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The Effect of Eight Weeks Plyometric Training On Anaerobic Power, Counter Movement Jumping and Isokinetic Strength in 15-18 Years Basketball Players

Niyazi Sıdkı Adigüzel, and Mehmet Günay[a]

[a]Gazi University, Collage of Physical Education and Sport, Ankara, TURKEY

ABSTRACT

The purpose of this study was to investigate the effect of eight weeks plyometric training on anaerobic power, counter movement jumping and isokinetic strength in 15 – 18 years aged basketball players. This study was including 30 male Basketball players. The subjects were divided into two groups as: the experimental group (n=15) and the control group (n=15). The combine training (The plyometric training and techniques – tactics) was performed by the experimental group for eight weeks. The control group was performed only techniques – tactics basketball training for eight weeks. Performance measurement; WAnT anaerobic power test, 60° and 180° s-1 isokinetic leg strength: for right and left legs, multiple jumping and vertical jumping test were performed by the subject pre and post training. Within statistical analysis, the significance of differences between these groups was tested. The arithmetic mean and standard deviation were used as descriptive statistics and Shapiro-Wilk test was used for normality distribution. While comparing paired groups Wilcoxon signed rank test was performed, Mann - Whitney U test was used for comparing independent groups. Statistical significance was taken as 0.05.

According to the result of comparison between groups; It was found that exercise had significantly effect on Peak Power (w/kg), Average Power (w), Average Power (w/kg) and Power Drop (w/kg) in experimental group ($p < 0,05$). While significant difference was found in Right leg 60° Hamstring and Quadriceps peak torch of experimental group ($p < 0,05$), there was no significant difference in pre- and post-training in Isokinetic leg power parameters of control group ($p>0.05$). In addition, significantly differences were found in free jump, 120° Squat jump and Active jump values of Vertical jump parameters for experimental group ($p < 0,05$).

KEYWORDS
Anaerobic power, isokinetic contraction, plyometric training, muscle strength

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CORRESPONDENCE Niyazi Sıdkı Adıgüzel ✉ nsadiguzel38@gmail.com

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Introduction

Basketball is a team sport which has high intensity, repeated in a restricted zone and time and characterized by attack and defence organizations (1,2). In terms of game characterstics, also, as the energy systems used, basketball has complex structures which is especially based on anaerobic and aerobic transitions (3).

Because of the nature of the game, in addition to the fact that it requires endurance the optimal development of muscle power is very important. The lower extremity is especially important in the specific movements such as sprint, jump, pass, shot, changing direction. The determination of the lower extremity power and the preparation of the training programs of the athletes accordingly has very much importance in terms of increasing performance (4). So, a basketball player has to have a highly developed general aerobic and anaerobic resistance. Speed qualities and direction change intervals also must be developed. In terms of power, special jump and shot force, quick power of legs and the body, their persistance of power, mobility and balance of joints are necessary (5,6,7). The perfectness of the movements during the match is based on the trainings done before the match. The more the trainings are carried on within the match conditions, the more appropirate is the performance made with the goal. At this stage what must be the training style is a question to be answered. This question can only be answered with the researches editted purposive (8).

This study aimed to investigate the effect of eigth weeks plyometric training on anaerobic power, counter movement jumping and isokinetik strength in 15 – 18 years aged basketball players..

Material and Methods

Participants

30 healthy sportsmen who have been playing basketball actively for at least 3 years and without a chronic illness, aging between 15 – 18 years participated to the study.

Procedures

Groups in the studies were specified according to the training program. In addition to the technic and tactic basketball training the group which implements plyometric training for 8 weeks 3 days per week is named experimental group and the group which is going to implement only technic and tactic basketball training is named control group. Basketball players, after they fill and sign the volunteer confirmation information form, they were evaluated as subjects. Both of the groups were implemented technic and tactic content basketball training for 3 days a week (10 min. warm up, 50 min. main section, 20 min. cool down). Experimental group players were subjected to plyometric exercises (Table:1) for 8 weeks 3 days a week in addition to technic and tactic basketball trainings. All the players were subjected to Wingate anaerobic power, Isokinetic leg power and Multiple jump test measurement twice both at the beginning and at the end of the training process.

