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Effects of a Rehabilitation Program Using Pilates Exercises on Some Bio-markers of Kick-Boxers with Thigh Muscles Rupture

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ABSTRACT:

The current research aims to design a rehabilitation program using Pilates exercises and identifying its effects on some bio-markers of kick-boxers with thigh adductor rupture. The researchers used the experimental approach (one-group design) with pre- and post-measurements. Research community included (24) kick-boxers of the Egyptian National Team with thigh adductor rupture. Pilot sample included (10) kick-boxers while the main sample included (14) players. Results indicated that:

- The rehabilitation program using Pilates exercises improves biomarkers represented by muscle tear enzymes (transaminase enzymes – Creatine phosphokinase – acetylcholinesterase). This improvement results in a statistically significant reduction in muscle tears, as evidenced by the pre- and post-measurement differences in muscle tear indicators and the enzymes ALT, AST, and CPK.
- Regular Pilates training leads to enhanced physical fitness, improved biological condition, and consequently, increased efficiency of the muscles working around the hip joint.

Key Words: Rehabilitation – Pilates – Bio-markers – Kick-Boxing.

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1. INTRODUCTION:

Sports Physiology is a major science for sports training workers as it is concerned with functional changes happening to the body as an adaptive response to physical exercise. Minor muscular injuries may hinder in-field performance. Therefore, it is necessary to find faster and better ways that help athletes to quickly return to play (**Heshmat & Shalaby 2003**).

Rehabilitation programs should be designed to fulfill the needs of each injured person considering the type and degree of injury. The more positive the patient's involvement is, the more successful the program is. The aim of post-injury rehabilitation is to help the patient to recover to the highest possible functional and physical conditions in addition to improving his/her quality of life on all levels (**McMahon, Patrick 2007**).

Rehabilitation is to restore or maintain full function of the injured body part. Basically, it depends on identifying the causes of the injury and to evaluate them correctly in addition to apply the best ways of treatment. The regular patient is rehabilitated to perform all necessary daily functions, needs and duties easily and without disturbance (**Gross et al, 2010**).

Thigh adductor muscles are more vulnerable to rupture due to excessive use. It is a common injury among athletes. It can lead to excluding the athlete and wasting time without any athletic activity. Some studies indicated that thigh adductor rupture is responsible for nearly 68% of total injuries among athletes (**Nakagawa et al 2008**).

Recent statistics indicated that thigh adductor rupture may return even more severe to the same place due to negligence or lack of or insufficient rehabilitation before competitions. Due to its importance, coaches should work on preventing injuries in these muscles and quick recovery in case of injury (**Widler et al 2009**).

This injury reappeared in many athletes even after rehabilitation and turned in a chronic injury. Studies indicated that the percentage of repeated thigh adductor rupture reached 75% and this makes it chronic. This percentage is divided into 25% for quick involvement in play before full recovery, 18% for insufficient rehabilitation period and false estimation of type, 13% for increased loads after return to matches and training and 19% for neglecting preventive exercises (**Crossley et al 2011**).

Rehab specialists working with thigh adductor rupture injuries should be patient till full recovery is achieved as treatment may take long time and hastiness to return to sport may lead to chronic pain and worsen the injury to the degree that it becomes difficult to heal (**Delmore et al 2014**).

Kick-boxing is a sport with high physical demands as other martial arts and combat sports require endurance but there is no other sport that requires this amount of explosive power to achieve efficiency of technical performance. Kick-boxing has many physical fitness requirements as the speed and power of the kick and punch are key factors in determining the

efficiency of performance and the ability to win. Technique is the back-bone of kick-boxing training as the player can direct kicks and punches with more power through focusing on accurate execution of technique instead of floundering and wasting effort. Each technique in kick-boxing consists of a group of basic points that should be followed so as not to waste the player's energy in vain. It is possible that the player may kick the opponent to take him down without applying suitable force and this wastes a chance for taking the opponent down due to not following the correct steps of technique as actual force is generated from learning the correct technique to preserve energy and control suitable force for execution (**Lai et al 2014**).

Due to high physical demands of kick-boxing, players feel exhausted quickly. To avoid that, endurance should be improved to enable players maintain this energy and the ability to execute kicks and punches with the required speed, accuracy and power. Endurance is responsible for maintaining performance for prolonged periods of time with the same efficiency and technical effectiveness while decreasing fatigue and exhaustion resulting from playing (**Salci 2015**).

Pilates became increasingly very popular recently in treating low back pain. It is named after Joseph Pilates in 1920. It was called "The Science of Control" as it can be performed with or without tools. It is based on a set of basic principles. It helps in full body adaptation that aims to improve body awareness and posture. It includes equally measured muscular contractions of the core muscles responsible for maintaining body static or dynamic stability without moving the joints. It includes purposeful use of trunk muscles to maintain the pelvic and lumbar areas (**Patti et al 2016**).

