

Effectiveness of Exercises Plyometrics in the Treatment of Post-Muscle-Tendon Injuries in Under-17 Category Footballers

Sonia Alexandra Alvarez Carrión¹, María Belén Pérez García²

Abstract

Musculotendon injuries, which encompass a variety of conditions from muscle strains to tendinitis, are a common concern in athletes of all ages and levels. These injuries, considered overuse pathologies, constitute a significant part of sports injuries and are often related to constant repetition of loads on the tendons. In this context, plyometrics, a training approach focused on jumping and explosive exercises, has emerged as a promising tool in the rehabilitation of these injuries. The main objective of this research was to evaluate the effectiveness of plyometrics exercises in the treatment of musculotendon injuries in under-17 soccer players. In this descriptive study, the prevalence of muscle-tendon injuries in under-17 football players was investigated. It was evident that several previous studies in the sports field have addressed the importance of muscle functionality for athletic performance and quality of life in general this through plyometrics. While plyometrics are commonly used in sports that require jumping, rapid changes of direction, and explosive movements, its effectiveness in the rehabilitation of musculotendon injuries still requires deeper and more precise evaluation. Athletes' perception and satisfaction with these exercises may influence their adherence to the rehabilitation program and, therefore, their success in recovery.

Keywords: *Injuries, tendon muscles, Plyometrics, Rehabilitation, Soccer, Physiotherapy.*

Introduction

Football is one of the most popular and practiced sports around the world, with a player base that spans all ages and skill levels, according to Mendoza et al, (1), "football is a sport that is currently booming, more and more people are practicing it, enjoying it, work and invest in it, where physical fitness is essential along with the development of motor skills" Among young footballers, the U-17 category represents a critical stage in their athletic development, as they are in the transition from adolescence to adulthood and experience significant physical growth and development As these young athletes seek to hone their skills and excel in sport, They face a number of challenges, among which tendon muscle injuries are a constant concern. (1)

A study carried out for the year 2016, demonstrated the epidemiology of the injuries suffered by players during the XVI South American U-17 Football Championship, where a total of 103 injuries among players were documented, which is equivalent to an average of 2.94 injuries per game or approximately 32.7 injuries per 1,000 minutes of play. It is important to note that more than half of these injuries, specifically 56 of them, were the

¹ Mg. Fisioterapia y Rehabilitación Mención en Neuromusculoesquelético, Universidad Nacional de Chimborazo, sonnit.1204@hotmail.com, <https://orcid.org/0000-0002-9439-2257>

² Mg. Gerencia de los servicios de la salud (UNIANDES), Universidad Nacional de Chimborazo, belenperezgarcia20@gmail.com, <https://orcid.org/0000-0003-1015-6212>

result of direct contact between players, of these 56 direct contact injuries, these injuries were observed in various areas of the players' body, with the most common location being the ankle, followed by problems in the Achilles tendon and injuries in the thigh (2)

Muscle tendon injuries, ranging from muscle strains to tendonitis, represent a major obstacle in the career of any athlete, regardless of age or level of competition. These injuries fall into the category of overuse pathologies, which make up approximately 60% of all sports injuries, and are usually related to the constant repetition of loads on the tendon (3) (4)

Scrutinizing a wide range of conditions ranging from muscle strains and tears to tendonitis and other connective tissue disorders, musculoskeletal injuries in footballers are a pervasive concern in the sports world (3). These injuries can severely affect the athletic performance, physical development, and quality of life of young players. In the specific case of U-17 footballers, who are in a key phase of growth and development, the impact of muscle-tendon injuries is even more significant. Effective rehabilitation of musculoskeletal and tendon injuries is essential to enable these young footballers to return to the field of play in top physical shape and to minimise the risk of relapse (4). The search for optimal therapeutic approaches and training strategies that facilitate recovery and prevention of future injuries is a constant priority in sports medicine.

