

Effect of Endurance Compounds on the Cardio-Pulmonary Fitness and the Effectiveness of the Skill Performance of Boxers

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Abstract: Given the importance of endurance in boxing, especially when performance is prolonged for long periods and due to the significance of this on Cardio-Pulmonary fitness and effectiveness of the skills performance of boxers, this research aims to identify the effect of endurance training on the Cardio-Pulmonary fitness and effectiveness of the skills performance of boxers. The research used the experimental design to test two groups (experimental - control) of 10 boxers and conducting (pre - post) measurements on an intentional sample of 20 boxers. The strength endurance test was used, in addition to the speed endurance test and the Cardio-Pulmonary fitness test "Cunningham and Volknz Treadmill" to measure (pulse during exercise, the rate of O₂ consumption per pulse) and the effectiveness of skill performance as well. The training program was implemented for 12 weeks (four training sessions per week). The time of the session lasts between 75 and 135 minutes. The most important result was that the training program for the development of endurance had a positive impact. The highest percentage to endure strength was 88.8 % and to endure speed was 82.5 %. The lowest rates of improvement were the consumption of O₂ per pulse (27.8%), the rate of pulse during effort (4.6%), while the improvement rate of the effectiveness of skill performance reached 64.3%.

Key words: Boxing % Endurance % Cardio-Pulmonary fitness % Effectiveness of skill performance

INTRODUCTION

The physical condition is one of the significant and influential factors in the development of the skill performance for boxers. The boxer who is characterized by good physical preparation has the ability to perform skillfully and tactically in an impressive manner during the games, in addition to performing such skills in a high technical level. The development of the physical characters of the boxer is necessary to allow a high-level skill performance.

Endurance compounds are composed of more than one physical character, i.e. speed and flexibility compose (speed endurance), while strength and endurance compose (strength endurance). The development of the physical preparation of the boxers depends on these important physical characters, which help the boxer to continue exerting efforts [1, 2]. Endurance plays a vital role in raising the standard of boxers to the levels of competition, because it is one of the key factors to win the game. The boxer beats his competitor through his ability

to perform at a steady rate without feeling tired or fatigue throughout the rounds of the game, due to the good development of efficient endurance, regular respiratory and muscle performance of a boxer.

Boxing is one of the competitive sports which requires high physical and physiological abilities and due to the nature of the motor performance in boxing, it benefited from the theories of the sports training physiology. The practice of boxing causes some changes in the boxers due to the influence of the physical effort. Sports training results in functional changes in various body organs, the respiratory system tries to supply the body with its needs of oxygen, transfers food and helps to keep the body temperature, in addition to transferring and using oxygen in the work of muscles and getting rid of the remnants energy within the muscle [3].

Cardio-Pulmonary training gives the athlete the opportunity to gain functional adaptation in the vital systems. As a result, some changes occur and indicate a remarkable improvement and high Cardio-Pulmonary fitness. Among these indicators are a higher level of

oxygen consumption to increase the capacity of oxygen saturation in the blood and the decrease in heart rate at a certain level of enduring the training [4].

The competitive performance of the athlete is the result of all the physical, skill, tactical and psychological preparation. Therefore, the competitive performance analysis of the athlete and the extent of its effectiveness by conducting a statistical analysis of the game is one of the important processes through which the strengths and weaknesses in the level of athlete can be identified [5].

The researcher believes that boxing is distinct from other sports due to the outstanding ability to exert efforts during the rounds through punching; such kinetic work can be observed when the boxer makes different blows and defend himself against the counterattack of the competitor. These variable motor skills are very intense large during the game in a specific number of time-bound rounds with short breaks which are not enough to fully recover. The game continues and the boxer starts the next round with an oxygen debt from the previous rounds. However, in order to continue as active, efficient and effective during the training and the games, the boxers should have a high level of Cardio-Pulmonary Fitness which depends on the various types of endurance and a high level of aerobic and anaerobic capabilities.

Through the researcher's experience in the field of boxing training, he noted the low level of skill performance efficiency of the boxers in the third round compared to first and second rounds, which may be due to their weak physical preparation that affects their Cardio-Pulmonary fitness. The number of rounds became 3 instead of 4 and the round duration increased to 3 min. instead of 2 min. In addition, the break between rounds is 1 min. The researcher believes that the use of different means for the development of functional efficiency of the heart and lungs is one of the important things that must be considered in the training of boxers. This requires the proper physical preparation of the boxer through practicing endurance compounds drills (strength and speed endurance) which had a positive impact in the functional efficiency of the heart, lungs and the skill performance efficiency during the games. Therefore, this study is trying to develop a set of exercises based on scientific principles and guiding the trainers to help upgrading of the physical efficiency level of boxers.

