DOI:https://doi.org/10.61841/bddqrh80 Publication URL:https://nnpub.org/index.php/EL/article/view/2946

THE EFFECT OF COMPLEX STRENGTH TRAINING ON EXPLOSIVE POWER AND SPEED STRENGTH OF BOXERS UNDER 20 YEARS OF AGE

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To Cite This Article: QASIM KADHIM , A. (2025). THE EFFECT OF COMPLEX STRENGTH TRAINING ON EXPLOSIVE POWER AND SPEED STRENGTH OF BOXERS UNDER 20 YEARS OF AGE. ***International Journal of Advance Research in Education & Literature (ISSN 2208-2441)*****,** ***11*****(2).** **https://doi.org/10.61841/bddqrh80**

ABSTRACT

Muscular capabilities are among the fundamental pillars upon which skill performance in boxing depends, particularly explosive power and speed strength, due to their crucial role in executing offensive and defensive combat skills during a fight. From this perspective, the research problem arose regarding the limited effectiveness of traditional training methods in developing these capabilities among juniors. This necessitated the search for more modern and effective training alternatives that keep pace with the demands of high performance in boxing.

Accordingly, this study aimed to develop a physical training curriculum based on the principle of strength complexity, a contemporary training method that combines weight training, plyometric exercises, and jumping exercises. The goal is to stimulate the neuromuscular system and achieve a high physiological response that contributes to the development of players' physical and skill performance. The researcher sought to measure the impact of this approach on developing explosive power and speed arm strength among Al-Hilla Club boxing players under the age of twenty. Based on the study's objective, the researcher formulated his main hypothesis, which states that there is a positive effect of physical training based on the principle of strength complexity on developing explosive power and speed strength in young boxers, with statistically significant differences between the results of the pre- and post-tests in favor of the post-test.

To achieve the study's objectives, the researcher used the experimental method with a single-group design with pre- and post-measurements, as it suited the nature and requirements of the study. The research sample included (6) players randomly selected from a research population of (9) boxers, while the other three were assigned to the exploratory experiment. The training program was implemented over a period of eight weeks, with three training sessions per week. Modern sports training principles were used in terms of intensity, volume, repetition, and rest, commensurate with the players' abilities.

Measurement tools relied on standardized field tests to assess the explosive power of the arms (throwing a medicine ball) and speed strength (lowering and raising the medicine ball within a specified time), supported by the use of technological means to ensure accuracy and reliability in performance and measurement. The importance of the study lies in its endeavor to provide a modern applied vision that contributes to the development of the physical abilities that influence the skill performance of junior boxers. This is achieved by employing advanced scientific training methods that keep pace with the requirements of high-performance sports. It also aims to enrich the training content of coaches and specialists with scientific material that can be applied practically.

The researcher concluded that exercises based on the principle of force complexity are an effective training tool for developing explosive power and speed arm strength. They significantly improved aspects of physical performance associated with skill performance among the sample. The researcher recommends adopting the force complexity approach within training programs directed at boxers, given its positive impact on developing muscular motor abilities. He emphasized the importance of focusing on developing explosive power as one of the critical variables in improving physical and skill performance in boxing.

Keywords: *Complex strength, explosive power, speed strength.*

INTRODUCTION

Boxing is a combat sport that requires a high level of physical and skill capabilities. Effective performance depends on multiple elements, such as speed, timing, accuracy, and the ability to execute strikes efficiently under stressful competitive conditions. Explosive ability and speed arm strength are essential characteristics of boxing combat performance, as they play a direct role in effectively executing offensive and defensive strikes.

With the development of sports training concepts, a modern training method known as "complex training" has emerged. This method combines high-resistance exercises and plyometric exercises in a single training unit, with the goal of achieving effective and speed neuromuscular adaptation. This method is considered a contemporary trend in developing specific strength and has shown positive results in sports that require explosive muscular performance and high-speed movement, such as boxing. Herein lies the research problem. Through field observation of the training situation at the Hilla Club for the under-20 youth category, the researcher observed a relative weakness in explosive power and speed strength, which could negatively impact the level of skill and combat performance in the ring. Hence, the idea of the research emerged, implementing a training program based on the principle of force complexity to measure its impact on developing these basic physical abilities among junior boxers. The research problem is embodied in the following question:

Do physical training based on the principle of force complexity contribute to the development of explosive power and speed strength among Hilla Club boxers under 20 years old?

