MODERN METHODS OF DIAGNOSIS AND TREATMENT OF MUSCLE INJURIES

Abstract. Muscular sports injuries are muscle damage that can occur as a result of various sports activities. Such injuries can vary in nature and severity, from mild sprains to serious muscle tears. Most often, they occur as a result of jumping, sudden movements, changes of direction or interaction with other players during sporting events.
The article discusses various aspects of sports muscle injuries, their diagnosis and modern treatment methods. It emphasises the crucial role of the patient's history in the diagnosis of injuries, taking into account factors such as the type of pain, its onset and the circumstances preceding the injury. Blood tests, MRI and CT scans are highlighted as essential for a comprehensive diagnosis. The text then goes on to discuss current treatments, including NSAIDs, PRP therapy and mesenchymal stem cell (MSC) therapy. The success stories of athletes such as Rafael Nadal and Cristiano Ronaldo, who have used stem cell treatments, are presented.

In addition, the text explores low-level laser therapy (LLLT) and its potential benefits, acknowledging that research into its effectiveness is ongoing. Athletes such as Kerri Walsh Jennings are mentioned as users of laser therapy in their recovery plans. Alternative methods such as massage, cryotherapy and hyperbaric oxygen therapy are also discussed. Although massage has potential benefits in stimulating blood flow, reducing muscle tension and increasing joint flexibility, its effectiveness remains controversial. The potential benefits of cryotherapy for reducing inflammation and pain are highlighted, with reference to the practice of athletes such as Floyd Mayweather, LeBron James and Usain Bolt. Hyperbaric oxygen therapy is explored in terms of its potential benefits in promoting angiogenesis, cellular repair and reducing oxidative stress. Examples are given of famous athletes, including Tiger Woods, Ronaldo and Nadal, who have chosen alternative treatments.

**Keywords:** platelet-rich plasma (PRP), mesenchymal stem cells (MSC), muscle injuries, sports injuries, laser therapy, treatment.
Сучасні можливі методи діагностики та лікування травм м'язів

Анотація. М'язеві спортивні травми - це ушкодження м'язів, яке може виникнути внаслідок різних видів спортивної діяльності. М'язеві травми можуть виникати з різних причин і часто є результатом комбінації факторів. Такі травми можуть мати різний характер та тяжкість, від легких розтягувань до серйозних розривів м'язів. Найчастіше вони виникають внаслідок стрибків, різких рухів, змін напрямку або взаємодії з іншими гравцями у ході спортивних заходів.

У статті обговорюються різні аспекти спортивних травм м'язів, їх діагностика та сучасні методи лікування. Підкреслюється вирішальна роль анамнезу пацієнта в діагностиці травм, враховуючи такі фактори, як тип болю, його початок і обставини, що передували травмі. Аналізи крові, МРТ і КТ висвітлюються як необхідні для всебічної діагностики. Далі в тексті розглядаються сучасні методи лікування, зокрема нестероїдні протизапальні препарати (НПЗП), терапія збагаченою тромбоцитами плазмою (PRP) і терапія мезенхімальними стовбуровими клітинами (MSC). Представлені історії успіху таких спортсменів, як Радаель Надаль і Кріштіану Роналду, які застосовували лікування стовбуровими клітинами.

Крім того, в тексті досліджується низькорівнева лазерна терапія (LLLT) та її потенційні переваги, визнаючи, що дослідження її ефективності тривають. Спортсмени, такі як Керрі Уолш Дженнінгс, згадуються як користувачі лазерної терапії у своїх планах відновлення. Також обговорюються альтернативні методи, такі як масаж, кріотерапія та гіпербарична киснева терапія. Хоча масаж має потенційні переваги у стимулюванні кровотоку,
zменшенні м'язового напружения та підвищенні гнучкості суглобів, його ефективність залишається суперечливою. Підкреслюється потенційна користь кріотерапії для зменшення запалення та болю, з посиланням на практику таких спортсменів, як Флойд Мейвезер, Леброн Джеймс та Усейн Болт. Гіпербарична киснева терапія досліджується з точки зору її потенційних переваг у сприянні ангіогенезу, клітинному відновленню та зменшенню оксидативного стресу.

Наводяться приклади відомих спортсменів, зокрема Тайгера Вудса, Роналду і Надаля, які обрали альтернативні методи лікування.

Ключові слова: збагачена тромбоцитами плазма крові, мезенхімальні стовбурові клітини, м'язеві травми, спортивна травма, лазерна терапія, лікування.