Research Objective: The research aims to identify the impact of endurance compounds training on Cardio-Pulmonary fitness and skill performance efficiency of boxers.

Research Hypotheses:

- C There are statistically significant differences between middle-level indices of pre and post measurements of the control group in (the performance level of strength and speed endurance, the Cardio-Pulmonary fitness and the skill performance efficiency) of boxers in favor of the post measurement.
- C There are statistically significant differences between middle-level indices of pre and post measurements of the experimental group in (the performance level of strength and speed endurance, the Cardio-Pulmonary fitness and the skill performance efficiency) of boxers in favor of the post measurement.
- C There are statistically significant differences between the control group and the experimental group in (the performance level of strength and speed endurance, the Cardio-Pulmonary fitness and the skill performance efficiency) of boxers in favor of the experimental group.

MATERIALS AND METHODS

Experimental design was used for the two groups (experimental -control) each consists of 10 boxers and by conducting pre and post measurements on an intentional sample of 20 boxers whose average age is 19.68, average weight is 67.8 and average height is 175.1.

Data Collection: The researcher used a variety of multiple data collection methods as follows:

- C Registration form: personal data of the boxer (age - height - weight - training period)
- C Strength endurance test, performing straight left and right blows on the punching bag for 1 min. [6].
- C Speed endurance test, performing straight left and right blows on the punching bag during 20 sec. [6].
- C Cardio-Pulmonary fitness test, Cunningham and Volknz Treadmill.

Cardio-Pulmonary Fitness is the functional capacity of both the Cardiovascular and the respiratory systems. Also it is the efficiency of the body to transport and consume oxygen (pulse during exercise, the rate of O₂ consumption per pulse). For skill performance efficiency, the researcher to divide it to the offensive behavior coefficient, the defensive behavior coefficient and the tactical activity coefficient, then he used the following equation [7].

The Equation:
$$M = \frac{\frac{n}{N} + \frac{n1}{N}}{m}$$

M = Skill performance efficiency

m = Number of rounds

n = Rate of right punches

N = Total technical skills carried out by the boxer

n1 = Rate of failed attacks rebuffed by the competitor

N1 = Total skills carried out by the opposing boxer

C Panasonic Video Tape Recorder (VCR - 225) to tape and analyze the game.

C Cardio-Pulmonary fitness measurement device (Cardio-Pulmonary fitness test)

Pre Measurements: The pre measurements for both the (experimental and control groups) were taken during 29-30/6/2011 in the boxing gym to measure (height- weight - strength & speed endurance test- the offensive behavior coefficient- the defensive behavior coefficient- the tactical activity coefficient). And the physiological measurements (pulse during exercise, the rate of O2 consumption per pulse) in the Faculty of Physical Education- Mansoura University.

Training Program: The training program was implemented on the experimental group in the Olympic Village in Mansoura University for a period of 12 weeks from 07/02/2011 to 09/23/2011. The number of weekly training units is 4 and the period of each unit is 75-135 min. Endurance levels were distributed on the training weeks, where the medium endurance level is between 50 and 74%, high endurance level is between 75 and 84% and the maximum endurance level is between 85 to the limits of the boxer 100% and the cycle of endurance is 1:1.

C The period of the training program has been divided into three stages:

C Weeks general strength and speed endurance exercise.

C Weeks special strength and speed endurance exercise.

C Weeks of general and special development training to improve the technical and tactical skills that enhances during the games by using devices and tools that are similar to the positions of the game.

The training program aims to develop (strength and speed endurance) using groups of various training exercises, whether individual exercises based on body weight or double exercises based on the body weight of a colleague or a medical balls and loads, taking into account individual differences of loads. As for the control group, the program has been applied and contained the same general and special physical preparation exercises, without focusing on strength and speed endurance development exercises.

Post Measurements: Post measurements were taken after the implementation of the training program on the experimental and control group during the period from 25-26/9/2011, according to pre measurements.

Statistical measurements: arithmetic average - Wilcoxon test - Mann-Whitney test - the equation of the improvement percentage.

