

The Effect of Plyometric Exercises Use on the Physical and Skillful Performance of Basketball Players

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Abstract: This study aimed to identify the effectiveness of plyometric exercises on the special physical abilities and skillful performance of basketball players. It was applied to a sample of 20 players of 16 years old from El-Shoban El-Muslmeen club in Port Said. They were divided into two equivalent groups (experimental and control) of 10 players each. The experimental group applied the plyometric exercises and the control group applied the usual program. The program was applied for 12 weeks with 3 training units at 120 minutes for each unit. Through the training unit, the exercises were united between the two groups except for the part of the special physical preparation. The experimental group performed the plyometric exercises while the control group performed the physical exercise. Then, the scientific coefficients were applied to tests using a sample outside the study sample. The scientific coefficients of constancy were between 0.764 and 0.970 and the reliability was between 0.903 and 984. The results pointed to a significant progress in the improvement percentages for the experimental group in all study tests compared to the improvement percentages of the control group, which were respectively: tests of vertical jump at 27.01%, medicine ball push (3 kg) at 20.14%, running 30m x 5n at 1.62% and shuttle running at 7.53%, which led to an improvement in the skillful performance (passing at 13.62%, dribbling at 13.46% , under-basket shooting at 18.58% and lay-up at 57.97%).

Key words: Plyometric exercises % Physical % Skillful performance % Basketball

INTRODUCTION

Basketball is one of the sports characterized by many of the basic and variable skills. The basketball player perfection to do such skills, defensive or offensive, needs development in the physical qualities of the basketball player, which enables him to do the required duties throughout the match. Special physical preparation in basketball is the main pillar for the players to carry out the special requirements (physical, skillful and tactical). Without these requirements, the player cannot achieve the objectives set up for the training or competition. Physical adaptation of the player to perform the sport activities is one of the practical functions of the training which improve the training of the player to reach to higher levels in the sport activities [1]. The skillful performance is relevantly associated with the special physical motor abilities as the perfection of the skillful performance depends on the range of the development of the special physical abilities to perform such requirements, such as

muscular power, endurance, agility and others. The skillful performance is often measured by the level of the player to acquire physical abilities [2].

In the field of training, there is a new technique emerged similar to the nature of performing basketball skills by developing the ability of vertical jump, which called plyometric as it includes stretching muscles (while you perform it) followed by a direct fast muscle contraction. The tension resulted from using the plyometric training is higher than the tension resulted from using other types of training, such as the static and dynamic contraction [3]. The central muscle contraction occurred at the moment of take off becomes stronger if it is preceded by non-central muscle contraction as this kind of contraction occurs at the moment of landing the take off foot to do the next taking off while a muscle contraction by stretching occurred (non-central) [4]. The main goal of plyometric training is to transform the energy that depends on the flexibility resulted from the body and gravity throughout muscle contraction by

stretching to an equivalent force in quantity and contrary in the direction throughout muscle contraction by shortening [5]. Despite using the plyometric training in a lot of exercises, all of them depend on the theory of using rapid and strong resistance, which leads to muscles' rubbery, then muscles' shortening to overcome this resistance. This training is used for carrying out jumping, hopping, steps and different moves of trunk rotation, taking into account that the performance should be at the possible high level of speed and power. The plyometric training affects both the muscles and nervous system. It is practically and generally useful for the performance and depends on the work of sense and motive organs in muscle and tendon [6]. Throughout this presentation, the author noticed that the explosive power represented in performing special basic skills using power, speed and perfection during the competition has an effective and vital role in increasing the level of all skills performed in the match in addition to the experience of the author in training the beginners' teams and university team, the matter that makes the explosive power in the present study as the problem requiring a solution. The importance of this study lies in demonstrating an important aspect of special preparation and training for the competition as through the matches' results, we can see the failure of a number of players in passing, dribbling and shooting during the matches: the matter that enables the author to determine the problems of that study as a scientific attempt directed to study the effect of using the plyometric training on developing the special physical abilities and the skillful performance of the basketball players.

Study Objectives:

- C To identify the effect of using plyometric exercises on the special physical abilities of basketball players.
- C To identify the effect of using plyometric exercises on the skillful performance level of basketball players.

