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PLYOMETRIC APPROACHES AND THEIR EFFICIENCY IN SPORTS TREATMENT AND REHABILITATION

ABSTRACT:

The paper is devoted to conducting a comprehensive analysis of plyometrics as a relatively new approach in training and rehabilitation that is becoming a must component of routine training and recovery programs. The usefulness and efficiency of plyometric exercises were proved by many scholars, trainers, athletes and therapists, the potential benefit that can be received from plyometrics is assured by the specific physiological and nervous changes that can be noticed in athletes while performing plyometric exercises which leads to further improvements in key physical characteristics of athletes as strength, coordination, speed of reactions, skills and the level of resistance. The conducted study has proven the importance of factors that can increase the efficiency of plyometrics or reduce it if trainers, athletes and physiotherapists are not prepared well, specifically regarding the consideration of previous injuries or other health issues of individuals before starting the implementation of these techniques. Moreover, as plyometrics includes a wide range of activities and they can be performed with different intensities it is possible to develop different skills within the group of athletes depending on their needs, individual physical characteristics, their previous training experience and past health issues, which makes this approach appropriate in all sports and rehabilitation program.

INTRODUCTION.

Currently, methods and knowledge regarding training and rehabilitation are constantly developing and going through modification to maximize their efficiency and usefulness. One of the modern approaches that can reach this goal is to combine the routine training and rehabilitation program with plyometric exercises. Specifically, those changes can be seen at the terminal stage of rehabilitation while preparing an individual for returning to an active lifestyle or intensive training after previously obtained injuries. At the same time, it was proved that including plyometric exercises in the training program leads to an increase in key characteristics of an athlete as strength, coordination, speed of reactions, skills and the level of resistance.

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As the concept of plyometrics is relatively new which means that its theoretical and practical foundations are in the process of formation and continuous modification to meet the needs and expectations of trainers, athletes and physical therapists, etc. According to one of the comprehensive definitions, plyometric exercise can be defined as "activity that involves and capitalizes on the mechanisms of the stretch-shortening cycle to increase the efficiency of force production at a joint or increase performance" [1].

Additionally, plyometric exercises as part of the rehabilitation process, as it was proved, are highly efficient, but they should not be used at the early stages of rehabilitation, instead, they should be implemented at the phase of return to intensive training. As at the first stage of rehabilitation patients should be able only to perform basic everyday activities without pain or swelling. Moreover, to start highly intensive exercises patients should have almost all range of motion, an appropriate base level of strength, endurance and neuromuscular control to minimize the risk of injury/reinjury and be able to do correctly plyometric exercise without feeling any discomfort [2].

The efficiency of plyometrics is proved by sports professionals, trainers and physical therapists as this program of exercises leads to an improvement in an athlete's muscular and jumping abilities, which directly increases the level of strength. As plyometrics can be used with different intensities, those exercises can be efficient at different stages of rehabilitation or training programs. Moreover, while implementing plyometric exercises its possible to modify their intensity during the training session to meet the needs of patients or athletes with different levels of physical readiness [3]. Also, plyometrics includes a wide range of exercises which makes it easier for athletes, trainers and physical therapists to organize the training in a way that will minimize the risk of burnout and reduction in motivation. Moreover, plyometrics becoming more popular among athletes as many exercises do not require any additional tools or equipment. Besides having a positive impact on muscle strength and endurance, those exercises stimulate and raise the metabolic rate, which leads to weight reduction and heart rate recovery.

PLYOMETRICS AS A METHOD OF TRAINING AND ITS FUNCTIONS.

Plyometrics as an approach to training and treating injuries in sports include strengthening exercises, jumps, bounding and hopping actions, which are associated with an increase in muscles' power as well as faster muscle contractions. Moreover, these exercises make an eccentric muscle contraction,

directly followed by a concentric contraction. Meaning that the muscle contracts, while being lengthened during the eccentric phase.

