

## EFFECTIVENESS OF RESPIRATORY MUSCLE TRAINING IN RECREATIONAL SOCCER PLAYERS: A RANDOMIZED CONTROLLED TRIAL

### EFICIENȚA ANTRENĂRII MUSCULATURII RESPIRATORII LA JUCĂTORII AMATORI DE FOTBAL: STUDIU RANDOMIZAT

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**Key words:** recreational soccer players, diaphragm fatigue, Yo-Yo intermittent recovery test

**Cuvinte cheie:** jucători de fotbal amatori, oboseala mușchiului diafragm, test de recuperare intermitentă, Yo-Yo

#### Abstract.

**Objective** The purpose of the study was to investigate the effectiveness of respiratory muscle training (RMT) on intermittent recovery performance and pulmonary function test in recreational soccer players. **Design** Randomized Controlled Trial. **Setting** Department of Cardiorespiratory Physiotherapy, Pravara Rural Hospital, Loni, Tal- Rahata, Dist-Ahmednagar, Maharashtra State, India- 413 736. **Participants** Forty male recreational soccer players between 19-24years of age. **Interventions** RMT by Pressure threshold device Powerbreathe® classic MR (medium resistance) along with regular physical training and Sham training (ST) along with regular physical training for 5 days of the week for 4 weeks (20 training sessions). **Main outcome measures** The outcome measures used in the study were Yo-Yo intermittent recovery test level 1 (YYIRT level 1), Maximum Voluntary Ventilation, (MVV) Forced Vital Capacity (FVC), and Peak Expiratory Flow Rate (PEFR). **Results** Significant improvements in intermittent recovery in terms of YYIRT level 1 and MVV were noted after the four weeks of RMT. However, no significant difference was observed in pulmonary function test in terms of FVC and PEFR. **Conclusions** RMT is useful in improving performance of male recreational soccer players and should be included in their training regimen.

#### Rezumat.

**Obiectiv** Scopul studiului a fost investigarea eficienței antrenării musculaturii respiratorii (AMR) cu recuperare intermitentă și testarea funcției pulmonare la jucătorii amatori de fotbal. **Design** Studiu randomizat. **Locație** Departamentul de Kinetoterapie Cardiorespiratorie, Spitalul Rural Pravara, Loni, Tal- Rahata, Dist-Ahmednagar, Statul Maharashtra, India- 413 736. **Participanți** : Patruzeci de jucători amatori de fotbal (bărbați) cu vârste între 19-24 ani. **Intervenții** AMR cu dispozitiv Powerbreathe pentru pragul de presiune RM (rezistență medie) împreună cu antrenament fizic obișnuit, și antrenament Sham (AS) împreună cu antrenament fizic obișnuit 5 zile pe săptămână timp de 4 săptămâni (20 de sesiuni de antrenamente). **Măsurători principale.** S-a utilizat testul de refacere intermitentă Yo-Yo nivel 1 (TRIYY nivel 1), Ventilație Voluntară Maximă (VVM), Capacitate Vitală Forțată (CVF) și Rata Maximă a Debitului Expirator (RMDE). **Rezultate** S-a observat o îmbunătățire semnificativă în recuperarea intermitentă a TRIYY, nivel 1 și VVM după 4 săptămâni de AMR. Totuși, nu au fost diferențe semnificative la testul de funcționare pulmonară la CVF și RMDE. **Concluzii** AMR este util în îmbunătățirea performanței la fotbalistii amatori și ar trebui inclus în regimul de antrenamente.

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## Introduction

The number of people following soccer for recreation is increasing day by day. The physical demands imposed by the sport are extreme [1-4]. Hence, soccer players need to have the ability to produce high aerobic and anaerobic power, during the game [3].

Many researchers stated that the respiratory system has an effect on the strength and exercise performance in healthy humans and highly trained athletes [5-11]. When there is an increase in the amount of work by respiratory muscles and when diaphragm fatigue occurs there is a shift of blood flow from locomotor muscles to respiratory muscles and vasoconstriction [12-15].

Increase in strength, muscle endurance and hypertrophy can be brought by resistance training when performed with straight scheme and load [16-18]. The respiratory muscles' strength and endurance can be improved in the same way. [19].

Respiratory muscle training (RMT) has been extensively researched over past few decades. RMT can be used during high intensity exercise, for prolonging the commencement of diaphragm fatigue and to increase respiratory muscle function [14, 16, 20, 21]. RMT may improve exercise capacity by delaying the respiratory muscle fatigue and by blood flow redistribution. Moreover it increases the efficiency and induces the blood flow necessity of respiratory muscles along with the exercise [12, 22].