Table 1. 8 - Week Training Program Implemented to the Experimental Group

8 Week Plyometric Training				
DAY	I - V. Weeks	II - VI. Weeks	III - VII. Weeks	IV -VIII. Weeks
Monday - Wednesday - Friday	WARM UP *Lat Slide to Block Jump 3x8 *Lat Drop - Box Jump 3x8 *Lat Box Jump 3x8 *Lat Hop to Block Jump 3x8 *Slide Boards 3x8 COOL DOWN	WARM UP *1 Step Box Jump 3x8 *Block Jump / X-Over / Block Jump 3x8 *Barrier Jump / Block Jump 3x8 *Drop jump / Block Jump 3x8 COOL DOWN	WARM UP *Repeat Lat Jump 3x8 *Lat Pyramid Box 3x8 *Slide Board 3x8 *MB Stand Twist Throw 3x8 *Drop Jump / Lat Box 3x8 COOL DOWN	WARM UP *1 Step Box Jump 3x10 *Approach Jump 3x10 *Box / Drop / Box 3x10 *MB Rotation Throw 3x10 *Repeat Block Jump 3x9 COOL DOWN
	WARM UP *Drop Jump / Block Jump 3x8 *Broad Jump / Block Jump 3x8 *Drop Jump / Barrier Jump 3x8 *Approach Jump 3x8 *Approach Jump 3x8 COOL DOWN	WARM UP *Lat Step / Lat Box Jump 3x8 *Block Jump / X-Over / Wall Jump 3x8 *Lat Barrier to Wall Jump 3x8 *Lat Drop Jump / Block Jump 3x8 COOL DOWN	WARM UP *Drop Jump / Box Jump3x8 *Triple Box Jump 3x8 *Approach Jump 3x8 *MB Forward Twist Throw 3x10 *Repeat Block Jumps 3x9 COOL DOWN	WARM UP *1 Step Box Jump 3x10 *Approach Jump 3x10 *Box / Drop / Box 3x10 *MB Rotation Throw 3x10 *Repeat Block Jump 3x9 COOL DOWN
	WARM UP *Slide to Box Jump 3x8 *Broad Jump / *Lat Slide 3x8 *Lat Hill Slides 3x8 *Slide Boards 3x8 *MB Back 2 Back Pass 3x8 COOL DOWN	WARM UP *Repeat Jumps 3x9 *Pyramid Box Jump 3x8 *Lat Hops 3x8 *MB Rotation Throw 3x8 *Drop Jump / Box Jump 3x8 COOL DOWN	WARM UP *Depth Jump / Lat Box Jump 3x8 *Lat Box Jump 3x8 *Lide to Block Jump 3x9 *MB Off-Center Twist Throw 3x10 *Repeat Lat Box Jump 3x9 COOL DOWN	WARM UP *Crossover Plant Jump 3x6 *Broad jump to Lat Slide 3x6 *Slide Boards 3x8 *Lat Pyramid Box Jump3x5 *Kneeling Twisting Throw 3x8 COOL DOWN

Anthropometric Evaluation

The age of athletes participating to the research was taken according to the identity information.

Body height was assessed with a portable stadiometer (Charder HM-200P Portstad) to the nearest 0.01 m. Body mass (kg) was measured using a Tanita BC-418 MA bioimpedance body analysis (Tanita Corporation, Tokyo, Japan), to the nearest 0.1 kilogram.

Wingate Anaerobic Power

In the determination of anaerobic performance Wintage Anaerobic Power Test (WAnt) was used. This test was created using bicycle ergometer (Monark 894 E). Standard, WAnt including methods were used. WAnt was implemented for 30 sec with the weight which was corresponding to each player's 7.5% of body weight. To help he subjects reach a specific pedal speed, they were required to keep the possible maximum pedal speed first without load (160-170 rpm) and then loaded for 30 sec. and through the test period the subjects were encouraged verbally. At the end of the test maximum power and average power of the subjects were estimated and recorded.

Isokinetic Leg Power

Range of motion (ROM) was determined as between 60^0 and 180^0. According to the prepared training protocol all the subjects' isokinetic right and left leg quadriceps, hamstring and quadriceps hamstring power rates were estimated as 60 degree / 5 repeats at second angular velocity, 180 degree / 20 repeats at second angular velocity with the Isomed 2000 brand named isokinetic dynamometer. The best degrees estimated were recorded as N/m.

