

Progressive Training of the Components of Muscular Strength and Agility and its Effect on Some Physical, Skilled and Physiological Variables amongst Volleyball Players

****Rasha Mostafa Mabrok Mohamed, *Hend Farouk Abdullah
Helwan University***

The purpose of this paper is to design a proposed training program and to identify the effect it has on different kinds of muscular strength (strength endurance, muscular power and maximum strength), agility, skilful performance level of spiking and serving skills, and on the levels of Adipsin and Adiponectin hormones in the blood amongst volleyball players. The experimental method was adopted using the pre-measurement-post-measurement design for two groups: control group and experimental group. Sixteen participants who were volleyball players in Eastern Company club (aged less than 17) were selected as a purposively selected sample. Duration of the training program extended 10 weeks with three training units per week of 120 minutes each. Results suggest a positive effect of the proposed program on the components of muscular strength, spike and serve skills, and levels of Adipsin and Adiponectin in the blood which was greater among the experimental group than among the control group, indicating the effectiveness of the proposed program.

Keywords: Physical Fitness, Health Fitness, sport training.

Introduction

The attainment of the optimal athletic performance in the practicing activity depends on the setting up of the training programs that are consistent with the requirements of this activity for the purpose of performance development to achieve highest levels.

Volleyball game has certain requirements in terms of physical fitness elements. There is a consensus about the significance of our muscular strength since it is considered to be the base component upon which the rest of elements are built. In this regard, Al-Walily (2000) indicates that the muscular strength is on top of other of physical fitness elements since it directly affects the development of other elements such as agility, speed and coordination. The muscular strength is a prerequisite for all volleyball skills. The player needs it when performing serving to be able to direct the ball to the required area powerfully and precisely such that his opponent (opposing player) cannot block him. He also needs it when performing spiking skill to reduce the chances the defender (back) may have to push the ball. It is also needed by the player when performing blocking skill in order to let him jump to block the ball pushed by his opponent on spiking.

**Department of Sports Training, Faculty of Physical Education for Girls – Helwan University, hend76@yahoo.com.*

The development of muscular strength in a meaningful form requires focusing on each kind of its forms (strength endurance, power characterized by speed and maximum strength) in a balanced and integrated manner. In order to achieve this integration, the components of muscular strength should be developed in a gradual (progressive) manner started by developing strength endurance to provide a strength basis followed by muscular power and ended by maximum strength. This manner should be applied during the primary period (setting) of the training season in order to enable the coach to control the components of the training load, allowing a gradual elevation of the player's capabilities to take place and to achieve the adaptiveness required for the three components of muscular strength, with the choice of exercises that looks similar to the performance during the competition in terms of the requirements of muscular strength. The component of agility plays an important role during the performance of defense as well as during the performance of spiking in order to direct the ball to the required area, block the ball in any direction, and change the positions and all requirements of high performance in terms of feet and agility movements.

Thus we should take all of them into consideration when dealing with the physical aspect, but we should not lose sight regarding the physiological aspect (body weight, cross sectional area of the muscle and level of blood lipids in the player's body) which is considered to be one of the main obstacles that interrupt the progress of his success to reach the required level in volleyball game.

Of the main hormones responsible for determining the Blood lipids level, Adiponectin and Adipsin were chosen to be the focus of this paper. These hormones are responsible for the disintegration or the deposition of triglycerides in Adipocytes, also known as lipocytes and fat cells that store energy as fat. We find that both hormones act in a reversal way; that is, when the level of Adiponectin in the blood increases this is an indicator for an increase in the fats inside the body and indicator for an incidence of some disorders as well. Of the most important ones, the influence of blood lipids on the production of insulin in the blood is revealed. This leads, on the long run, to diabetes mellitus condition and fatty deposits on the walls of blood vessels, therefore, the risk of developing hypertension and atherosclerosis disorder. Also, when the level of Adipsin in the blood increases this is an indicator for an increase in the fat burning inside the body. The normal level of Adiponectin hormone in the blood should be (9 ± 4) Ug/ml while the normal level of Adipsin hormone in the blood should be (1 ± 0.2) Ug/ml.