Study Hypotheses:

- C There would be statistically significant differences between both pre- and post- tests of the control group in the study variables in favor of the post-test.
- C There would be statistically significant differences between both pre- and post- tests of the experimental group in the study variables in favor of the post-test.
- C There would be statistically significant differences

between both experimental group and control group in the post-test of the study variables in favor of the experimental group.

Abdel-Aziz [7] conducted a study aimed to identify the effect of a training program of muscles fitness and power fitness on the growth rates of physical qualities and basic skills of basketball on a sample of 17 players under the age of 17 years old. The author used the experimental method where the most important results were that the proposed training program led to the development of the muscles fitness and power fitness and improvement of the basic skills of basketball. Tammam [8] conducted a study aimed to identify the effect of a training program by using plyometric training on the development of muscular power and the level of performance of the shooting during basketball players jumping on a sample of 12 players under the age of 18 years old. The author used the proposed experimental method, while the main results show that the proposed training program leads to the development of maximum power and muscular power all over the body and also improves the performance of shooting through jumping. Bilal [9] conducted a study aimed to know the effect of electro plyometric training on developing the explosive power of the two legs and its relation to the performance of the players to some basic principles in basketball. The sample included 20 players under the age of 20 years old. The author used the experimental approach which leads to the most important results for the development of the explosive power of the muscles of the legs and improvement some basic skills (speed - accurate shooting through jumping and the speed of dribbling) in basketball. Bakhit [10] conducted a study aimed to know the effect of adapting the plyometric training with the skills of the muscular power of the legs and the skill of shooting of the basketball players on a sample of 16 players under the age of 18 years old. The author used the experimental approach which resulted in the most important results show that the plyometric exercise leads to improve the ability of the legs' muscles while adapting the plyometric exercise with the direction of shooting skills leads to the improvement of the shooting rate.

Vallabhajosula *et al.* [11] conducted a study aimed to identify the kinematic differences of the part during the performance of plyometric exercise by multi-weight medical balls on a sample of 59 beginners. The descriptive methods (Mechanical analysis) have been used. The most important results were that performing the successive

chest pass 10 times by medical balls leads to the improvement of throwing angle associated with an indication, despite an increase of the weight of the ball. The increase of the weight of the medical balls should be taken into consideration during performing the plyometric exercise. Ashley *et al.* [12] conducted a study aiming to identify the effect of the plyometric training, Speed training and agility training on the thigh muscles, linear speed, agility and airless capability on a sample of 43 players. The authors used the experimental methods as the results show the superiority of the plyometric training in speed and agility during the training of the skills. Kotzamanidis [13] conducted a study aiming to identify the effect of the plyometric training on the running speed and vertical jumping for the beginners on a sample of 30 players divided to two groups. The author used the experimental method as the results show the improvement of the experimental group in the vertical jumping and running, especially, in the 30-m distance. Markovic *et al.* [14] conducted a study aiming to identify the effect of plyometric training on the work of the muscle and sport performance on a sample of 93 players divided to three groups. The author used the experimental method as the results show the improvement of the plyometric group in the tests of broad jumping, running a speed of 20 m and shuttle running of 30 m.

MATERIALS AND METHODS

The author used the experimental method and applied the experimental approach on two groups: one of them is experimental and the other is the control. The sample has been selected by the purposive method containing 20 players of El-Shoban El-Muslmeeen club in Port Said with ages under 16 years old. They have been divided to two equal groups (10 players in each group): one of them performed the plyometric training and the other is the control performed the normal program. plyometric training (operational definition) are exercises performed using a technique of muscular reflex designed to reduce the time between decentralized contraction and central contraction and benefit from it to generate the greatest force in the shortest time possible. The author distributed the members of the sample into pairs according to the variables of tall, weight and physical and skillful tests (in the present study). A Player of each pair has been distributed to one of the two groups (each group 10 players). Lot has been carried out to determine the

experimental group and the control group. It has been determined for the experimental group to perform the plyometric training, while the control to perform of the normal program.

