



RESEARCH ARTICLE

EFFECT OF INSPIRATORY MUSCLE TRAINING ON CARDIOVASCULAR  
ENDURANCE IN LAWN TENNIS PLAYERS

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ABSTRACT

**Objective:** Insufficient strength of muscle causes fatigue and affects the basic activities. The IMT is the device (POWER breathe KH1) which is recently developed, which has an electronically controlled valve which provides resistance. Resistance training provides constant oxygen delivery at pretraining levels which improve strength.

**Methods:** The lawn tennis players were selected according to the inclusion and exclusion criteria and those who were willing for treatment. Then Queens Step test was evaluated of all participants from which Pulse rate and VO<sub>2</sub> max was calculated before and after treatment. 1RM reading was taken with help of IMT device (POWER breathe KH1). Then after that by taking 40-50% of 1RM the treatment was given with same device for 5days for 4 weeks.

**Result:** In the beginning 1RM was checked which showed the mean  $2.3 \pm 0.7022$  then after treatment it was  $8.17 \pm 0.9499$ . The mean of queen's college's step test that is VO<sub>2</sub>max before treatment showed  $52.428 \pm 9.588$  and after treatment showed  $54.621 \pm 10.350$ .

**Conclusion:** There is significant improvement in cardiovascular endurance and strength in lawn tennis players after progressive inspiratory muscles training.

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INTRODUCTION

Tennis is an unpredictable sport. The physiology of the tennis players is influenced by the unpredictability of point length, shot selection, strategies, match duration, weather and the opponent. These matches last longer than 2 hours where they have high-intensity, short- duration bouts with short rest time. Many muscle groups are involved with highly variable duration of work and rest time. In tennis performance specific tennis endurance, Upper body power, severs velocity and tennis specific endurance are especially important for tennis performance. As the game progresses, heart rate and VO<sub>2</sub> max increases and during rest periods with changing ends the values decreases (Kavas, 2006; Jaime Fernandez- Fernandez, 2009). Competition of blood flow between locomotor muscles and respiratory muscles may cause reduction in blood flow to respiratory muscle which may result in decreased muscle cell oxygen content and lactate and other metabolic by-products which when elevated causes inspiratory muscle fatigue (James, 2001; Lee. Romer, 2001).

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The increase VO<sub>2</sub>max is the result of cardiac function and peripheral blood flow which enhanced peripheral supply of oxygen (Daniel Konig et al., 2001). VO<sub>2</sub> max it is maximum consumption of oxygen and it may be measured by Queens's college step test. The other reasons which affect the tennis performances are playing style, surface, environment, strategy, level of play, velocity of shot and motivation. Strength refers to ability of neuromuscular system which produce, control forces which are imposed during activity. Hence insufficient strength of muscle causes fatigue and affects the basic activities. Repetition maximum is define as the greatest amount of weight a muscle can move through the full, available ROM with control specific number of times before fatiguing. It is to measure the baseline of dynamic strength of muscle against which exercised induced improved strength can be compared (Carolyn kisner, 2012). The IMT is performed by the device called (POWER breathe KH1) which is recently developed, this device applies an inspiratory load that is provided by an electronically controlled valve which provides resistance. Resistance training provides constant oxygen delivery at pretraining levels. Hence the IMT was used this

study (Lee. Romer, 2001; Birgitte Hanel and Niels H. Secher, 1991)

## MATERIALS AND METHODS

The willing and co-operative participants were selected and underwent clinical examination and evaluation for socio-demographic data. Then according to exclusion criteria that is not willing to participate and any known case of respiratory conditions and inclusion criteria that is both males and females and age 18-29 years were selected along tennis court yards in pune. The participants were asked to do the queen's college step test where it requires a step of height 16.25in on which they have to step up and step down for 3 min (up one leg, up the other leg, down the first leg, down the other leg). Then after 3 min the patient stops and the therapist takes the pulse (at the radial site, preferably) while standing within the first 5 seconds. Then participants VO<sub>2</sub> max in ml/kg/min is determined by formula (Gregory, 2008)

