

Synchronized Breathing with Pelvic Floor Contractions Increase the Lower Limb Power in Young Football Players

Vijayamurugan Eswaramoorthi¹, Mohamad Razali Abdullah^{2,*}, Naresh Bhaskar Raj¹,
Rabiu Muazu Musa³, Ahmad Bisryi Husin Musawi Maliki²

¹Faculty of Health Science, School of Rehabilitation Science, Universiti Sultan Zainal Abidin (UniSZA), Gong Badak Campus, Kuala Nerus, Malaysia

²Faculty of Applied Social Science, Universiti Sultan Zainal Abidin (UniSZA), Gong Badak campus, Kuala Nerus, Malaysia

³Centre for Fundamental and Continuing Education, Universiti Malaysia Terengganu, Kuala Nerus, Malaysia

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Abstract The aim of this study was to find out the most significant exercise training in improving lower limb power in young male football players. Sixty non-smoking young male football players with the mean age of 14.18 (0.79) years, were randomly allotted to four groups (Group A, B, C, D) of 15 players in each group. Lower limb power was assessed at baseline by vertical jump test. The Group A athletes were instructed to perform diaphragmatic breathing exercise with conventional sports training. Group B athletes instructed to do pelvic floor muscle exercise with conventional sports training. Group C athletes advised to do synchronized diaphragmatic breathing with pelvic floor contraction with conventional sports training and Group D (Control group) players received conventional sports training alone. The training regimen was scheduled for 15-minute length 5 times per week for 8 weeks, along with their 60-minute conventional sports training. Mid and post intervention assessment were carried out at the fourth week and the eighth week with similar baseline assessment regimen. The repeated measures of ANOVA exposed that, noticeable development in lower limb power was obvious amongst all of intervention groups, however post hoc analyses

implicated that synchronized diaphragmatic breathing with pelvic floor contraction was advantageous in enhancing lower limb power than the pelvic floor exercise, diaphragmatic breathing exercise and conventional sports training ($P < .05$). Hence, synchronized diaphragmatic breathing with pelvic floor contraction training should be considered as a part of sports training to improve lower limb power.

Keywords Lower limb Power, Football, Pelvic Floor Exercise, Diaphragmatic Breathing Exercise

1. Introduction

Competition is the ultimate test of performance capability, and is therefore the finest sign of training success. However, when trying to improve performance, it is vital to decide the player's ability in individual aspects of performance. Fitness testing attempts to measure individual components of performance, with the definitive aim of analysing and maximizing the player's ability in

each component [1].

There are several components of fitness that are essential for success in football (soccer). The progress of certain physical fitness components such as cardiorespiratory endurance, speed, body flexibility, core body strength, upper body strength, agility, and leg power are potential outcomes of effective performance in the sport of soccer [2]-[3].

Power is a human physical ability which is extremely important in sport, and is the capability to apply force in as short time as possible, as in rushing, pitching, shooting, etc. Power skills are more perplexing for players and further challenging in team sports like football than other skills because of immense runs and jumps in the course of the football [4].

Breathing is a secret weapon in game performance used by players which can make the modification between winning and losing at game [5]. There are sufficient numbers of scientific reviews that state breathing interventions can support sports performance and have functional implications [6].

The human physique is planned, hence the muscles are accountable for respiration and the heart will yield primacy for oxygenated blood in excess of limb muscles, sense the remaining of the physique- upper and lower limbs will get the premature fatigue quick [7]. Accordingly enhancing respiratory muscle strength and endurance will avoid premature fatigue in leg muscles, and enhance the power.

For the successful performance in game and enhance respiratory muscle strength and endurance, usually suggested practise is diaphragmatic breathing exercise [7]. Correspondingly, to enhance breathing function the latest investigation endorses the pelvic floor muscle exercises [8]. Scientific proof debates that the pelvic floor muscles contract and relax with dynamism in the course of every breath, analogous to the diaphragm, they mobile caudally during breath in cranially during breathe out along with the diaphragm [9].

So which exercise is topmost to enhance lower limb power is still uncertain. In the meantime synchronized diaphragmatic breathing with pelvic floor contraction has been really ignored. So exploration befitted crucial for this Synchronized diaphragmatic breathing with pelvic floor contraction, and its influence on lower limb power. Thus this study aims, to scrutinise most significant exercise in enhancing lower limb power in young male football players through which they can enrich their performance in sports.