The author measured the tall, the weight, the training age and the physical and skillful tests of each player of the sample on Wednesday dated 15/07/2009 to 17/07/2009. Mann-Whitney U Test has been also applied to show the least possible differences between the two groups and the skew coefficient of pre-tests of each group (experimental and control) and on the light of the above the author will be confident of the equivalence and homogeneity of the two groups (Tables 1 and 2). Table 1 shows no statistical significant differences between the experimental and control groups in the variables of age, height, weight, training age, physical tests and skillful tests (in the present study), where calculated U came greater than the tabulated U, which indicates the homogeneity of the experimental and control groups in all variables.

It is clear from Table 2 that the values of skew coefficient of the variables of age, height, weight, training age, physical tests and skillful tests range between 266.0 and 775.1, these values range between ± 3 which indicated the homogeneity of the sample combined in the variables in the present study.

Data Collection Tools were medical scale to determine the weight to the nearest kilogram; restameter device to measure the height to the nearest centimeter; digital stopwatch 1/1000 Sec; Medical balls and Weight jacket allowing putting additional weights.

Physical Tests:

- C Vertical jump test from stability (the muscular ability of legs) [15, 16].
- C Test of pushing a medical ball (muscular power of the arms) [16].
- C Test of running 30m \times 5n (speed, endurance) [17].
- C Test of shuttle running (agility) [18, 19].

Skillful Tests:

- C Test of quickness of passing [20].
- C Test of dribbling around a set of obstacles (quickness of dribbling) [21].
- C Test of the quickness of under-basket shooting 30/Sec [21].
- C Test of the lay-up [22].

Table 1: Homogeneity of experimental and control groups in the variables of age, height, weight and physical and skill tests

Variables	Measure Unit	N		Mean Ranks		Sum of Ranks		U	Sig. Level
		Con.	Exp.	Con.	Exp.	Con.	Exp.		
Age	Year	10	10	05.10	95.10	5.100	5.109	5.45	739.0
Height	m	10	10	3.10	7.10	103	107	0.48	912.0
Weight	Kg	10	10	7.9	3.11	97	113	42	579.0
Training Age	Year	10	10	90.9	10.11	99	111	44	684.0
Vertical Jump	cm	10	10	20.10	80.10	102	108	47	853.0
Medicine Ball Push (3 Kg)	m	10	10	15.10	85.10	5101	108.5	46	796.0
Running 30m x 5n	Sec	10	10	90.10	10.10	109	101	5.46	798.0
Shuttle Running	Sec	10	10	45.10	55.10	5.104	5.105	5.49	971.0
Quickness of Passing	N	10	10	85.10	15.10	5.108	5.101	5.46	796.0
Dribbling	Point	10	10	25.10	75.10	5.102	5.107	5.47	853.0
Under-basket Shooting	N	10	10	05.10	95.10	5.100	5.109	5.45	739.0
Lay-up	N	10	10	65.10	35.10	5.103	5.106	50.48	912.0

U Value 0.05 = 23

Table 2: Mean, standard deviation and skew coefficient of age, height, weight and physical and skilful tests in the present study

Variables	Measure Unit	Mean	SD	Median	Skew Coefficient
Age	Year	65.14	.670	0.15	775.1
Height	m	65.176	115.6	0.175	410.0
Weight	Kg	25.71	447.7	0.70	- 508.0
Training Age	Year	6.4	569.1	0.5	- 613.0
Vertical Jump	cm	9.35	745.4	0.37	- 272.0
Medicine Ball Push (3 Kg)	m	915.5	725.0	05.6	- 968.0
Running 30m x 5n	Sec	1.27	141.1	35.27	- 066.1
Shuttle Running	Sec	906.10	913.0	69.10	583.0
Quickness of Passing	N	95.11	761.1	0.12	- 135.1
Dribbling	Point	55.21	394.2	22.0	- 349.0
Under-basket Shooting	N	05.12	959.1	0.12	- 266.0
Lay-up	N	35.2	875.0	0.2	773.0

Table 3: Correlation coefficient and reliability of the physical and skilful tests in the present study

Tests	Measure Unit	Q 1	Q 2	Sum of P-1	Sum of P-2	T	Self-reliability
Vertical Jump	cm	8.32	5.32	Zero	8	951.0*	975.0
Medicine Ball Push (3 Kg)	m	87.4	83.4	Zero	5.5	966.0*	982.0
Running 30m x 5n	Sec	010.27	190.27	Zero	5	970.0*	984.0
Shuttle Running	Sec	305.11	295.11	Zero	22	867.0*	931.0
Quickness of Passing	N	90.11	60.11	Zero	26	842.0*	913.0
Dribbling	Point	80.19	80.19	Zero	5.18	887.0*	941.0
Under-basket Shooting	N	60.9	40.9	Zero	13	920.0 *	959.0
Lay-up	n	400.2	500.2	Zero	5.22	764.0*	903.0