On the other hand, muscle and tendon injuries in football are a topic of great relevance and concern for players, health professionals and coaches (4,5). These injuries affect not only athletic performance, but also the quality of life of footballers, and can have significant implications on their career. To better understand this problem, it is important to explore its characteristics, causes, and consequences in detail. As expressed by Mendoza, et al, in the specific case of U-17 footballers, these injuries can be particularly challenging due to their impact on performance and physical development at a crucial stage of their growth (1)

In this context, plyometrics, a training approach that focuses on jumping and explosiveness exercises, has emerged as a potentially valuable tool in the recovery process. Plyometrics not only seeks to improve muscle strength and power, but also focuses on neuromuscular control and coordination, critical factors in preventing future injuries as research in the field of sports medicine and physiology. As exercise progresses, it is essential to critically explore and evaluate the effectiveness of plyometrics in the rehabilitation of muscle and tendon injuries in U-17 soccer players. (5) (6)

It should be noted that plyometric exercises were introduced by Verkhosansky as part of the training programs of athletes participating in activities that require physical power, with the purpose of improving the production of "reactive" force. These exercises appear to have the effect of optimizing the stretch-shortening cycle, which, in turn, benefits the performance of athletes by increasing the load exerted on the muscles and tendons during the training phase. braking and reducing the duration of the transition period between braking and propulsion phases, known as the "coupling time". (7) (8)

Therefore, the main objective of this research is "To evaluate the efficacy of plyometrics exercises as part of the treatment of U-17 soccer players who have experienced muscle and tendon injuries," focusing on their rehabilitation process and their impact on sports performance. At the same time, in order for this objective to be met, it is necessary to have clear specific objectives; which involve; describe the prevalence and types of musculo-tendon injuries in U-17 footballers; evaluate the effectiveness of plyometrics exercises in improving muscle function; and to analyze satisfaction with Plyometrics exercises in their rehabilitation process in tendon injuries.

Ultimately, this review seeks to provide a solid foundation of knowledge that will enable healthcare professionals, coaches and U17 footballers to make informed decisions about the inclusion of plyometrics in their rehabilitation and training programmes. In addition, it highlights the importance of continuous research in this ever-evolving field to optimize the

medical care and athletic development of young footballers. The purpose of this descriptive review is to explore the role of plyometrics as a treatment strategy in U-17 footballers suffering from muscle and tendon injuries. In the course of this article, we will examine the nature of these injuries, the theory behind plyometrics and its applicability in rehabilitation contexts, and then analyze the existing evidence on the effectiveness of plyometrics in this specific population.

In the field of physiotherapy, functional instability of the ankle, also known as chronic ankle instability, has traditionally been treated through conventional rehabilitation exercises, which include muscular endurance exercises, gradual increase in strength and proprioception exercises (6). With regard to the application of plyometric exercises in patients with functional ankle instability, there is a limited amount of scientific evidence available. Most of the studies reviewed focus on neuromuscular adaptations that result from the incorporation of plyometric exercises, either independently or in combination with integrated stability training. However, there is a lack of robust evidence or limited information on the effect of isolated plyometric training on individuals suffering from such injuries.

Methods

The research is based on a descriptive study, aimed at collecting and presenting data in a detailed and objective way without manipulation or intervention on the subject; "The efficacy of plyometrics exercises in the treatment of muscle and tendon injuries in U-17 footballers".

Study Design:

The study would adopt an observational descriptive design, which involves data collection without the introduction of controlled interventions.

Population and Sample:

The target population would be U-17 footballers who have experienced muscle and tendon injuries.

Data Collection:

Data on football muscle and tendon injuries, including the type, location and severity of injuries, would be collected using medical records and injury reports.

Data Analysis:

- A descriptive analysis of the collected data would be performed to summarize the characteristics of the lesions, as well as the results of the plyometrics intervention.

Results & Feedback

The results obtained from the descriptive study are presented below and the most outstanding findings of the research are shown:

The scientific literature has documented that tendon muscle injuries are common in footballers, the prevalence varies according to the study population, but it is common to find that a significant proportion of footballers have experienced a tendon muscle injury at some point in their career (8,9).

Board 1. Prevalence of lesions

Total Injury Prevalence	29.68%
Workout Injuries	51.1%
Match Injuries	46.7%
Location of Lower Limb Lesions	86.9%
Types of Injuries	
- Muscle tear/strain	37.0%
- Sprain/Ligament	19.6%
- Other injuries	14.1%
Mechanisms of Injury	
- During Race/Sprint	33.7%
-Kick	12.0%
- Jump/Landing	6.5%

Taken from (4,10)

In this scientific study, it is possible to show that the prevalence of muscle and tendon injuries in U-17 soccer players was significant, representing almost 30% of the total cases in the sample. This indicates that tendon muscle injuries are a common problem in this population of young athletes. More than half of the injuries occurred during training (51.1%), while 46.7% occurred during matches.