The purpose of the current study was to design a training program to develop three components of muscular strength (strength endurance, muscular power and maximum strength) in a balanced way along with the agility component, without doing any harm to the components of the muscle with the possibility of fats burning that provides the body with the required energy for doing muscular activity without causing muscular ruptures or overload. This paper also addressed the effect of Adiponectin and Adipsin hormones on the level of fat in the body as being two main indicators for fat burning and links them with the progressive development of the components of muscular strength and agility of volleyball players.

We hypothesized the following:

Hypothesis 1: There would be significant differences between pre- and post-measurements among the experimental group in favor of the post-measurement in each of physical and skilful and physiological variables.

Hypothesis 2: There would be significant differences between pre- and post-measurements among the control group in favor of the post-measurement in each of physical and skilful and physiological variables.

Hypothesis 3: There would be significant differences between pre- and post-measurements among the experimental and control groups in favor of the post-measurement of the experimental group in each of physical and skilful and physiological variables.

Method**Participants**

Sixteen volleyball female players (aged 14-17) who play for Eastern Company club were enrolled in the study as a sample that was purposively selected. A simple random sample was equally divided into two groups (eight players per group). The homogeneity and valence were considered between both groups regarding age, height, weight, training period, muscular strength components, agility, flexibility, serving, spiking Adiponectin hormone and Adipsin hormone variables.

Assessment instruments

- A questionnaire is designed to seek the opinions of experts about the physical tests of physical elements and the skillful tests of skills under study.
- An interview with some experts in the faculties of physical education and with some coaches of junior teams of volleyball to recommend the best time period of the proposed program execution and to determine the intensity and size of training and to what extent they are appropriate for the sample.

Equipment and tools

Restmeter to measure height in cm, medical balance to measure weight in kg, stop watch, meter, chalk, sponge mattresses, Swedish chairs, loads of 1 kg each-medical balls of different weights, volleyball court, volleyballs and body composition equipment to measure the muscle mass and the fat mass.

Procedure

According to the questionnaire, the researchers have chosen the physical and skillful tests that rated more than 75% of experts' agreement. These include tests of:

1. Vertical jump from stationary to measure the power of legs.
2. Throwing a medical ball weighted 3 kg to a farthest distance to measure the power of legs.
3. Sitting from reposition position from knee flexion position to measure the endurance of the abdomen's muscular strength.
4. Inclined prostration from arms flexion position to measure the endurance of the arms' muscular strength.
5. Inclined prostration from standing position to measure the endurance of general muscular strength.
6. Back muscular strength using Dynamometer.
7. Legs muscular strength using Dynamometer.

8. Test of zigzag running to measure agility.
9. Forward flexion of trunk from standing position to measure the flexibility of trunk and thigh.
10. Precision of spiking.
11. Precision of serving. These tests have been standardized on a pilot (explanatory) study sample drawn from the study population after excluding the main study sample to verify how precision the scientific coefficients were.

The program

The duration of the program is determined (10 weeks) with frequency: 3 training sessions per week. Duration of a training unit was 120 minutes using the frequent training method to develop the endurance of strength and the interval training of low and high intensity to develop the maximum strength, flexibility and agility. The loads components have been controlled by means of measuring the maximum number of frequencies of each exercise practiced individually. They have also recorded in their special cards to determine the percentage of each exercise. The pulse is used as an indicator for load intensity. The components of training load are shown in table (1).

Table (1): Components of Training loads of the Experimental Group's Program

Weeks	Elements of fitness	Mode of training	Individual intensity	Repetitions	Sets	Rests between sets
First	Maximum strength Flexibility/agility	Interval	55%	8	3	90 sec.
Second		Low	60%	8	3	90 sec.
Third		intensity	65%	10	4	120 sec.
Fourth	Endurance of strength Flexibility/agility	Repeation	40%	6	2	60 sec.
Fifth			50%	4	2	60 sec.
Sixth			60%	4	3	90 sec.
Seventh	Muscular power Flexibility/agility	Interval high intensity	75%	12	4	2.0 min.
Eighths			85%	14	4	3.0 min.
Ninth			90%	14	4	3.0 min.
Tenth			90%	16	4	3.0 min.

