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The Effects of Plyometric Trainings on Agility Performances in Male Basketball Players

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ABSTRACT

The aim of this study was to investigate the effect of plyometric training on agility performance in male basketball players. Isparta Municipality Sports Club Basketball League Team participated in the study voluntarily with 24 people. Basketball players were randomly divided into two groups as normal training group (n = 12) and plyometric training group (n = 12). While the regular training group continued routine training, the other group received plyometric trainings in addition to routine trainings for 8 weeks, 3 days a week, at least 30 minutes a day. "T-Drill Test" was used to determine agility in both groups as at the beginning of the training period "pre-test" and "post-test" at the end. Data were analyzed by using statistical package program. Descriptive statistics were used for demographic information and "Paired t test" and "Independent t Test" were used for comparisons. Results were evaluated according to significance level of "0.05".There was no significant difference in Paired and Independent t Test results ($p > 0.05$). As a result, the reason for the lack of effect of plyometric training applied to male basketball players is that the athletes are able to reach maximum strength even in the pre-tests due to the practice of the training in the preparatory season, the minimal changes in the motor abilities of the athletes in the final tests and the frequency and duration of the plyometric trainings. It is recommended to increase the objectivity by considering these issues in future researches.

1. Introduction

The characteristic structure of basketball requires to reach the top performance. The validity, reliability and accuracy in all options brings a significant success. The selection of talented and athletic players in basketball at a young age, and the discovery of basketball players superior to their age mates as a result of physical-physiological tests, have increased the quality in basketball. Supporting athletes and sportsmen working with science; talent selection, proper nutrition, proper training methods, appropriate annual planning, the establishment of the necessary facilities, environment and financial opportunities have significant impact on success (1). Especially in the training programs to be applied to athletes, a careful work plan should be implemented considering many variables (2). As it is known, players perform many movements and short distance runs during a basketball competition. By increasing the tempo of the match constantly, by pressing the opponent team with immediate and fast attacks, basketball players aim to win through. In addition, they have to be successful in defense with the same basis (3).

Regarding the ability of a basketball player, one of the first things that viewers comment on is the speed and quickness of a player's breathing. When an attacker quickly pass through the defense, it arouses excitement for

viewers. Or, when a defensive player press the ball holder, the fans can suddenly comment how fast the athlete is. Speed and quickness are the dominant qualities of a basketball player's athletic ability. In basketball, maximum speed can never be reached during the game and repeated short-speed runs are more general (4).

In basketball game, motoric and anthropometric features play an important role in achieving sportive success. The primary motoric properties for basketball are strength, speed, flexibility, explosive and endurance. In terms of anthropometric characteristics, the length of the basketball players has an important role in team success. Therefore, it is possible to predict future success by making scientific measurements about the length of the players. (5). As a branch of basketball, it is a sport that requires a high level of biomotoric properties. In terms of energy systems, it is an activity that; - requires a coherence between the timing and force of anaerobic power and hence the rapidity that elicits explosive and force, - strengthens the general athletic position with vertical jump, balance and skill combined with timing rhythm and speed,- help to implement technical movements more easily and smoothly with these features. In order to ensure the perfect movements during the realization of the performance, the previous history of training is very important. If the training is at the competition level, the resulting performance will be as appropriate for that purpose. The diversity of the trainings performed in this period can be provided with good and high quality plans and programs (6). It is obvious that biomotoric and physiological qualities and technical and tactical parameters are of significance in order to be successful (7).

In basketball, which has a game structure with high intensity movements such as fast attack, deflection movements, deflection runs and jumps are performed continuously. It is important that players are able to practice the movements frequently used in basketball in agile and quick way. When evaluated in this way, it can be said that agility is important for basketball players. Various field tests are performed to determine the agility ability of athletes in basketball. It is seen that the tests performed to determine the agility characteristics of the athletes involve the sudden direction changes which are the characteristic movements of basketball (8).

In the light of these information, the aim of our study was to investigate the effect of plyometric training on agility performance in male basketball players.

