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The Evaluation of Strength Training and Body Plyometric Effects on the Male Basketball Players

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This research evaluated the effects of resistance training with upper body plyometric effects on the performance of male basketball players. Sixteen males in the physical education and sport science faculty of Ataturk University were randomly determined into two groups. The experimental group performed a combined strength and plyometric training twice a week for six weeks. Also, experimental group subjected basketball training (2 h), once a week that was separated from strength with plyometric sessions. The control group only participated in basketball skills training, two hours a week. Pre-test and post-test on upper body strength, grip strength, vertical jump and American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) battery of tests were collected for basketball players. Results showed a significant main interaction of intervention and test time on passing skill at $F(1, 7) = 0.50$, $p < 0.05$, partial $\eta 2 = 0.07$. In conclusion, a six-weeks strength and upper body plyometric has significantly lower passing score in compare to the control.

Key words: Sport-specific training, resistance training, plyometric training, physical education.

INTRODUCTION

Basketball is one of the famous physical activity intermediations in physical education and sport science faculty. Researchers have found that basketball improves physical fitness parameters as well as psychological health (Sözen et al., 2013; Vamvakoudis et al., 2007). A primal basketball class pertained to technical and tactical instructions directed towards intra-class or inter-class competition. In recent years, strength training interventions integrated application with basketball training has been considerable attention among coaches. Combination of strength and plyometric exercises in a single session is one of these interventions. The strategy showed increasing in motor performance among youth basketball players (Andrejic, 201). Santos and Janeiro (2008) indicated similar significant enhancement in the squat jump, counter-movement jump, Abalakov Test and medicine ball throw by using a similar program. Plyometic improves strength training in long jump, medicine ball toss and pro-agility shuttle compared to the strength training alone (Faigenbaum et al., 2007). The results indicated greater vertical jump and leg strength production by participants under combination of both strength training with plyometric condition compared to the only strength training groups (Fatouros et al., 2000). Strength training

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Table 1. Six weeks' strength training program.

Period	Exercise	Sets/Reps
Week 1 and Week 2	Lunge, Shoulder Shrug, Peck Deck Flye, Military Press, Biceps Curl, Triceps Extension, Wrist Curl, Wrist Extension, Internal Rotation, External Rotation Crunches	2x 15; 3x 12-15 3 x 25–30 crunches
Week 3 and Week 4	Leg Extension/Leg Curl, Lat Pulldown, Bench Flye, Back Press, Hammer Curl, Bench Dip, Wrist Curl, Wrist Extension, Internal Rotation, External Rotation, Lying Leg Raise	3 x 8-10; 3 x 30–50 crunches
Week 5 and Week 6	Squat, Bent Over Row, Bench Press, Upright Row, Reverse Curl, Triceps Pushdown, Wrist Curl, Wrist Extension, Internal Rotation, External Rotation, Lying Knee Raise	3 x 6-8; 3 x 40–60 crunches

Table 2. Medicine ball exercise.

Period	Type of pass	Sets/Reps	Weight of medicine ball	Distance of subjects
Week 1 and 2	Overhead Throw Side Throw Forward Chest Pass	3x15	1 kg.	3 m
Week 3 and 4	Overhead Throw Side Throw Forward Chest Pass	3x15	2 kg.	3 m
Week 5 and 6	Overhead Throw Side Throw Forward Chest Pass	3x15	2 kg.	4 m

activities combination may improve more variables compared to the basketball training alone. Hence, the aim of this study is to evaluate the effects of strength training with plyometric together with basketball training in the physical and basketball specific parameter of physical education and sport science faculty male players.