It should be mentioned that during the eccentric contractions phase the maximum amount of force is produced. So, at this phase, the maximum amount of energy is created and will be stored by the elasticity of the muscle. Therefore, a following concentric contraction should occur as soon as possible to undertake the whole benefit of the previously stored energy in this stretch-shortening sequence [4].

In general, all plyometric exercises have three main phases [5; 6]:

1. Eccentric, at which the musculotendinous unit deforms under the load created by a rapid stretch. At this phase, kinetic energy is employed to generate tension on the series elastic components of the muscle-tendon unit. Meanwhile, it will lead to the stiffening of the tendon with an isometric pre-contraction, directly followed by its mild eccentrical lengthening when the joint angles vary.

2. Amortization, during this phase there is a shift from the eccentric to the concentric phase. Meaning that at this phase the kinetic energy is given and remains as elastic potential energy depending on the degree of tendon stiffness or compliance. This process can be explained with the physics of the loaded spring that is ready to bounce back. Depending on the duration of this phase the relative elastic energy will be changed back into kinetic energy, which will be used at the next phase of the exercise. At this phase, to ease the spring-like tendon, muscles should be working isometrically.

3. Concentric, at this phase, the previously obtained and stored elastic potential energy transforms back into kinetic energy while joining the related conscious and reflex muscle contraction forces, which further leads to the explosive movement of the system's center of mass in the applied direction.

Because of its functions, plyometrics is widely used in all types of sports and games. There are three main types of plyometric exercises:

1. Involving depth jumping and box drops, bounding and hopping should be used to train the forward motion;

2. Using medicine balls to improve power in the upper body, the exercise includes two phases catching and throwing back the ball, at first, an eccentric contraction is seen to control the motion and catch a ball, next, a concentric contraction to throw it back;

3. Push-ups with additional movements like a clap to make it as a two phases exercise, so, during the first phase, an eccentric contraction of the chest muscles is done, directly followed by a strong concentric contraction to

lift the body and clap.

Based on previously performed tests, potential effects of plyometrics can be seen as changes in key characteristics of performance as peak power output, jump performance, muscle volume, and ball throwing velocity. Also, the study concludes that adopting biweekly plyometric exercises to the routine training program positively affects the key physical features of athletes as explosive actions, such as sprinting and jumping [7].

In the context of the plyometric training application, the risks of injuries should be discussed as well, so because of its high explosive nature, the risks of injuries are quite high. The risks can be prevented or minimized by assuring that athletes are well trained specifically regarding their resistance strength. Additionally, to avoid injuries plyometric training should be done once or maximum twice a week when an athlete is not tired from previous training. For the same reason, each training session should include the warm-up and cool-down stages, also, the intensity of exercises should be increased gradually.

HEALTH CONSIDERATIONS.

Existing diseases should be considered before starting plyometric training, especially in adults and youths. Specifically, weak health status like diabetes, other illnesses will reduce the efficiency of youths and athletes' performance and the speed of their recovery. Thus, to minimize or avoid this outcome, all health issues should be recorded and kept in the appropriate way to decide if an athlete can start plyometric training.

Moreover, orthopedic factors are crucial while starting the training program such as age, gender, physical maturity and, specifically, the level of previously obtained experience in sports activities.

As was mentioned earlier, any previous injury will reduce the efficiency of an athlete's performance of the plyometric program. For individuals with patellofemoral symptoms, it is forbidden to do any deep squats and knee extensions with resistance. For instance, individuals with previous or current anterior cruciate ligament insufficiency will need additional strength exercises before starting a plyometric program, namely training sessions to strengthen hamstrings and triceps, joint contraction programs. Additionally, post-surgery individuals will have specific contraindications and accordingly require superior consideration [8; 9].

Besides that, additional resistance training should be made to improve eccentric strength and to prepare muscles and tendons for tension and

stretching that occur during plyometric training. It is known that the more trained the muscles are, the greater the shock absorbers [7]. It should be mentioned that eccentric exercises done as a part of an individual working out or rehabilitation program involve minimal energy and lead to an increase in strength and power in athletes. Meaning that eccentric strength exercises have to be included in training and rehabilitation programs for better performance or recovery.