2. Materials and Methods

2.1. Participants

Using randomized control trial design, in the absence of

any musculoskeletal, cardio-respiratory, neurological illness and living for a least of one year in Malaysia, a total of 60 non-smoking young male football players aged 13-15 years were included for the trial based on the sample size calculation using G power version (3.1). The players were derived from football team of *Majlis Sukan Negeri Terengganu* (MSNT), Malaysia. Players who had respiratory disturbance, major illness, could not learn exercise and failed to properly attend the training session were excluded from the study. The coaches and players were informed of the research purpose. Prior to the study all players were asked to sign the informed consent form. The current trial began after the approval of the Universiti Sultan Zainal Abidin Human Ethical Research Committee (UHREC/2018/01), after which the players were brought to the exercise therapy laboratory, Faculty of Health Sciences, UniSZA for the baseline evaluations.

2.2. Anthropometric Measurements

The players' height, weight and BMI were measured and registered by means of a stadiometer and weighting scale.

2.3. Vertical Jump Test

Vertical jump test was used to assess lower body power. The test was accomplished by following the rules proposed in ref [10]. In this study, the vertical jump was led by following the identical etiquettes. At first, the investigator pasted a few tape measurements on the wall perpendicularly to record the jumping height. Then, the athletes stood sideward relative to the wall with feet together [11] and raise the closest arm to the wall above their head without lifting up the feet off the ground. The point touched by the fingertips showed a standing reach height. A sticky paper was given to them, then the athlete performed jumping action from the starting position. The highest point that they reach during the jump was marked with sticky paper and measured using a measuring tape to record the height. Vertical jump height is defined as the difference between the height of the raised hand in the standing position and that acquired during the jump. Each athlete received two trials with a 3 min rest in between the trials. Then, the best trial was recorded as the vertical jump height. The results from standing and jump height were recorded in cm.

2.4. Methods

The players were chosen from a population based on cluster sampling. Randomization was performed using Research Randomizer (Version 4.0) [Computer software] Urbaniak & Plous (2013) to divide the players into four groups 1) Group A – [12]. Diaphragmatic exercise training group provided diaphragmatic breathing exercise

with conventional sports training (n = 20); 2) Group B – Pelvic floor muscle exercise group instructed to do pelvic floor muscle exercise with conventional sports training (n = 20); 3) Group C – synchronized diaphragmatic breathing with pelvic floor contraction group followed synchronized diaphragmatic breathing with pelvic floor contraction with conventional sports training (n = 20) and 4) Group D – control group received conventional sports training only (n = 20). Measurements of mid-and post-intervention were conducted at the fourth and eighth week using the same procedure for baseline evaluation.

2.5. Diaphragmatic Breathing Exercise Training Protocol

During the practice session each player was equipped with a regular yoga mat. The player was then told to lie on a yoga mat in a relaxed crook-like posture (lay supine with both hip joints flexed to 45 degrees and foot flat on the floor) with their hands positioned on the upper part of the abdomen (immediately below the frontal costal cartilage), after that, the player was told to inhale slowly and deeply through their nose mean while they were asked to focus on allowing their abdominal wall to rise gently and steadily with a fixed upper chest and relaxed shoulder. They were then told to slowly exhale through their mouth mean in the guided manner, while again being asked to focus on their abdominal wall to gradually fall back to rest [13]. Assigned players were asked to do this 15-minute workout 5 times a week for 8 weeks, along with their conventional sports training [14].



Figure 1. Diaphragmatic breathing exercise training

2.6. Pelvic Floor Muscle Exercise Training Protocol

At first, the players were given instruction to properly recognize the pelvic floor muscles to do the exercise, and then each player was given a regular yoga mat. The player was then told to lie in a comfortable crook-lying pose on the yoga mat (Lay supine with both hip joints flexed to 45 degrees and foot flat on the floor and resting their arms at the side of the subject) denied contracting the abdominal, lumbar, gluteal, and lower-limb muscles. Then the player were asked to contract the pelvic floor muscles alone for 5 seconds gradually, meaning at the end of fifth second they would reach the maximum strength of contraction. Instead

they were asked to relax at the sixth second, followed by a rapid contraction and relaxation between the seventh and ninth seconds and in the tenth second they were asked to rest the muscle. The player was asked to keep their usual breath while doing so and breath holding was forbidden. One set of exercises included performing 10 sets of the exercise described above. There was a 40-second break in between the sets. This protocol of pelvic floor exercise intervention was adapted from [13]. Assigned athletes, along with their conventional sports training, were asked to do this 15-minute training 5 days a week for 8 weeks.