Multiple Jumps

Multiple jump measurements of the players participated in the study was implemented with Opto Jump Next brand – model device and they were required to jump with hands on the waist, without bending knees, on toes within 1m area for 30 sec to the highest rate possible and falling on the same area. Vertical jump measurements were implemented with Smart Speed Lite System brand name device, on the jumping mat having Free jump, 120° Squat jump and Active jump measurements.

Statistical Analysis

Data were evaluated within SPSS 21.0 statistics packet program. Whether the data was distributed normally was evaluated with Shapiro-Wilk test. The measurement results were stated as average ($\bar{X}$) and the standard deviation (SS). In the comparisons between the groups while on the dependent groups Wilcoxon test was implemented, on the independent groups Mann Whitney U test was implemented. The level of significance is $p < 0.05$.

Results

Table 2. The comparison of the performance parameters of the Experimental and the Control groups

Variables	Exercise group (n:15)			Control group (n:15)		
	Pre test $\bar{x} \pm SS$	Post test $\bar{x} \pm SS$	%	Pre test $\bar{x} \pm SS$	Post test $\bar{x} \pm SS$	%
Peak Power (w/kg)	9,19±1,69	10,73±1,54[b-c]	16,70	10,13±1,25	10,89±1,58[b]	7,42
Average Power(w)	544,93±89,64	618,31±65,01[b-c]	13,46	571,82±87,33	588,27±83,06[b]	2,87
Average Power(w/kg)	6,92±0,96	7,85±0,87[b-c]	13,33	7,79±0,76	8,07±0,91[b]	3,59
Min Power(w/kg)	4,59±0,66	4,59±0,80	0,17	5,05±0,91	5,29±1,08[b]	4,82
Power Drop (w/kg)	4,96±2,22	6,31±1,89[b-c]	27,21	5,08±1,05	5,39±1,36	6

a- The significant difference before the exercise. ($p<0,05$)

b - the significant difference after the exercise ($p<0,05$)

c - The significant difference between experimental and control groups ($p<0,05$)

As a result of in group comparisons of the rises in the anaerobic power parameters of experimental and control groups subjects a significant difference was observed on the both groups' after exercise Peak power (w7kg), Average power (w), Average power (w/kg) parameters. Besides, a significant difference was observed in Power drop (w/kg) parameters of experimental group subjects and after exercise Min Power (w/kg) parameters of control groups.

When the rises in the anaerobic power parameters of experimental groups are compared with the control group a significant difference was observed in favor of the experimental group in the Peak Power (U=55.5) Average Power (w) (U=50), Average Power (w/k) (U=55), and Power Drop (U=55.5) parameters ($p<0.05$). However, no significant difference was observed in the Min Power (w/kg) (U=81) points of the subjects participating in the study ($p>0.05$).

As a result of the rises in Isokinetic Leg Power of the experimental and control groups after the exercise a significant change was observed in 60° Right (H) Peak Power, 60° Left (Q) Peak Power, 60° Right (R) and 60° Left (R) parameters ($p<0,05$). Besides, a significant difference was also seen in the after exercise 180° Right (H) Peak Power, 180° Left (H) Peak Power and 180° Right (Q) Peak Power parameters of the experimental group.

When the rises in Isokinetic Leg Power parameters of the experimental group compared with that of control group a significant difference was observed in 60° Right (H) Peak Power (U=55.5), 60° Right (Q) Peak Power (U=44.5), 180° Right (H) Peak Power (U=41.5) and 180° Right (Q) Peak Power (U=61.5) parameters in favor of the experimental group ($p<0,05$).

However, no significant difference was observed in 60° Left (H) Peak Power (U=88.5), 60° Left (Q) Peak Power (U=81), 60° Right Ratio (U=85.5), 60° Left Ratio (U=111), 180° Left (H) Peak Power (U=73.5), 180° Left (Q) Peak Power (U=75.5) ,180° Right Ratio (U=83.5) and 180° Left Ratio (U=109) points of the subjects participated in the study.

As a result of the within-group comparison of the rise in the multiple bounce and vertical jump parameters o of the experimental and the control groups a significant difference was observed in after exercise Free Jump, 120 Squat jump and Active Jump parameters. Moreover, a significant difference was observed in T-Contact parameters of control group subjects after the exercise.

