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Original article

Effect of flywheel resistance exercises on oxidative stress and record level of 100m backstroke for young swimmers

BAKRY Osama[1], ELHABASHY Ahmed[2], CAZAN Florin[3], DRAGOMIR Lenuța[3], AMR Hamza[1]

Abstract

Aim. Use of inertial flywheel for multi-directional movements in certain sporting conditions leads to greater improvements in performance compared to conventional training. The aim of this study was to investigate effectiveness of flywheel resistance exercises on oxidative stress and record level of 100m backstroke for young swimmers.

Methods. The main sample was selected from the Benha Sports Club, (22) swimmers under 16 years old, and (4) juniors were excluded as an exploratory study, so that the actual research sample consisted of (18) swimmers, samples were divided equally into two groups, one experimental and the other control group. Experimental group practiced 10-weeks of flywheel resistance training, and the control group practiced 10-weeks of traditional swimming training. The data collected before - after the training programs for the two groups.

Results. Statistical analyses showed that: Significant Difference between the experimental group and control group in all physical variables for posttest to the experimental group. Significant Difference between the experimental group and control group in (Superoxide dismutase, Catalase, Malondialdehyde) for posttest to the experimental group. Non-Significant Difference between the experimental group and control group in in 100m backstroke record

Conclusions. Under the conditions of our article, the researcher conclusion that ten weeks of flywheel resistance training contributed to improving oxidative stress and record level of 100m backstroke for young swimmers.

Key words: Flywheel Resistance Training, Power, 100m Backstroke.

Introduction

Muscles or muscle fibers can be activated while maintaining their constant length (isometric contraction) are "shortened" (concentric contraction) or "lengthened" (eccentric contraction). In the latter scenario, the muscle-tendon system is stretched allowing the performance of negative work (e.g., deceleration) and the absorption of mechanical energy, which can be dissipated as heat or stored as elastic energy and recovered by immediate concentric contraction.

Franchi et al. (2014) that resistance training (RT) can be performed through (3) different types of muscle movements, concentric, eccentric, isometric, and central movement occurs when the muscle produces force as it shortens; Extension actions occur when a muscle produces force during its extensions; Isometric measures occur when a muscle produces a force without changing its length.

It has been observed that the muscle activation strategy used by the system is specific to the type of contraction and that during eccentric contractions, although the response of the motor cortex is increased, at the spinal level there is an inhibition of the descending signals of supraspinal areas (Enoka and Duchateau, 2016). This would explain the fact that, compared to concentric contractions, in the face of submaximal loads, the motor units recruited and the rate of fire of these are lower, or that during maximum contractions the rate of fire and, in some cases the voluntary activation, is lower. In short, that the electrical signal that reaches the muscle is lower in both maximum and submaximal eccentric contractions.

In this regard, Amr (2022) indicates that Eccentric Overload Training using Flywheel is great interest in the

[1]Faculty of physical education, Sohag University, Egypt
[2]Faculty of physical education, Benha University, Egypt
[3]Faculty of physical education, Ovidius University of Constanța, Romania
E-mail: amr297@aswu.edu.eg
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sports field, as it allows the athlete to move his maximum capabilities from muscular strength to advanced levels.

Timmins et al. (2015) that the beginnings of longitudinal overload training were in bodybuilding and weightlifting halls, then sports scientists began subjecting it to scientific experimentation to explore its multiple benefits, and then it became a major part of the sports teams' programs, until it is now implemented with advanced methods.

Schoenfeld (2016) points out that of these three procedures, extension movements have been hypothesized to be the most important when improving muscular strength. This hypothesis is supported by findings that lengthening exercise leads to higher levels of muscle protein synthesis and a greater increase in intracellular anabolic signaling and gene expression versus central exercise.

Friedmann-Bette et al. (2010) that eccentric contraction is an active movement of a muscle, as it is lengthened under load. Prolongation is also known as "negatives," in old school bodybuilding gyms, and every resistance lift we do in the gym will have an eccentric element within.