2. Materials and Methods

2.1. Participants

Süleyman Demirel University Men's Basketball League Team participated to the study voluntarily with 24 athletes. Players were randomly divided into two groups as normal training (NT, n = 12) and plyometric training group (PT, n = 12).The mean age of the athletes was calculated as NT 21.16 ± 1.94, PT 20.16 ± 1.47 years; the mean length was as NT 1.86 ± .10, PT 1.88 ± .08 m; the mean weight was as NT 82.50 ± 11.62, PT 81.50 ± 19.71 kg; the mean body mass index (BMI) was as NT 23.58 ± 1.64, PT was calculated as 22.67 ± 3.77 kg / m^2. The groups were informed before the study and “Informed Consent Form” was obtained from each of them and their participation was ensured. We applied the principles outlined in the Declaration of Helsinki.

2.2. Measurements

Measurement of Height

The height of the athletes was measured with a “Holtain” stadiometer with a sensitivity of 0.1 mm. The athletes were measured in anatomical posture, bare feet, heels combined, head frontal plane, head position above the vertex point and the values were recorded as “cm”.

Measurement of Weight

Athletes' weights were measured with "Seca" electronic scales with a sensitivity of 0.1 kg. Players wore only shorts, bare feet and with anatomical posture position. Values were recorded as "kg".

Measurement of BMI

BMI was calculated by the athletes were proportioned according to their body weight and height with a certain mathematical calculation. BMI was calculated with the formula of: *Body weight (kg) / Height^2 (m^2)*

Measurement of Agility (T-Drill Test)

After 5-6 min of free warming, the subjects had tried the test at low speed, and then randomly entered the test. The length and width of the T-drill test track were 9.14 m. The course was formed by placing the 3rd and 4th cones in the vertical direction on the right and left sides of a cone which was put forward 9.14 m in the vertical direction from the starting point. After the athletes start the test, they run in a straight run from the starting cone and touch the second cone 9.14 m away. Player then goes to the left side cone at 4.57 m distance and touches it with the left hand in side runs, and goes to the right side cone at 4.57 m distance from the middle cone with side runs and touches it with the right hand. Finally, after going to the cone at the midpoint with the side run and touching it with the left hand, it runs back to the starting cone and ends the test.

2.3. Procedure

As the NT group continued routine trainings, the PT group received plyometric trainings in addition to routine trainings for 8 weeks, 3 days a week, at least 30 minutes a day. "T-Drill test" was used to determine agility in both groups at the beginning of the training period as "pre-test" and "post-test" at the end.

2.4. Statistical Analysis

Analysis of the data was carried out by using statistical package program. Descriptive statistics were used to determine the mean, standard deviation values of the groups. Paired Samples T Test was used to test the difference between pretest and posttest values of the groups, and Independent Samples T Test was used for comparisons between groups. The results were evaluated according to significance level of "0.05".

3. Results

Table 1. Descriptive statistics of groups

Variables	Group	x	SD
Age (years)	NT	21.16	1.94
	PT	20.16	1.47
Height (m)	NT	1.86	.10
	PT	1.88	.08
Weight (kg)	NT	82.5	11.62
	PT	81.5	19.71
BMI (kg/m^2)	NT	23.58	1.64

	PT	22.67	3.77

Table 2. Paired t Test results of groups' agility tests

Test	T-Drill	Test Sequence	x±SD	t	p
	NT	Pre-test	11.10±.73	2.23	.076
		Post-test	10.82±.68		
	PT	Pre-test	11.49±.71	2.39	.062
		Post-test	11.35±.74		

Table 2 shows the Paired t Test results of groups' agility tests. So differences were not found significant in both NT and PT groups' pre and post-test values ($p>0.05$).

Table 3. Independent t Test results of groups

	Groups	Test Sequence	x±SD	t	p
	NT	Pre-test	11.10±.73	-.93	.797
	PT		11.49±.71	-.93	
	NT	Post-test	10.8±.68	-1.29	.771
	PT		11.35±.74	-1.29	

Table 3 shows the Independent t Test results between groups. So there were not found differences in comparison results between groups ($p>0.05$).