Pre-measurement

Pre-measurements have been conducted for both study groups in all study variables (age, height, weight, training period, physical tests, and skillful tests, levels of Adiponectin and Adipsin in the blood. The measurements were taken between 10th to 12th of June, 2014.

Program Execution

For the experimental group, the proposed training program and the traditional program has been executed seeking to develop the elements of physical fitness in volleyball in a balanced manner for the experimental group) between 14th of June and 16th of August, 2014 for 10 weeks with frequency 3 training sessions per week. The duration of the training unit is 120 minutes.

Post-measurements

Post-measurements have been conducted for both study groups in all study variables after program execution (experimental and control). The measurements were taken between 16th to 17th of August, 2014 considering same circumstances and measurement conditions that were followed in the pre-measurement.

Results

For the experimental group, the descriptive statistics for the study are shown in table 2

Table (2): Significant Differences between Pre- and Post- Measurements for the Experimental Group in Physical, Skilful and Physiological Variables N₁=8

Variables	Difference		Mean rank	Sum of rank	Z value	Sig.
	Trend	number				
Power of legs	Neg. rank	0	0	0	2.533	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Power of arms	Neg. rank	0	0	0	2.524	0.012
	Pos. rank	8	4.5	36		
	Equal	0				
Strength of legs	Neg. rank	0	0	0	2.521	0.012
	Pos. rank	8	4.5	36		
	Equal	0				
Strength of back	Neg. rank	0	0	0	2.524	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Strength of abdomen	Neg. rank	0	0	0	2.524	0.012
	Pos. rank	8	4.5	36		
	Equal	0				
Endurance of arms	Neg. rank	0	0	0	2.585	0.010
	Pos. rank	8	4.5	36		
	Equal	0				
General endurance	Neg. rank	0	0	0	2.552	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Agility	Neg. rank	8	4.5	36	2.524	0.012
	Pos. rank	0	0	0		
	Equal	0				
Flexibility	Neg. rank	0	0	0	2.585	0.010
	Pos. rank	8	4.5	36		
	Equal	0				
Spiking	Neg. rank	0	0	0	2.539	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Serving	Neg. rank	0	0	0	2.527	0.012
	Pos. rank	8	4.5	36		
	Equal	0				
Muscle mass	Neg. rank	0	0	0	2.530	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Fat mass	Neg. rank	8	4.5	36	2.521	0.012
	Pos. rank	0	0	0		
	Equal	0				
Adipsin hormone	Neg. rank	1	2	2	2.243	0.025
	Pos. rank	7	4.86	34		
	Equal	0				
Adiponectin hormone	Neg. rank	8	4.5	36	2.524	0.012
	Pos. rank	0	0	0		
	Equal	0				

Significance ≤ 0.05 (Neg = negative) (Pos = positive)

Table (2) has shown that there are significant differences between pre- and post-measurements for the experimental group in favor of the post-measurement in all physical, skilful and physiological variables. Z value ranged between 2.243 to 2.585. Pos. means all sample (8) players are improved, Neg. means no improve, Equal means no change between pre- and post-measurements

Table 3 shows Percentage of change between Pre- and Post- Measurements for the Experimental Group in Physical, Skilful and Physiological Variables.

Table (3): Percentage of Change between Pre- and Post- Measurements for the Experimental Group in Physical, Skilful and Physiological Variables N = 8

Variables	Units of Measurement	Mean of Pre-	Mean of Post-	Difference	% of change	
Physical variables	Power of legs	Cm.	41.13	45.5	4.37	%10.62
	Power of arms	Min.	7.92	8.61	0.69	%8.71
	Strength of legs	Kg	65.36	75.84	10.48	%6.03
	Strength of back	Kg	56	68.5	12.5	%22.32
	Strength of abdomen	No. of times	63.75	82.75	19	%29.8
	Endurance of arms	No. of times	20.13	25.63	5.5	%27.32
	General endurance	No. of times	56.5	67.25	10.75	%19.03
	Agility	sec.	7.08	6.63	0.45	%6.36
	Flexibility	Cm.	11	13.75	2.75	%25
	Skilful variables	Spiking	Degrees	15.38	20.13	4.75
Serving		Degrees	32.25	40.5	8.25	%25.58
Physiological variables	Muscle mass	Kg	32.65	38.78	6.13	%18.77
	Fat mass	Kg	18.81	11.13	7.68	%40.83
	Adipsin hormone	Ug/MI	1.05	1.17	0.12	%11.43
	Adiponectin hormone	Ug/MI	8.99	8.16	0.83	%9.23

Table (3) has shown the percentages of change between pre- and post measurements for the experimental group in physical, skilful and physiological variables where the percentages ranged between 6.03 to 40.83%.