MATERIALS AND METHODS

Sixteen male physical education and sport science students from the Ataturk University volunteered to participate in this study. They completed the Physical Activity Readiness Questionnaire (PAR-Q) and randomly divided into control group with basketball training (CON; n = 8; age: 18.1 ± 0.8 years; height: 180 ± 2.0 cm) and experimental group consisting of resistance training with plyometrics and basketball training (EXP; n = 8; age: 18.3 ± 1.5 years; height: 179 ± 4.0 cm). Basketball training was executed for 2 h once a week. All the participants signed a written informed consent with testing procedures in agreement for Human Testing. In this study, experimental group performed strength training with plyometrics and basketball training twice a week for 6 weeks. Control group received only basketball training. Both groups received a standardized basketball training program. For experimental group, the strength training program was executed in a circuit manner which consisted of exercises completed for 2-3 sets of 6-15 repetitions. In circuit training, exercises were executed one after the other with minimum rest interval. Rest in between circuits or sets were 1-3 min. A weekly progression of increasing intensity with decreasing volume was facilitated. Table 1 shows the six-week strength training program.

Performance of upper body plyometrics was followed after strength training. Upper body circuit-type plyometrics were performed by using of a medicine ball (1-2 kg). Rest interval was 1-3 min in between circuits or sets. Table 2 indicates the medicine ball exercises in EXP.

Pre and post measures were done 3 days before and after the interposition in experimental and control groups. These included upper body strength, right and left hand grip strength and vertical jump measured inside the strength training facility of the university. On the other hand, fundamental skill tests in basketball were administered at the open basketball grounds of the university.

Repetition maximum (1RM) bench press test

Participants performed a 5-min warm-up and static stretching before the test of 1 RM bench press. They lie down on a bench, with back flat on the surface and the feet flat on the floor. Grip distance was shoulder width apart with arms fully extended. From this starting position, the participants attempted to lower the bar to the chest. After the bar was pushed back until arms return to the starting position. Subjects lifted a 5 kg bar for 10 repetitions as familiarization. Beginning load was 40-60 percent of perceived maximum. Load progression was between 1-3 kg. A 3-5 min rest period was allowed between attempts. This procedure was repeated until the heaviest load in a single repetition was attained. 1 RM load was recorded for analysis.

Hand grip strength

A handheld dynamometer (Jamar Brand Model 5030J1 Lafayette,

IN, USA) was used to measure grip strength. With the participants standing upright and dynamometer held on the extended right hand in line with the forearm, the handle of the dynamometer is then pressed as hard as possible without swinging the arms. Two more trials were performed by using of the right hand. Right hand grip strength measurement was succeeded with left hand grip strength measurement. Intra and inter trial rest interval was 1 min. The best trial for each limb was kept for analysis.

Vertical jump

The Sargent Jump Test was used to determine leg power (Sargent, 1921). With both feet flat on the ground, a participant extends his dominant arm closest to the wall without lifting his feet. The highest fingertip serves as his reference point. The participant then performed a vertical jump with one hand on the hip and the other hand was raised above the head. The participant marked his jump with a chalk after reaching the peak of the jump trial. The difference between the reach height and the jump height represents the vertical jump value of the participant. The best of three trials was recorded as the score of the subjects.

Speed spot shooting

This test aimed to determine the rapid shooting skill from different positions and to some extent, agility and ball handling. Upon the tester's signal, a participant starts to shoot, retrieves the ball and dribbles it to another spot behind any of the five spots set at 457.2 cm. A participant had to make at least one shot from each of the five markers. Two consecutive shots in the same spot were not allowed. Only a maximum of four lay-ups could be attempted. 2 points was scored for a successful shot. An unsuccessful shot hitting the rim or bouncing at the backboard was scored 1 point. No point was awarded for ball handling infractions, 2 consecutive lay-ups and more than 4 lay-ups. 3 trials were administered to a participant with the first trial as practice trial. Each trial lasts for 60 s. A trial is repeated when a participant fails to take a shot in all 5 spots. The sum of the scores, were kept for the 2nd and 3rd trial for analysis.

Control dribble

The Control Dribble test is a test for dribbling efficiency. In this test, a participant was asked to complete a single hand dribble from a specified course as fast as possible right after the given signal. Three trials per limb were performed in this test with the first trial used as practice trial. If a participant commits a dribbling infraction, the test is stopped and the participant performs another trial. The fastest trial was recorded for analysis.