4. Discussion and Conclusion

This study was conducted to investigate the effect of plyometric trainings on agility in male basketball players. There were not found differences in both t Test results within and between groups ($p>0.05$). This could be said that the reason for the lack of effect of plyometric trainings during the preparation season, reaching maximum strength even in the pre-test, minimal changes in the last tests because of the athletes gained in motor abilities and the frequency and duration of plyometric trainings.

Pauole et al. (2000) reported that the T test is a good way to follow the development of speed, force and power combinations. Çakır (2016) did not receive any difference as a result of the t-test he applied to handball players. The reasons for this are the shortcomings that will affect the results of the evaluation tests in this study, and some are listed as follows. Firstly, in order to evaluate objectively the effect of plyometric training program, a professional team was divided into two to form control and plyometric groups, and the number of subjects was low, which could affect the reliability of the results. Instead, it is recommended that we plan a study on the players of the two teams that have the same plyometric applications with similar anthropometric properties. Secondly, due to the fact that the plyometric training program was conducted during the season, factors such as the fact that the athletes had reached almost maximum force in the pre-tests, the final tests carried out towards the end of the season and the tiredness of the

athletes as a result of the successive competitions may have prevented objectivity in the evaluation of the data.

Atılan (2010) stated that, besides the positive effects of plyometric training on leap and quickness-agility abilities, with keeping the amortization phase short during running, because it provides running economy, it has positive effects on running coordination, and therefore, due to its positive effects in running speed, positive effects that may reveal. In our thesis study which the effects of different strength training on the quickness and jump ability of children playing basketball in the 12-14 age group is investigated ,independent samples t test was applied to both groups and Mann Whitney U test was applied to support this test. Based on the findings, the pretest values of both groups were compared. According to the results of CMJ, SJ, DUA, T 'test and Illinois test with and without ball, there was no significant difference between A and B groups according to 0.05 error margin. As a result of the comparison of the posttest values of both groups, it was found that according to the results of CMJ, SJ, DUA, T test and Illinois tests with and without ball , similarly, there was no significant difference between A and B groups with respect to 0.05 error margin.

In the study of Çağlayan et al. (2018), During this 10-week period, improvements in agility and leg strength of the athletes in the study group were also observed, but these improvements were not statistically significant ($p > 0.05$).In the control group and the athletes who continue their traditional training, no statistically significant change was found in any parameters in the pre-posttests. The fact that there was no difference in the pre-tests of the groups could be an important factor for the reliability of the study. As a result of the measurements made in the last tests, when the two groups were compared again, a statistically significant improvement was found in favor of the athletes in the Study group in the vertical jump test. As a result, it was seen that the training program consisting of eccentric and concentric contractions had an effect on vertical jump which is an indicator of explosive strength .Longer training programs should be designed for the development of leg strength and agility.

In another study conducted by Özdemir (2009), the effects of 8-week complex training program on explosive power, strength, agility and speed in males of 14-16 age group of Maltepe Sports Club football players were investigated. Of the 28 players participating in the study, 14 of them were from training group and 14 of them were from control group. Generally the first test results of the groups (training group, 10 m sprint: 1.77 sec, 30 m sprint: 4.37 sec, t test: 11.07 sec), (control group, standing 10 m sprint: 1.79 sec , 30 m sprint: 4.49 sec, t test: 11.13 sec), with the final test results (training group, standing 10 m sprint: 1.40 sec, 30 m sprint: 4.11 sec, t test: 10 (39 sec), control group, 10 m sprint: 1.85 sec, 30 m sprint: 4.61 sec, t test: 11.35 sec) while it is evaluated, it is seen that the training group significantly increased in the last 41 tests. When we look at the relationship between the first tests of the study and control groups, no significant difference appears. This is thought to be due to the same level of demographic and strength, explosive power, agility and speed characteristics of football players.