For example, he adds, during a basic squat, the muscles work eccentrically when descending. However, lengthening training (also known as AEL - accentuated eccentric loading) typically uses a variety of means to overload the eccentric portion of the lift. This intense (centered) longitudinal loading can take many different forms, with some having more scientific reasons than others.

Giovanni Fiorilli et al. (2020) that the inertial flywheel method attributes its effectiveness to its combination of the benefits of both variable resistance and extension training with overload.

Amr (2022) points out that the use of the inertial flywheel for multi-directional movements in certain sporting conditions leads to greater improvements in performance compared to conventional training.

Maroto-Izquierdo et al. (2017) that in flywheel training, the athlete first uses force to speed it up, and then uses force again to slow it down. This means that there is constant resistance in both the "pull and return" movements, ie in the phases of contraction by shortening (central) and muscle lengthening (eccentric). Whereas with conventional weights, the weight is fixed, so resistance is only felt in the contraction (central) phase.

Festa et al. (2019) adds that with flywheel training, the athlete feels resistance when going up and when squatting. It uses its power to rotate the disk, and then to slow the disk's momentum. This allows for increased continuous muscle stimulation in both the central and eccentric phases.

Amr (2022) indicates that the flywheel tool, which is commercially called the kBox, is a simple and easy tool to manufacture, as it is a wooden box, a double rope, and a small iron bar with an iron reel, at the end of which a rotating disk (with multiple weights) is attached.

During the last decade, both physical exercise and certain dietary models have been widely studied as important inducers of oxidative stress.

Free radicals are highly reactive compounds that are produced because of metabolic activity of cells in biological systems. Both aerobic and anaerobic physical exercise cause an increase in the production of different free radicals.

Leeuwenburgh, Heinecke (2001) Oxidative stress during physical exercise has been introduced as a cause of damage at the level of the myocyte membrane, which leads to an exacerbated inflammatory response, and consequently to the suffering of excessive pain and muscle fatigue after exercise. However, in the current literature there are obvious discrepancies, both in the presence of oxidative stress associated with different efforts, and in the adaptive phenomena that could result if this imbalance persists during a given period. Possibly, the main determinants of these discrepancies are the high reactivity and short half-life of free radicals.

Amr (2022) Fernandezto et al. (2009) indicated that physical exercise in varying degrees, induces metabolic and mechanical stress that can cause an imbalance of oxidant/antioxidant homeostasis in favor of oxidizing compounds. Not one, but several physiological mechanisms, are involved in production of more free radicals during exercise; but in addition, there are other factors extrinsic to exercise (oxidative risk factors) that can favor the occurrence of oxidative stress, such as diet, postprandial situation, temperature, degree of hydration, level of training of the individual, etc. Although oxidative stress is potentially relevant among the mechanisms linked to muscle fatigue, recovery from exercise, and perhaps even also for better sports performance, there is a growing number of publications that link it with the occurrence of adaptive phenomena of the immune system and antioxidant defense of the athlete, which ultimately leads to greater cytoprotecting and biological resistance of the organism.

Some coaches believes that swimming is 80% technical and 20% physical condition to highlight the enormous importance of performing a good technical gesture in this sport and the effects that an improvement in efficiency can have on swimming speed. mainly because the aquatic environment is 800 times denser than air and knowing how to move properly in this adverse environment is essential.

Aim of this study was to investigate effectiveness of flywheel resistance exercises on oxidative stress and record level of 100m backstroke for young swimmers

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Methods

The main sample was selected from the Benha Sports Club, (22) swimmers under 16 years old, and (4) juniors were excluded as an exploratory study, so that the actual research sample consisted of (18) swimmers, samples were divided equally into two groups, one experimental and the other control group. Experimental group practiced 10-weeks of flywheel resistance training, and the control group practiced 10-weeks of traditional swimming training. The data collected before - after the training programs for the two groups.