For the control group, the descriptive statistics for the study are shown in table 4

Table (4): Significant Differences between Pre- and Post- Measurements for the Control Group in Physical, Skilful and Physiological Variables N2=8

Variables	Trend	Difference	Mean rank	Sum of rank	Z value	Sig.
		number				
Power of legs	Neg. rank	0	0	0	2.271	0.023
	Pos. rank	6	3.5	21		
	Equal	2				
Power of arms	Neg. rank	0	0	0	2.384	0.017
	Pos. rank	7	4	28		
	Equal	1				
Strength of legs	Neg. rank	0	0	0	2.524	0.012
	Pos. rank	8	4.5	36		
	Equal	0				
Strength of back	Neg. rank	0	0	0	2.536	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Strength of abdomen	Neg. rank	0	0	0	2.539	0.011
	Pos. rank	8	4.5	36		
	Equal	0				
Endurance of arms	Neg. rank	0	0	0	2.588	0.010
	Pos. rank	8	4.5	36		
	Equal	0				
General endurance	Neg. rank	0	0	0	2.636	0.008
	Pos. rank	8	4.5	36		
	Equal	0				
Agility	Neg. rank	6	5.25	31.5	1.902	0.057
	Pos. rank	2	2.25	4.5		
	Equal	0				
Flexibility	Neg. rank	1	2	2	2.047	0.041
	Pos. rank	6	4.33	26		
	Equal	1				

Follow Table (4): Significant Differences between Pre- and Post- Measurements for the Control Group in Physical, Skilful and Physiological Variables N2=8

	Variables	Difference		Mean rank	Sum of rank	Z value	Sig.
		Trend	number				
Skilful variables	Spiking	Neg. rank	0	0	0	2.456	0.014
		Pos. rank	7	4	28		
		Equal	1				
	Serving ¹	Neg. rank	0	0	0	2.539	0.011
		Pos. rank	8	4.5	36		
		Equal	0				
Physiological variables	Muscle mass	Neg. rank	0	0	0	2.521	0.012
		Pos. rank	8	4.5	36		
		Equal	0				
	Fat mass	Neg. rank	8	4.5	36	2.524	0.012
		Pos. rank	0	0	0		
		Equal	0				
	Adipsin hormone	Neg. rank	2	3.5	7	1.611	0.107
		Pos. rank	6	4.83	29		
		Equal	0				
	Adiponectin hormone	Neg. rank	8	4.5	36	2.552	0.011
		Pos. rank	0	0	0		
		Equal	0				

Significance ≤ 0.05

Table (4) has shown that there are significant differences between pre- and post measurements for the control group in favor of the post-measurement in all physical, skilful variables. Z value ranged between 1.611 to 2.636. Pos. means all sample (8) plyers are improved, Neg. means no improve, Equal means no change between pre- and post-measurements.

Table (5) shows the percentages of change between pre- and post measurements for the control group in physical, skilful and physiological variables where they ranged between 1.41 to 20.87%.

Table (5): Percentage of Change between Pre- and Post- Measurements for the Control Group in Physical, Skilful and Physiological Variables N = 8

