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COMPARISON OF CONCENTRIC AND ECCENTRIC HAMSTRING STRENGTH TRAINING IN IMPROVING MUSCLE STRENGTH AND POWER AMONG FUTSAL PLAYERS – A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Hamstring injury is a common problem in many sports, especially those involving acceleration and maximal sprints. Hamstring strains are both common and painful. During sprinting the hip flexor and knee extensor torques are frequently produced and is opposed by the hamstring muscles, hence there are numerous studies done on the muscle strength training to prevent the hamstring strain injury as it is statistically stated as the highest rate involved injury in the contact sport. This study has been focused to evaluate the effectiveness of concentric and eccentric exercises in improving hamstring muscle strength and power among futsal players.

Method: Thirty recreational futsal players were recruited for the study and were randomly divided into two groups. Each group received either hamstring curl exercise (concentric) or Nordic hamstring exercise (eccentric) twice a week for 4 weeks. The manual muscle test (MMT) and 40-yard dash test was used to evaluate the muscle strength and power respectively by comparing the pretest and posttest values for both groups.

Results: Wilcoxon signed rank test showed that there is no statistically significant difference between pre and post test values of MMT (Concentric (right side, z=.317; left side, z=.157), Eccentric (right side, z=.157; left side, z=.317)) in both groups. Based on paired 't' test there is a significant difference between the pre and post test on improving muscle power [Concentric group, P=.020; Eccentric Group, P=.000]. Mann–Whitney U test and unpaired 't' test showed that there is no significant difference between both groups of MMT (z=.775) and 40-yard dash test (P=.707) respectively.

Conclusion: The concentric strength training and eccentric strength training have a similar effect in improving hamstring muscle power in futsal players.

Keywords: Eccentric strength training, Concentric strength training, Hamstring injury, Futsal.

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INTRODUCTION

Futsal is one of the popular sport which played by professional leagues in most of the countries in these recent years. As it is a small sided game, the players encounter the challenging situations where they have to run fast and tackle the opponent players.

During sprinting the hip flexor and knee extensor torques are produced and is opposed by the hamstring muscles, hence there are numerous studies done on the muscle strength training to prevent the hamstring strain injury as it is statistically stated as the highest rate involved injury in the sprinting swing–stance transition [1].

In futsal games, it requires a sequence of different physical activities or skills. Running is the predominant activity in the sport and it needs an explosive type of the efforts or power, such as sprinting generated by the hamstring for the contribution to a successful futsal game. In the sprinting cycle, the hamstrings first will undergo a stretch-shortening cycle. However hamstrings also take part in the explosive type of action, such as sprinting where the muscle power facilitates in achieving maximum speed or acceleration which is important for a successful performance [2].

Muscle strength is the crucial foundation in developing the muscle power. Muscle power is one of the important aspects of the muscle performance that related to the strength and speed. It can be enhanced by increasing the input that a muscle needs to work over a specific time[3].

Isotonic resistance training is superior to isokinetic resistance training in terms of increasing muscle strength and power [4]. Several studies show that concentric and eccentric exercises are used independently or in combination in improving the muscle strength in hamstring, but there are fewer studies have been done in improving hamstring muscle power.

In sprint gait cycle, during the forward and double swing phases the activity of the hamstrings increase as they eccentrically subdue the terminal stages of hip flexion and knee extension. The hamstrings concentrically contract to extend the hip and flex the knee during the stance phase of running and sprinting [5]. Hamstring posses a significant role in running activities which are predominant in futsal games. The hamstring tends to injure, especially the terminal swing phase where the hamstring contracts eccentrically[6].

In futsal game, running is the predominant activity in the sport and it needs an explosive type of the efforts or power, such as sprinting generated by the hamstring for the contribution to a successful futsal game.

Since the strength training can improve the muscle power [7], four week protocol for concentric and eccentric strength training is used, so that the futsal players can have shorter period training in order to enhance their performance in the games. There are still less number of studies have been done on comparing the two hamstring strength training in improving the muscle power. Hence this study focused on to determine the effectiveness of concentric and eccentric hamstring strength training in improving muscle strength and power among futsal players.

METHODS AND RANDOMIZATION

The study was a randomized control trial to compare the hamstring strength and power in recreational futsal players followed by two different strength trainings. The study was approved by University Human Ethical Committee (HEC, Asia Metropolitan University, Malaysia); The study was conducted at the Asia Metropolitan University, Malaysia. The research design was two group pretest-posttest experimental study design. The sampling technique used in this study was purposive sampling with random allocation of 15 participants, respectively in each concentric strengthening group and eccentric strengthening group. Systematic assignment was used for randomization. The subjects who fulfilled the selection criteria were recruited for the study. The inclusion criteria for the study were as follows: Adultsage between 18 and 30 (Figure 1), both genders (Figure 2) , no previous and/or present illness/condition limiting participation. Exclusion criteria were as follows: participating in any other clinical trials and /or lower limb strength training and history of doping.

