness: Practitioners Vs Non-practitioners
  - 10 Days YPDC

- **Variables**
  - Study 6: Exercise

Yogic Squat enhances cognitive ability
10.3 IMPLICATIONS FOR INTERVENTIONS AND FUTURE RESEARCH DIRECTIONS

This study has successfully validated the research findings on the role of yoga on physical fitness seen in earlier robust controlled studies through the field studies on large samples. Further, it has clearly shown that Yoga plays an important role in all round development of physical and mental ability. The evidence shows that regular long term practitioners of yoga have an extra edge over others in terms of physical and mental fitness, thereby encouraging practice of yoga on large scale in all schools.

This study has brought to light the possibility of using a simple cost effective assessment technique, the BHT, as a potential variable to assess the development of pulmonary functions, which is an important indicator of physical fitness. This can be applied in wide range of educational setups like schools and colleges. Further, this study has contributed in bring up the culturally rooted practices, which have far reaching implications in overall scholastic performances.

In a nutshell, this study has asserted the important role of yoga in the overall development of physical and mental fitness, suggested simple tools to measure important fitness parameters, and promoted culturally rich practices to promote physical and mental abilities.

10.4 SUMMARY

1. A failure rate of 71% on KW test in urban children (10-16 years) of both genders points to an urgent need of physical fitness training programs for the enhancement of the strength in areas that shape their physical fitness.
2. The observation that the group of students who succeeded on minimum muscular fitness had significantly higher PEFR, points to a positive relationship between muscle fitness and lung functions.

3. Results suggest that BHT can be recommended for use in mass camps as an acceptable scientifically validated yogic tool in young population to assess the ventilatory function and progress of their practices in each class.

3. Children who practice yoga seem to have higher physical fitness than non-practitioners.

4. The results of this study have confirmed the effect of yoga on enhancing physical fitness.

5. Promising results of immediate effects of yogic squat on selective attention is also demonstrated.

Although the current study provides significant insight into the role of yoga in physical fitness and cognitive abilities further research is necessary to explore its various applications.