- For men: - VO<sub>2</sub>max (ml/kg/min) = 111.33 - (0.42 × HR)
- For women:-VO<sub>2</sub>max (ml/kg/min) = 65.81 - (0.1847 × HR)

IMT is performed by using a recently develop device called (POWER breathe) which consist of a mouth piece consists of a short piece of firm rubber tubing with an internal diameter of 3cm. nose clip was used (Noppawan Charususin, 2017). The subject pressed the tubing firmly around the mouth the lips being contained within the tubing. The participants were asked to breath for assessment of 1RM that is maximum repetition defined as the greatest amount of weight a muscle can moved through the full, available ROM with control a specific number of times before fatiguing. Then 40-50 % of 1RM is taken and then training is done for 5 days for 4 weeks (James S. Williams, 2001; Alba Ramirez-Sarmiento, 2002). After four weeks treatment again queen's colleges step test is done and pre- treatment and post- treatment result were compared.

## RESULTS

Statistical analysis was done using unpaired t test by comparing pre-treatment and post-treatment. The unpaired t test showed significant difference in pre and post treatment (0.0001). We founded that there is improvement in cardiovascular endurance and strength in lawn tennis players after progressive inspiratory muscles training.

**Table 1. Comparison of pre-treatment and post- treatment of 1RM**

	Pre-treatment	Post-treatment
Mean± SD	2.3±0.7022	8.17±0.9499

**Table 2. Comparison pre-treatment and post- treatment of pulse rate**

	Pre-treatment	Post-treatment
Mean± SD	121.93±12.673	114.9±12.067

**Table 3. Comparison pre-treatment and post- treatment of VO<sub>2</sub> max**

	Pre-treatment	Post- treatment
Mean± SD	52.428±9.588	54.621±10.350

## DISCUSSION

The study was conducted to find out the effect of IMT on cardiovascular endurance in lawn tennis players as there in tennis matches there is a general trend toward an increase in VO<sub>2</sub> max and heart rate as the game progresses, with a decrease during the rest periods while changing ends. In this study the treatment protocol was given for five days for four weeks by using IMT device (POWER breathes). In the beginning 1RM was checked which showed the mean 2.3± 0.7022 then after treatment it was 8.17± 0.9499. . The mean of queen's college's step test that is VO<sub>2</sub>max before treatment showed 52.428± 9.588 and after treatment showed 54.621±10.350. The mean of pulse rate showed 2.3± 0.7022 before treatment and 114.9±12.067 after treatment.

Resistive manoeuvre can reduce fatigue by increasing air flow associated with bulk air movements thus increase the strength of the respiratory muscles (Joseph, 1993; Hirofumi Tanaka and Thomas Swensen, 1998). This improve heart function and improved peripheral vascularization and decreases the chances of hypoventilation thus leading to increase in VO<sub>2</sub> max (Daniel Konig et al., 2001; Inbar et al., 1993). The study conducted by OMIR INBAR at ell founded that there was improvement in VO<sub>2</sub> max and strength of inspiratory muscles after training by specific inspiratory muscle training which was done for 10 weeks (Omira Inbar, 1999; Lee M. Romer, 2002). The same result was also founded by ALBA RAMIREZ-SARMIENTO at ell in the study by giving inspiratory muscle training for 5 days a week for 5 consecutive weeks (Alba Ramirez-Sarmiento, 2002). The study conducted by JAMES S. WILLIAMS at ell founded that the respiratory muscle strength and endurance was improve by 4-wk period of IMT but they also suggests that these result are not applicable for whole body endurance exercise capacity at 85% of VO<sub>2</sub> max in competitive athletes (James S. Williams, 2001). The Limitations of this study were, it was done on smaller sample size. The year and duration of practice was not included in the study. The study can be done by using other devices like spirometry and other respiratory muscle exercise used for training purpose.

## Conclusion

We concluded that there is significant improvement in cardiovascular endurance and strength in lawn tennis players after progressive inspiratory muscles training.

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