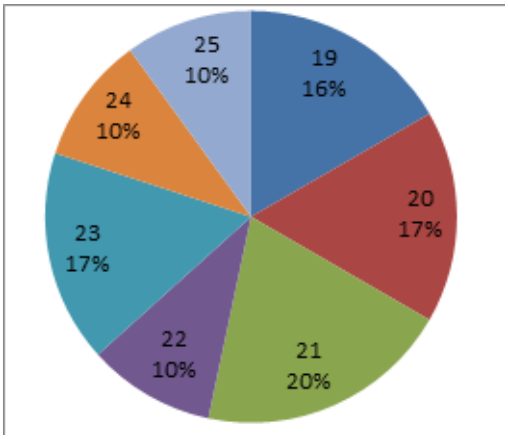

Figure 1: Age- Frequency distribution

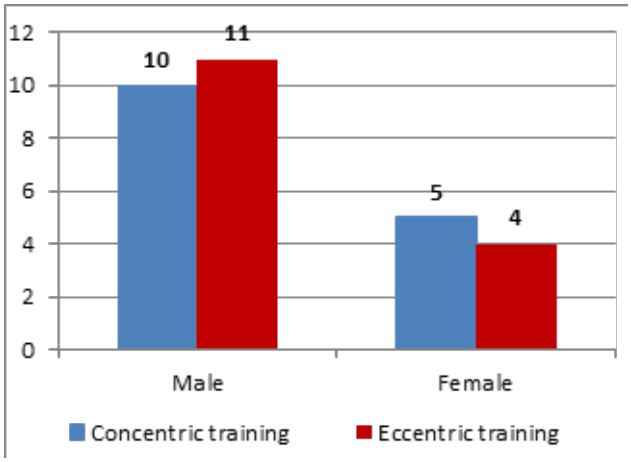

Figure 2: Gender- Frequency distribution

Outcome measures and Interventions:

Both groups were assessed for pretest and posttest for hamstring muscle strength and muscle power by using MMT and40-yard dash test respectively. The independent variables were concentric and eccentric strength training; whereas dependent variables were hamstring muscle

strength and power. The concentric and eccentric hamstring strength trainings were started after pretest and were performed for 4 weeks of 8 training sessions. Training sessions were given in 2 sessions in a week. Posttest was taken from all subjects at the end of 4th week[9] (Figure 3).

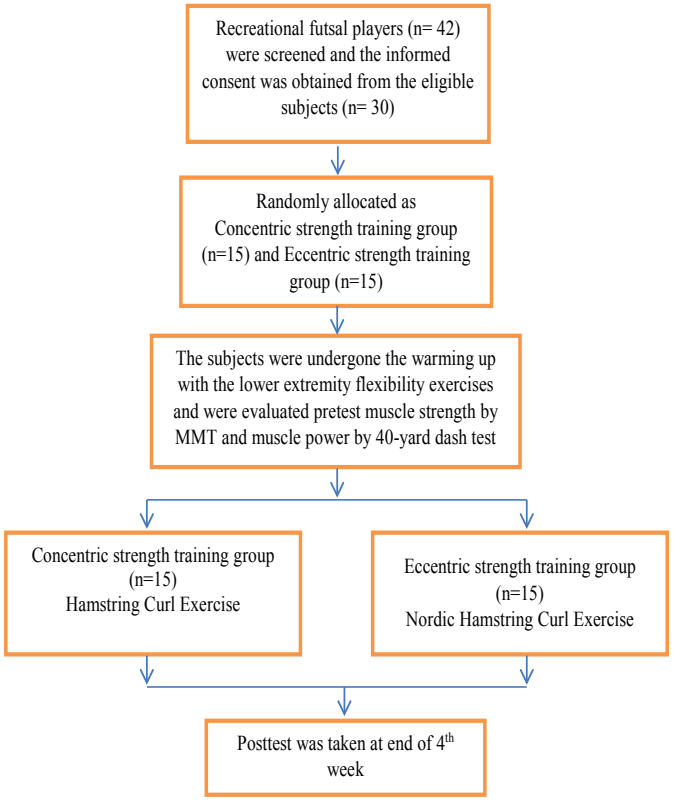

Figure 3: Participant flow diagram.

