THE EFFECTS OF A 6-WEEK PLYOMETRIC TRAINING ON AGILITY PERFORMANCE IN SILAT OLAHRAGA

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Abstract

The purpose of this study was to determine if six weeks of plyometric training can improve an athlete's agility performance in *silat olahraga*. Protocol: Thirty-four (*n*=34) *silat olahraga* athletes (mean age 14 ± 3.22 years old), mean weights (42 ± 10.89 kg), mean heights (148 ± 8.79 cm) were selected as a subject for this study. All subjects were randomly divided into two groups (control and experimental group). Seventeen athletes (*n*=17) in experimental group performed conventional *silat* workout routine and plyometric training for 6-week for 2 sessions per week in 45 min to 1 hour while the control group (*n*=17) only performed conventional *silat* workout routine. All subjects participated in hexagon agility test. The subjects were required to attend the pre-test on a week before the intervention for pre-test session, mid-test on the third week of the intervention training, and post-test session on the end of intervention week. Repeated measure mixed between-within ANOVA was utilized to analyze the results. Results: End of the 6-week intervention, results revealed, agility performance were statistically changed across the times (p<0.05) in the experimental group. The plyometric training group had a quicker time and reduced time on the ground across the time for the hexagon agility test. The results of this study proved that plyometric training could be an effective training technique to improve the agility performance among *silat olahraga* athletes.

Keywords: Training, plyometric, *silat olahraga*, combat sports

Introduction

Over the past two decades, plyometric training has developed into broadly recognized and significantly effective drills to increase agility (Matthew, 2003). Agility is not a single ability but a complex of several abilities (Blume, 1978; Dey, Kar, & Debray et al., 2010; Meinel & Schnabel, 1976). Agility is the physical ability that enables an individual to rapidly change the body position and direction in a precise manner (Johnson, 1988). Agility is also defined as the ability to maintain or control the body position while quickly changing direction during a series of movements (Twist & Benickly, 1996) which can be defined as a skill to uphold or control body situation while rapidly shifting direction during a sequence of activities. Agility, by theory, should be improved by enhancing balance and control of body positions during a movement (Miller et al., 2006). Muscle spindles, golgi tendon organs, and joint proprioceptors are going through some sort neuromuscular conditioning and neural adaptation in agility training (Barnes & Attaway, 1996; Craig, 2004). Agility training is thought to be a re-enforcement of motor programming through neuromuscular conditioning and neural adaptation of muscle spindles, golgi-tendon organs, and joint proprioceptors. By enhancing balance and control of body positions during movement, agility theoretically should improve (Barnes & Attaway, 1996; Craig, 2004, Potteiger et al., 1999). These abilities are primarily dependent upon the coordinative processes of the central nervous system that are important, specifically in *silat olahraga* (Shapie, 2011).

Past studies have shown that enhancing power and competence in plyometric may develop the agility training objectives (Stone & Kroll 1991) and plyometric activities have been used in sports such as football, tennis, soccer and other variety of sports skill proved that agility maybe benefit their athletes (Parsons & Jones, 1998; Yap & Brown, 2000). Although plyometric training has been shown to improve performance objective, limited scientific information is available to define if plyometric training has actually improved agility performance.

Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can assist in developing agility (Craig, 2004; Miller, Hilbert, & Brown, 2001; Parsons & Jones 1998; Yap & Brown, 2000; Young, McDowell & Scarlett, 2001). The studies on plyometric training on agility discovered that plyometric training had benefited agility performance and improve muscular strength and explosiveness while working to become more agile (Miller et al., 2006).

In addition, Mitkle (2004) suggested, that the program of plyometric training given to the targeted subjects should be sports specific. It might be shrewd to be more specific to combat sports in order to give an impact to the subjects' agility performance. The program should be modified in terms of sets, repetition, volume, and type of specific drills in order to give better results affecting agility performance to the athletes. A training program should be formulated in a periodized fitness training program that stresses more on the lower part of the body and sport specificity in their sports (Shapie, 2011). In addition, to expand these factor, exercise may be performed in a regular and organized manner, these exercise sessions should provide stimulation for the development on components of fitness and create a situation to develop the body (Anbary, 2012).