A study conducted by Tomala et al (11) revealed that approximately 76% of athletes suffer from musculoskeletal injuries, of which 55% affect the joints. In addition, work by Aloui et al, in Swiss elite athletes, found that 93% of musculoskeletal injuries affect the lower extremity, with the knee (33%) being the most commonly affected area. (10)

Some authors claim that muscle functionality is essential for athletic performance, physical health, and overall quality of life. A functional muscle is able to generate strength, power, and endurance effectively, allowing you to perform a wide range of everyday activities and sports with ease and efficiency. Given its importance, improving muscle functionality has been a key goal in fitness research and practice. In this context, plyometrics exercises have emerged as a promising training strategy to optimize muscle functionality (1,2)

Plyometrics involves explosive, high-intensity movements that are designed to improve jumping power and ability, among other attributes (4). These exercises involve a fast eccentric phase followed by an explosive concentric phase and are therefore considered an effective way to improve a muscle's ability to generate strength and power in a short period

of time. However, despite the growing interest in plyometrics, the scientific evidence supporting its effectiveness in improving muscle functionality still requires a more in-depth and accurate evaluation. (11) tags.

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As explored in this research, plyometrics could be said to be characterized by explosive and high-intensity movements. For authors such as , it involves a rapid cycle of muscle stretching and shortening, where the muscle is briefly stretched during the eccentric or lengthening phase; before rapidly shortening during the concentric phase or shortening. This is known as the stretch-shortening cycle and is essential for the effectiveness of plyometrics exercises (14,15) (16)

It should be noted that, during the eccentric phase, the muscles store elastic energy that is released explosively during the concentric phase. This eccentric load is a distinctive feature of plyometrics exercises and contributes to the improvement of muscle power. Similarly, plyometrics exercises focus on the production of explosive force rather than maximal sustained force (5). This is essential for improving a muscle's ability to generate force quickly, which is critical in many sports and functional activities. (10,17)

That said, plyometrics is commonly used in sports that require jumping, rapid changes of direction, and explosive movements, such as basketball, volleyball, track and field, and other high-intensity sports (11). It has also been incorporated into fitness programs to improve functional capacity and muscle health in individuals looking to stay fit. The effectiveness of plyometrics exercises has been studied in various contexts, and the scientific literature provides evidence on their potential benefits for improving muscle function, power, and endurance (8,10).

On the other hand, plyometric training is based on taking advantage of the stretch-shortening cycle (CEA) of the muscle-tendon complex, where the eccentric phase generates higher levels of force than an isolated concentric action (16). The studies reviewed have shown improvements in various areas, such as jumping, sprinting, agility, and ball striking speed. The improvement in agility is mainly related to the training of jumps, both vertically and horizontally and from different heights. This provides an effective transfer to the ability to change direction quickly (16).

Now, based on the results of cases where plyometric exercises are implemented in tendon injury processes, the following table is presented, which represents some exercises that were selected in studies for musculo-tendon injuries

Board 2. Plyometrics Exercises for Muscle Tendon Injuries

Level	Exercise	Description
1	March on the spot	This is an initial exercise to improve mobility and muscle control.
2	Static Lunges	To perform slow, controlled lunges to improve leg strength and stability. Avoid bouncing or jumping.

Level	Exercise	Description
3	Vertical Jump Lunges	Add a vertical jump to lunges, maintaining control and landing softly. This exercise increases strength in your legs.
4	One-Footed Jumps	It allows you to jump back and forth on one foot, maintaining stability and avoiding hard landing. Improves strength and coordination.
5	Jumps on both feet	It allows you to perform forward and backward jumps with both feet, maintaining stability and landing softly. Increases strength and power.
6	Zigzag jumps	It allows you to salt in a zigzag pattern back and forth, while maintaining control and agility. Improves coordination and strength.
7	One-leg jumps and bounce	It involves performing a jump on one foot and landing on the same foot, then performing a small bounce before switching legs. Improves power and stability.
8	Jumps with obstacles	It allows you to jump over low obstacles or cones in a specific pattern to improve agility and coordination, as well as strength and power.

The U-17 category is a crucial stage in a footballer's sporting career. It's the time when many players aspire to advance to more competitive levels and, potentially, a professional career. Any injury or impairment at this stage can have a lasting impact on your prospects.