Statement of the problem. Injuries to muscles are a prevalent issue, particularly in the realm of professional sports. Fast and accurate diagnosis is the basis for successful treatment [1,2]. Quickly determining the type and severity of a muscle injury allows for targeted and effective treatment strategies, minimising downtime and facilitating a quick return to competition. Several diagnostic tools and techniques are used to assess muscle injuries [3,4]. Cutting-edge imaging technologies, such as magnetic resonance imaging (MRI) and ultrasound, play a crucial role in offering intricate visualization of the impacted muscle tissue. These imaging techniques help to determine the extent of the injury, including the location and severity of muscle tears or strains. In addition to imaging, clinical assessment by a sports medicine specialist is crucial. This evaluation may include a thorough physical examination, medical history assessment and functional tests to determine the athlete's range of motion, strength and flexibility. Combining these clinical assessments with imaging findings allows for a comprehensive understanding of the injury and the development of an individualised treatment plan [5,6].

Once a muscle injury is diagnosed, the treatment plan may include various therapeutic interventions such as physical therapy, rehabilitation exercises and, in some cases, surgery. Rehabilitation is not only aimed at healing the injured muscle, but also at preventing future injuries by strengthening, conditioning and improving biomechanics. Continuous monitoring and follow-up assessments are important throughout the recovery process to track the athlete's progress and adjust the treatment plan accordingly. This collaborative approach involving medical professionals, coaches and athletes is crucial to optimise recovery and ensure a safe return to sport. The goal is to start the right treatment steps as early as possible to quickly regain full stability and at the same time prevent relapses. A thorough history and recording of symptoms, palpation of the muscle injury, functional tests and identification of the cause of the injury are prerequisites for this. After a diagnosis is established, the anticipated duration of treatment can typically be predicted with
a high degree of accuracy. This information is vital for the individual with the injury, providing guidance on when and how to safely resume training and competition. [7,8].

**Analysis of the latest research and publications.** Clinical assessment remains a fundamental aspect of muscle injury diagnosis. It provides an immediate insight into the patient's condition and guides further diagnostic steps. Imaging techniques such as ultrasound and MRI continue to be crucial for accurate diagnosis. They offer non-invasive ways of visualising soft tissue, assessing the extent of damage and making treatment decisions [9].

While blood tests are not the primary method of diagnosing muscle injuries, they can be important in ruling out other potential causes of muscle-related symptoms. Physical therapy plays a crucial role in the rehabilitation and recovery phase. It is aimed at restoring strength, flexibility and function, and preventing long-term complications. In severe cases or when conservative measures do not help, surgical intervention, such as muscle repair or reconstruction, may be necessary. Improvements in surgical techniques continue to improve outcomes. Never treat conditions such as platelet-rich plasma (PRP) injections and stem cell treatments, as well as other methods that we will introduce in this article, show promise for promoting tissue healing. Research in this area is ongoing, and these methods are being studied for their potential benefits [10,11].

**The aim of this article** was to analyse and describe the features of muscular sports injuries, to describe modern and previously known methods for the treatment of these injuries.

**Presentation of the main material.** Muscle sports injuries can occur for a variety of reasons, often related to excessive physical effort, poor training techniques, insufficient warm-up or other factors [1,12,13]. We can divide the main reasons into the following points:

- Improper or no warm-up can increase the risk of injury, as insufficiently warmed-up muscles are less prepared for intense physical activity [14].
- Improper technique during training or sports movements can lead to excessive strain on certain muscle groups and contribute to injury [1].
- Prolonged training without sufficient rest can lead to muscle strain, which increases the risk of injury [15].
- Insufficient muscle strength, flexibility and stability can make muscles less resistant to injury [16].
- Defective or poor quality training equipment and the lack of protective equipment can cause injuries [17].
- Uneven muscle development or lack of training for certain muscle groups can create imbalances and increase the risk of injury [1].
- Poor physical fitness, lack of flexibility, and age can all contribute to a susceptibility to muscle injury [18].
- Pre-existing medical conditions, such as mineral or vitamin deficiencies, can increase the risk of injury [19].
- Poorly fitting running shoes can lead to improper pressure distribution during movement, increasing the risk of injury [20].
- Inadequate water and nutrient intake can lead to muscle fatigue and reduced efficiency, increasing the risk of injury [21].
- Poor surface conditions, slippery surfaces or cold weather can reduce stability and increase the risk of sprains, particularly in the knee or ankle [22].
- In contact sports such as football, rugby or hockey, there is an increased risk of injury as players may be placed in situations of physical contact that can lead to muscle damage [23].

In 2013, the "Munich Consensus Classification" was published in the British Journal of Sports Medicine, which classifies all muscle injuries in professional sport into functional, structural and related subgroups. The MRI-based classification, on the other hand, only divides into four groups. Functional injuries, especially neurogenic muscle strain, are the most common muscle injuries. Currently, they can only be reliably identified by palpation of the muscles by a very experienced doctor and a thorough review of the clinical history and symptoms [24,25]. Structural injuries encompass partial and (sub)total tears, while functional injuries result from overload or neuromuscular causes [20,26].