Other personal parameters are also significant as body weight and strength ratios while considering starting a plyometric workout. It is recommended that an athlete should be able to do a squat with weight 1.5 times greater than his or her body weight to start a high-intensity plyometric workout. Based on this parameter young athletes can lose the benefits obtained through the implementation of plyometric exercises in their normal training as they are lacking maturity or sufficient training background. The only solution that can be seen here is to use low-intensity plyometric exercises to minimize the risks of related injuries. These types of exercises will make athletes more efficient in controlling the center of gravity, landing softly, changing direction faster, meaning spending the shortest time on the ground. Moreover, a low-intensity plyometrics program is usually seen as an ancillary workout for safer training of the youth when it is done together with bodyweight resistance and landing exercises, advances in eccentric strength [10;11].

In general, it should be mentioned, that the strength required to increase or maintain the efficiency of performance can be trained by well prepared, adequate, controlled and sophisticated resistance training exercises. As it was proved, free weight lifting training develops the resistance needed to create greater strength production, strength development potential and faster speed of action.

PLYOMETRICS AS A METHOD OF REHABILITATION.

The significance of plyometrics as a method of rehabilitation is that it involves a stretch-shortening cycle of muscles, which yields the reactive ability of the muscles. For instance, repeated sessions of jumping or reactive drop jumps will make muscles go through a phase of stretch before directly going through a phase of reactive shortening, which is making this approach unique. This two phases method stimulates two key physiological components as proprioceptive reflexes and elastic properties of muscle. Specifically, those components are crucial while an athlete is getting prepared to return to high

intensity and/or power base training.

Regarding the effects of plyometrics as a method of rehabilitation the following ones should be discussed [12; 13]:

1. Plyometric exercises help to determine an effective and safe return to an active lifestyle or sports activities, reduce the risk of re-injury;

2. Plyometrics stimulates the formation of neuromuscular adaptations, which are extremely important in optimizing and retrieving coordination and control of the joints and muscles;

3. As the intensity and duration of actions are changing while having a session of training it stimulates receptors in the muscles that are extremely sensitive to any type of stretching and tension variations within the muscles;

4. During this type of training, the information on the length and tension within muscles is transmitted between those structures and the central nervous system which helps athletes to know the position of their joints and the state of their muscles, moreover, it will make it easier for them to coordinate themselves to change the position of the joints and muscles, reduce the risk of re-injury while returning to sports activities.

Regarding the rehabilitation application of plyometrics for upper-body injuries, it should be mentioned that using plyometrics for treating shoulder injuries leads to an improvement of joint position sense and joint awareness of an athlete. Meaning that the neural adaptations caused by plyometric sessions are efficient and can reduce the length of the rehabilitation period. Mentioned neuromuscular adaptations exactly adjust muscle coordination and upsurge the involvement of motor units within the muscle. As a result, the pre-activation and control of the muscles during high-intensity training and explosive movements are advanced.

Additionally, talking about the lower-body injuries, plyometric sessions lead to increased muscle activity. According to Zebis et al. [14], treatment sessions force changes in the activity of the hamstring areas, hip adductors and abductors, which minimize the bowing in of the knees during dynamic movements. Also, implementing plyometric exercises stimulates changing muscle activity and correcting any compensatory or dysfunctional joint movements.

In general, establishing the direct connection between the brain and muscle through neural adaptations improves the athletes' awareness of the limb and joint position, which will help to identify any incorrect or injury-prone postures and limb positions. Being aware of variations in muscle activity, recruitment, and coordination, together with the joint position sense, athletes can be more

careful in detecting and preventing any injury-prone limb positions.

The obtained advancements in muscle activities also improve muscle pre-activation and the co-activation of muscle groups, meaning that the athlete's muscles will be well prepared for explosive activities and groups of muscles while working together will be highly productive. This type of activity stimulates the development of the ability to restraint and control muscles and joints, adjust joint positions while being involved in dynamic movements. As a result, all those changes and developments will reduce the risk of re-injury by forming and improving the ability to prevent injury-prone limb and joint positions, and control the joints in dynamic movements, which advances the stability of the joint.