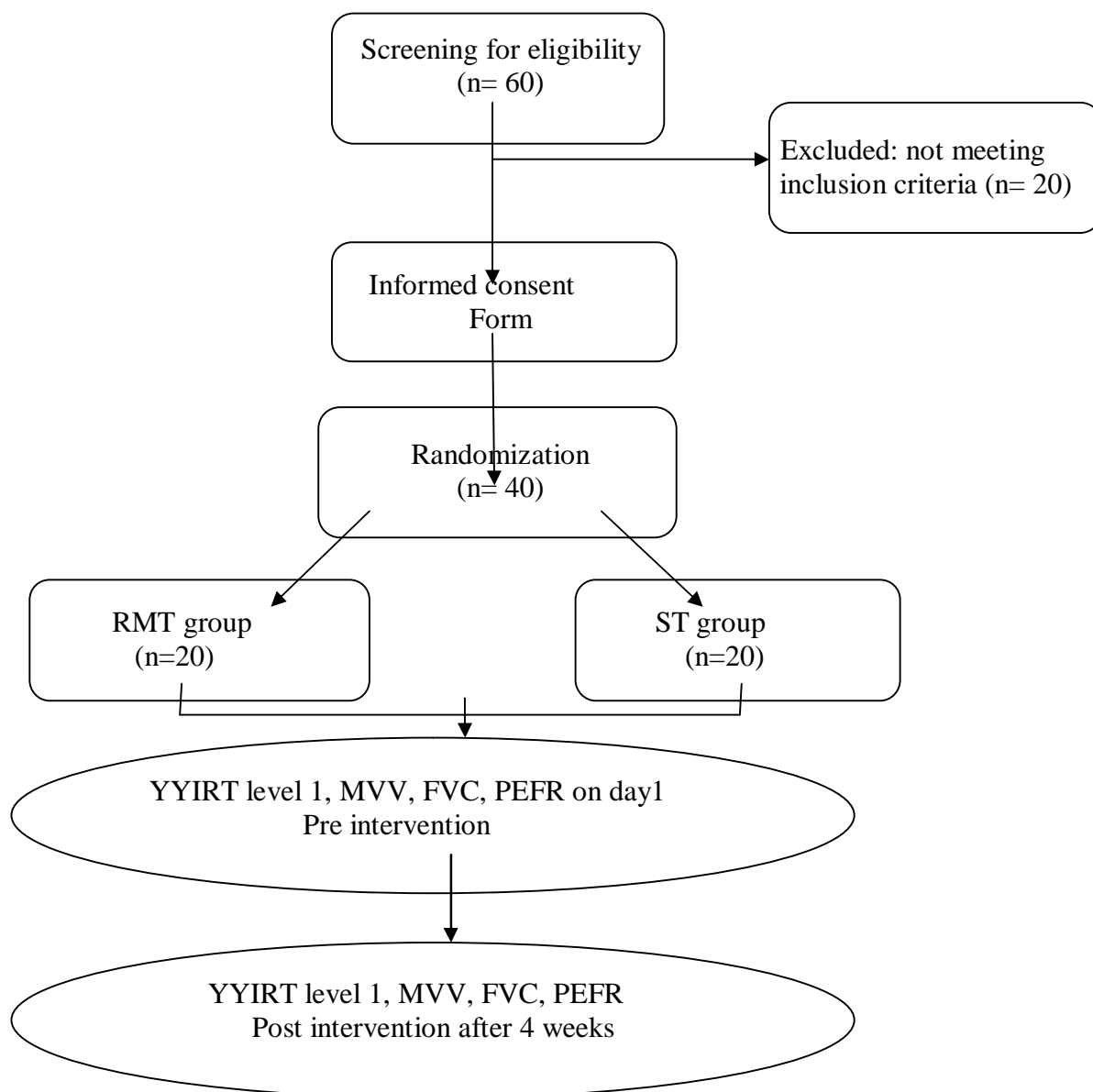
Intermittent sports require participants to exert high intensity bouts of exercise followed by short bouts of recovery. Soccer players have to perform in intervals over a prolonged period of time. Hence they need to have a high intermittent recovery performance which is evaluated by the Yo-Yo intermittent recovery test (YYIRT level 1) [23]. In one study intermittent sprint athletes who completed RMT significantly decreased selected recovery time [24]. There is hardly any literature about RMT in recreational soccer players. Therefore, this study was done to determine the effectiveness of RMT on pulmonary functions and intermittent recovery performance of young male recreational soccer players. Furthermore, this investigation would highlight the importance of RMT as an ergogenic aid in intramural soccer sports.