RESULTS AND DISCUSSION

It is clear from Table 3 that the highest percentage of improvement was the offensive behavior coefficient by 58.9% and the least percentage of improvement was the pulse during exercise by 0.9%.

It is clear from Table 5 that the highest percentage of improvement was the strength endurance behavior coefficient by 88.8% and the least percentage of improvement was the pulse during exercise by 4.6%.

It is clear from Tables 2 and 3 and Fig. 1 the existence of significant differences at the level of 0.05 between pre and post measurements of the control group in favor of the post measurements in speed endurance test, strength endurance test, where the value of (Z) is 2.803 and 2.705. The percentage increase to 37.6% and 42.1%. This shows significant progress in this test in terms of regular training which has a positive effect on increasing the physical capacity for post measurements [8, 9].

As shown in Tables 2 and 3 and Fig. 1, there are significant differences at the level of 0.05 between pre and post measurements of the control group in favor of the post measurements in Cardio-Pulmonary fitness (pulse during exercise, the rate of O2 consumption per pulse). The value of (Z) is 1.973 and 2.121. The percentage of increase is 6.3% and 0.9% as regular training leads to functional changes in body organs. Whenever such changes are positive, the athlete performance is better [10, 11].

Table 1: Endurance compounds and characteristics of their implementation

Serial	Endurance compounds	Endurance Characteristics	Performance Time	Breaks	Pulse Rate P/min.	Endurance intensity %
1	Strength endurance	medium	20:30 sec.	30:60 sec.	133:150 sec.	50:74
		High	30:45 sec.	60:90 sec.	154:169 sec.	75:84
		Maximum	45:60 sec.	90:120 sec.	171:200 sec.	85:100
2	Speed endurance	medium	45:60 sec.	50:60 sec.	133:150 sec.	50:74
		High	20:45 sec.	20:30 sec.	154:169 sec.	75:84
		Maximum	10:20 sec.	10:20 sec.	171:200 sec.	85:100

Table 2: Significant differences among average pre and post measurements of the control group for endurance compounds, Cardio-Pulmonary fitness and skill performance efficiency N=10

S	Variables	Test	Pre-test mean	Post-test mean	Positive Ranks		Negative Ranks		Z
					mean Ranks	Sum of Ranks	mean Ranks	Sum of Ranks	
1	Endurance Compounds	Performing straight left and right blows on the punching bag during 20 sec.	43.4	59.7	5.5	55.5	-	-	2.803
2		Performing straight left and right blows on the punching bag for 1 min.	83.3	118.4	6.00	54.00	1.00	1.00	2.705
3	Cardio-Pulmonary fitness	pulse during exercise	181.6	179.9	2.00	4.00	5.33	32.00	1.973
4		the rate of O ₂ consumption per pulse	22.3	23.7	3.5	15.00	-	-	2.121
5	skill performance efficiency	the offensive behavior coefficient	0.175	0.278	5.00	45.00	-	-	2.692
6		the defensive behavior coefficient	0.225	0.283	4.5	36.00	-	-	2.673
7		the tactical activity coefficient	0.400	0.561	5.5	55.5	-	-	2.807

The value of "Z" indexed at the level of significance $0.05 = \pm 1.96$

Table 3: The percentage of the control group improvement in terms of endurance compounds, Cardio-Pulmonary fitness and skill performance efficiency

S	Variables	Test	Pre-test mean	Post-test mean	Mean difference	Development percentage %
1	Endurance Compounds	performing straight left and right blows on the punching bag during (20 sec.)	43.4	59.7	16.3	37.6
2		performing straight left and right blows on the punching bag for (1 min.)	83.3	118.4	35.1	42.1
3	Cardio-Pulmonary fitness	pulse during exercise	181.6	179.9	1.7	0.9
4		the rate of O ₂ consumption per pulse	22.3	23.7	1.4	6.3
5	Skill performance efficiency	the offensive behavior coefficient	0.175	0.278	0.103	58.9
6		the defensive behavior coefficient	0.225	0.283	0.058	25.8
7		the tactical activity coefficient	0.400	0.561	0.161	40.3

Table 4: Significant differences among average pre and post measurements of the experimental group for endurance compounds, Cardio-Pulmonary fitness and skill performance efficiency N=10