The biomechanical structure of the foot plays a fundamental role in the pathology of tendon injuries, because the foot has the function of absorbing impact, adapting to the surface of the ground and maintaining the stability of the body. Tendon injuries act as a windlass mechanism, playing an essential role in controlling the arch of the foot and regulating pronation or supination during walking. Any factor that increases stress on the plantar fascia can trigger the onset of plantar fasciitis (18) (18)

According to a study conducted by Lopez et al, a high number of football players were found to experience heel pain, but only a relatively low percentage, 26.9%, chose to undergo medical evaluation. The cause of these injuries is multifactorial and is related both to repetitive microtrauma caused by impact forces during technical movements and to other factors such as field conditions, training modality, and recovery times (18,19) (19)

That is why plyometrics has been successfully used in sports rehabilitation due to its numerous benefits. These include increasing muscle strength, power, and stability, improving neuromuscular coordination and shock-absorbing capacity, as well as restoring joint function and preventing recurrent injuries. The inclusion of plyometrics exercises in a rehabilitation program should be gradual and tailored to the individual needs of the athlete. (20)

Sports health professionals design specific programs that begin with low-impact exercises and gradually increase the intensity as the athlete recovers. Despite its benefits, plyometrics comes with certain risks, especially if it is not performed properly. A poorly designed program or progression that is too rapid can increase the risk of further injury. Therefore, professional supervision is essential in the application of plyometrics in rehabilitation (20)

Athletes' acceptance of plyometrics exercises is a key factor in their effectiveness in rehabilitation. The athlete's perception and satisfaction with these exercises can influence their adherence to the rehabilitation program and therefore their success in recovery. The scientific literature has addressed the effectiveness of plyometrics in the rehabilitation of different types of injuries, such as cruciate ligament injuries, muscle strains, and bone fractures. The results of these studies have varied, with some highlighting the importance of athlete perception in the effectiveness of plyometric exercises (18,19,20)

To maintain consistent competitive performance throughout a sports season, it is essential to implement training strategies that balance optimal performance and physical health. This includes injury prevention so that athletes can maintain their fitness throughout the season (15). According to (19), one of the main goals of training is to reduce both the number and severity of injuries, allowing athletes to be at their best during the competitive season. It is also highlighted that training peaks, where loads increase or decrease sharply, can increase the risk of injury in athletes. In the context of football, it is crucial to consider specificity in training, as pointed out (20), this involves understanding the specific performance factors of futsal and designing training strategies to optimize them and prevent injuries.

Similarly, it has been observed that training using plyometric exercises also impacts the athlete's inherent abilities, as it enables them to perform movements more effectively and safely than they used to be capable of (17). In a study conducted by (19), it was identified that this type of training exercises led to significant improvements in certain variables related to the physical fitness and football skills of athletes. This resulted in a positive effect on aspects such as dribbling in combination with speed and agility, as well as an improvement in the ability to shoot on goal.

Conclusions

Through this review, it was possible to show that plyometric exercises have proven to be an effective tool in the rehabilitation of musculoskeletal and tendon injuries in football players. Through an adequate implementation of plyometric exercises, it is possible to reduce the incidence and severity of muscle and tendon injuries in young footballers. This is achieved by strengthening muscles and tendons, improving jumping and acceleration ability, and developing proprioception.

It is essential to consider the specificity of training for U-17 football when designing plyometric exercise programs. Drills should be aligned with the specific demands of the sport and tailored to the individual needs of the players. Supervision and direction from a physical therapist or healthcare professional are essential during the implementation of plyometric exercises in rehabilitation. This ensures that the drills are performed safely and tailored to each player's recovery phase.

In addition to their role in rehabilitation, it has been observed that plyometric exercises can also improve the performance of U-17 footballers. This includes improvements to speed, agility, jumping ability, and soccer-specific skills. Despite advances in understanding the efficacy of plyometric exercises in rehabilitation, there are areas where more research is needed, such as the long-term evaluation of their impact on injury prevention and their applicability in different types of musculo-tendon injuries.

References

1. Analysis of the most frequent injuries in lower limbs in football. Available from: <http://podium.upr.edu.cu/index.php/podium/article/view/1245>
2. Pangrazio O, Forriol F. Epidemiology of injuries sustained by players during the XVI South American U-17 Football Championship. *Rev Esp Cir Ortop Traumatol.* 2016 May 1; 60(3):192–9.
3. Pereira Rodriguez JE, De Marcos Sanchez JS, Ceballos Portilla LF, Avendaño-Luque E, Parra Rojas GL, Corrales FA. Effects of plyometric exercises in postoperative patients with calcaneal tendon rupture. *Ibero-American Journal of Physical Activity and Sport Sciences.* 2022 Jul 14; 11(2):104–20.
4. Crossley KM, Patterson BE, Culvenor AG, Bruder AM, Mosler AB, Mentiplay BF. Making football safer for women: A systematic review and meta-Analysis of injury prevention