	Variables	Units of measurement	Mean of Pre-	Mean of Post-	Difference	% age of change
Physical variables	Power of legs	cm.	41.25	43.63	2.38	%5.77
	Power of arms	min.	7.97	8.23	0.26	%3.26
	Strength of legs	Kg	65.38	69.63	4.25	%6.5
	Strength of back	Kg	56	59.88	3.88	%6.93
	Strength of abdomen	No. of times	65.75	73.13	7.38	%11.22
	Endurance of arms	No. of times	21.88	23.75	1.87	%8.55
	General endurance	No. of times	56.38	61	4.62	%8.19
	Agility	sec.	7.11	7.01	0.1	%1.41
	Flexibility	cm.	10.38	12.13	1.75	%16.86
Skilful variables	Spiking	Degrees	15.5	17.25	1.75	%11.29
	Serving	Degrees	32.5	36.88	4.38	%13.48
Physiological variables	Muscle mass	Kg	32.75	35.4	2.65	%8.09
	Fat mass	Kg	18.85	15.03	3.82	%20.27
	Adipsin hormone	Ug/MI	1.12	1.15	0.03	%2.68
	Adiponectin hormone	Ug/MI	9.16	8.88	0.28	%3.06

For both the experimental and control groups, the descriptive statistics for the study are shown in table 6

Table (6): Significant Differences between Pre- and Post- Measurements for the Experimental and Control Groups in Physical, Skilful and Physiological Variables $N_1 = N_2 = 8$

Variables	Experimental group		Control group		value U	Sig.	
	Mean of rank	Sum of rank	Mean of rank	Sum of rank			
Physical variables	Power of legs	12	96	5	40	4	0.002
	Power of arms	12.13	97	4.88	39	3	0.002
	Strength of legs	12.5	100	4.5	36	0.000	0.001
	Strength of back	12.5	100	4.5	36	0.000	0.001
	Strength of abdomen	12.5	100	4.5	36	0.000	0.001
	Endurance of arms	11.5	92	5.5	44	8	0.009
	General endurance	12.5	100	4.5	36	0.000	0.001
	Agility	4.94	39.5	12.06	96.5	3.5	0.002
	Flexibility	11.56	92.5	5.44	43.5	7.5	0.008
Skilful variables	Spiking	11.88	95	5.13	41	5	0.004
	Serving	12.19	97.5	4.81	38.5	2.5	0.002
Physiological variables	Muscle mass	12.5	100	4.5	36	0.000	0.001
	Fat mass	4.5	36	12.5	100	0.000	0.001
	Adipsin hormone	11.31	90.5	5.69	45.5	9.5	0.017
	Adiponectin hormone	5.31	42.5	11.69	93.5	6.5	0.007

The above table has shown that there are significance difference between two post-measurements for the experimental and control groups in favor of the experimental group in physical, skilful variables. U values ranged between 0.00 to 11.5.

Discussion

For the experimental group, the results of physical variables are discussed as follows:

Table (2) has shown that there are significant differences between pre- and post-measurements for the experimental group in favor of the post-measurement in all physical variables. Z value ranged between 2.243 to 2.585.

Table (3) has indicated that the percentages of change between pre- and post-measurements for the experimental group in physical, skilful variables ranged between 6.03 to 40.83%.

Both researchers referred these results to the effect of the proposed program for progressive training of the components of muscular strength and agility and to what extent the program was effective. This program was executed in the setting up period and included the training of muscular strength. The training was conducted in a progressive manner; started by the developing of strength endurance component to provide the strength basis upon which the muscular power is built and followed by the maximum strength component along with the development of agility component. These results agree with those of Allaway (1990) in that the individual should be

characterized by having a high degree of muscular strength, speed and motor skills whose causes become possible to be integrated with the muscular strength factor in order to provide the components of muscular power for an individual.

The program consists of exercises with body weight and loads. These exercises have been designed on standardized practical basics in terms of intensity, capacity, repetitions and rest intervals that have to be consistent with the age class under study.

The percentages of change in the magnitude of physical fitness components (represented in the muscular power of arms and legs, muscular strength of legs, back and abdomen, muscular endurance of arms, general endurance, along with the agility component) in the pre measurement rather than in the post measurements were referred to the content of the program in terms of general and particular, single and paired free weight exercises using body weight, colleague 's weight and loads of different weights that aimed directly to develop the components of muscular strength and agility as they are considered to be the most important components of physical fitness that are needed by a volleyball player to do motor skills of volleyball game in an effective manner that allows him to do so.