The aim of the research was to develop physical training using force complexity and include it in training modules for boxers, and to determine the impact of these exercises on developing explosive power and speed strength of the arms. The researcher hypothesized that there is a positive effect of physical training with force complexity on developing explosive power and speed strength among Hilla Club boxers under 20 years old. There are statistically significant differences between the results of the pre- and post-tests in favor of the post-test for the experimental group. The importance of this research stems from the fact that it addresses a modern training method that has not been widely applied in the local environment, especially among juniors. The research also contributes to providing an integrated scientific vision for a physical program that can be adopted to improve the specific physical abilities associated with combat performance in boxing. It is expected that its results will contribute to enriching the training practices of coaches and specialists in preparing young boxers according to modern scientific foundations. The research areas were: A sample of Al-Hilla Club boxers in the under-20 category, numbering (9) players, for the period from 10/12/2024 to 10/4/2025, in the Al-Hilla Sports Club hall.

METHOD AND PROCEDURES

The nature of the problem is the basis that determines the most appropriate scientific approach to address it, with the goal of arriving at and uncovering the truth in a systematic, organized manner that leads to accurate results. This is confirmed by (Omar, 2001, p. 221), who states: "The nature of the problem determines the research methodology for arriving at and uncovering the truth to arrive at a specific result." Based on this, the nature of the phenomenon the researcher is addressing determines the type of approach used. Therefore, the researcher adopted the experimental approach by designing two groups, the experimental and control, with pre- and post-tests, according to its scientific steps, and to suit the nature and objectives of the research, as shown in Table (1).

Table (1) shows the experimental design adopted in the research.

Groups	pre-test	Experimental dealing	post- test
Experimental group	Explosive power for arm and speed strength for arm test	Physical Training Strength Complexity+ Coach Method	Explosive power for arm and speed strength for arm test
Control group		Coach- Workouts Only	

The research community and sample were determined by the Hilla Sports Club's (9) boxers for the 2024-2025 sports season. The researcher selected (6) boxers by lottery, and the remaining three boxers represented the exploration sample. When selecting the sample, the researcher ensured the greatest degree of homogeneity to ensure a unified research approach in terms of training intensity, program duration, and implementation and monitoring methods. This enhanced the accuracy of the results and the validity of the conclusions drawn from the experiment.

TOOLS USED IN THE RESEARCH

Arab and foreign sources, the Internet, observation, testing, and measurement, (1) Korean-made Dell laptop, (1) Korean-made Casio video camera with a speed of (500 fps) and its accessories, (3) Chinese-made Kislo 610 manual stopwatches, (1) Chinese-made Sharp handheld electronic calculator.

TESTS: MEDICINE BALL THROW TEST (800 G)

- Purpose: To assess explosive power of the arms, which is the ability to generate large forces in a short period of time, essential for high performance in boxing and other explosive-based activities (Hoffman et al., 2010).
- Equipment:
  - Sitting chair
  - Medicine ball weighing 800 g
  - Measuring tape
- Performance Procedure: The subject sits on a chair with their back fixed to minimize trunk movement, holding the medicine ball with their preferred hand. They begin by pulling their arm backward as far as possible without the assistance of their other arm, then throw the ball as far as possible. Two repetitions are allowed, and the best distance achieved is considered.
- Recording Procedure:
  - Explosive power is calculated using the following equation (Spirito & Feldman, 1992):
  - \text{Explosive power} = \frac{(\text{Throwing distance} \times \text{Ball mass}) + \text{Thrower's arm mass}}{2}

