EFFECTS OF A SIX-WEEK STRENGTH TRAINING AND UPPER BODY PLYOMETRICS IN MALE COLLEGE BASKETBALL PHYSICAL EDUCATION STUDENTS

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Abstract

This study investigated the effects of a six-week resistance training with upper body plyometrics in the performance of male college students in a basketball physical education (PE) class. Sixteen males in a novice class in a college basketball PE were randomly assigned into two groups. The experimental group (EXP; age: 17.4 ± 0.74 years; height: 1.66 ± .04 m; weight: 61.3 ± 7.6 kg) performed a combined strength and plyometric training twice a week for six weeks. Also, EXP underwent a once a week basketball training (2 hours) separated from strength with plyometric sessions. The control group (CON; age: 17.8 ± 1.28 years; height: 1.65 ± .03 m; weight: 60.6 ± 8.2 kg) only participated in two hours a week of basketball skills training. Pre-test and post-test upper body strength, grip strength, vertical jump, and American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) battery of tests for basketball were gathered. 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-week strength and upper body plyometrics posted a significantly lower passing score than the control.

Key words: *resistance training, plyometric training, sport-specific training, basketball, physical education*

INTRODUCTION

Basketball is a popular physical activity intervention in college physical education. Such activity has been found by researchers to improve physical fitness parameters as well as psychological health (Sözen, Saç & Kalkan, 2013; Vamvakoudis et al., 2007). A traditional basketball class involves technical and tactical instructions directed towards intraclass or interclass competition.

In the recent decade, the utilization of strength training interventions integrated with basketball training has been receiving notable attention among coaches. One of these interventions is the combination of strength and plyometric exercises in a single session. Andrejić (2012) found out that such strategy demonstrated enhancement in motor performance among youth basketball players. Similarly, Santos and Janeiro (2008) showed significant gains in the squat jump, countermovement jump, Abalakov Test, and medicine ball throw using a similar program. Faigenbaum et al. (2007) discovered significant improvements in strength training with plyometrics in long jump, medicine ball toss, and pro-agility shuttle than strength training alone. Lastly, Fatouros et al. (2000) determined that combination of strength training with plyometrics participants produced greater vertical jump and leg strength when compared with strength and plyometric training groups.

Most of the studies in strength training with plyometrics were conducted in athletes. There seems to be a paucity in literature when using the previous intervention in basketball PE. Incorporating strength training activities may improve more variables than basketball training alone. Thus, the purpose of this study was to examine the effects of strength training with plyometrics together with basketball training in the physical and basketball specific parameter of male college PE students.

METHODS

Participants

Sixteen (n = 16) male physical education students from the University of the Philippines Baguio volunteered to participate in this study. The subjects completed the Physical Activity Readiness Questionnaire (PAR-Q) and were cleared for physical activity participation. They were randomly assigned to a basketball training only group (CON; n = 8; age: 17.4 ± 0.74 years; height: 166 ± 4.0 cm) or experimental group consisting of resistance training with plyometrics and basketball training (EXP; n = 8; age: 17.8 ± 1.28 years; height: 165 ± 3.0 cm). Basketball training was administered once a week for 2 hours (Wednesday). All the participants signed a written informed consent with testing procedures in agreement with the Declaration of Helsinki for Human Testing.

Procedures

In this study, EXP underwent a twice a week (Monday and Friday) strength training with plyometrics and basketball training (Wednesday) for 6 weeks. On the other hand, CON only received basketball training. Both groups received a standardized basketball training program. In EXP, the strength training program is conducted in a circuit manner which consisted of exercises completed for 2-3 sets of 6-15 repetitions. In circuit training, exercises are executed one after the other with minimum rest interval. Rest in between circuits/sets is 1-3 minutes. A weekly progression of increasing intensity with decreasing volume was facilitated. Table 1 presents the six-week strength training program.

Table 1. Six-Week Strength Training Program

Period	Exercise	Sets/Reps
Week 1 &Week 2	Lunge, Shoulder Shrug, Peck Deck Flye, Military Press, Biceps Curl, Triceps Extension, Wrist Curl, Wrist Extension, Internal Rotation, External Rotation	2x 15 3x 12-15
	Crunches	3 x 25–30 crunches
Week 3 &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 &Week6	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

After strength training, performance of upper body plyometrics followed. Upper body circuit-type plyometrics were performed using a medicine ball (1-2 kg). Rest interval was 1-3 minutes in between circuits/sets. Table 2 displays the medicine ball exercises in EXP.

Table 2. Medicine Ball Exercises

Period	Type of Pass	Sets/Reps	Weight of Medicine Ball	Distance of Subjects
Week 1 & 2	Overhead Throw Side Throw Forward Chest Pass	3x15	1kg.	3 meters
Week 3 & 4	Overhead Throw Side Throw Forward Chest Pass	3x15	2kg.	3 meters
Week 5 & 6	Overhead Throw Side Throw Forward Chest Pass	3x15	2kg.	4 meters

Measures

Pre and post measures were gathered 3 days prior and after the interventions in EXP and CON. These include 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.

1 Repetition Maximum (1RM) Bench Press Test. Prior to determining the 1 RM bench press of each subject, a 5-minute warm-up and static stretching were administered In this test, the participants lay on a bench, with back flat on the surface and the feet flat on the floor. Grip distance is shoulder width apart with arms fully extended. From this starting position, the participants attempt to lower the bar to the chest. After, the bar is pushed back until arms return to the starting position. Subjects lifted a 5 kg bar for 10 repetitions as familiarization. Beginning load is 40-60 percent of perceived maximum. Load progression is between 1-3 kg. A 3-5 minute rest period was allowed between attempts. This procedure is 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 using the right hand. Right hand grip strength measurement was succeeded with left hand grip strength measurement. Intra and inter trial rest interval was 1 minute. 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 performs a vertical jump with one hand on the hip and the other hand raised above the head. The participant marks 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.