For the experimental group, results of skilful variables are discussed as follows:

Table (3) has indicated that there is an improvement in the measuring of spiking and serving skills in the pre- measurement rather than in the post-measurement. The percentage of change ranged between 25.58 to 30.06 in favor of the post-measurement. The researchers referred this change to the consequent result of the improvement in the components of physical fitness presented in the components of muscular strength and agility. The skilful performance relies on what the player possesses, progress of play without fatigue and speed recovery to the normal state without doing any harm to the components of the muscle.

These results seem to agree rather closely with those of Gregory et al., (2005) and Gregory and Levin (2007) and to some extent with those of Kravitz (2004) on considering the progressive training of muscular strength components one of the training methods that have a positive effect on the improving of record and performance levels.

We agree also with Darwish et al., (2002) and Al-walily (2001) about the performance level improvement that is to be gained by means of improving physical state and strength and developing motor skills of the player.

For the experimental group, results of physiological variables are discussed as follows:

Table (3) has shown that there are significant differences between the pre- and post-measurements for the experimental group in the physiological variables under study presented in Adiponectin and Adipsin hormones, muscle mass, fat mass in favor of post-measurement. The percentage of change ranged between 9.023 to 40.83%.

The researchers referred this change to the proposed program and its content; resistant exercises using body weight, colleague's weight and training associated with loads of different weights, different kinds of strength training and agility training. Training has led to a decrease in the Adiponectin level and to an increase in the

Adipsin level in the blood due to the link between Adiponectin and Adipsin hormones and the presence of fat and fat burning in the body. Haluzik et al., (1998) suggested that Adiponectin is a protein hormone formed in the fat tissue and its level in the blood reflects the content of fats in the body; that is, the level of Adiponectin in the blood is increasing with an increase in weight and is decreasing with a decrease in weight. Adipsin hormone reflects the increase in fat burning, and hence the decrease in the level of fat mass in the player's body.

Results seem to agree with those of Halle and Berg (1999); Okazaki et al., (1999); and Sartorio et al., (2003) that have repeatedly shown that the regular training of the components of muscular strength in a standardized manner is leading to a reduction in the level of Adiponectin hormone in the blood, and hence a reduction in the fat mass level. The increased level of secretion of Adipsin hormone and muscular mass is considered as an indicator for that due to the elevated level of muscular strength components of the player, therefore, better movement of the player in the court is resulted which helps to do motor skills faster without doing any harm to the components of the muscle and without causing ruptures. Thus, the first hypothesis that states that "there are significant differences between pre- and post measurements for the experimental group in physical and skilful and physiological variables in favor of the post-measurement" is accepted.

For the control group, results of physical variables are discussed as follows:

Results of table (5) have demonstrated that there are significant differences between pre- and post measurements for the control group in favor of the post-measurement in all physiological variables except for the agility component. The percentage of change ranged between 1.41 to 16.86%. The researchers maintained that these differences were due to the program, set by the coach, which includes the development of the components of physical fitness that have to do with the game in a balanced form within the period of setting. This leads to an improvement in the components of the physical fitness that are represented in strength, endurance, agility, flexibility and balance. Results agree with Allawy (1990) in that the Adherence of the player to train on a regular basis helps to elevate the level of the physical fitness elements of the player in a balanced manner.

The researchers referred the lack of improvement in the agility variable to an inadequate time given to the program developed for the control group to develop that element till they are developed sufficiently.

For the control group, results of physiological variables were discussed as follows:

Table (5) has shown that there are significant differences between the pre- and post-measurements for the control group for the physiological variables (Adiponectin and Adipsin), muscle mass and fat mass. The percentage of change ranged between 2.68 to 8.09% as indicated by table 5.

The researchers referred these differences to sports training on regular basis that leads to improvement of physiological efficiency of body systems which results in an influence on the components of the body; the muscle mass has increased and the fat percentage has decreased. These findings agree with those of Thong (2000) in

that the training on a regular basis leads to minimizing of percentage of fats and the improving of physiological efficiency of the body.

For the control group, results of skilful variables are discussed as follows:

Table (5) has shown that there are significant difference between the pre- and post-measurements in the skillful variables represented in spiking and serving.

The researchers attributed these differences to the higher physical level the player possess, and hence improvement in the skillful level in terms of the power and precision of directing the skill. Table 5 has revealed these findings as the percentage of change ranged between 11.29 to 13.48 %.