When the rise in anaerobic power parameters of the experimental groups are compared with that of the control group a significant difference was observed in Free Jump (U=35), 120 Squat jump (U=36) and Active Jump (U=50) parameters in favor of the experimental group ($p<0,05$). However, no significant difference was observed in T-flight (U=95), T-contact (U=73), Height (U=92.5), Power (U=90.5) points of the subjects participated in the study ($p>0,05$).

Discussion

Within this study in which it is aimed to research the relationship among the anaerobic capacity, isokinetic muscle power and vertical jump height of young male basketball players the data gained is evaluated by relating it to the literature.

In a study Bogdanis G. and his friends carried out on 27 young basketball players a significant rise was observed in peak power (w/kg) and average power (w/kg) rates of anaerobic power parameters after the exercise in experimental

groups when compared to the control group [9]. Orhan S., Sağıroğlu İ. and his friends in a study they carried on to observe the effect of plyometric exercise done at two different exercise frequency on anaerobic performance within the competition period they also gained the results supporting this study [10-11]. The results of a similar study Siegler J and his friends, Fatouros G. and his friends, Humberto M. and his friends carried out on young basketball players support this study (Table 2) [12-13-14].

Table 3. The comparison of the Right and Left Leg Isokinetic Power Measures of the Experimental and Control Groups

Variables	Exercise group (n:15)			Control group (n:15)		
	Pre test $\bar{x} \pm SS$	Post test $\bar{x} \pm SS$	%	Pre test $\bar{x} \pm SS$	Post test $\bar{x} \pm SS$	%
60° Right (H) Peak Power	144,70±30,05	164,91±31,73[b-c]	13,9	147,98±22,18	168,34±34,01[b]	13,7
60° Left (H) Peak Power	123,12±20,98	125,36±26,12	1,8	123,50±16,24	129,76±24,41	5,0
60° Right (Q) Peak Power	244,24±49,70	251,89±56,76[c]	3,1	243,79±46,10	246,15±45,37	0,9
60° Left (Q) Peak Power	212,50±18,97	183,68±23,09[b]	-13,5	201,52±23,14	191,69±16,84[b]	-4,8
60° Right (R)	59,86±9.17	67,40±6,62 [b]	12,5	61,26±7.11	67,26±7,13[b]	9,7
60° Left (R)	58,40±10,80	69,46±15,56[b]	18,9	61,40±5,28	68±11,49[b]	10,7
180° Right (H) Peak Power	139,72±26,09	154,64±28,22 [b-c]	10,6	144,22±26,49	153,73±30,98	6,5
180° Left (H) Peak Power	122,85±19,06	132,63±21,91[b]	7,3	128,10±14,36	127,06±21,04	-0,8
180° Right (Q) Peak Power	206,09±30,15	238,29±61,22[b-c]	15,6	134,22±26,49	143,73±30,98	6,5
180° Left (Q) Peak Power	193,67±24,67	187,60±36,92	-3,1	133,10±14,36	123,06±21,04	-7,5
180° Right (R)	70,26±9,82	66,06±10,29	-5,9	71,66±11,70	70,66±7,88	-1,3
180° Left (R)	69,86±14,95	67,93±18,71	-2,7	70,53±10,23	69±9,05	-2,1

a. The significant difference before exercise ($p<0,05$)
b. The significant difference after exercise ($p<0,05$)
c. The significant difference between the experimental and control groups ($p<0,05$)

Table 4. Comparison of multiple bounce and vertical jump parameters of the experimental and control groups

Variables	Exercise group (n:15)			Control group (n:15)		
	Pre test $\bar{X}$ ±SS	Post test $\bar{X}$ ±SS	%	Pre test $\bar{X}$ ±SS	Post test $\bar{X}$ ±SS	%
T - Flight (sec)	0,41±0,04	0,43±0,05	4,64	0,38±0,04	0,38±0,05	2,27
T - Contact (sec)	0,22±0,03	0,22±0,02	0	0,22±0,03	0,21±0,04[b]	-4,36
Height (cm)	21,59±5,11	21,30±7,75	-1,33	18,24±4,56	17,18±6,44	-5,80
Power (Watt)	29,66±6,91	31,44±8,06	6,01	25,66±5,71	26,73±7,88	4,15
Free Jump (cm)	39,94±7,02	43,34±7,18[b-c]	8,51	37,08±6,21	38,85±6,44[b]	4,77
120° Squat Jump (cm)	31,95±3,59	36,11±4,63[b-c]	13,03	30,05±6,72	31,67±6,79[b]	5,40
Active Jump (cm)	34,60±4,77	37,61±5,55[b-c]	8,72	31,78±5,49	33,12±5,51[b]	4,22

a. The significant difference before the exercise ($p<0,05$)
b. The significant difference after the exercise within group (pz0,05)
c. The significant difference between the experimental group and control group ($p<0,05$)