On the process in improving agility, plyometric training adapted few movements that including stopping, starting, varying directions in explosive method (Miller et al., 2001; Parsons & Jones 1998; Yap & Brown, 2000; Young et al., 2001). Related to this concept of movements, most of it, mimics or have similar movements in *silat olahraga* movements, i.e., body dodge, fake movements and evading during defending movements (Shapie, Oliver, O'Donoghue, & Tong, 2013; Shapie, Oliver, O'Donoghue, & Tong, 2014). In another supportive study that illustrated the importance of agility informed that optimum agility performance enables the karateka to avoid the opponent's attacks and to assume the optimal position for efficient performance of karate techniques (Blaevi, Kati, & Popovi, 2006).

Agility performance also effects by the learning effects (Beekhuizen, Maurice, Kolber, & Cheng, 2009), with a practice trial implemented before the actual in hexagon agility test, participants were not part of an intervention or participating in an agility-based training program, can only attribute this as a learning effect in which subjects might still be learning the tasks and thus had a better performance.

The importance to have an optimum agility performance in *silat olahraga* have been discussed by Shapie (2011). In performing motion as "*elakkan*" (dodging or evade) the elements of agility is essential to *silat olahraga* athletes in protecting themselves or avoiding the athletes from the fast strikes of the opponents (Shapie et al., 2013; Shapie & Elias, 2015). In their investigation, the agility 3-directional jump was examined by using the contact mat (Smart Jump, Fusion Sport, Australia) in order to measure body awareness in agility during jumping ability to move in the different patterns of *silat* movements, which mimics evasive movements during silat match (Shapie et al., 2014; Shapie & Elias, 2015). This test was designed to reflect the evading and attacking movements during silat match. The study revealed significant value (p<0.05) in gender on three kick test between male and female *silat* athletes. It was necessary for *silat olahraga* athletes to have optimum motor abilities and skill related components like agility, balance and coordination, reaction time and power (Shapie et al., 2014).

In order to measure agility, there exist some general standard tests (Lacy & Hastad, 2007). These test results can be used both to motivate self-improvement and help individuals to plan their fitness goals. A test is a tool or instrument of measurement; measurement is a major step in evaluation, and evaluation is an encompassing process, making qualitative decisions based on the quantitative data derived from tests and measurement.

Therefore, tests of agility can provide an objective measure of the agility among *silat olahraga*. Related to this, Beekhuizen et al. (2009) discovered that the hexagon agility test revealed significant reliability for measuring agility, which supports the used of hexagon agility test as a tool to assess athletic performance and lower-extremity agility performance. A significant difference was identified during the same day test-retest sessions. Evidence of reliability, in addition to its ease of administration, makes the hexagon test a practical and effective method to measure agility. When using this test as a measure of agility, a change of greater than 1.015 seconds is necessary to be 95% certain that the change in time reflects improvement and exceeds measurement error. According to Shapie (2011), activity *silat olahraga* pattern during a performance in *silat* arena requires the *silat* performer to move around with so many different patterns such as shape pattern, diagonal pattern, a zigzag pattern and triangular pattern which have a similarity in agility movements. Therefore, it appears that the hexagon agility test is a suitable tool to be used in order to measure agility performance in *silat olahraga* athletes. It is suggested that this test will improve the performer's ability to attack or counter-attack their opponents (Shapie et al., 2013).

In addition, a study by Asadi (2012) on the effects of a 6-week depth jump and counter movement jump training on agility performance in healthy male students, indicated that there was a significant improvement on pre-training in Illinois agility test and T-test ($p<0.05$). Therefore, it could be observed that Depth Jump and Counter Jump training is an appropriate test to improve agility performance. It has been suggested that the increase in power and efficiency due to plyometric training may increase agility training objectives (Stone & O'Bryant, 1984). It is worth to note that plyometric activities have been used in sports such as football, tennis, soccer or other sporting events such as combat sports, agility may be very useful for the athletes (Parsons & Jones, 1998; Renfro, 1999; Robinson & Owens, 2004; Roper, 1998; Yap & Brown, 2000). Based on the literature discussed, it has been shown that plyometric training does to some extent enhance agility performance. Therefore, the purpose of this study is to determine the effects of 6-week plyometric training on the agility performance in silat *olahraga*.

Methods

Subjects

Thirty-four *silat olahraga* athletes from the Selangor team participated in this study. The purposive sampling was used to choose the participants in this study. The participants that were selected fulfills the *silat olahraga* characteristics. The *silat* participants were randomly assigned into two groups namely experimental and control group (Table 1). The participants represented the state of Selangor at the national level. The samplings were chosen on the whole population of Selangor *silat olahraga* team. The subjects selected does not exhibit any presence of lower extremity injuries.