T Value 0.005 = 8

The author carried out the scientific coefficients of the tests in the present study from 07/01/2009 to 03/07/2009 on a sample of 10 players from outside the study sample. The author used the method of applying and re-applying the test to ensure the constancy of the tests as well as self-reliability to ensure the reliability of the tests. Table 3 shows the scientific coefficients of the tests used.

The author conducted an exploratory study on another sample (other than the sample of the present study) of 10 players. It was of the same study population of the age group under 16 years old on Wednesday, 08/07/2009 to make sure of the validity and safety of tools and time to make the measurements and the implementation of the program. The aim of the training program is to identify the effect of using plyometric

exercises on developing the special physical abilities and the skillful performance of basketball players. The special physical abilities were determined according to the opinions of the expertise and the references on muscular power, agility and speed endurance.

Foundations of Laying out the Training Program:

- C Using the driving force to increase the strength of working muscles in addition to increasing the muscular contraction force in the muscular group.
- C The plyometric training exercises are designed to develop the strength and flexibility of muscular groups.
- C Grading the difficulty of the exercise considering using the element of excitement and suspense during the training period.
- C Similarity of the exercises used in plyometric training in terms of form and muscular work with the position used during performing the skill.
- C Doing the stretching exercises before starting the training unit as the muscle power is increased in case of stretching.

The training program was applied on both study groups in a period of 12 weeks: three training units per week (on Saturday, Monday and Wednesday). The period of the training unit was 120 m where exercises have been unified except the part of the special physical preparation. The experimental group performed the plyometric training, while the control group performed the traditional physical training. The time of performance and the number of repeating the exercise have been fixed for each player, taking into account that the rest should be active in which working joint exercises shall be performed. The period of preparation and fitness for both study groups should be considered as follows:

- C 5-7 minutes of light running.
- C 7-10 minutes of flexibility and stretching muscles' exercises.
- C 10-15 minutes of basic physical exercises relating to the basketball players.
- C 15 minutes of plyometric training performed by the experimental group, while the control group performed the traditional exercises.

The plyometric training was applied on the first and third week of every month using only the weight of the body. The plyometric training has been applied on the second and fourth week of every month using an

additional weight (weight jacket) to be in the first stage with the percentage of 3 % of body weight for each player then gradation should be applied as the weight jacket should be in the second stage with the percentage of 4 % of body weight and 5 % in the third stage. Each stage shall be a month from the period of applying plyometric training.

As for developing the muscular power of the arms using the plyometric training, medical balls shall be used as the first stage a medical ball of one kg will be used, the second stage with a medical ball of two kg and the third stage with three kg medical ball. Weight of lead pieces has been used with a weight of (50, 0.5, 0.01, 0.02 g). These weights have been put in specified places in the weight jacket where the amount of the additional weight added to the player during the training can be controlled. The weight of the jacket has been taken into consideration. Training loading was increased in each stage (stage is month) with a percentage of 1% of the body weight to fix the adaptation of the loading.

The Exploratory Study: The author conducted a survey with a help of an assistant on Monday dated 13/07/2009 to illustrate the following:

- C The aim of the study and the application plan.
- C How to put the weight in the specified places in the weight jacket.
- C The author assured the necessity of the player attendance in his group and non absence during the period of the experiment.
- C Each player did his performance in his group in front of the author and the assistants.

The program has been carried out in El-Shoban El-Muslmeen club in the period from Saturday dated 18/07/2009 to Wednesday dated 09/09/2009 (3 training units per week). The training was as follows:

- C Warm up - Flexibility - stretching (for both experimental and control group)
- C Performing plyometric training by the experimental group and Physical exercises by the control group.
- C Performing skillful and schemed training by the experimental and control group.

After finishing the training program set out for each group (experimental, control). The post- tests were conducted on the players of both groups on Friday dated 11/09/2009 in the skillful and physical variables of the study, with the same technique used in the pre- test.