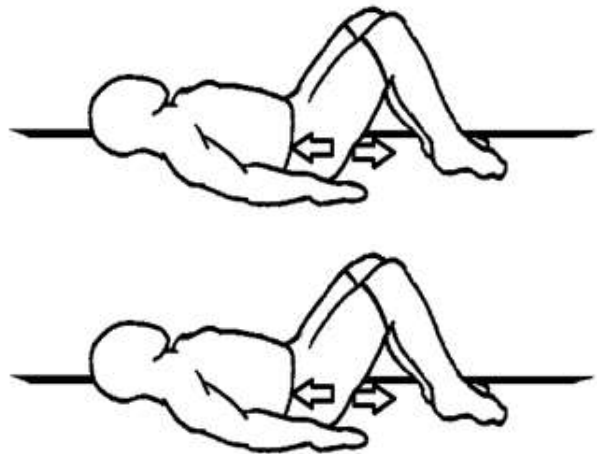


Figure 2. Pelvic Floor muscles Exercise

2.7. Synchronized Breathing with Pelvic Floor Contraction Training Protocol

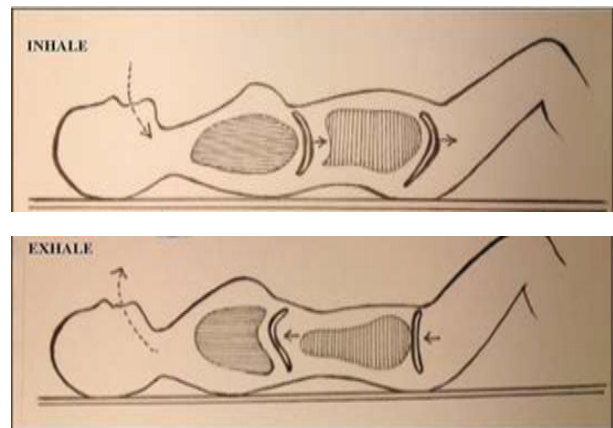


Figure 3. Synchronized Breathing with Pelvic Floor Contraction Training

For this exercise preparation, phase-locked synchronized motion of the diaphragm and pelvic floor was concentrated during breathing. Primarily, the players were trained to correctly identify the pelvic floor muscles to do the exercise, and then each player received a standard yoga mat. The players were then requested to lie on a yoga mat in a relaxed crook-lying posture (Lay

supine with both hip joints flexed to 45 degrees and foot lying flat on the ground) with their hands placed on the upper part of the abdomen (immediately below the frontal costal cartilage), after which the athlete was instructed to inhale slowly and deeply through their nose mean while they were asked to willingly relax their pelvic floor muscles till the end stage of inhalation. They were then told to exhale slowly through their mouth mean in the controlled fashion, while they were again asked to contract their pelvic floor muscles voluntarily as much as possible until the exhalation phase ended [9]. Assigned players were asked to do this 15-minute workout 5 times a week for 8 weeks together with their conventional sports training.

2.8. Conventional Sports Training Protocol

Despite this group, the conventional sports training consisted of drills in four groups typically used by football coaches. It includes warm-up session, skill trainings, group activities (mini football game) and time for cool-down. The training was organized and monitored by football coaches using of *Majlis Sukan Negeri Terengganu* (MSNT), sports-specific training protocol, and the athletes were also instructed to keep their exercise training in a dairy. The investigator undertook a blind periodic testing on the spot. For their sport training, athletes were told to meet their coaches 5 days a week for 8 weeks for 60 minute duration.