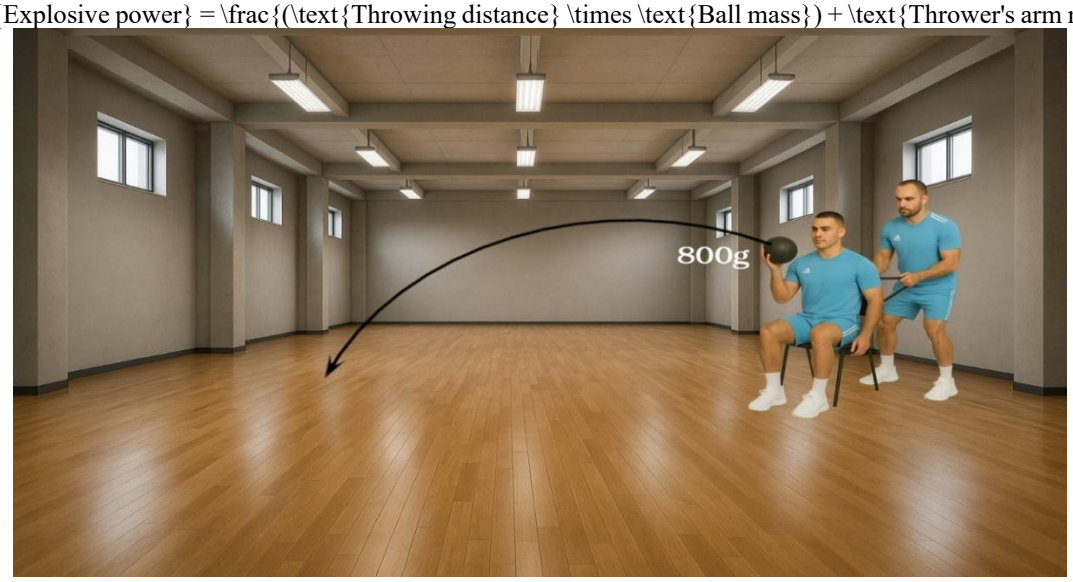

Figure (1) show the medicine ball throw test (800 grams)

MEDICINE BALL LOWERING AND RAISING TEST (2 KG) FOR 15 SECONDS

- Purpose of the test: To measure the speed of the preferred arm, which represents the muscles' ability to perform speed repetitions of motor movements with high force within a short period of time (Cormie et al., 2011).
- Equipment:
  - A 2 kg medicine ball
  - A flat field or hard floor
  - A stopwatch
  - A whistle
  - A scoring form
- Performance method: The player lies on their back holding the medicine ball in their preferred arm. When the starting whistle is heard, they flex and extend their arm as quickly as possible, repeating the movement for 15 consecutive seconds.
- Recording: The number of times the ball is lowered and raised during the 15 seconds is recorded. The test is performed only once per player.

Figure (2) illustrates the 15-second medicine ball lowering and lifting test (weight 2 kg).

EXPLORATION EXPERIMENT

The researcher conducted the Exploration experiment on December 15, 2024, on (2) members of the research sample who were not excluded from the main experiment. The purpose was to determine the progress of the tests, control the components of the qualifying curriculum, and ensure the safety of the equipment and tools.

PRE-TESTS

Before beginning the strength-complexity physical training, the researcher conducted a pre-test on the research variables (arm explosive power, arm speed power) on December 28, 2024. This was to establish the measurement scores, identify physical levels, and work accordingly when preparing strength-complexity physical training.

MAIN EXPERIMENT

The researcher conducted the main experiment within the framework of a physical training program based on the principle of strength complexity, with the goal of developing explosive power and arm speed power among Al-Hilla Club boxing players under 20 years of age. This program was prepared based on an extensive scientific review of a number of foreign and local sources and references specializing in sports training, taking into account the physical levels and individual capabilities of the research sample. The training program was implemented within the special preparation phase, and the experiment extended for the period from Saturday 2/1/2025 until Saturday 12/3/2025, for a period of (8 training weeks).

TRAINING PROGRAM DETAILS

- Number of training units per week: 3 units.
- Training days: Sunday, Tuesday, Thursday.
- Total number of training units during the program: 24 training units.

Training method used: Repeated Effort Method, due to its effectiveness in developing the targeted physical attributes.
Training intensity: Ranged between 90% and 100% of the one-repetition maximum (1RM).
Duration of each training unit: Ranged between 60 and 75 minutes, depending on the nature of the exercises and training intensity.