These results agree with those of Darwish et al., (2002) and Hassanein and Abdule-Moneam (1997) in that the improvement of the performance level is attained by means of the improvement of the physical state of the player. The latter stated that the good physical preparation of the player provide a good state that enables her/him to do skills and to slow the incidence of muscle fatigue.

From the previous presentation, it has been illustrated that the second hypothesis stated that "There are significant differences between pre- and post-measurements for the experimental group in the physical, skillful and physiological variables and in favor of the post-measurement" was partially verified.

For the experimental and control groups, results of physical variables in the post-measurement are discussed as follows:

Table (6) has suggested that there are significant differences between the post-measurements for the experimental and control groups in the physical variables in favor of the post-measurement of the experimental group. The researchers attributed these differences that were in favor of the experimental group to the proposed program including the sequential training of the components of muscular strength and agility and to its content in terms of exercises that were developed on a scientific and standardized basis concerning sizes, intensity, repetitions, rest between sets that take the individual differences into account in comparison with the results of the control group that has also improved but with lower percentage than the experimental group. These findings agree with those of a study by Abdul-Hamid (2002) in that the program that was designed to develop these elements leads to improving them in a better manner.

These results agree with those of Hammad (1998) in that the development of the components of muscular strength has contributed in the development of other physical elements such as agility and speed. So, this should take part in the programs of sports training. The program has significantly succeeded in the developing of agility element. Omission of this element in the program developed by coach took place for the control group. This is illustrated by a comparison of the results of the experimental group and for the agility element in particular with results of the control group that do not provide agility with the adequate time necessary for its improvement.

For the experimental and control groups, results of physiological variables in the post-measurement are discussed as follows:

Table (6) has indicated that there are significant difference between the post-measurements for experimental and control groups in the physiological variables in favor of the experimental group.

The researchers referred these differences to the positive effect of the developed program that leads to an increase in fat burning and an increase in the muscle mass due to an improvement in the level of muscular strength components and agility. These findings agree with what Ibrahim (2004) pointed out in that the interval training with high and low intensity leads to the improving of muscular strength and muscular endurance to a large extent that works to strengthen muscles of the body. This refers to as an increase in the muscle mass.

Also, these results agree with those by Abdel-Fattah (1997) in that the increase in muscle mass in the player's body is an reflection of low fat mass, and hence a better motor performance and an improvement in the level of agility in general.

Skilful variables between post-measurements for experimental and control groups.

Table (6) has indicated that there are significant difference between the post-measurements for experimental and control groups in the skilful variables in favor of the experimental group. U values ranged between 0.00 to 11.5.

The researchers referred this improvement to the proposed program which leads to an increase in the muscular strength and agility in an acceptable manner that is better than the control group with respect to the development of muscular strength that started by strength endurance in order to make a base for power development and ended by the maximum strength. Consequently, this leads to an improvement in the level of skilful performance of spiking and serving skills.

These results agree with those of Tawfik (2001) in that the improvement of the level of performance is a result of an improvement of the physical state and strength of the player and the development of motor skills, and also as a results of an increase in the muscle mass in comparison with the fat mass that helps the player to move in the court from the defense to the attack positions and vice versa in a faster manner and better without hindrances. The third hypothesis stated that "There are significant differences between the post-measurements for experimental and control groups in all physical, skilful and physiological variables in favor of the post-measurement" is verified.

Conclusion

- The progressive training of the components of muscular strength and agility has a positive effect on all physical, skillful and physiological variables under study since there were significant differences between the pre- and post-measurements at a level of significance 0.05 in favor of the post-measurement.
- The percentage of the rate of change suggested an improvement in the results of post-measurement than those of the pre-measurement in all physical, skillful and physiological variables for the experimental group than for the control group.

Recommendation

- The researchers recommend the application of the proposed training program (progressive training of the components of muscular strength and agility) since it has a positive effect on some physical, skillful and physiological variables amongst volleyball players aged less than 17 and amongst those who have the same training period. They also recommended conducting more studies that address the influence of the progressive training of the components of muscular strength and agility on other sports, different samples, other hormones and enzymes, and on different age classes.

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