Data collection tools**.**

- Stadiometer to measure the length to the nearest 1 cm
- Medical scale to measure weight in kilograms to the nearest 1/2 kg
- Measuring tape for lengths to the nearest 1 cm
- A 30w Casio stopwatch is recorded to the nearest 1/100th of a second.
- A dynamometer to measure the strength of the muscles of the legs and back - to the nearest 1 kg
- Grip dynamometer to measure grip strength (right and left) to the nearest 1 kg
- Jump boxes
- Bars
- kBox
- swimming pool (50m)
- Plastic syringes
- Blood Collection Tube
- Cotton
- Ice tank

Physical tests.

- Testing the strength of the leg's muscles using a dynamometer.
- Testing the strength of the back muscles using a dynamometer.
- Grip strength test (right and left)
- Testing the muscular ability of the legs (vertical jump from a step up).
- Testing the muscular ability of the arms (throwing a medical ball weighing 3 kg).

Statistical analysis

Statistical analyses were calculated by the SPSS statistical package version 26. The results were reported as means and standard deviations (SD). Differences between two groups reported as mean difference. Confidence intervals (± 95%). Student's t-test for groups were used to determine the differences.

Results.

Table 1. Characteristics of the two groups (Mean ± SD)

Group	N	Age [years]	Weight [kg]	Height [cm]
Experimental	9	15.12 ± 0.3	55.00 ± 3.9	167 ± 3.80
Control	9	12.09 ± 0.6	53.14 ± 4.7	155 ± 3.60

Table 1 shows characteristics of the two groups. There were no significant differences observed in the variables between the different groups.

Table 2. Differences significant between the posttests for the two Groups (experimental and control) in physical variables

Variables	Experimental group	Control group	Sign.
	After	After	
Medicine ball throw (3kg)	6.40 ±0.11	6.20 ±0.13	S
Leg strength	82.14 ±3.47	78.34 ±3.52	S
Back strength	79.63 ±3.50	74.11 ±3.28	S
Grip Strength (Right)	23.91 ±2.67	21.48 ±1.97	S
Grip Strength (Lift)	21.15 ±2.30	19.08±2.00	S

Table 2 shows that:

- Significant Difference between the experimental group and control group in all physical variables for posttest to the experimental group.

Table 3. Differences significant between the posttests for the two Groups (experimental and control) in oxidative stress variables

Variables	Experimental group	Control group	Sign.
	After	After	
Superoxide dismutase (ng/ml)	68.57 ±7.14	59.14 ±8.17	S
Catalase (pg/ml)	63.92 ±8.16	57.11 ±10.20	S
Malondialdehyde (nmol/ml)	15.65 ±2.08	18.27 ±2.19	S

Table 3 shows that:

- Significant Difference between the experimental group and control group in (Superoxide dismutase, Catalase, Malondialdehyde) for posttest to the experimental group.

Table 4. Differences significant between the posttests for the two Groups (experimental and control) in 100m backstroke record

Variables	Experimental group	Control group	Sign.
	After	After	
100m backstroke record	58.14 ±0.78	59.89 ±0.67	NS

Table 4 shows that:

- Non-Significant Difference between the experimental group and control group in in 100m backstroke record.

Discussion

The researchers attributed those differences in the physical variables to the good planning of the program of longitudinal overload exercises, and the legalization of the training loads in a scientific manner appropriate to the dental and training phase of the research sample, and to the use of rotating wheel exercises as a main part of the longitudinal overload exercises with the aim of developing muscular strength of both types, maximum strength, and ability.

In this regard, Schoenfeld, (2016) confirms that eccentric exercises are the most important when improving muscle strength. This hypothesis is supported by findings that lengthening exercise leads to higher levels of muscle protein synthesis and a greater increase in intracellular anabolic signaling and gene expression versus central exercise.

Amr (2022) asserts that greater intensity can be obtained through supramaximal eccentric training. This has several positive effects, as more strength means more adaptation. Extension training does this by increasing neural drive levels.

Friedmann-Bette et al. (2010) It has been shown that lengthening training also enables preferential recruitment of HTMUs (high-threshold motor units), which has been shown to increase force production.