Pilates exercises aim to improve static and dynamic stability, movement and posture in general. Many Pilates programs depend on strengthening back muscles to decrease low back pain. The idea of rehabilitation programs using Pilates exercises depends on increasing the strength of low back muscles and correcting muscular strength imbalance in patients with low back pain (**Wells et al 2012; Monfort-Panego et al 2009**).

As all researchers work in the field of sports injuries rehabilitation, it was clear for them that thigh adductor rupture is a wide spread injury among athletes and many of them complain of repeated injuries. This may be due to increased loads in training or competitions, lack of physical and functional efficiency or assuming wrong body positions for long time during training. The researchers tried to study physical rehabilitation using Pilates exercises and its effects on some bio-markers of kick-boxers with thigh adductor rupture.

Aim:

The current research aims to design a rehabilitation program using Pilates exercises and identifying its effects on some bio-markers of kick-boxers with thigh adductor rupture.

Hypothesis:

1. There are statistically significant differences between the pre- and post-measurements of participants in favor of post-measurements on some bio-markers that include:

Transaminase enzymes (AST, ALT) - Creatine phosphokinase (CPK) – Acetylcholinesterase.

2. METHODS:

Approach:

The researchers used the experimental approach (one-group design) with pre- and post-measurements.

Participants:

Research community included (24) kick-boxers of the Egyptian National Team with thigh adductor rupture. Pilot sample included (10) kick-boxers while the main sample included (14) players. Table (1) shows descriptive data of participants normalized by Squewness.

Table (1): Descriptive Data of Participants (n=24).

S	Variables	Measurement	Mean	Median	SD	Squewness
1	Age	Year	20.67	21.0	0.48	-0.76
2	Height	Cm	162.71	162	2.29	0.56
3	Weight	Kg	61.02	60.75	1.39	0.19
4	Training Experience	Year	9.150	9.000	1.089	-0.055

Table (1) indicated that Squewness values were between (± 3). This clearly indicates participants' data normality on basic variables.

Data Collection Tools and Means:

a) Tools and Equipment:

- A restameter for measuring heights (cm) and weights (kg).
- Spectrum Analysis device for measuring enzymes (Transaminase - Creatine phosphokinase – Acetylcholinesterase) by a specialized pathologist.
- Plastic syringes (5cm³) for collecting blood samples.
- Test tubes with heparin for preserving blood samples from clotting.
- Ice box for storing test tubes.

b) Data forms:

The researchers prepared a special form for identifying experts' opinions about criteria of the training program (duration of the program – number of weekly units – duration of each unit).

c) Blood Measurements:

Two pathologists (from a pathological lab in Cairo) collected blood samples with assistance of a nurse according to the following conditions:

- Psychological cool down for participants
- Relaxation during blood collection.
- Quick transference of samples to the lab to assure correct results.

Blood samples were collected according to the following procedures:

- Blood samples were collected while the player is in sitting position with his arm on the table. A rubber cord was used to tie the arm over a point of collection.
- Point of collection was sanitized with alcohol.
- A sample of (5cm³) was collected using a one-use sterilized syringe.
- Sample was stored in a test tube (10 cm³) with heparin as an anti-clotting agent.
- The syringe needle was to the tube wall to prevent any bubble formation.
- The tube was covered with a cork and stored into the tube holder.

The Recommended Rehabilitation Program:**Duration:**

Total duration of the program was (7) weeks (3 units per week). Each unit lasted for (45) minutes that increased to (60) minutes by the end of the program through adding (5) minutes to the main part every (3) weeks.

Table (2): Experts' Opinions about the program time distribution (n=10)

S	Duration	Opinion	Number of experts	Percentage
1	Total Time of the Program	Two and half months	7	70%
2	Number of Units	3 units	9	90%
3	Duration of Unit at the beginning (minutes)	45 minutes	8	80%
4	Duration of Unit at the end (minutes)	60 minutes	8	80%

Table (2) showed total time of the program, number of unites and duration of each unit. The researchers accepted an agreement percentage of 70% or higher.

Content:

All used exercises work on developing and improving flexibility, balance, strength and stretching of muscles without increasing muscle mass in addition to improving energy levels. Based on basic principles (focus – control – breathing – centralization – accuracy – coordination) the exercises targeted all body muscles using body weight as resistance with special consideration to the correct position of certain muscles (head – neck – shoulders – abdomen – feet). Each unit is divided into:

- **Warm-up:** It took (10) minutes. Each exercise took (10:20) seconds with deep and slow breathing without over-performance. Players were instructed not to get up quickly after performance.
- **Main Part:** It started with (45) minutes with gradual increase of (5) minutes each (3) weeks to reach (60) minutes at the end of the program.
- **Cool-down:** It took (5) minutes to recover to normal condition.