2.9. Statistical Analysis

At the end of the 8th week the final players' data after dropout was taken for analysis in order to find out the mean differences at different times between groups. The data were analysed using version 24.0 of SPSS replicated from previous researches [15]-[16]. Descriptive statistics [17]-[19] and repeated measures ANOVA within and between interactions was conducted to quantify the study results.

The information was gathered from 60 players as about 20 players from the groups dropped out. Table 1 shows the anthropometric feature of the players. Sixty young male football players were involved in this research with an average age of 14 years [14.18(0.79)]; mean BMI was 19kg/m² [19.70(1.46)] with an average height and weight of 158 cm [158.75(9.52)] and 49 kg [49.87(7.36)]. Table 2 details the mean difference in vertical jump over various exercise and stages. It could be differentiated that the lower limb power in all the intervention groups increased. Kolmogorov-Smirnov test acknowledged data normality. Mauchly's Sphericity test was performed to determine the variances of difference between groups followed by corrections to Greenhouse Geisser due to the violation of the sphericity. Table 3 provides a time-based comparison of the vertical jump for each exercise category. The lower limb power (P<0.05) was substantially increased at 4th week and the end of 8th week. A repeated measure ANOVA within group analysis was applied tailed by pairwise comparison with 95% confidence interval adjustment by Shefe correction. The findings indicate substantial differences in all exercise group including control group (P<0.05). Using repeated measure ANOVA accompanied by post-hoc multiple comparisons using Shefe correction the findings of the intervention effect (Table 4) demonstrate that synchronized breathing with pelvic floor contractions group was substantially stronger than conventional sports training and the diaphragmatic exercise training group (P<0.05), although there was no substantial difference between other groups. Pairwise comparison of group analysis based on time (Table 5) illustrates the disparity in the vertical jump values between the intervention groups. It is clear that synchronized breathing with pelvic floor contractions group was better to conventional sports training at the end of the 4th week of intervention but yet again synchronized breathing with pelvic floor contractions group at the end of the 8th week was reported to be significantly better in developing lower limb power compared to that of conventional sports training, diaphragmatic breathing exercise group, and pelvic floor exercise group (P<0.05).

3. Result and Discussion

Table 1. Anthropometric feature of the players

Variables	Over all n=60 Mean (SD)	Group A n=15 Mean (SD)	Group B n=15 Mean (SD)	Group C n=15 Mean (SD)	Group D n=15 Mean (SD)
Age (Years)	14.18 (0.79)	14.33 (0.72)	14.13 (0.83)	14.07 (0.88)	14.20 (0.77)
Height (cm)	158.75 (9.52)	162.60 (11.32)	155.93 (9.99)	157.80 (8.47)	158.67 (7.55)
Weight (kg)	49.87 (7.36)	50.79 (9.38)	49.56 (6.56)	50.22 (8.05)	48.88 (5.49)
BMI (kg/m ²)	19.70 (1.46)	19.04 (1.37)	20.35 (1.56)	20.06 (1.69)	19.35 (0.81)

SD = Standard deviation

Table 2. Mean difference in Vertical jump test score (Centimeters).

PHASES	GROUP A Diaphragmatic Breathing Exercise Training Mean (SD)	GROUP B Pelvic Floor Muscle Exercise Training Mean (SD)	GROUP C Synchronized Breathing exercise Training Mean (SD)	GROUP D Conventional Sports Training Mean (SD)
PRE	32.73 (4.79)	34.53 (4.78)	34.47 (5.00)	33.07 (7.09)
MID	35.47 (4.49)	37.33 (4.88)	41.27 (8.07)	34.33 (7.03)
POST	38.60 (6.38)	40.40 (4.84)	51.00 (11.25)	35.67 (7.32)

PRE= Baseline intervention assessment
 Mid= end of 4th week intervention assessment
 Post= end of 8th week intervention assessment

Table 3. Comparison of Vertical jump within each treatment group based on time (Time effect)