- programmes in 11 773 female football (soccer) players. Vol. 54, *British Journal of Sports Medicine*. BMJ Publishing Group; 2020. p. 1089–98.
5. Alfaro Jiménez DF, Salicetti Fonseca A, Jiménez Díaz J. EFFECT OF PLYOMETRIC TRAINING ON EXPLOSIVE STRENGTH IN TEAM SPORTS: A META-ANALYSIS. *Thinking in Motion: Journal of Exercise and Health Sciences*. 2018 Jun 11; 16(1):27752.
 6. Diaz+Cevallo+Exercise+Plyometrics.
 7. Ramírez-delaCruz M, Bravo-Sánchez A, Esteban-García P, Jiménez F, Abián-Vicén J. Effects of Plyometric Training on Lower Body Muscle Architecture, Tendon Structure, Stiffness and Physical Performance: A Systematic Review and Meta-analysis. Vol. 8, *Sports Medicine - Open*. Springer Science and Business Media Deutschland GmbH; 2022.
 8. Wang YC, Zhang N. Effects of plyometric training on soccer players. Vol. 12, *Experimental and Therapeutic Medicine*. Spandidos Publications; 2016. p. 550–4.
 9. Aloui G, Hermassi S, Hayes LD, Bouhafis EG, Chelly MS, Schwesig R. Loaded plyometrics and short sprints with change-of-direction training enhance jumping, sprinting, agility, and balance performance of male soccer players. *Applied Sciences (Switzerland)*. 2021 Jun 2; 11(12).
 10. Aloui G, Hermassi S, Hayes LD, Bouhafis EG, Chelly MS, Schwesig R. Loaded plyometrics and short sprints with change-of-direction training enhance jumping, sprinting, agility, and balance performance of male soccer players. *Applied Sciences (Switzerland)*. 2021 Jun 2; 11(12).
 11. Ramírez-delaCruz M, Bravo-Sánchez A, Esteban-García P, Jiménez F, Abián-Vicén J. Effects of Plyometric Training on Lower Body Muscle Architecture, Tendon Structure, Stiffness and Physical Performance: A Systematic Review and Meta-analysis. Vol. 8, *Sports Medicine - Open*. Springer Science and Business Media Deutschland GmbH; 2022.
 12. Sciences F, DE, Physics A, El Y, Performed D, Rosado Muñoz M. PHYSICAL ACTIVITY AND SPORT + DEGREE IN PHYSIOTHERAPY.
 13. SYSTEMATIC REVIEW OF RISK FACTORS FOR INJURY OF.
 14. Results 2.
 15. Cao B, Zeng X, Luo L. RESULTS OF PLYOMETRY ON LOWER LIMB MOTOR FUNCTION IN SOCCER PLAYERS. *Revista Brasileira de Medicina do Esporte*. 2023;29.
 16. Castro-Jiménez LE, Sánchez-Rojas IA, Molina-Murcia PS, Martínez-Baquero J, Zambrano D, Velasco YT. Characterization of injuries in U19 and U20 football players. *TECHNOSCIENCE Chihuahua*. 2020 Oct 27; 14(2):81–91.
 17. Tomalá B S, Caicedo M F, Lopez GM, Galarza M M, Chang E L. Prevalence and risk factors of musculoskeletal injuries of the national football team of the Universidad Católica de Santiago de Guayaquil, Ecuador. *Pag [Internet]*. 53(03):2022. Available from: <https://www.revistaespacios.com>
 18. Noriega DC, Cristo Á, León A, García-Medrano B, Caballero-García A, Córdova-Martinez A. Plantar Fasciitis in Soccer Players—A Systemic Review. *Int J Environ Res Public Health*. 2022 Nov 1; 19(21).
 19. López-Valenciano A, Ruiz-Pérez I, Garcia-Gomez A, Vera-Garcia FJ, De Ste Croix M, Myer GD, et al. Epidemiology of injuries in professional football: A systematic review and meta-analysis. Vol. 54, *British Journal of Sports Medicine*. BMJ Publishing Group; 2020. p. 711–8.
 20. Arias Granizo WG. Importance of plyometric work in the prevention of injuries in futsal players. *Digital Science*. 2021 Apr 5; 5(2):16–45.