Pilot Study:

The researchers performed a pilot study on a pilot sample (n=10) from the same research community and outside the main sample to validate tools and equipment and to verify the validity and reliability of tests.

Main Study:

Pre-measurements:

Pre-measurements of all research variables were taken to all participants (n=14) inside the Hall of Cairo International Stadium while blood analysis was performed in a specialized lab.

Main Application:

The recommended rehabilitation program using Pilates exercises was applied to all participants (n=14) for (7) weeks (3 units per week: Sunday – Tuesday – Thursday). Units started with (45) minutes and ended with (60) minutes as scheduled. Each unit included warm-up, main part with Pilates exercises and cool-down.

Post-measurements:

At the end of the recommended rehabilitation program, the researchers took post-measurements following the same protocol of pre-measurements.

Statistical Treatment:

The researchers used SPSS software to calculate the following: Mean – Median – Standard Deviation – Skewness – Correlation Coefficient – (t) test – Improvement Percentage.

3. RESULTS:

Table (3): Difference Significance between Pre- and Post-Measurements of Participants on Bio-markers (n=14).

Bio-markers		Measurement	Pre-	Post-	Difference	(t) value	Improvement percentage
Transaminase	AST	U/L	18.71	15.57	3.14	8.36*	16.78
	ALT	U/L	15.36	13.71	1.64	6.62*	10.68

Creatine phosphokinase	CPK	U/L	126.50	53.71	72.79	19.0*	135.52
Acetylcholinesterase		U/L	3343.0	4293.00	950.0	30.58*	28.41

(t) table value on $P \leq 0.05 = 1.77$

Table (3) showed statistically significant differences between pre- and post-measurements of participants (n=14) on all bio-markers under investigation in favor of post-measurements. Improvement percentages ranged from (10.68%) to (135.52%). This indicates the positive effects of the recommended rehabilitation program on all research variables.

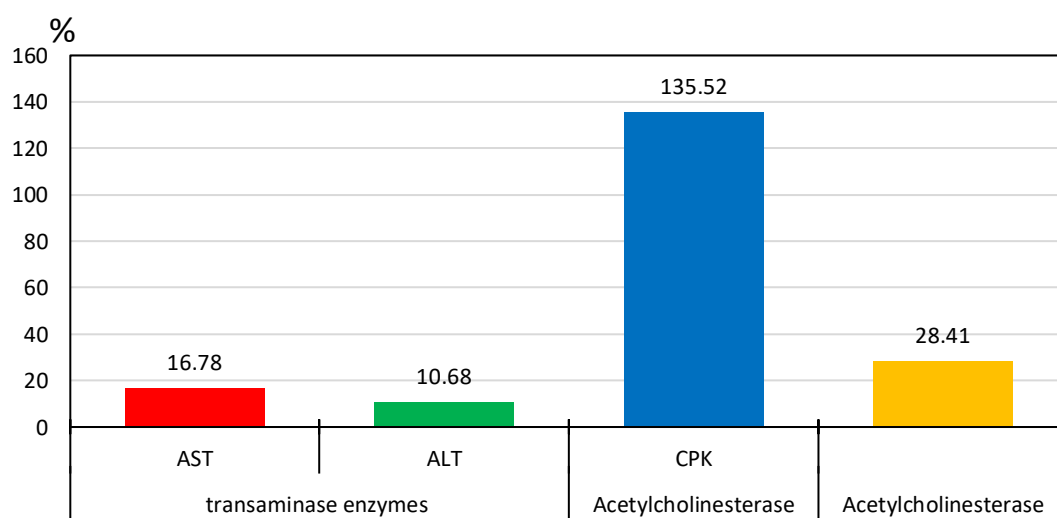


Fig. (1): Percentages of Improvement in Post-measurements of Bio-markers

4. DISCUSSION:

Table (3) showed statistically significant differences between pre- and post-measurements of participants (n=14) on all bio-markers under investigation in favor of post-measurements. Improvement percentages for CPK, Acetylcholinesterase, AST and ALT were (135.52% - 28.41% - 16.78% - 10.68%) respectively.

Researchers attribute the decrease in the concentration of (transaminase enzymes and creatine phosphokinase) to the improvement brought about by the recommended rehabilitation program with Pilates exercises, which the research sample underwent throughout its application period that lasted for (7) weeks. This program focused on strengthening and improving muscle fibers, resulting in the body getting rid of transaminase enzymes and creatine phosphokinase. Pilates exercises rely on transferring the body's weight from one place to another and are considered low-intensity exercises but are performed continuously. Therefore, Pilates training is considered smooth aerobic exercise that can be done anywhere in an interesting and easy manner (King, 2001).