Amr (2022) asserts that eccentric overload training enables the athlete to develop strength across the full range of motion. Thus, the force is generated in long, medium, and short muscle lengths, maximizing the positive effect in developing muscle strength in addition to preventing injuries, as the force is effectively generated to prevent injury.

Anderson & Aagard (2010) add that preferential recruitment of type II fibers can be obtained through lengthening overload exercises – these fibers have a greater growth potential than type I fibers and are arguably more important fibers for high-intensity activities such as volleyball. soccer, swimming.

Roig, et al. (2009) confirms. that there is a growing body of studies showing that eccentric overload training has a greater effect on muscle strength when compared to core training.

Amr (2022) asserts that eccentric overload exercises cause an increase in the number of sarcomeres within the chain, allowing muscle shortening to occur at greater speeds in the bundles.

Wahab (1998) indicates that despite the devastating effects of Free Radicals, we need them to live, but in small proportions, and because they work with the immune system in preventing some diseases that invade the body and help in regulating muscle and water contraction. It also helps in blood flow processes by stimulating the muscle tone of these blood vessels

Abul-Ela (1999) adds that the accumulation of oxygen atoms in large proportions in cells causes damage to the components of the muscle cell, especially (DNA).

Leeuwenburgh & Powers (1999) add that free radicals are a natural product of chemical reactions and metabolic processes that occur within the body, and that the increase in free radicals is an indicator of fatigue and muscle stress.

Vasankari et al. (1996) indicated that free radicals are characterized by a short lifespan, which makes it difficult to measure them, but their presence and percentages can be inferred by identifying the ratios of MDA in blood or urine.

While Friedmann-Bette et al. (2010) show that longitudinal overload exercises improve satellite cell reproduction and activation in type II muscle fibers.

Blazevich et al (2007) adds that satellite cells are cells that donate their muscle nuclei to another cell (in this case muscle fibers), allowing greater control over a group of muscle fibers. The easiest way to think about it is to imagine muscle as an airport: satellite cells are like control towers, and runways are muscle fibers. If we only had one control tower, only a few runways could be had before the control tower could no longer handle aircraft traffic. And if we want to increase airport capacity, we need more control towers - and with more control towers, we could create more runways (muscle fibers). And if, during the lift, we can put in more satellite cells, then we could put in a lot of passages (muscle fibers).

In this direction confirm Douglas et al. (2016) that eccentric overload exercises depend on the principle of reversibility. Even if aircraft traffic stops, the control towers remain, so there is still potential for growth if aircraft traffic returns. Therefore, when someone stops training for an extended period, they can bulk up much faster than someone who has never trained before. For this reason, there is a strong case for exposing young athletes to this type of training to place satellite cells early and give them greater potential for growth at a later age.

Verkhoshansky & Verkhoshansky (2011) confirm that the vertical jump distance depends on the number of excited fibers. The higher the number of fibers, the greater the ability to perform, as well as the muscles and their tendons. For the athlete to reach the maximum distance, all muscle fibers of the muscles involved in the work must be excited to the maximum degree and at the highest rate.

This is confirmed by Adams et al. (1992) that the activity of the elastic reflexology allows for an excellent transfer of muscular power to the same biomechanically similar movements that require a high capacity of the trunk and legs.

Tillin, & Bishop (2009) stress that the increased actions of motor units induced by heavy loads or resulting from short-term high intensity movements, results in an increase in the number of motor or recruited units (higher threshold motor units) in addition to an increase in the rate of firing of these motor units.

The results of the study constant with those of (Suarez-Arrones, et al. 2018; Francisco Javier, et al. 2018; Luca Festa, et al. 2019; Joey Brien, et al. 2020; Giovanni Fiorilli, et al. 2020; Alejandro Azze, et al. 2020) that eccentric overload training contributes to improving the performance of the vertical jump, and the muscular endurance of the experimental group.

Conclusion

Under the conditions of our article, the researcher conclusion that ten weeks of flywheel resistance training contributed to improving oxidative stress and record level of 100m backstroke for young swimmers.

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