## Methods

### *Participants*

A total of sixty soccer players through the Pravara Institute of Medical Sciences, Loni, Tal-Rahata, Dist-Ahmednagar, Maharashtra State, India- 413 736 from Jan 2011 to Nov 2011 were screened for the study and forty players fulfilling the inclusion criteria, were included in the study. Prior to the study written informed consent was taken from all the participants.

Participants were included if they were male recreational soccer players participating in recreational soccer as per Boston University intramural outdoor soccer rules [25] and who were between 19 to 24 years age. Participants were excluded if they : 1) had taken up smoking recently, or those who were chronic smokers, 2) were chronic alcoholics, 3) had musculoskeletal injuries of the back and lower limbs which would have affected the performance in the test, 4) had positive history of respiratory disease, 5) had anemia, 6) had hypertension and 7) had cardiovascular disorder.



**Flow Diagram showing the procedure of participant allocation**

### ***Outcome measures***

The main outcome measures used in this study were Yo-Yo intermittent recovery test level 1 to measure the intermittent recovery performance, and Pulmonary Function Test in which Maximum Voluntary Ventilation(MVV), Forced Vital Capacity(FVC) and Peak Expiratory Flow Rate(PEFR) were assessed. These outcome measures have considerably good reliability and validity [26].

### ***Procedure***

The study received approval from Ethical Committee of Pravara Institute of Medical Sciences, Loni. After the screening and as the written informed consent were obtained from all the participants they were allocated in two groups by lottery method: Respiratory muscle training (RMT) group (n= 20) and Sham training (ST) group (n= 20).

On the first day of treatment, participants in RMT group were taught how to perform RMT with Powerbreathe®. Thirty sets of inhalation and exhalation lasting 5five minutes, two times a day, i.e. in the morning and, in the evening 3-4hrs after meal were performed in each session.

This was given for five days per week throughout 4 weeks (20 training sessions). The resistance was set such that the participant could complete 30 sets, once continuously. When the

participant was able to complete 30 sets with ease, the resistance was increased by 1 level so that he could just be able to complete 30 sets in one go. This was done as prescribed by Powerbreathe® manufacturers (HaB International Ltd.). Participants in ST group were also taught how to perform RMT with Powerbreathe® but with minimal resistance i.e. level 1. In the following sessions the participants performed RMT under the therapist's supervision to minimize the error and for the better results.

Regular physical training was continued by both the groups which included warm up running approximately 400 m and stretching of hamstrings, quadriceps and gluteals.

## Results

Statistic analysis was carried out using the GraphPad InStat software trial version. Confidence interval was set at 95%. The baseline characteristics of the participants in both the groups are shown in table1 and reveals that both the groups were comparable.

**Table1: Demographics of the participants in RMT and ST groups**

Parameters	RMT	ST	p
Age (Year)	21.25±1.713	21.35±1.725	0.8550
Height (cm)	168.95±5.835	169.2±4.764	0.8828
Weight(kg)	65.5±7.112	63.1±3.932	0.8550
BMI(kg/m <sup>2</sup> )	22.4735±1.638	22.036±1.335	0.0913
Training(hrs/wk)	4.65±1.468	4.85± 1.309	0.3688

The intermittent recovery performance was measured with the help of the Yo-Yo Intermittent Recovery test (Level 1). In RMT group the average difference in the pre and post intervention score of YYIRT (Level 1) was 53±17.502 meters, whereas in ST group it was 27±14.903 meters. Unpaired test revealed highly significant difference between average of difference in scores of YYIRT (level 1) in RMT and ST groups after 4 weeks. ( $p < 0.0001$ ,  $t = 5.058$ ,  $df = 38$ )