Informed consent was obtained from all the eligible subjects. Prior to the strength trainings, the subjects from both groups were evaluated with pretest session using MMTand 40-yard distance on the flat surface. The players performed warm up with the stretches for quadriceps, hamstrings and calf muscles before each session. Each stretch was held for 15 seconds with 3 repetitions to above mentioned muscles. After the warm-up exercises hamstring muscle strength was assessed by standard MMT procedure [8]; then, subjects were asked tobe ready in a starting position with the appropriate foot postion behind the starting line without any physical movements and subjects ran up to 40-yard when the signal was given out. The stopwatch was started when the players started to run and stopped when they had reached the finishing line. The procedures were repeated for the second time. Two trial results were documented and the best result was taken.

Hamstring Curl Exercise:

The subjects were asked to lie in prone on the quadriceps table. A small towel roll was placed under the femur just proximal to the patella to avoid compression of the patella between the treatment table and the femur. Before starting out with the exercise protocol, the 10 RM for both legs of the subjects were identified. In prone lying with the resistance of 10 RM against the ankle in quadriceps table, the subjects flexed the knee to only 90° as fast as possible in their comfortable pace [9,10]. The 10 RM of the subjects was rechecked every week. After the 10 RM was tested, the percentage of the exercise load was adjusted according to the training protocol (Table 1).

Nordic Hamstring Exercise:

The subject was in kneeling position on exercise mat and attempted to resist a forward-falling motion using the hamstring to maximize loading in the eccentric phase. The subjects kept their hips fixed in a slightly flexed position throughout the range of motion, and to break the forward fall for as long as possible using their hamstrings, and to keep the tension in their hamstrings even they have to "let go" [7,11]. They had to use arms and hands to buffer the fall, let the chest touched the surface and immediately got back to the starting position by forcefully pushing with their hands to minimize loading in the concentric phase (Table 1).

Concentric strength training - Hamstring curl				
	Sessions	No of sets	No of repetitions	Load (% of 10 RM)
WEEK 1	1	1	15	60
	2	1	15	
WEEK 2	1	2	12	'70
	2	2	12	
WEEK 3	1	3	10	80
	2	3	10	
WEEK 4	1	3	8	90
	2	3	8	
Eccentric strength training - Nordic Hamstring Curl				
	Sessions	No of sets	No of repetitions	Load (% of 10 RM)
WEEK 1	1	1	20	The subjects were asked to move forward their trunk as slow as possible
	2	1	20	
WEEK 2	1	2	20	
	2	2	20	
WEEK 3	1	3	20	
	2	3	20	
WEEK 4	1	3	20	
	2	3	20	

Table 1: Training protocols

Results and Statistical Analysis

The data were statistically analyzed by using Predictive Analytics SoftWare (PASW) Version-18.0. Outcome measures were compared by paired "t" test, independent "t" test, Mann–Whitney U test and Wilcoxon signed rank test [12,13]. Intra group analysis was by paired "t" test and-Wilcoxon signed rank testfor pre and posttest values of 40-yard dash test and MMT respectively. Whereas, intergroup comparison was done using independent "t" test and Mann–Whitney U test for posttest values of 40-yard dash test and MMT respectively. Since the confidence interval for this study was at 95% (p= 0.05) for parametric tests and alpha value of 0.05 for nonparametric tests, $p< 0.05$ and was considered as significantly different among training programs.

RESULTS

Table 2 and 3 show that paired and independent samples inferential statistics of 40-yard dash test for concentric and eccentric strengthening groups.

Table 2 shows that the calculated 't' value is 2.612, which slightly greater than table value 2.145 and the p value of p<0.05 (0.020). Hence this exhibits that there is less significant improvement in concentric strength training group. For eccentric strength training group, table reveals that the calculated 't' value is 10.862 larger than table value 2.145 and a p value of p<0.05 (0.00). Hence, it confirms that high significant improvement in the eccentric strength training group.

		Mean	N	Std. Deviation	t	df	Sig. (2-tailed)
CONCENTRIC GROUP	PRE-TEST	6.2533	15	.76749	2.612	14	.020*
	POST-TEST	6.1173	15	.76502			
ECCENTRIC GROUP	PRE-TEST	6.5620	15	.57230	10.862	14	.000*
	POST-TEST	6.2133	15	.61127			

Table 2: Paired Samples test for 40-yard dash test

			t-test for Equality of Means						
		N	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
POST TEST	Equal variances assumed	30	-.380*	28	.707*	-.09600	.25284	-.61391	.42191
	Equal variances not assumed		-.380*	26.700	.707*	-.09600	.25284	-.61505	.42305

Table 3: Independent Samples Test for 40-yard dash test

Table 3 conveys that there is no significant difference between concentric and eccentric groups with p<0.05 (0.707), respectively calculated 't' value is 0.380 smaller than table value 2.048. So the alternative hypothesis is rejected.