Comparison	Group A Diaphragmatic		Group B Pelvic Floor Training		Group C Synchronized Breathing		Group D Control	
	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value
Pre-Mid	-2.73* (-4.27,-1.20)	0.00	-2.80* (-3.99,-1.61)	0.00	-6.80* (-10.42,-3.18)	0.00	-1.27* (-1.89,-.65)	0.00
Pre-Post	-5.87* (-8.72,-3.01)	0.00	-5.87* (-8.31,-3.42)	0.00	-16.53* (-22.56,-10.50)	0.00	-2.60* (-4.38,-.83)	0.00
Mid-Post	-3.13* (-5.24,-1.03)	0.00	-3.07* (-4.62,-1.51)	0.00	-9.73* (-15.08,-4.39)	0.00	-1.33 (-2.83,.16)	0.09

Based on estimated marginal means
 *. The mean difference (MD) is significant at the .05 level.
 b. Adjustment for multiple comparisons: Bonferroni.
 PRE= Baseline intervention assessment
 Mid= end of 4th week intervention assessment
 Post= end of 8th week intervention assessment

Table 4. Overall mean differences of Vertical jump among intervention groups (Intervention effect)

Comparison	Mean difference (95% CI)	p-value
Diaphragmatic- Pelvic floor	-1.82 (-8.27,4.62)	0.88
Diaphragmatic -Synchronized	-6.64 (-13.09,-0.20)	0.04
Diaphragmatic - Control	1.24 (-5.20,7.69)	0.96
Pelvic floor- Synchronized	-4.82 (-11.27,1.62)	0.21
Pelvic floor- Control	3.07 (-3.38,9.51)	0.60
Synchronized - Control	7.89 (1.44,14.33)	0.01

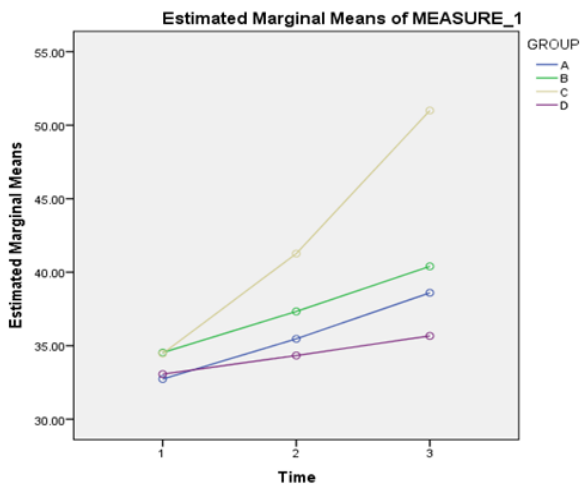


Figure 4. Profile plot of the mean vertical jump among four different groups based on time

Changes in lower limb power of group A with diaphragmatic breathing exercise point out that, at the end of the fourth week the mean lower limb power improved from 32.73 (4.79) centimeters to 35.47 (4.49) centimeters and the rise was 8.03 per cent. After the fourth week of intervention to the end of the eighth week, it rised from 35.47 (4.49) centimeters to 38.60 (6.38) centimeters, the percentage of rise was 8.45 per cent. The total increase in mean lower limb power from baseline to the end of eighth week with diaphragmatic breathing exercise was 16.45 per cent.

Variations in lower limb power of group B with pelvic floor muscle exercise intervention suggest that, at the end of the fourth week, mean lower limb power increased from 34.53 (4.78) centimeters to 37.33 (4.88) centimeters, with an increase of 7.79 per cent. From the fourth week of intervention to the end of the eighth week, it rised from 37.33 (4.88) centimeters to 40.40 (4.84) centimeters, the percentage of rise was 7.89%. The overall increase in mean lower limb power from baseline to the end of eighth week with pelvic floor muscle exercise intervention was 15.66 per cent.

Fluctuations in lower limb power of group C with combined diaphragmatic and pelvic floor muscle contractions exercise intervention propose that, at the end of the fourth week, mean lower limb power improved from 34.47 (5.00) centimeters to 41.27 (8.07) centimeters, with an increase of 17.95 per cent. From the fourth week of intervention to the end of the eighth week, it rised from 41.27 (8.07) centimeters to 51.00 (11.25) centimeters, the

percentage of rise was 21.09%. The whole increase in lower limb power from baseline to the end of eighth week with combined diaphragmic and pelvic floor muscle contractions exercise intervention was 38.68 per cent.