RESULTS AND DISCUSSION

It is clear from Table 4 that calculated W, between pre-tests and post- tests for the control group in the skillful and physical tests in the present study, has been confined between -2.096 and -2.809 with statistically significance level between 0.05 and 0.036 as calculated W using Wilcoxon signed ranks test is less than tabular W at the level of 0.05 in favor of post-tests. That means that the difference between the previous variables is real and in favor of the post- tests. The author discerns that the improvement of the skillful and physical variables is due to the control group applied the common exercises of the training program carried by the experimental group (warming up, flexibility and stretching, exercises for developing the general and special physical abilities and exercises for developing the skillful and tactical capabilities) except the plyometric training, in addition to the program period and the regular attendance of all players of the sample in this experiment from its beginning till the end. That led to improve the physical abilities and its effect on developing the control group level during the post- tests.

El-Beek [23] assured that during the preparation period all the main duties ensuring success were realized, where the functional rule permits the performance of large volumes of specialized work as well as developing the physical qualities and motor experience. The regular training raise the fitness, while standardized training program based on scientific bases lead for the developing of the players' level [2, 24, 25]. Therefore the first hypothesis, which states that "There would be statistically significant differences between both pre- and post- tests of the control group in the study variables in favor of the post-test" was realized.

Table 5 indicated that the calculated W through the application of Wilcoxon signed ranks test referred to statistical significant differences between pre and post-tests in the skillful and physical variables in the present study of the experimental group which confined between -2.701 and -2.850 while the statistical significance level confined between 0.004 and 0.007 at the level of 0.05 in the favor of the post-test. This refers to the development of the experimental group level in the physical and skillful variables in the present study. The author views that the progress of the experimental group in the post tests is due

Table 4: Significant differences of pre and post- tests of the control group in the physical and skillful variables of the present study .n = 10

Variables	Measure Unit	Number of Ranks		Mean Ranks		Sum of Ranks		W	Sig. Level
		-	+	-	+	-	+		
Vertical Jump	cm	Zero	10	Zero	5.50	Zero	55	-2.809	0.005
Medicine Ball Push (3 Kg)	m	1	9	3	5.78	3	52	-2.449	0.012
Running 30m x 5n	Sec	9	1	5.33	7	48	7	-2.96	0.036
Shuttle Running	Sec	10	Zero	5.50	Zero	55	Zero	-2.805	0.005
Quickness of Passing	n	Zero	9	Zero	5	Zero	45	-2.701	0.007
Dribbling	Point	Zero	10	Zero	5	Zero	55	-2.809	0.005
Under-basket Shooting	n	Zero	8	Zero	4.50	Zero	36	-2.588	0.010
Lay-up	n	Zero	7	Zero	4	Zero	28	-2.530	0.011

W Value 0.05 = 8

Table 5: Significant differences of pre and post- tests of the experimental group in the physical and skillful variables of the present study.n = 10

Variables	Measure Unit	Number of Ranks		Mean Ranks		Sum of Ranks		W	Sig. Level
		-	+	-	+	-	+		
Vertical Jump	cm	10	Zero	5.50	Zero	55	Zero	-2.821	0.005
Medicine Ball Push (3 Kg)	m	9	1	6	1	54	1	-2.701	0.007
Running 30m x 5n	Sec	10	Zero	5.5	Zero	55	Zero	-2,807	0.005
Shuttle Running	Sec	Zero	10	Zero	5.50	Zero	55	-2.803	0.005
Quickness of Passing	n	Zero	10	Zero	5.50	Zero	55	-2.823	0.005
Dribbling	Point	Zero	10	Zero	5.5	Zero	55	-2.809	0.005
Under-basket Shooting	n	Zero	10	Zero	5.5	Zero	55	-2.827	0.005
Lay-up	n	Zero	10	Zero	5.5	Zero	55	-2.850	0.004

W Value 0.5 = 8

Table 6: Significant differences between post tests of the experimental group and control group for the physical and skillful variables in the present study. $n_1 = n_2 = 10$