Thus, taking into account all benefits of implementing plyometric exercises as a part of a routine training or rehabilitation program it was possible to identify the main effects and factors that can improve the efficiency of plyometrics or reduce it (Fig.1).

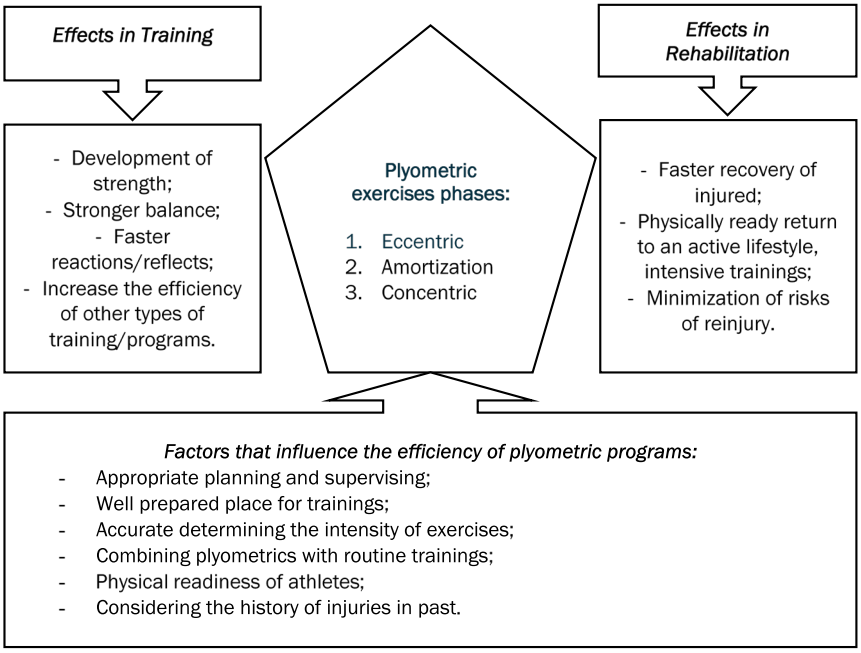

Figure 1. **Effects of plyometric exercises in training and rehabilitation.**
Source: developed by the author.

CONCLUSIONS.

This study shows that plyometrics is a relatively new approach to training and treating individuals with injuries and thus requires a comprehensive analysis from theoretical, historical and practical angles. Regarding the implementation of plyometrics in the rehabilitation process, it should be mentioned that plyometric exercises have to be used at the last stage of physical recovery while returning to an active lifestyle and training. As it was proved that adding plyometric exercises to the routine training or recovery program leads to an increase in key characteristics of an individual as strength, coordination, speed of reactions, skills and the level of resistance.

Besides having benefits of using plyometrics in training and rehabilitation programs, there is a crucial issue on how to minimize the risks of injury/re-injury. Among possible solutions are to ensure that athletes are well trained specifically regarding their resistance strength; plyometric training should be done once or maximum twice a week when an athlete is not tired from previous training; each training session should include the warm-up and cool-down stages; the intensity of exercises should be increased gradually.

While analyzing the impact of plyometrics in rehabilitation the following effects were identified as it helps to determine an effective and safe return to an active lifestyle or sports activities; reduces the risk of re-injury; stimulates the formation of neuromuscular adaptations, which optimize and retrieve coordination and control of joints and muscles; stimulates receptors in the muscles that are sensitive to any type of stretching and tension variations within the muscles; transmutes the information on the length and tension within muscles to the central nervous system which helps athletes to know the position of their joints and the state of their muscles; improves athletes' coordination ability to change the position of the joints and muscles; reduces the risk of re-injury while returning to sports activities.

Additionally, to expand the existing literature on plyometrics, studies of its historical and methodological development and further modifications should be done, as well as the studies regarding the comparative efficiency of plyometric exercises as a part of training and rehabilitation programs.

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