Defensive movement

This test measures basic defensive movement skill in a restricted area. The test started with the participant facing away from the basket. Then a defensive slide was performed to a specified course upon hearing the whistle. A defensive slide had to be executed without crossing the feet. Also, a participant had to touch the floor using the hand to which the direction of the slide was made. A drop step was required for diagonal defensive movement. Three trials were facilitated in this test with the first trial as a familiarization trial. The best time for defensive movement was used for further analysis.

Passing

This test is a combination of speed and accuracy in chest passing. Upon the signal “ready, go”, the participant passed the ball to specified spots using chest pass only from a 243.8 cm distance. A participant was allowed to move while passing the ball. Passing sequence was from A to F and vice versa. Each pass hitting the target corresponded to 2 points. A pass that hit the intervening spaces was equivalent to 1 point. A pass was not scored when executed over the restraining line (243.8 cm). No point was awarded for 2 consecutive passes made on the same spot. Three 30-s trials were administered with the sum of the scores for the last two trials utilized for analysis.

Data were expressed as mean and standard deviation. A two-way repeated measures ANOVA was used to establish significant main effects of time (pre- vs. post) and intervention (control vs. experimental) on performance variables. It was also used to determine significant interaction effects of time and intervention on performance variables. Data were analyzed by using of a commercial statistical package (SPSS version 19, Chicago, USA). Effect size was established using eta squared (η2). Kolmogorov-Smirnov was used to test the normality of data. The level of significance was set at 0.05 for all analyses.

RESULTS

Kolmogorov-Smirnov confirmed normal distribution of data. Pretest and post test scores of performance parameters of the control group and experimental group are presented in Table 3.

RM bench press.

In terms of upper body strength, there was a significant main effect of test time on the 1 RM bench press, $F(1, 6) = 19.3$, partial $\eta 2 = 0.78$. There was no significant main effect of intervention in 1 RM Bench Press. No significant interaction between intervention and test time was observed.

Grip strength

There were no significant main effect and interaction seen from the left hand and right hand grip strength of the subjects.

Vertical jump

As a measure of lower body power, results showed that there was a significant main effect of test time on the vertical jump height, $F(1, 6) = 17.5$, $p < 0.01$, partial $\eta 2 = 0.73$. On the other hand, no significant main effect of intervention was identified. There was no significant interaction between intervention and test time.

Table 3. The mean data of Pre and Post variables for control and experimental groups.

Parameter	Control		Experimental	
	Pre	Post	Pre	Post
1 RM Bench Press (kg)	31.2, 6.2	35.2, 9.1	30.1, 6.4	34.5, 5.3
Handgrip Strength - Right (kg)	40.9, 6.1	41.9, 6.1	39.1, 6.1	40.8, 5.1
Handgrip Strength - Left (kg)	38.2, 9.0	38.8, 8.2	38.2, 6.0	42.4, 3.1
Vertical Jump (cm)	56.1, 4.8	60.9, 6.5	51.1, 6.4	56.7, 3.6
Speed Spot Shooting (pts)	32.1, 9.9	36.6, 7.9	31.9, 6.4	37.1, 5.1
Control Dribble – Right (sec)	21.3, 3.3	18.5, 2.1	19.9, 1.2	19.3, 1.3
Control Dribble – Left (sec)	20.2, 2.1	19.1, 2.2	21.4, 2.2	18.9, 1.6
Defensive Movement (sec)	22.9, 5.1	22.1, 1.1	25.3, 2.5	23.2, 1.6
Passing (pts)	47.4, 2.2	88.7, 15.2	47.8, 2.0	86.6, 14.5

Speed spot shooting

In speed spot shooting, a significant main effect of test time $F(1, 6) = 12.1$ $p < 0.05$, partial $\eta 2 = 0.61$ was identified. There was no significant main effect of intervention as well as interaction between intervention and test time.