Variables	Measure Unit	Mean Ranks		Sum of Ranks		U	Sig. Level
		Exp.	Con.	Exp.	Con.		
Vertical Jump	cm	14.20	6.80	142	68	13	0.004*
Medicine Ball Push (3 Kg)	m	13.80	7.20	138	72	17	0.011*
Running 30m x 5n	Sec	7.55	13.45	75.5	134.5	20.5	0.023*
Shuttle Running	Sec	6.65	14.35	66.5	143.5	11.5	0.002*
Quickness of Passing	n	13.65	7.35	136.5	73.5	18.5	0.015*
Dribbling	Point	13.4	7.6	134	76	21	0.029*
Under-basket Shooting	n	13.7	7.3	137	73	18	0.015*
Lay-up	n	14.3	6.7	143	76	12	0.003*

U Value 0.05 = 23

Table 7: improvement percentage between the experimental and control groups in the skillful and physical tests in the present study.

Tests	Con. Group			Exp. Group			Differences in Imp. Per.	Notes
	Pre	Post	Imp. Per. %	Pre	Post	Imp. Per. %		
Vertical Jump	35.5	50.7	42.80%	36.3	61.7	69.90%	27.01%	In favor of the
Ball Push (3 Kg)	5.91	6.975	18.02%	5.92	8.18	38.16%	20.14%	Medicine
Running 30m x 5n	27.19	26.36	3.05%	27.01	25.78	4.67%	1.62%	experimental
Shuttle Running	10.90	10.41	4.54%	10.90	9.59	12.07%	7.53%	group
Quickness of Passing	12	14.5	20.83%	11.9	16	34.45%	13.62%	
Dribbling	21.4	27.1	26.63%	21.7	30.4	40.09%	13.46%	
Under-basket Shooting	11.9	13.2	10.92%	12.2	15.8	29.50%	18.58%	
Lay-up	2.4	3.2	33.33%	2.3	4.40	91.30%	57.97%	

to the effect of the proposed training program using the free plyometric training and due to the effect of these exercises on some of physical characteristics of the basketball players and subsequently, on the skillful abilities. Sticking to the training program, regular and permanent performance of the plyometric exercises using the free weights (weights jacket and medical balls) 3 units per week in a period of 12 weeks and graduating in raising the level of training loading in each stage of training program (adapting and rippling in training loading) led to a remarkable improvement in the levels of some special physical characteristics and its effect on the skillful abilities of the basketball players.

The most important advantages of the plyometric exercises which correspondences the nature of the skillful performance is that the strength gained from that kind of training leads to better motor performance than the exercise activity through increasing the muscle power of contraction with a faster rate during the movement of the joint [1,26]. the training program which contains plyometric exercises for the development of muscular power lead to the improvement of skillful performance of the players and the increase of the accuracy and speed of

skillful performance [27,28]. Therefore, the second hypothesis, which states that "there would be statistically significant differences between both pre- and post- tests of the experimental group in the study variables in favor of the post- test" was realized.

Table 6 cleared that there are statical significant differences between the control and experimental group in the post measurement of the physical and skillful tests in the present study in favor of the post- tests of the experimental group as it confined between 0.002 and 0.029 while calculated U using Mann-Whitney equation is less than the tabular U at the level of 0.05. The author discerns that the difference is due to plyometric exercises program performed by the free weights as it considered the only variable occurred to the experimental not the control group. The plyometric exercises aim to develop the muscular power; however, the development integration of fitness components as an important principal of physical preparation is the decisive criterion. The differences in the tests of the present study and the mastery of the experimental group over the control group helped in improving the other elements through the mutual influence among the functional variables. Abdel-Maksoud [29] assured that the internal organs of the

human being are a unified structure and no development can occur in one of the physical abilities without other abilities. It can only happen if this development is positive and not affected ability as it is necessary to raise the development of any physical ability to the maximum level to be kept pace with raising the whole level of the functional abilities of the internal organs. The author noticed the improvement of the physical power of both arms and legs as a direct result of the plyometric exercises using the free weights helped in the improvement of the skillful performance level in the present study. The muscular power of arms contributed in increasing the speed of passing and shooting, while the muscular power of legs contributed in increasing the speed of dribbling and shooting as both these skills depend on the muscular power of leg: the matter which has been considered by the author during putting the plyometric exercises using the free weights in the program. The author paid attention to making the exercises similar to the skills in the present study, in developing working muscular group in these skills and in making working muscular group in the same direction of the work of these skills, too. The excellent planned and skillful performance is closely related to the high fitness of the player, while the special exercises have an important role in developing and improving the physical abilities which raise the accuracy and perfectness of the skillful performance [2, 30]. The third hypothesis, which states that "There would be statistically significant differences between both the experimental group and control group in the post- test of study variables in favor of the experimental group" was realized.