Table 1: *Demographic data on physical characteristic of Selangor silat olahraga*

Variables	Control Group n=17	Experimental Group n=17
	Mean±SD	Mean±SD
Age (years)	20.71±2.596	19.94±4.308
Height (cm)	163.41±8.242	164.15±9.550
Weight (kg)	62.04±10.220	61.66±11.853

Procedures

The experimental group participated in the training carried out a variation of plyometric training which designed for the lower extremities based on the recommendations by Piper and Erdmann (1998) as described in Table 3. A 6-week plyometric training program was developed using two training sessions per week. The experimental group participated in the training carried out a variation of plyometric training 2 times a week with forty-five minutes to one-hour sessions. The training days were programmed alternately, on Tuesday and Thursday in each week as described in Table 2. The training loads progressively increased in terms of volumes (90-140 foot contacts), training drills, repetitions, sets and the intensity was set from low to high. Neuromuscular adaptations were a causative factor to explosive power may occur early in the periodization phase of training, as suggested by some sport physiologists (Adams, O'Shea, O'Shea, & Climstein, 1992). Twice per week of plyometric training were required to allow sufficient recovery between workouts as opined by researchers (Adams et al., 1992). Four to six week of high-intensity power training is an ideal length of time for CNS to be stressed without extreme strain fatigue as reviewed from the physiological and psychological standpoint (Adams et al., 1992).

Table 3: The intervention training program

Group/ Days	Control Group	Experimental Group	
	Conventional *Silat* Training	Conventional *Silat* Training	Plyometric Training
Monday	✓	✓	X
Tuesday	X	X	✓
Wednesday	✓	✓	X
Thursday	X	X	✓
Friday	✓	✓	X

✓ - Training day
X - Rest day

Table 5: The 6-week plyometric training program

Training	Training Volume (foot contacts)	Plyometric Drill	Sets X Reps	Training Intensity
Week 1	90	Side to side ankle hops	2x15	Low
		Standing jump and reach	2x15	Low
		Front cone hops	5x6	Low
Week 2	120	Side to side ankle hops	2x15	Low
		Standing Long jump	5x6	Low
		Lateral jump over barrier	2x15	Medium
		Double leg hops	5x6	Medium
Week 3	120	Side to side ankle hops	2x12	Low
		Standing Long jump	4x6	Low
		Lateral jump over barrier	2x12	Medium
		Double leg hops	3x8	Medium
		Lateral cone hops	2x12	Medium

Week 4	140	Diagonal cone hops	4x8	Low
		Standing long jump with lateral sprint	4x8	Medium
		Lateral cone hops	2x12	Medium
		Single leg bounding	3x8	High
		Lateral jump single leg	2x12	High
Week 5	140	Diagonal cone hops	2x7	Low
		Standing long jump with lateral sprint	4x7	Medium
		Lateral cone hops	4x7	Medium
		Cone hops with 180-degree turn	4x7	Medium
		Single leg bounding	4x7	High
		Lateral jump single leg	2x7	High
Week 6	120	Diagonal cone hops	2x12	Low
		Hexagon drill	2x12	Low
		Cone hops with change of direction	4x6	Medium
		Double Hops	3x8	Medium
		Lateral Jump Single leg	4x6	High

The control group did not participate in any of the plyometric training sessions during the intervention period. This group only participated in the conventional *silat olahraga* workout routine program. The subjects were required to attend a test on a week before the intervention for pre-test session, mid-test on the third week of the intervention week, and post-test session on the end of intervention week illustrated in Figure 1. The training activities of the experimental group and the control group during intervention as shown in Table 2 also participated in the conventional *silat* workout routine.