However, the analysis statistically shows there is a significant difference between pretest and posttest score of the 40 yard dash test for the concentric and eccentric strength training respectively.

Pre and post test manual muscle test comparison for concentric and eccentric strength training was done by Wilcoxon signed rank test. There was no significant statistical difference between pre and post test of both groups Concentric group (right), Z>. 317; Concentric group (left), Z>. 157, Eccentric group (right), Z>. 157, Eccentric group (left), Z>. 317) (Table 4).

	Asymp. Sig. (2-tailed) 95% CI	
	RIGHT	LEFT
CONCENTRIC GROUP	Z>.05(.317)*	Z>.05(.157)*
ECCENTRIC GROUP	Z>.05(.157)*	Z>.05(.317)*

Table 4: Within group compassion for MMT

There was no significant statistical difference between concentric and eccentric strengthening group on manual muscle test in improving hamstring muscle strength with Z >.05 (.775) for the right side and with Z >.05 (.775) for left side (Table 5, 6).

Ranks – Right side				
	GROUP	N	Mean Rank	Sum of Ranks
POST-TEST	CONCENTRIC	15	16.00	240.00
	ECCENTRIC	15	15.00	225.00
	Total	30		

Test Statistics[b]	
	Posttest right
Mann-Whitney U	105.000
Wilcoxon W	225.000
Z	-.424
Asymp. Sig. (2-tailed)	.671
Exact Sig. [2*(1-tailed Sig.)]	.775[a*]

a. Not corrected for ties.

b. Grouping Variable: GROUP

Table 5: Group comparison for MMT – Right Side

Ranks- Left side				
	GROUP	N	Mean Rank	Sum of Ranks
POST-TEST	CONCENTRIC	15	16.00	240.00
	ECCENTRIC	15	15.00	225.00
	Total	30		

Test Statistics[b]	
	Posttest left
Mann-Whitney U	105.000
Wilcoxon W	225.000
Z	-.424
Asymp. Sig. (2-tailed)	.671
Exact Sig. [2*(1-tailed Sig.)]	.775[a*]

a. Not corrected for ties.

b. Grouping Variable: GROUP

Table 6: Group comparison for MMT- Left Side

DISCUSSION

There is a potential positive result in both concentric and eccentric strength training groups showed that there is a significant difference between the pretest and posttest on 40-yard dash test for the muscle power. Aagaard P et al (2010) and Kisner C et al (2015) found that this could be due to muscle hyper trophy followed by eccentric ecercises [7] and improving neuromuscular control and muscle endurance followed by concentric exercises [9]; but there is no change in muscle strength between pre and posttest in both groups. This can be explained by Newton R et al (1994), when the type II fibers are selectively recruited when there is a dynamic and explosive movements. The muscle has the ability to produce high force output as the velocity of contraction increases [14].

The more the cross sectional area occupied, the greater the number of fast myosin cross-bridge that can produce force during contraction. Thus, when the type II motor unit pool is recruited to produce explosive movement, these can be produced with correspondingly greater force and hence enhancing the power output. Hence the results of the present study suggest that, there is the significant improvement in posttest of the 40-yard dash test for concentric strength training among the futsal players.

The sport which integrates with running and jumping activities, it is important to improve muscle strength while minimizing the increases in muscle mass. This can be further explained with as the muscle size increases, strength increases at a slower rate than the muscle mass, Kendall F et al, (2010) [8].

For the Nordic hamstring exercise, previous study had suggested that as the athletes lowered themselves towards the ground where the hamstring contracted eccentrically and this had placed a great magnitude of stress on the limb. Clark R et al (2005) found that the Nordic hamstring exercise enhanced the explosive power performance in athletes [15]. Hence, the overload on the hamstring may enhance the neuromuscular adaptation in the limb. It can be seen in the results of the present study that there is a significant difference in pretest and posttest of 40 yard dash test in eccentric strength training.

With regard to the previos study Mjolsnes R et al (2004), it was foud that there was a improvement in maximal eccentric hamstring strength in Nordic hamstring exercise group compared to traditional hamstring curl exercise group [16]. The main reson for this may be that the different outcome measures and the duration were used in the study. Thererfore, further randomized trials, number of participants would be increased and various protocols can be compared to improve muscle power and strength in futsal players .

CONCLUSION

This current randomized control trial concludes that the concentric (hamstring curl) and eccentric (Nordic hamstring) strength training is similarly effective in improving hamstring muscle power in futsal players.

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Conflicts of interest

The author declares no conflicts of interest.

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