S	Variables	Test	Pre-test mean	Post-test mean	Positive Ranks		Negative Ranks		Z
					mean Ranks	Sum of Ranks	mean Ranks	Sum of Ranks	
1	Endurance Compounds	performing straight left and right blows on the punching bag during (20 sec.)	46.8	85.4	5.5	55.0	-	-	2.805
2		performing straight left and right blows on the punching bag for (1 min.)	85.6	161.6	5.5	55.0	-	-	2.803
3	Cardio-Pulmonary fitness	pulse during exercise	23.0	29.4	5.5	55.0	-	-	2.827
4		the rate of O ₂ consumption per pulse	181.0	172.0	-	-	5.5	55.0	2.811
5	skill performance efficiency	the offensive behavior coefficient	0.199	0.363	5.00	55.0	-	-	2.812
6		the defensive behavior coefficient	0.232	0.345	4.5	39.0	-	-	2.539
7		the tactical activity coefficient	0.431	0.708	5.5	55.0	-	-	3.803

The value of "Z" indexed at the level of significance $0.05 = \pm 1.96$

Table 5: The percentage of the experimental group improvement in terms of endurance compounds, Cardio-Pulmonary fitness and skill performance efficiency

S	Variables	Test	Pre-test mean	Post-test mean	Mean difference	Development percentage %
1	Endurance Compounds	Performing straight left and right blows on the punching bag during 20 sec.	46.8	85.4	38.6	82.5
2		Performing straight left and right blows on the punching bag for 1 min.	85.6	161.6	76.0	88.0
3	Cardio-Pulmonary fitness	Pulse during exercise	23.0	29.4	6.4	4.6
4		The rate of O ₂ consumption per pulse	181.0	172.7	8.3	27.4
5	Skill performance efficiency	The offensive behavior coefficient	0.199	0.363	0.164	82.4
6		The defensive behavior coefficient	0.232	0.345	0.113	48.7
7		The tactical activity coefficient	0.431	0.708	0.277	64.3

Table 6: Significant differences between average pre and post measurements of the control group for endurance compounds, Cardio-Pulmonary fitness and skill performance efficiency, N=10

S	Variables	Test	Mean Control	Mean experimental	Control		Experimental		Z
					Mean Ranks	Sum of Ranks	Mean Ranks	Sum of Ranks	
1	Endurance Compounds	Performing straight left and right blows on the punching bag during 20 sec.	59.7	85.4	5.5	55.0	15.5	155.0	3.784
2		Performing straight left and right blows on the punching bag for 1 min.	118.4	161.1	5.5	55.0	15.5	155.0	3.791
3	Cardio-Pulmonary fitness	pulse during exercise	179.9	172.7	5.5	55.0	15.5	155.0	3.891
4		the rate of O2 consumption per pulse	23.7	29.4	15.5	155.0	5.0	55.0	3.820
5	skill performance efficiency	the offensive behavior coefficient	0.278	0.363	6.15	61.5	14.85	148.5	3.302
6		the defensive behavior coefficient	0.283	0.345	7.7	77.0	13.3	133.0	2.131
7		the tactical activity coefficient	0.561	0.708	5.95	59.5	15.05	150.5	3.443

The value of "Z" indexed at the level of significance $0.05 = \pm 1.96$

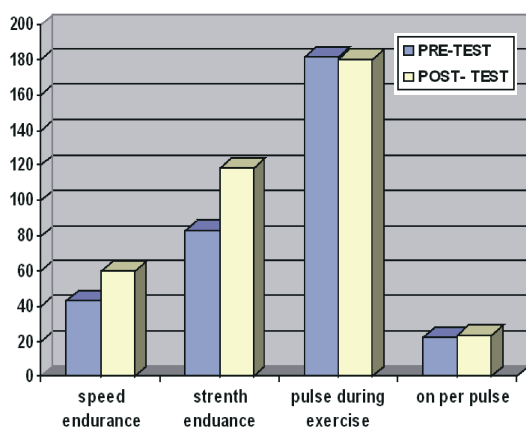


Fig. 1: The significance of differences between average pre and post measurements of the control group for endurance compounds and Cardio-Pulmonary fitness

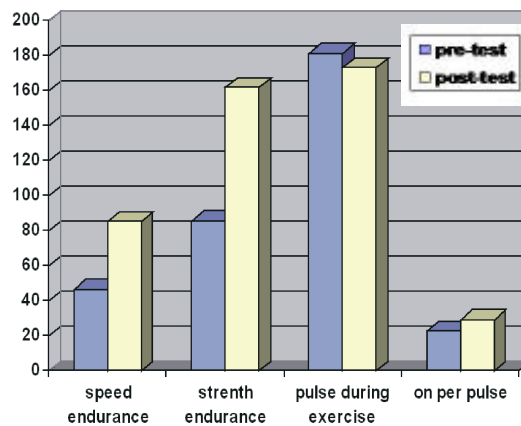


Fig. 3: The significance of differences between average pre and post- measurements of the experimental group for endurance compounds and Cardio-Pulmonary fitness