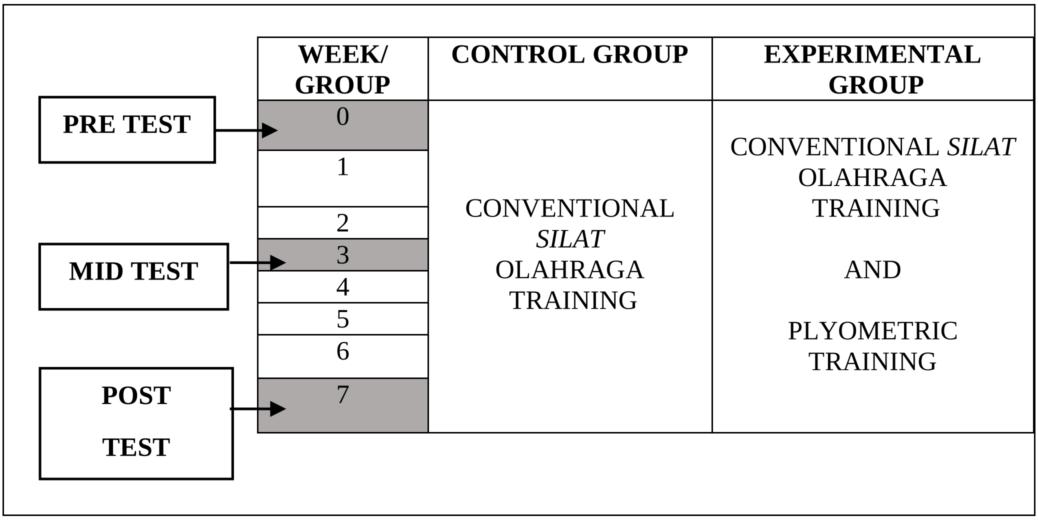

Figure 1: Research design

Testing procedure

All participants performed a standardized warm-up prior to testing. Participants jogged for 10 minutes and then performed a few submaximal runs and jumps. No stretching was included in the warm-up. A significant difference was identified during the same day test-retest sessions ($p<0.001$). The hexagon test was conducted based on NSCA's Essentials of Strength and Conditioning textbook (Baechle & Earle, 2000). A hexagon was made of tape on a hard surface. Each side was 24-inch 120 degrees' angle. The middle of the hexagon was marked as the starting position, and 12-inch tape trip was used for this Hexagon. A stopwatch was used to record time in millisecond for this test.

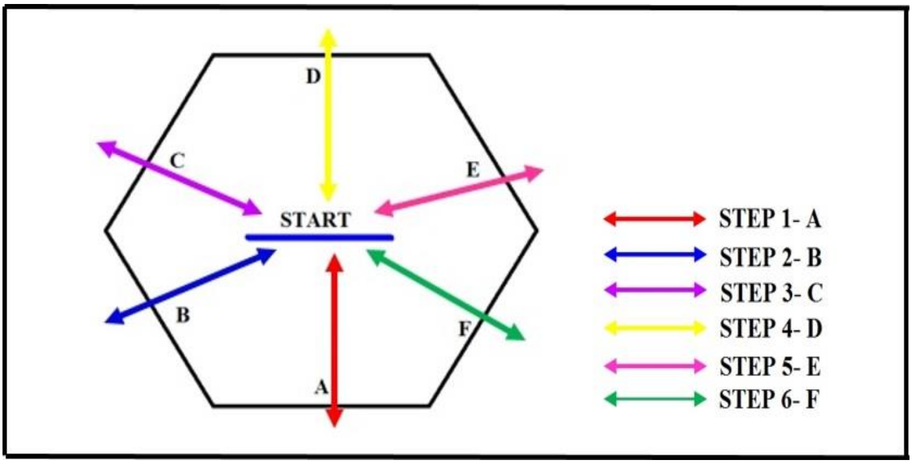

Figure 2: The hexagon test diagram

Procedures

i. The test began with the athletes standing on the tape strip placed at the center of the hexagon, which is marked as the starting position labelled as "START".
ii. The subject (athlete) was instructed ''Ready, "Start'' and the time from the stopwatch is recorded. On the ''Start'' command, each athlete began to double-leg hopping from the mid center of the hexagon over each side and returned to the mid-center in a clockwise path until the athletes repeated around the hexagon three times and returned to the mid-center for 18 jumps.
iii. The stopwatch was stopped once the athletes return to the mid center position after 3 repetitions around the hexagon.
iv. The athletes were required to head in the same path during the progression of the test, and the athletes' feet are not allowed to step on the taped edges of the hexagon or the trial will be cancelled and the athletes will be asked to perform the test again. Athletes were given a break for a period of ten seconds between each trials. The athlete's best three score were recoreded per trial.

Results

Test of normality indicated that dependent variables were normally distributed. The estimated mean score on the agility performance by hexagon agility test between control and experimental group is illustrated in Figure 3.