The program was implemented in the Al-Hilla Boxing Club gym. The researcher ensured adherence to the training schedule and adherence to the principle of gradual training load, while recording all observations related to the players' performance and training responses.

POST-TESTS

After completing the strength-based physical training program, which was prepared by the researcher and included in the training curriculum for the experimental group, the researcher re-administered the post-tests to measure the variables of explosive power of the arms and speed power of the arms. These are the same two tests administered in the pre-test phase.

The researcher ensured that the post-tests were conducted under the same conditions and procedures as the pre-tests, to ensure the consistency of the results and the accuracy of the comparison between the pre- and post-tests.

The post-tests were administered on Thursday, March 25, 2024, in the same location, using the same tools, and under the supervision of the same team, to ensure the standardization of all variables influencing the measurement process.

STATISTICAL METHODS

The researcher used the statistical methods relevant to comparing the results of the pre- and post-tests. He used the statistical package (SPSS) and the following: mean, standard deviation, simple Pearson correlation coefficient, and independent samples t-test.

RESULTS

Table (2) shows the values of the mean and standard deviation, the calculated (T) value, and the level and type of significance for the explosive power of the arms and the speed strength for arm of the arms for the experimental group.

Variables	Pre-test		Post-test		mean of difference	standard deviation of differences	T value calculated	Level Sig	Type Sig
	mean	STD	mean	STD					
Explosive power for arm	224.833	36.597	389.833	28.820	165	59.441	6.799	0.001	Sig
speed strength for arm	22.833	1.472	33	1.414	10.167	1.722	14.458	0.000	Sig

Table (2) shows the statistical values of the results of the pre- and post-tests of the study variables for the experimental group members.

The results showed a clear superiority in the post-test averages compared to the pre-tests in both the explosive power of the arms and the speed strength of the arms. This improvement resulted in statistically significant differences in favor of the post-tests, as demonstrated by the results of the (T) test for related samples, where the statistical significance value was less than the (0.05) level, confirming the existence of a positive and effective impact of training based on the strength complexity method in improving the targeted physical variables of the sample members.

DISCUSSION

The results of the experimental group showed significant differences between the pre- and post-measurements in all physical variables, particularly explosive power in the arms and speed power in the legs. These differences were in favor of the post-measurements. This improvement is attributed to the effectiveness of the strength complexity training program, which included a combination of high-resistance and plyometric exercises. This training style helped stimulate the neuromuscular system in an integrated manner, leading to a clear improvement in physical performance.

These results support the study by (Liu et al. 2024), which showed that variable resistance training within a complex framework led to a significant improvement in maximum strength and punching performance in boxers, thanks to the combination of high-intensity exercises and those that rely on speed and muscle explosion.

A recent systematic review by (Wang et al. 2023) also confirmed that complex training is one of the most effective training methods for developing explosive power, especially when applied for periods exceeding 6 weeks, as it contributes to effective physiological adaptations in the neuromuscular system. Similarly, (Yi et al. 2023) indicated in their study that strength training using combined methods contributed to the development of physical indicators associated with combat performance, including reaction speed and motor timing accuracy.

In a similar vein,(Cui et al. 2024) found that training using optimal loads significantly improved reactive strength and punching ability in boxers, by enhancing neuromuscular adaptation resulting from regular training.

Accordingly, these results confirm the importance of adopting a complex training approach in the physical preparation of boxers, given its clear impact on developing the motor and skill capabilities associated with combat performance.

The researcher indicates that the exercises based on the strength complexity approach included in the training program were characterized by a variety of intensity and repetitions, which clearly impacted the nervous system, helping to accelerate muscular responses and improve the training status of the sample. The results of the explosive power and speed strength tests showed a significant improvement as a result of using these complex exercises, especially when combined with weight training and plyometrics, which have proven effective in improving neuromuscular performance (Berriel et al., 2022).

The researcher attributes this improvement to the careful rationing of training loads and the selection of exercises based on the strength complexity approach, with a systematic gradation in intensity and difficulty. Research confirms that this

method leads to significant increases in explosive power due to the recruitment of a greater number of motor units (Duthie, Young, & Aitken, 2002). (Kawamori & Haff ,2004) also explain that fast performance under high resistance stimulates the central nervous system to activate the largest possible number of neurons, enhancing the effectiveness of nerve conduction to the relevant muscle groups. This contributes to the development of strength characterized by speed and explosiveness.