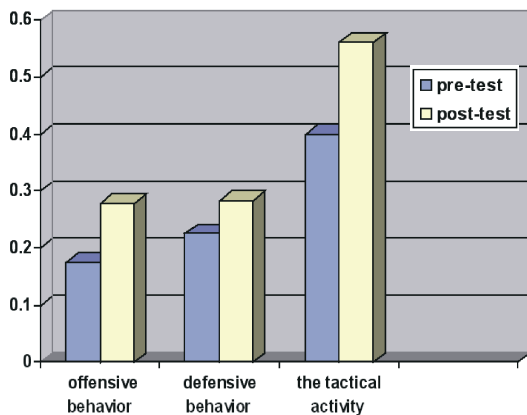


Fig. 2: The significance of differences between average pre and post measurements of the control group for the efficiency of the tactical activity

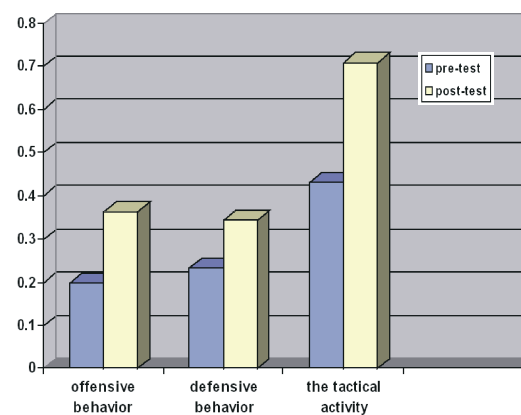


Fig. 4: The significance of differences between average pre and post measurements of the experimental group for the efficiency of the tactical activity

It is clear from Tables 2 and 3 and Fig. 2 that there are significant differences between pre and post measurements of the control group in favor of the

post measurements in skill performance efficiency (the offensive behavior coefficient-the defensive behavior coefficient-the tactical activity coefficient),

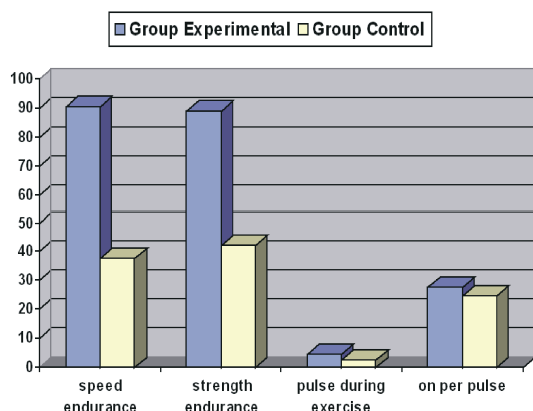


Fig. 5: The significance of differences in the improvement percentage between the control and the experimental group for endurance compounds, and Cardio-Pulmonary fitness

where value (Z) is 2.692, 2.673 and 2.807. The percentage of increase is 58.9%, 25.8% and 40.3% indicating the progress of the control group in the technical skills under study.

It is clear from Tables 3 and 4 and Fig. 3 the existence of significant differences at the level of 0.05 between pre and post measurements of the experimental group in favor of the post measurements in speed endurance test, strength endurance test, where the value of (Z) is 2.805 and 2.803 and the percentage increased to 82.4% and 88.8%. This shows the progress of the level of boxers in the experimental group in terms of the endurance compounds under discussion. The researcher believes that this progress is due to the impact of training program, which depends on regular training, as well as the number of training units for this group, which amounted to (4) training units per week and regular training [12].

The researcher explains the significant differences in speed and strength endurance test by that the modern boxing depends on the speed and dodges blows and counter-attacks. Light boxing training affects the vital organs of the boxer positively in terms of the physiological work that led to the high level of speed and strength endurance [13].

It is clear from Tables 2 and 3 and Fig. 2 the significant differences at the level of (0.05) between the pre and post measurement of the experimental group in favor of the post measurement in Cardio-Pulmonary fitness where the value of (Z) is 2.811 and 2.827 and the percentage increase is 27.9% and 4.6%.