The researcher believes that a scientifically well-planned rehabilitation program positively impacts muscular strength through numerous biological changes within the muscle. These changes include an increase in muscle size, thickness, and length of muscle fibers, enhanced blood supply to the muscle, and an increase in the amount of myoglobin and stored energy in the muscle. The research results indicate an improvement in muscle fiber flexibility, evidenced by a decrease in post-exercise enzymes as previously mentioned. This improvement is attributed to the program being scientifically designed after consulting references and studies related to the research concept and taking expert opinions into account, modifying it accordingly. **Andrade et al.** (2015) suggests that Pilates exercises not only activate the rectus abdominis muscles but also increase the activity of the iliopsoas and the multifidus muscles, especially when Pilates exercises are performed on stable surfaces, aligning with most exercises used in the proposed rehabilitation program. This is consistent with the findings of **Zhang et al.** (2006), which indicate that ground-based rehabilitation exercises contribute to improving motor fitness, range of motion, and postural balance restoration. **Denise** (2002) indicates that Pilates training strengthens and elongates all muscles of the body through the full range of motion. This combination of strengthening and stretching helps in achieving long, strong muscles and improves muscle strength, tone, flexibility, and body balance. Moreover, **Michael** (2001) points out that Pilates exercises help strengthen and lengthen muscles around the spine, particularly the deep abdominal muscles, back muscles, and thighs, thereby maintaining its alignment, which helps build a strong foundation and achieve balance.

Figure (1) shows varying percentages of changes between pre- and post-measurements of the enzymes under investigation, ranging from (10.68-135.52%). The highest percentage change was observed in the CPK enzyme, while the lowest was in the ALT enzyme. Researchers attribute these changes to the impact of the recommended rehabilitation program, which increased the functional efficiency of the research sample. Regular and well-organized training tailored to the individual's condition leads to improved physiological efficiency.

The results of the study by **Barbosa et al.** (2015) indicated that proper breathing techniques during Pilates exercises increase electrical muscle activity in the deep abdominal muscles. **Giacomini et al.** (2015) confirmed that Pilates exercises lead to an increase in the thickness of the transverse abdominal muscles, which helps increase intra-abdominal pressure and thus enhances spinal stability.

Sekendiz et al. (2007) affirmed that Pilates exercises positively affect the strength of lower back and abdominal muscles. Several studies, including **Kloubec** (2010) and **Patti et al.** (2016), have unanimously concluded that Pilates exercises improve core muscle strength in the abdominal and trunk areas. Pilates training positively impacts certain blood catecholamine, reduces muscle tension, improves general physical condition, and enhances match results for judo athletes.

Accordingly, researchers believe that developing muscle strength through Pilates exercises contributes to improving body enzymes, including transaminase enzymes and Creatine-kinase enzyme, which are associated with muscle tears. The rehabilitation program

using Pilates exercises helped improve these enzymes. Several studies, such as **Smith et al.** (2006), **Monfort-Pañego et al.** (2009), **Wells et al.** (2012), **Kao et al.** (2015), **Stieglitz et al.** (2016), and **Patti et al.** (2016), have confirmed that Pilates exercises increase muscle strength and flexibility in the trunk, balance the working muscles, enhance trunk stability, and reduce stress on ligaments and cartilage, thereby decreasing pain levels. The changes in CPK enzyme concentration can be relied upon as an early indicator of muscle fiber tears, with the research showing the highest percentage change in this enzyme at 135.52%.

Therefore, researchers attribute this improvement to the Pilates program used, which supports the research hypothesis: "There are statistically significant differences between the pre- and post-measurements of participants in favor of post-measurements on some biomarkers that include: Transaminase enzymes (AST, ALT) - Creatine phosphokinase (CPK) – Acetylcholinesterase."

5. CONCLUSIONS:

According to this research aim, hypothesis, methods and results, the researchers concluded the following:

1. The rehabilitation program using Pilates exercises improves biomarkers represented by muscle tear enzymes (transaminase enzymes – Creatine phosphokinase – acetylcholinesterase). This improvement results in a statistically significant reduction in muscle tears, as evidenced by the pre- and post-measurement differences in muscle tear indicators and the enzymes ALT, AST, and CPK.
2. Regular Pilates training leads to enhanced physical fitness, improved biological condition, and consequently, increased efficiency of the muscles working around the hip joint.

Recommendations:

According to these conclusions, the researchers recommend the following:

- Implementing the rehabilitation program using Pilates exercises on kickboxing athletes with thigh adductor rupture.
- Conducting regular biological tests and analyses for kickboxing athletes to monitor their enzyme levels and prevent muscle injuries.
- Conducting studies to compare the impact of the Pilates training program on other variables.
- Utilizing the study's findings to reduce muscle tears, fatigue, and exhaustion, especially for kickboxing athletes.
- Equipping sports facilities with modern laboratories and devices to aid in the planning, monitoring, evaluation, and modification of training programs to prevent injuries.

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