In a study conducted by Tillaar et al. (2015) on 26 adolescent female and male handball players, half of the group applied squat training program and the other half applied plyometric training program twice a week in addition to the team's other training program. At 6 weeks, both groups had agility (t-test), 30 m sprint, yoyo tests, but no difference in CMJ (arm swing), strength test and heart rate. In this study, the PA program was prepared only for the lower extremity, and no additional program was applied to the upper extremity. The reason why there was no change in the jump height after the PA program was that the 6-week training period was short, that handball players already had jump exercises in their training programs, and that increasing the number of jumps could not make a significant difference on the handball players in the team and therefore significant difference in CMJ test. They stated that there was no increase in the level.

Miller et al. (2006) found a significant increase in the agility and balance assessments in favor of the plyometric group at the end of T-drill test, Illionis agility test and strength platform evaluations as a result of the plyometric training program applied twice a week for 6 weeks.

Usgu (2016). According to the results of the study, it was accepted that the effects of vibration-guided plyometric training on physical speed, strength, speed, agility, flexibility and balance were different from vibration-free plyometric training. After 6 weeks of plyometric training, there was a significant increase in all parameters examined in both groups, but the improvement in the vibration-guided plyometric training group was significantly higher in all parameters except posterior HDT balance test values than in the study group. In this study, it was observed that the plyometric education group with vibration accompanied a reduction of 3.12% in the agility test times and improved their agility by completing the T test in a shorter time, while the control group provided a decrease of only 1.43%.

In a study conducted by Asadi (2013) on the effects of 6-week plyometric training on agility and strength parameters on 20 basketball players, the effects of vertical jump, horizontal jump and deep jump (from 45 cm box) exercises were evaluated by T test and Illinois test. At the end of the study, it was found that the T-test duration of the education group decreased by 8.6% and the Illinois test duration decreased by 7.1% and agility was increased. The results of this study showed that agility was increased in athletes with plyometric training in parallel with Asadi's study.

Pamuk and Özkaya (2017), there was a statistically significant difference in the agility values of the first and last measurements of the study groups and in the second measurements compared to the first measurements in all three groups. According to statistical analysis between groups, the increase in plyometric training was higher than that of control group.

In another study of Vaczi et al. (2013) that lasted for 6 weeks, the effects of high intensity plyometric training on agility strength and strength performance were examined, and an increase in agility performance, depth jump height and maximal strength of athletes were noted.

In their study, Rameshkannan and Chittibabu (2014) studied the 8-week plyometric training program that they performed twice a week with 30 male handball players. In the plyometric trainings, T-Drill Test results of this set, which was divided into 15 PG and 15 CG, PG pre-test was 12.21 ± 0.34 sec and post-test was 11.61 ± 0.52 sec, and CG pretest was 12.10 ± 0.17 sec and the final test was found to be 12.10 ± 0.18 sec.

Erdoğan et al. (2014) applied 8 weeks of plyometric trainings (30-40 min) twice a week to 13 girls and 7 boys with a mean age of 20 at Physical Education and Sports School. With this application, students examined anaerobic power, flexibility, speed, agility and aerobic values. As a result of the evaluations made after the pre-test and post-test, performance parameters were increased. Here, the speed and agility similar to our study differ from the test results. Suna et al. (2016) reported in their study that trainings had minimal positive effects of agility performances of athletes.

Atacan (2010) in his study of 8-week plyometric training to find the effect of agility in Illinois agility test; While the test results of the athletes in the experimental group were 17.13 ± 0.48 sec before the training, this value was found to be 15.95 ± 0.50 sec with an increase of 6.88% after the training. On the other hand, the pre-training values of the control group were 17.43 ± 0.50 sec, after the training it was found to be 17.08 ± 0.47 sec with a 2% increase. As a result of the analysis, a statistically significant difference was found between the pretest and posttest agility scores of the experimental group. However, the increase in the experimental group was about 5% higher. This

increase in the experimental group was evaluated as an indicator of the positive effect of plyometric training applied with normal football training program. Significant differences were found between the experimental and control groups in Illinois agility test.

As a result, the reason for the lack of effect of plyometric training applied to male basketball players is that the athletes are able to reach maximum strength even in the pre-tests due to the practice of the training in the preparatory season, the minimal changes in the motor abilities of the athletes in the final tests and the frequency and duration of the plyometric trainings. It is recommended to increase the objectivity by considering these issues in future researches.

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