A comparative study of the effects of yoga and swimming on pulmonary function in sedentary subjects

Materials and Methods

100 volunteers were accepted into the study and randomly (block randomization) divided into two groups:

- 12 weeks training yogic exercises (41 people)
- 12 weeks training swimming (40 people)

They practiced the same frequency and duration: 6 days/week for 60 min daily.

Pre training (at the start of study) and post training (after 12 weeks of training) lung function measurements were done.
- The lung function parameters

*FVC (FVC: Forced Vital Capacity: the amount of air which can exhale forcibly from the lung after deep breathing)

*FEV1/FVC ratio

(FEV: Forced Expiratory Volume; the amount of air which can be forcibly exhale from the lung in the first second of first forced exhalation)

*PEFR (maximum speed of expiration)

*FEF 0.2-1.2 L

(FEF: Forced Expiratory Flow; expiratory flow during measurement of forced vital capacity)

*FEF 25-75%

*MVV

(MVV: Maximal Ventilatory Volume; the maximum amount of air which can be inhaled and exhaled within one minute)

were recorded with computerized spirometer (Helios, Recorders and Medicare Systems Pvt. Ltd., Chandigrah, India)

<table>
<thead>
<tr>
<th>parameter</th>
<th>Yoga Improvement</th>
<th>Swimming Improvement</th>
<th>Yoga Percentage Improvement</th>
<th>Swimming Percentage Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC% predicted</td>
<td>4.786</td>
<td>6.258</td>
<td>6.26%</td>
<td>8.063%</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>0.401</td>
<td>1.343</td>
<td>0.610%</td>
<td>1.539%</td>
</tr>
<tr>
<td>PEFR% predicted</td>
<td>4.119</td>
<td>4.238</td>
<td>5.84%</td>
<td>5.747%</td>
</tr>
</tbody>
</table>
All Pulmonary Functions Test parameters except FEV1/FVC improved significantly (P<0.0001) in both yoga and swimming groups.

**Conclusion**

Raised tolerance of respiratory center to higher PCO$_2$ and low PO$_2$ is achieved with yoga exercises. Short periods of conscious control of the rate and depth of breathing have claimed wide human interest. During the performance of yoga breathing, the subject keeps his skeletal muscles relaxed and immobile can exercise a close, continues voluntary control over his respirator muscles. This yoga exercise may change his ordinary rate of 15-18 respirations/min to 1-2 respirations/min and reduce his ventilation volume great deal. Also, yoga exercise dramatically makes long duration of expiration. This predominant stimulation may change the sensitivity of respiratory centers therefore increasing the breath holding time or decreasing the resting respiratory rate.

The ability of individual to inflate and deflate the lungs depends on the strength of the thoracic and abdominal muscles, posture of the individual and elasticity of lungs. **Swimming increases this ability because it is performed in horizontal position compared to the vertical position in other sports.** Ventilation is restricted during swimming, leading to irregular intervals of hypoxia in every respiratory cycle for one moment or the other. This irregular interval hypoxia creates the anaerobic process by which lactic acid starts accumulating in the blood leading to "lactic oxygen deficit". This leads to the **stimulation of respiratory center** in the medulla therefore increasing respiration. The resultant alveolar hyperplasia may be responsible in increasing FVC, CV and number of alveoli. Also, **swimming require high pressure** on the thorax from outside, thus, swimming leads to better function of respiratory muscles.
Inspiratory resistive loading improves cycling capacity: a placebo controlled trial

*15 healthy subjects (10 men, 5 women) put into three groups; IRL (inspiratory resistive loading), PLA (placebo), and CON (no IRL training) for 3 days a week for 10 weeks.

IRL breathing device is flow resistive, with breathing through 2mm leak. Placebo subjects used same device with reduced flow resistance. All subjects continued regular exercise program during 10 weeks and the program wasn’t different within the three groups.

- Lung function test; Spirometry system
- Exercise testing; Cycle ergometer

![Figure 3](image_url)  
Figure 3: Effects of 10 weeks of inspiratory resistive loading (IRL), placebo (PLA), or no respiratory training (CON) on Tlim0.5 before and after the intervention. All data are the best of the two trials. *Significantly different (p<0.05).
After training, **time to exhaustion at 75% VO$_{2\text{peak}}$** had significantly improved by 36% in the IRL group. All subjects of FEV (forced expiratory volume), FVC (forced vital capacity), FEV1/FVC, PEF (peak expiratory flow) are improved in IRL group while PLA and CON groups were not significantly changed.

![Graphs showing heart rate changes before and after training](image)

**Figure 4** Effects of 10 weeks of inspiratory resistive loading (A), placebo (B), or no respiratory training (C) on heart rate during the Tlims. Values are mean (SD). *Significantly different from value before the test (p<0.05).
After the IRL intervention, heart rate was significantly reduced at 10, 20 and 30 minutes.
After IRL intervention, ventilation was significantly decreased at 20 and 30 minutes.

All subjects in IRL referred that their RPE (rating of perceived exertion) at intervals time via the trials using Borg scale after training was lower than PLA and CON.