Control dribble

There was a main effect of test time on the right-hand control dribble $F(1, 6) = 14.1$, $p < 0.01$, partial $\eta 2 = 0.69$. No significant main effect of intervention and interaction between intervention and test time on right-hand control dribble were posted. For the left-hand dribble, no significant main effect and interaction were noted.

Defensive movement.

The main effect of test time on defensive movement $F(1, 6) = 10.4$, $p < 0.05$, partial $\eta 2 = 0.64$ was found to be significant. On the other hand, no significant main effect of intervention was demonstrated. No significant interaction between intervention and time was distinguished.

Passing

A significant effect of test time on the passing scores was discovered, $F(1, 6) = 99.1$, $p < 0.01$, partial $\eta 2 = 0.92$. No significant main effect of intervention was noticed. However, there was a small but significant main interaction of intervention and test time on the passing skill of the subjects $F(1, 6) = 0.51$, $p < 0.05$, partial $\eta 2 = 0.08$.

DISCUSSION

The aim of the study was to evaluate the effects of six-week strength training and upper body plyometrics on the male basketball players. The results showed significant higher passing scores in control group in compare to the experimental group.

This may be explained by the fatigue experienced by the experimental group from frequency of training. In this study, experimental group participated in 3 times a week physical activity sessions while control group only attended to the training session once a week. So, it may be possible that the experimental group showed a negative net potentiation effect in post activation potentiation (Robbins, 2005). Post activation potentiation (PAP) acknowledges the co-existence of fitness and fatigue with mechanical stimulus. When fitness is greater than fatigue, PAP is achieved and vice versa. Although experimental group may have experienced fitness gains, the recovery time was allowed to indicate transference in passing accuracy may not be enough. This result is partially supported by Ahmed (2013) who posted that fatigue led to negative effects in strength and passing accuracy. Also, Lyons, Al-Nakeeb and Nevill (2006) suggested that novice basketball players tend to experience more detrimental effects in passing after undergoing a fatiguing condition. Another possible mechanism which resulted to control group delivering better scores is its specificity training. Control group focused motor-unit activation patterns specific to basketball, thus creating a faster neural adaptation that requires accuracy (Bompa and Carrera, 2005). The results of the study contradicted the findings by previous researchers which showed improvements in performance from strength training with plyometrics while undergoing basketball training (Andrejic, 2012; Santos and Janeira, 2008; Faigenbaum et al., 2007; Fatouros et al., 2000).

These discrepancies may be attributed mainly to the nature of participants involved in the study. Previous studies included athletes while this study was done by novice participants. Although there was a similarity in the training program of this study with previous studies, the mechanical stimuli may be highly-fatiguing for the

population in the study. This is supported by Wilson et al. (2013) which presented the role of training experience in augmenting the benefits of a conditioning activity via PAP. One interesting finding in this study showed that sport specific training alone improved performance parameters and basketball fundamental skills of the subjects for control group. This implies that practicing specific skills in basketball does not only produce skill efficiency but also increase fitness scores as well (Bompa and Carrera, 2005). Such intervention may be advantageous to novice basketball players to achieve faster skill learning and retention. Although the study identified valuable information in incorporating strength inducing stimuli in basketball physical education, certain limitations should be noted. First, the study is a short-term study which may mask the gains of the intervention for experimental group. Also, generalization should be avoided as the findings of the study are applicable only to the participants. Inclusion of other performance variables that may be helpful in interpreting other aspects of fitness and performance should also be noted. Lastly, additional session for experimental group reduced its applicability in college physical education. Future studies considering the limitations of the current study should be warranted. In conclusion, a six-week strength training and upper body plyometrics produced no significant difference in upper body strength, grip strength, vertical jump, speed shooting and control dribble when compared to a control group. However, the passing score in the experimental group was significantly lower compared to the control group.

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Conflict of Interests

The author has not declared any conflicts of interest.

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