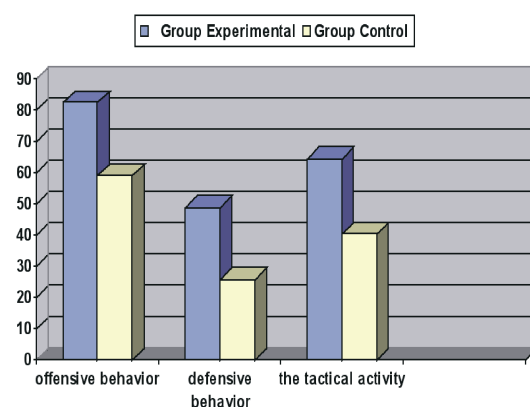


Fig. 6: The significance of differences in the improvement percentage between the control and the experimental group for the tactical activity coefficient

The researcher confirms the progress in the level of the boxers in the experimental group in terms of the functional changes due to the quality of endurance training according to physiological, as well as the training methods used [14,15].

It is clear from Table 3 and 4 and Fig. 4 that there are statistically significant differences between the pre and post measurements for the experimental group in favor of the post measurements in the skill performance efficiency, as the value of (Z) is 2.812, 2.539 and 2.803. The percentage of increase is 82.4%, 48.7% and 64.3%. This indicates the progress of the boxers in the experimental group in terms of the technical skills in question. This difference is also due to using training devices and instruments with loads that are similar to the positions of the game, so this led to increasing the skill performance efficiency of the boxers positively [16,17].

Table 6 and Fig. 5 and 6 indicate statistical significant differences at the level of (0.05) between the two experimental and control groups of in favor of the experimental group in the (endurance compounds-Cardio-Pulmonary fitness - skill performance efficiency) tests under discussion, where the limited value of (Z) is between 2.131 and 3.891, while (ϕZ) indexed ± 1.96 .

The researcher believes that these moral differences between the two groups in terms of endurance compounds exercise is due to the set of various and multiple exercises, which enhanced the capabilities of the players taking into account their individual differences of endurance, progression, severity and occurrences which contributed significantly to increase the endurance compounds for the study sample. It also enhanced the

physical attributes of boxer, which play an important role in the continued motor performance in the attack, defense and counterattack.

The regular training and appropriate training program for boxers lead to improvement in the functional variables (pulse rate during exercise, the rate of O₂ consumption per pulse). During the game (11 min) in three rounds (each 3 min), breaks between each round were 1 min. [18, 19].

The researcher believes that these moral differences between the two groups in terms of skill performance efficiency test, is due to the set of punching exercises similar to the performance of the boxer during the games and the training using devices and punching tools under different conditions of training loads that are similar to what happens during games through special training programs for each boxer [20].

CONCLUSION

Within the study sample, characteristics and capabilities available and the implemented procedures to achieve the objectives of the study, the following conclusions could be reached:

- C The training program of the control group had a positive impact on endurance compounds and Cardio-Pulmonary fitness.
- C The training program, which aims at the development of endurance compounds in its content and characteristics, had a positive impact on the development of strength endurance, speed endurance and Cardio-Pulmonary fitness.
- C There is a positive trend of uneven improvement in the level of endurance compounds and Cardio-Pulmonary fitness of the experimental group. The highest percentage for strength endurance was 88.8%, speed endurance was 82.5%, while the lowest rate of improvement was for pulse during exercise 4.6% and the rate of O₂ consumption per pulse 27.8%.
- C High rate of improvement in the degree of effectiveness of the boxer's performance in the experimental group, which amounted to 64.3% and it amounted to 40.3% in the control group.

Recommendation: Based on the findings of the researcher and in light of the results and objectives of the research the researcher recommends the following:

- C The application of exercises using endurance compounds under study because of its effectiveness in raising the level of strength and speed endurance, pushing in the direction of improving the Cardio-Pulmonary fitness and skill performance efficiency of the boxers.
- C Trainers need to take account of the extreme importance of speed and strength endurance exercises of boxers in the light of amendments to the law and guide the training according to their importance.
- C Application of endurance compounds training in the preparation and tactical pre-match phase at the end of the module after the warm-up to ensure the benefit of the policy actions to the fullest.
- C Attention to developing scientific programs that raise the level of physical and tactical skills of the boxers of all different levels.

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