In the fundamental skills in Basketball, AAHPERD Test Battery was conducted (AAHPERD, 1984). It involved speed shooting, control dribble, defensive movement and passing.

Speed Spot Shooting. This test aims 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 should make at least one shot from each of the five markers. Two consecutive shots in the same spot is not allowed. Only a maximum of four lay-ups can be attempted. 2 points was scored for a successful shot. An unsuccessful shot hitting the rim or bouncing at the backboard is scored 1 point. No point was awarded for ball handling infractions (e.g. double dribble), 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 seconds. A trial is repeated when a participant fails to take a shot in all 5 spots. The sum of the scores for the 2nd and 3rd trial were kept 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 (3) trials per limb were administered in this test with the first trial used as practice trial. If a participant commits a dribbling infraction (e.g. travelling), 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 starts with the participant facing away from the basket. Then a defensive slide is performed to a specified course upon hearing the whistle. A defensive slide should be executed without crossing the feet. Also, a participant should touch the floor using the hand to which the direction of the slide is made. A drop step is required for diagonal defensive movement. Three (3) 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 passes the ball to specified

spots using chest pass only from a 243.8 cm distance. A participant is allowed to move while passing the ball. Passing sequence is from A to F and vice versa. Each pass hitting the target corresponds to 2 points. A pass that hit the intervening spaces is equivalent to 1 point. A pass is not scored when executed over the restraining line (243.8 cm). No point is awarded for 2 consecutive passes made on the same spot. Three 30-second trials were administered with the sum of the scores for the last two trials utilized for analysis.

Statistical Analyses

Data is expressed as mean and standard deviation. A two-way repeated measures ANOVA was utilized 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 was analyzed using a commercial statistical package (SPSS version 19, Chicago, USA). Effect size was established using eta squared ($\eta 2$). 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 the following table:

Table 3. Pre and Post Variables of Control and Experimental Groups (mean, standard deviation)

Parameter	Control		Experimental	
	Pre	Post	Pre	Post
1 RM Bench Press (kg)	30.3, 6.5	34.3, 8.2	29.2, 6.1	33.5, 5.0
Handgrip Strength - Right (kg)	41.4, 6.0	42.0, 6.6	38.8, 6.6	41.2, 5.0
Handgrip Strength - Left (kg)	37.5, 9.3	39.1, 8.0	39.4, 5.7	41.4, 3.3
Vertical Jump (cm)	55.8, 5.1	61.1, 6.3	50.5, 6.7	55.7, 3.8
Speed Spot Shooting (pts)	31.4, 10.3	36.0, 8.0	32.5, 6.3	36.4, 4.9
Control Dribble – Right (sec)	20.3, 3.2	18.2, 1.9	20.1, 1.4	18.7, 1.1
Control Dribble – Left (sec)	19.4, 2.2	18.7, 2.3	20.5, 2.0	19.4, 1.8
Defensive Movement (sec)	24.4, 4.4	21.8, 1.5	24.5, 2.1	22.4, 1.7
Passing (pts)	46.4, 2.3	89.1, 14.9	46.6, 2.2	85.0, 14.0

1 RM Bench Press. In terms of upper body strength, there was a significant main effect of test time on the 1 RM bench press, $F(1, 7) = 19.4$, partial $\eta 2 = 0.74$. 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, $F(1, 7) = 17.4$, $p < 0.01$, partial $\eta 2 = 0.71$. On the other hand, no significant main effect of intervention was identified. There was no significant interaction between intervention and test time.

Speed Spot Shooting. In speed spot shooting, a significant main effect of test time $F(1, 7) = 11.7$ $p < 0.05$, partial $\eta 2 = 0.63$ 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 $F(1, 7) = 13.9$, $p < 0.01$, partial $\eta 2 = 0.67$. 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 $F(1, 7) = 10.3$, $p < 0.05$, partial $\eta 2 = 0.60$ 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, $F(1, 7) = 98.7$, $p < 0.01$, partial $\eta 2 = 0.93$. 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 $F(1, 7) = 0.50$, $p < 0.05$, partial $\eta 2 = 0.07$.

DISCUSSION

The purpose of the study was to determine the effects of a six-week strength training and upper body plyometrics in male college basketball physical education students. Findings showed significant higher passing scores in CON than EXP. This may be explained by the fatigue experienced by the EXP group from frequency of training. In this study, EXP participated in 3 times a week physical activity sessions while CON only attended once a week training session. With this, it may be possible that the EXP group exhibited a negative net potentiation effect in post activation potentiation (PAP) (Robbins, 2005). 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 EXP may have experienced fitness gains, the recovery time allowed to exhibit transference in passing accuracy may not be enough. This result is partially supported by Ahmed (2013) which 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 CON delivering better scores is its specificity training. CON focused motor-unit activation patterns specific to basketball, thus creating a faster neural adaptation that requires accuracy (Bompa & Carrera, 2005).

The results of the study contradicted the findings by previous researchers which demonstrated improvements in performance from strength training with plyometrics while undergoing basketball training (Andrejić, 2012; Santos & 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 were participated 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 in CON. This implies that practicing specific skills in basketball does not only produce skill efficiency but also increase fitness scores as well (Bompa & 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 PE, certain limitations should be noted. First, the study is a short-term study which may mask the gains of the intervention in EXP. 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 in EXP reduced its applicability in college PE. 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 than the control group.

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