According to (Dunn et al. 2022), applying weight- and plyometric training at an intensity ranging from 90% to 100% with correct techniques contributes to improving players' performance by increasing the effectiveness of the neuromuscular system.

A recent study supports this research, showing that compound training that combines high intensity and motor speed enhances overall physical performance and develops strength and speed in athletes (Chen et al., 2018). The researcher attributes the noticeable improvement in the experimental group to the effectiveness of the training program based on the strength complexity approach, which combined weight training with plyometrics in a scientifically studied manner. This combination contributed to the development of explosive power in the arms and speed strength. Plyometric exercises utilize fixed resistance and emphasize speed of performance, which aligns with the power development equation (power = strength × speed) and enhances the performance of fast-twitch muscles (1) (Cormie et al., 2011).

Weight training was effective in stimulating the largest number of fast-twitch muscle fibers, while plyometric training supported this work through the stretch-shortening cycle, leading to reduced muscle contraction and relaxation time, and consequently, reduced ground contact time during skill performance. This was reflected in the improved post-test results of the players (2) (Markovic & Mikulic, 2010).

The researcher asserts that the varying intensity of exercises within the strength complexity approach led to clear adaptations in muscle fibers, which helped increase the efficiency of force production, especially among players who rely heavily on physical attributes such as explosive power and speed strength, which are essential elements in boxing (3) (Suchomel et al., 2018).

He also (4) (Zatsiorsky & Kraemer, 2006) indicated that strength training alone may not be sufficient to improve an athlete's overall motor performance. Rather, it must be supported by plyometric training, which contributes to the development of neuromuscular coordination and enhances range of motion and flexibility, which is the foundation for integrated physical development.

The researcher therefore concludes that the integration of weight training and plyometrics forms a solid training foundation, the results of which are reflected across various aspects of athletic performance. He emphasized that the use of the strength complexity approach in the training program was one of the decisive factors in improving the physical and skill outcomes of the experimental group. Training using a strength complexity approach, which combines plyometric and weight training, contributes to improving explosive power and speed arm strength. These exercises rely on fixed resistance, which enhances strength stability and focuses on speed of performance, leading to the development of physical abilities according to the power equation (power = strength × speed). Weight training stimulates fast-twitch muscle fibers, which is essential because these fibers play the largest role in the development of speed muscle strength. This requires the muscles to adapt to contract with maximum force and speed, with high coordination in the central nervous system (Smith et al., 2021).

The selected exercises also stimulate the necessary muscle fibers and increase the number of activated motor units, which increases explosive power and speed strength. Studies confirm that the response of the neuromuscular system and the development of sensorimotor pathways contribute to improving the speed of reflexes and generated force (Johnson & Lee, 2022). Therefore, the researcher focused on designing training modules that emphasize explosive exercise performance, applying correct techniques and high intensity, yielding tangible positive results in developing speed strength in the arm muscles. This is consistent with recent studies, which have shown that combining high-speed strength training with plyometric exercises leads to increased motor unit engagement and effective arousal, while reducing muscle contraction time, enhancing muscle force production at the fastest possible speed (Garcia et al., 2023). This integration of training techniques enhances athletic performance by developing muscular structure and neuromuscular capabilities, which is essential for achieving optimal strength and explosiveness in athletes, especially in sports that require high speed and strength, such as boxing.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

- The strength-complexity physical exercises prepared and included in the training curriculum had a positive impact on the research sample.
- Strength-complexity physical training has a positive impact on developing (explosive power and speed strength) in the arms.

RECOMMENDATIONS

- Using strength-complexity physical training because of its positive impact on developing the physical capabilities (explosive power and speed power) of boxers.
- The need for coaches to focus on developing explosive power, given its fundamental role in improving boxers' physical performance.
- Emphasizing the development of speed power in a scientific and thoughtful manner, given its positive impact on boxers.
- Conducting similar studies on other physical abilities and various sporting activities.

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