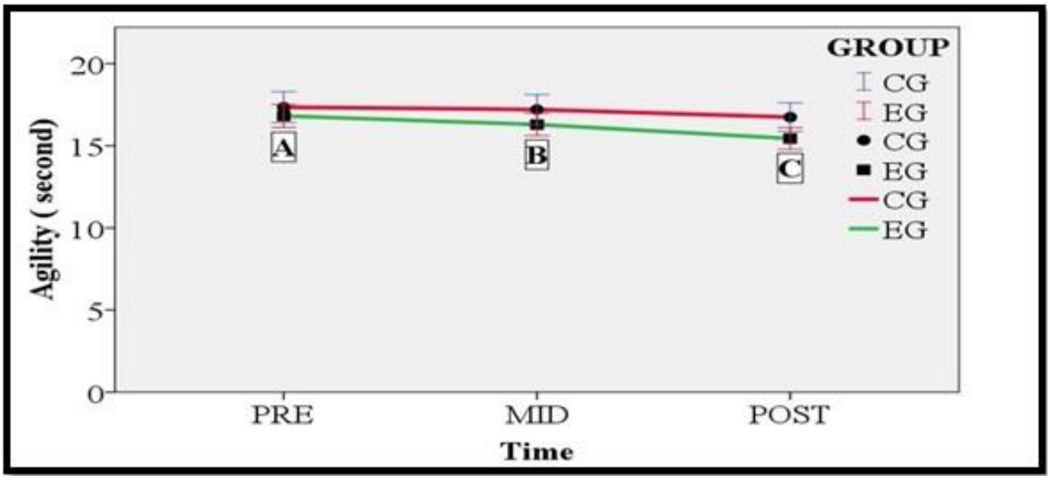

Figure 3: Line graph on the effects of plyometric training on agility performance across time. A significant difference was found on point A–B (between pre-test and mid-test), point B-C showing the significant difference between mid-test and post-test and point A-C showing a significant difference between pre-test and post-test in the experimental group.

A repeated measure mixed between-within analysis of variance was conducted to assess the impact of the interventions on agility performance across observations. Results revealed significant interaction observed between groups and time, Wilks' Lambda = .792, F (2, 31) = 4.08, p=.027, partial eta squared = .208. There was also a significant for time, Wilks' Lambda = .450, F (2, 31) = 18.95, p=.000, partial eta squared = .550 with both groups showing a reduction in time score across observation in hexagon agility test. The main effect between control and experimental group, was not significant, F (1, 32) = .21.418, p =.421, partial eta squared = .020.

Discussion

The main findings from the descriptive data, revealed that the time taken for the tests gradually decreases in the hexagon agility test score between PRE to MID by 3.09 %, between MID and POST by 5.27% and continually decreases between PRE and POST by 8.20% in experimental group (EG). The progression shown by the EG, revealed an outstanding result. This suggests that the intervention does affect the agility performance of *silat olahraga* athletes. This study also establishes that plyometric training improved the athletes' agility. The consistency of the results was also in line with (Miller et al., 2006; Shaji & Isha, 2009; Parsons & Jones,1998).

Moreover, Potteiger et al. (1999) opine that the improvement in the agility as observed in the present study might be a result of the enhanced motor unit recruitment patterns developed by the plyometric training effect. In addition, Craig (2004) added, that the occurrence of neural adaptations developed by the training effect is a consequence of the adaptation towards the plyometric training drills. Nonetheless, as the physiological aspect of the study was not investigated, therefore, there is a need to explore on how much it affects the agility of the athletes.

Conversely, it was evident from the present investigation that there is no significant difference observed in agility performance between the evaluated groups. This is due to the small effect size (.02) (Pallant, 2013). There are a number of plausible reasons that draws to the aforesaid conclusion. Firstly, the need for being agile by the silat athletes is not uncommon. Secondly, it is assumed that the athletes in the control group (CG) are categorised as elite athletes or high performers, whereby the foundation of athletes' physical fitness was already developed through their *silat* workout routines programme. This opinion is shared by (Shapie, 2011; Shapie et al., 2014), who observed that *silat olahraga* workout routine is an agility based sport.

It is suggested that a periodized specific plyometric training program should be included as a training regime to improve the agility based on the *silat olahraga* characteristics as well as activities with regards to *silat* matches for the lower body. It is suggested that the employment of the aforementioned test to a larger sample size should be investigated before any definite conclusion could be drawn.

Conclusion

In conclusion, with regards to this investigation, it could be observed that the EG who undergone the plyometric training were able to decrease the time contact with the ground (ground reaction time) progressively across the time. From the investigation, it is assumed that the plyometric training could enhance the agility of *silat olahraga* athletes. Plyometric training does not only breaks the monotony of conventional *silat olahraga* training, but it also could improve other motor skills like speed and coordination while working on the transformation towards being more agile.

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