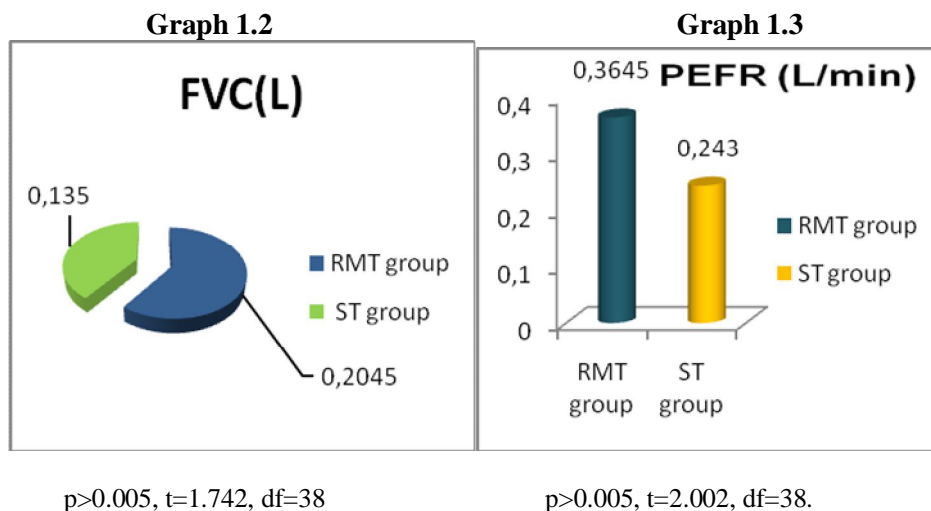
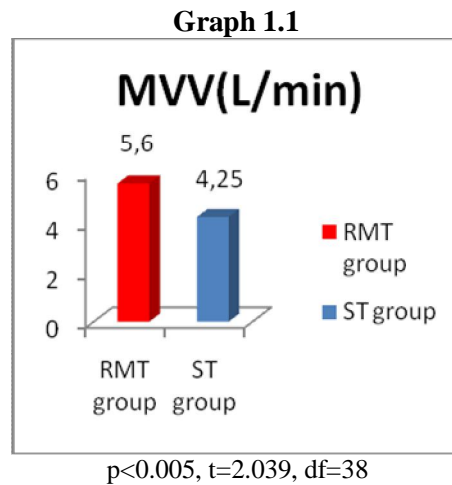
**Table 2.1: Pulmonary function in RMT group before and after 4 weeks of intervention**

	Pre Mean ± SD	Post Mean ± SD (After 4 wks)	p value	t value	df
MVV	139.3±8.736	144.9±7.369	<0.0001	10.466	19
FVC	3.4775±0.3607	3.682±0.3225	<0.0001	6.662	19
PEFR	7.8655±0.7204	8.23±0.6878	<0.0001	6.689	19

**Table 2.2: Pulmonary function in ST group before and after 4 weeks of intervention**

	Pre Mean ± SD	Post Mean ± SD (After 4 wks)	p value	t value	df
MVV	141.55±7.280	145.8±7.592	<0.0001	10.902	19
FVC	3.5015±0.2710	3.6365±0.3082	<0.0001	5.298	19
PEFR	8.092±0.7534	8.335±0.8135	<0.0001	9.099	19

Graphs 1.1, 1.2, 1.3 show changes in pulmonary function amongst the participants in both the groups as revealed by unpaired 't' test:



No adverse effect was noted during the study period. Thus, the result suggests clinical benefits over the period of four weeks.

## Discussion

The result of this study showed that respiratory muscle training was more effective than sham training in improving intermittent recovery performance. This is in accordance with the study by Nicks et.al who concluded that RMT produces improvement in performance of intermittent sprint athletes [8]. An explanation for this may be that the improvement is due to reduction in blood flow to limbs due to a reflex mediated by inspiratory muscles. This is supported by the study of St Croix et al who stated that fatiguing inspiratory muscle work causes reflex sympathetic activation [15]. This metaboreflex produces vascular responses in limb at rest. Harms et al examined these responses during whole body cycling at maximal exercise and concluded that work of breathing normally incurred during maximal exercise causes vasoconstriction in locomotor muscles and compromises locomotor muscle perfusion and oxygen consumption [13, 27]. In addition to this, McConnell & Lomax [28] used an isolated human lower limb model and reported that four weeks inspiratory muscle training changes the

threshold of inspiratory muscle work required to elicit the vasomotor response for activation of this metaboreflex. Therefore, respiratory muscle training can increase intermittent performance.

An explanation for the finding that sham training was not significantly effective in improving intermittent recovery performance may be that, it did not activate the metaboreflex.

Our result provides the evidence that respiratory muscle training shows improvement in intermittent recovery performance and MVV but not in FVC and PEFR. This result was similar to that of Boutellier et al who found significant difference in MVV but no difference in PEFR pre and post RMT [5]. The reason for this may be that when blowing into the spirometer there is no resistance and thus is different from RMT. Other reason might be the short duration of RMT (i.e. 4 weeks). There was improvement in pulmonary function test in terms of FVC and PEFR but it was not statistically significant in both the groups. This may be because of short training duration. Another study investigating the effectiveness of respiratory muscle training showed no significant improvements in terms of FVC in both the ST and the RMT groups [29]. Our study was in agreement with that of Romer et al in terms of the similar improvements in intermittent recovery after inspiratory muscle training [24]. Another explanation for the effectiveness of RMT is that, it may delay or increase accessory muscle function which leads to development in breathing efficiency and therefore less energy consumption for breathing and supplying blood to the locomotor muscles [30, 31, 32].

**Conclusions** RMT was effective in improving the performance in male recreational soccer players and may be incorporated in the players training regimen.

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