It is clear from Table 7 that the difference in the improvement rates of the skillful and physical tests in the present study between the experimental and control group is in favor of the experimental group. The highest percentage of improvement is in favor of the vertical jump variable as it becomes 27.1 % while the lowest percentage of improvement is speed loading as it becomes 1.5 %. For the Skillful performance, the highest percentage of improvement is in favor of layup variable as it becomes 57.97 % while the lowest percentage of improvement is in dribbling variable which becomes 13.46 %. The author noticed that the improvement percentage in the percentages of the variables is due to the vital role of plyometric training as it works against the gravity where the resistance increases in the same direction of motor path of these skills which leads to the improvement of the special physical abilities and it has been reflected on improving the skillful performance.

CONCLUSION

In light of the results of the study and the limits of the sample and the framework of statistical treatments used, the following was concluded:

- C The plyometric exercises in the training program for the experimental group led to an improvement in physical abilities and skillful performance of the basketball players.
- C The performance of plyometric exercises with free weights in the direction of the work of skill leads to improvement in the level of skillful performance.
- C The time of the application of the proposed program for plyometric exercises is appropriate to assess the special physical abilities and skillful performance of the basketball players.

Recommendations:

- C The proposed training program including the plyometric exercises should be a part of physical preparation of basketball players, because of their significant influence on raising the level of the player physically and skillfully.
- C It is necessary to raise awareness of the trainers with the importance of the plyometric exercises in the direction of the skill because of their significant influence on raising the physical and skillful level of basketball players.
- C Studies should be conducted in the same area on different samples in terms of age and gender.

REFERENCES

1. Abdel-Dayem, M.M., M. S.Sayed and T.S. Kattan, 1993. The Training Program for Physical Preparation and Weightlifting Training. Egyptian Book House, Cairo, Egypt, pp: 13- 377. (In Arabic)
2. Abdel-Khalek, E., 1992. Sports Coaching (Theories - Applications). Monshaat El-Maaref ,Alexandria, Egypt, pp: 7, 17, 141. (In Arabic)
3. Boatwright, D. and E. Todd, 1994. Preseason Interval Training Application for Basketball. The Applied Research in Coaching and Athletics Annual, pp: 223- 233.
4. Gambetta, V., 1989. Plyometrics for beginners- basic considerations. New Studies in Athletics , 4: 61-66.