Accordingly, it can be said the regular trainings, the intensity of and sports activities made an increase in players' anaerobic performances based on time.

Matavulj and his friends found out that after plyometric trainings the rate of force development of hip extensors and knee extensors developed of the age group of 15-16 years [12]. Toumi and his friends in a study they carried out on 22 male handball players aging 17-24 and making plyometric training, they stated the increase of maximal isometric force and maximal concentric force [15].

When we look into literature is obvious that plyometric training have positive effects on leg power. The isokinetic leg power rates gained and observed in our researches coincides with other studies and researches done before.

Akkoyunlu Y. and his friends in a study carried on 33 male subjects for 8 weeks to look into the effect of squat exercises carried out at different positions on flexion and extension force development they classified the subjects into 3 groups and they carried out full squat exercise on the first group, and half squat exercise on the second group and they did not carry out any exercise on the third group. At the end of the study significant difference was found in right and left leg 180° Hamstring and Quadriceps top torque (Nm) rates before and after the training. When before and after exercise the right and left leg 180° Hamstring and Quadriceps parameters of experimental and control groups are compared a significant difference in favor of the experimental groups was found. In this study while the right and left leg 180° Hamstring and Quadriceps top torque (Nm) rates are similar to those of our study, in other parameters opposite results to our study (Table 3) were found [16].

It was observed that there was a significant rise in favor of the last tests in the right and left leg 60° H/Q muscle force of experimental group subjects. The H/Q rates gained at the end of the study and the literature examples have similar rates. Kannus and his friends pointed out that in the studies they carried out H/Q rates varied about between 0.31 – 0.80. besides, Orchand and his friends pointed out that H/Q rates must be at least 0.60 [17,18].

Mjolsnes and his friends in a research they carried on male players after eccentric hamstring training of 10 weeks they observed a significant difference in H/Q rates of the players in favor of the last tests. Research findings (Table 3) have parallel results with the literature findings. In this context, plyometric trainings which are carried out regularly can have positive effects on the H/Q rates of the players [19].

It was observed that the rates gained from the measurements of Multiple (Repeated) Jump parameters, although there was not a significant difference in T-Flight (sn), T-Contact (sn), Height (cm) and Power (watt) points of the subjects participated in the study, had a positive contribution in all the parameters of the both of the groups.

Miyaguchi A.and his friends couldn't find a significant difference in T-flight and T-contact periods of players as a result of the different jump trainings they carried on players from different branches. However, it was observed that the trainings made had a positive effect on the jumping abilities of the players [20].

In a study in which the effect of short time plyometric trainings in the season on jumping and skill performances was researched on 20 participants at the end of a 6-week plyometric training vertical jump skills were evaluated. At the end of the study it was stated that there was a dramatic rise in vertical jumping skills of

experimental group players on whom plyometric trainings were carried out when compared with the control group [21]. In a study in which Arazi H. and his friends carried on young basketball players within 3 groups as water plyometric, land plyometric and control groups for 8 weeks it was stated that vertical jump performances of plyometric trainings carried out on the land dramatically increased in this study too (Tablo 4) when compared to the control group [22-23].

The rates (values) gained in this study are similar with the data given in the literature. In the study carried out it can be stated that the development of anaerobic power of the experimental group when compared to the control group is based on the carrying out the jumps in a very short time as an explosive in the plyometric trainings which were made and accordingly the development of explosive power and explosive quality.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Niyazi Sıdkı Adigüze is a PhD student at Gazi Universty, Collage of Physical Education and Sport, Ankara, Turkey.

Mehmet Günay holds a PhD in physical education and now is professor at Gazi Universty, Collage of Physical Education and Sport, Ankara, Turkey.

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