Variations in lower limb power of group D with conventional sports training intervention validate that, at the end of the fourth week, mean lower limb power increased from 33.07 (7.09) centimeters to 34.33 (7.03) centimeters, with increase of 3.73 per cent. Commencing from fourth week of intervention to the end of the eighth week, it rised from 34.33 (7.03) centimeters to 35.67 (7.32) centimeters, with rise of 3.82 per cent. The overall rise in mean lower limb power since baseline to the end of eighth week with conventional sports training intervention was 7.56 per cent.

The analysis of the vertical jump findings highlighted the fact that a significant rise in lower limb power was noticeable across different evaluation phases, and was found across all intervention teams, including conventional sports training group ($p < .05$). This means diaphragmatic breathing exercise, pelvic floor exercise, synchronized breathing with pelvic floor contractions and conventional sports training all have a positive effect on lower limb power development. In addition to the overall mean difference in the vertical jump between four groups (treatment effect), the synchronized breathing with pelvic floor contractions group players with lower limb power was higher than the conventional sports training and diaphragmic breathing exercise group players. While we looked at the group-wise improvement scenario, we noticed that there was an upsurge in lower limb power in

the post-term intervention assessment phase between the synchronized breathing with pelvic floor contractions training group (Group C) of players especially in comparison to those in the other groups ($p < 0.05$). This results suggest that players with synchronized breathing with pelvic floor contractions exercise training could obtain superior lower limb power compared to their counterparts.

According to Newton's second law, the acceleration of an object or person depends on force. The output of the accelerations is directly analogous to the applied force. The stronger the force, the larger the acceleration generated. Velocity and force are the key drivers of the output of muscle power. In order to achieve the highest amount of muscle power, athletes should increase the intensity of the speed as well as the resistance during training [20]. Hence the current study result of greater lower limb power in synchronized breathing with pelvic floor contractions exercise training group could be due to greater improvement of respiratory and pelvic floor muscle strength, effective synchronisation diaphragm and pelvic floor contraction, improved pulmonary capacity and delayed premature fatigue of leg muscles of those players.

There are certain limitations to this study such as recruitment of only male players from Terengganu state, no measurement of muscle strength and sporting performance changes and no inclusion of age matched controls. These deficiencies should be well thought-out for future research.

Table 5. Comparison of the Vertical jump among four different treatment groups based on time (Time-treatment interaction)

	Comparison	Mean difference (95% CI)	p-value
PRE	Diaphragmatic- Pelvic floor	-1.80 (-7.29,3.69)	1.00
	Diaphragmatic -Synchronized	-1.73 (-7.23,3.76)	1.00
	Diaphragmatic - Control	-.33 (-5.83,5.16)	1.00
	Pelvic floor- Synchronized	.07 (-5.43,5.56)	1.00
	Pelvic floor- Control	1.47 (-4.03,6.96)	1.00
	Synchronized - Control	1.40 (-4.09,6.89)	1.00
MID	Diaphragmatic- Pelvic floor	-1.87 (-8.15,4.42)	1.00
	Diaphragmatic -Synchronized	-5.80 (-12.09,.49)	0.09
	Diaphragmatic - Control	1.13 (-5.15,7.42)	1.00
	Pelvic floor- Synchronized	-3.93 (-10.22,2.35)	0.56
	Pelvic floor- Control	3.00 (-3.29,9.29)	1.00
	Synchronized - Control	6.93 (.65,13.22)	0.02
POST	Diaphragmatic- Pelvic floor	-1.80 (-9.60,6.00)	1.00
	Diaphragmatic -Synchronized	-12.40 (-20.20,-4.60)	0.00
	Diaphragmatic - Control	2.93 (-4.87,10.74)	1.00
	Pelvic floor- Synchronized	-10.60 (-18.40,-2.80)	0.00
	Pelvic floor- Control	4.73 (-3.07,12.54)	0.62
	Synchronized - Control	15.33 (7.53,23.14)	0.00

PRE= Baseline intervention assessment

Mid= end of 4th week intervention assessment

Post= end of 8th week intervention assessment

4. Conclusions

Diaphragmatic breathing, pelvic floor muscle exercise, synchronized breathing with pelvic floor contractions have been effective in improving the lower limb power of young male footballers. But synchronized breathing with pelvic floor contractions evidently proved to be better at enhancing the lower limb power of young male football players.

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