5. Brown, M.E., J.L. Mayhew and L.W. Boleach, 1986. Effect of plyometric training on vertical jump performance in high school basketball players. *J. Sports Medicine and Physical Fitness*, 26: 1-4.
6. Adams, T.M., D. Worley and D. Throgmartin, 1984. An investigation of selected plyometric training exercises on muscular leg strength and power. *Track Field Q. Rev.*, 84: 36-40.
7. Abdel-Aziz, O.A., 1999. Effect of a Program for the Training of Muscular Fitness and Energy Fitness on Growth Rates of Physical Attributes and Basic Skills for Basketball. M.Sc. Thesis , Faculty of Physical Education, Helwan University, Al-Haram, Egypt, pp: 55. (In Arabic)
8. Tamman, A.H., 2000. Effect of a Training Program by Using the Plyometric Exercises on the Development of Muscular Power and the Performance Level of Shooting from Jumping to Basketball Players. Ph.D. Thesis, Faculty of Physical Education, Tanta University, Egypt, pp: 32. (In Arabic)
9. Bilal, M.A.H., 2003. Effect of the Plyometric Electric Training on the Development of the Explosive Power of the Legs and Its Relationship with the Performance of the Players to Some Basic Principles in Basketball. Ph.D. Thesis. Faculty of Physical Education, Alexandria University, Egypt, pp: 70. (In Arabic)
10. Bakhit, A.R., 2004. Effect of Functioning the Plyometric Training in the Skilful Direction on the Muscular Ability of the Legs and Shooting Skill for Basketball Players. *J. Menoufia University of Physical Education and Sports*, 4: 55-61. (In Arabic)
11. Vallabhajosula, S., K.R. Ford, M.V. Paterno, G.D. Myer, J.G. Divine, H. Facsm and E. Timothy, 2005. Effect of Changes in Ball Weight On Shoulder Rotations During Upper Body Plyometrics. *Medicine and Science in Sports and Exercise*, 37: 395.
12. Ashley, M.S., G. Ventimiglia, S. Gordon, L. Kelly and R.C. Jayaraman, 2006. The Effects of Plyometric, Sprint and Agility Training. National Conferences on Undergraduate Research, Dominican University of California, pp: 32.
13. Kotzamanidis, C., 2006. Effect of Plyometric training on running performance and vertical jumping in prepubertal boys. *J. Strength and Conditioning Res.*, 20: 441-445.
14. Markovic, G., I. Julic and D. Milanovic, 2007. Effects of Sprint and Plyometric Training on Muscle Function and Athletic Performance. *J. Strength and Conditioning Res.*, 21: 543-549.
15. Khater, A.M. and A. El-Beek, 1996. Measurement in the Athletics Field. Modern Book House, 4th Ed. Cairo, Egypt, pp: 249. (In Arabic)
16. Allawi, M.H. and M. Nasrel-Din, 1994. Tests of Motor Performance. Dar El-Fikr Al-Arabi, 3rd Ed. Cairo, Egypt, pp: 84, 106 .(In Arabic)
17. El-Bisatti, A., 1995. Training and Physical Preparation in Football. Monshaat El-Maaref, Alexandria, Egypt, pp: 80 .(In Arabic)
18. Hassanein, M.S., 1995. Measurement and Evaluation in Physical Education and Sports. Dar El-Fikr Al-Arabi ,Cairo, Egypt, pp: 369. (In Arabic)
19. Ahmed, B., 1999. Principles and Theories of Sports Training. Dar El-Fikr Al-Arabi, Cairo, Egypt, pp: 269. (In Arabic)
20. Fawzi, A.A. and M.A. Salama, 1990. Basketball for Beginners. Al-Faneya for Printing and Publishing, Alexandria, Egypt, pp: 407. (In Arabic)
21. Abdel-Dayem, M.M. and M.S. Hassanein, 1984. Measurement in Basketball. Dar El-Fikr Al-Arabi, Cairo, Egypt, pp: 168, 176. (In Arabic)
22. Mohamed, S.I., 1984. Building a Set of Tests to Measure Some of the Basic Skills of Basketball Players. M.Sc. Thesis, Faculty of Physical Education, Helwan University, Egypt, pp: 37. (In Arabic)
23. El-Beek, A.F., 1992. Principles of the Football Player Preparation and Team Games. El-Tuni Press, 1st Ed. Alexandria, Egypt, pp: 165. (In Arabic)
24. Abdul-Basir, A., 1992. Sports Coaching: Theory and Practice. Published by the Author, Port-Said, Egypt, pp: 117. (In Arabic)
25. Allawi, M.H., 1990. Science of Athletic Training . Dar El Maaref, 13th Ed. Cairo, Egypt, pp: 285. (In Arabic)
26. El-Nemr, A. and M. Saleh, 1998. Basketball: Education-Training. Al-Asateza for Publishing and Distribution, Cairo, Egypt, pp: 114. (In Arabic)
27. Saber, A.S., 1999. Proposed Skillful Program for the Development of Some Offensive Skills of Basketball Players. Ph.D. Thesis , Faculty of Physical Education, Tanta University, Egypt, pp: 31. (In Arabic)
28. Mohamed, A.S., 2005. Effect of Using Plyometric Training on Improvement of Motor Speed for the Beginners of Table Tennis. M.Sc. Thesis, Faculty of Physical Education, Banha University, Egypt, pp: 32. (In Arabic)
29. Abdel-Maksoud, E.S., 1997. Theories of Athletics Training, Strength Training and Physiology. Book Center for Publishing, Cairo, Egypt, pp: 236. (In Arabic)
30. Mukhtar, H.M., 1989. Principles of Planning Athletic Training Program. Dar Zahran, Cairo, Egypt, pp: 68. (In Arabic)