Skeletal muscle healing follows a consistent sequence of phases, regardless of the cause of the injury, whether it be contusion, stretch, or laceration. These phases, namely destruction, repair, and remodeling, are interconnected, with the latter two overlapping. During the destruction phase, myofibrils rupture, leading to necrosis. Simultaneously, a hematoma forms in the space between the ruptured muscle, accompanied by the proliferation of inflammatory cells. The repair and remodeling phase involves the phagocytosis of necrotic tissue, regeneration of myofibrils, and simultaneous production of connective scar tissue. Additionally, there is vascular neoformation and neural growth during this phase. The remodeling phase represents the maturation of regenerated myofibrils, involving the contraction and reorganization of scar tissue, leading to the restoration of muscle functional capacity. A specific protective mechanism, known as a contraction band, mitigates the risk of necrosis spreading along the length of the fiber. Following the subsidence of the destruction phase, the repair of muscle injury initiates with simultaneous processes: the regeneration of myofibrils and the development of scar connective tissue. A harmonious progression of these processes is crucial for the optimal recovery of muscle function. While myofibrils are generally considered nonlytic, the regenerative capacity of skeletal muscle relies on satellite cells, an undifferentiated cell reserve beneath the basal lamina of each myofibril. These cells proliferate, differentiate into myofibrils, and eventually form multinucleated myofibrils in response to injury. The gap formed between ruptured muscle fibers is initially filled
by a hematoma, and inflammatory cells, including phagocytes, coordinate the clot organization. Granulation tissue, composed of blood-derived fibrin and fibronectin, establishes a framework for fibroblasts. Approximately 10 days post-trauma, scar maturation advances to a point where it is no longer the most vulnerable site of the muscle injury. Although excessive fibroblast proliferation may result in the formation of dense scar tissue within the muscle lesion, the majority of skeletal muscle lesions heal without the development of disabling fibrous scar tissue. Vascularization emerges as a crucial process for muscle regeneration, with the restoration of vascular supply serving as the initial indication of regeneration and a prerequisite for subsequent morphological and functional recoveries [27,28,29].

The diagnosis of a sports injury relies primarily on a history. Details about the course of the injury and the preceding circumstances play an important role in determining the correct nature of the injury and provide key guidance for developing effective treatment and rehabilitation. It is important to find out how the athlete felt the pain - whether it was sharp, dull or cramping, or whether there was painful tightness. Details about how quickly the pain developed (whether gradually or suddenly) can be key to correctly identifying the cause of the injury. From the pre-injury history, attention should be paid to the situation before the injury, warm-up and stretching, and any previous signs of muscle fatigue. It is important to determine whether the training was carried out on unusual surfaces, or if the shoes or insoles were changed. Consider whether the type of training has changed and whether there have been any new activities that could cause injury. Look for factors such as changes in coaching staff or club, the amount and intensity of training in recent days, whether there have been any breaks between training sessions, and previous injuries to the area or adjacent joint. You should ask in detail about possible risk factors such as infections, normal laboratory values before the injury, and whether the athlete fell after the injury or was able to continue with limited running. To get a complete picture of the injury, blood tests and comprehensive examinations such as MRI and CT are also necessary [30].

Modern methods of treating muscle injuries are known, such as non-steroidal anti-inflammatory drugs, platelet-rich plasma and mesenchymal stem cell injections, and laser therapy.

Non-steroidal anti-inflammatory drugs (NSAIDs) are commonly used to treat muscle injuries due to their anti-inflammatory, analgesic and anti-scarring properties. However, the effectiveness of these medications may depend on the type and extent of the injury, as well as the individual patient [31,32].

The main benefits of NSAIDs in the treatment of muscle injuries include:
- Reduced Inflammation: NSAIDs block enzymes known as cyclooxygenases (COX), which leads to a reduction in the synthesis of prostaglandins that cause inflammation.
- Analgesic action: NSAIDs have analgesic effects, helping to reduce pain and discomfort associated with muscle injuries.

However, it is important to take into account certain limitations and potential side effects when using NSAIDs: namely, the stomach and intestines (long-term use of NSAIDs can lead to gastrointestinal irritation and increase the risk of peptic ulcers).

PRP involves using a concentration of the patient's own platelets to enhance the natural healing process. Platelets contain various growth factors and biologically active proteins that play a crucial role in tissue repair and regeneration [33]. For this purpose, a small amount of the patient's blood is taken, usually from a vein in the arm. The blood is then centrifuged using a centrifuge, a device that separates its components based on density. The centrifuge separates the platelets from the other components of the blood, resulting in a concentrated PRP solution.

This PRP solution is then extracted and prepared for injection. The PRP is typically injected directly into the site of muscle damage using a guided imaging technique, such as ultrasound, to ensure accurate placement. The growth factors released by platelets in PRP promote tissue repair, increase blood flow and attract stem cells to the damaged area [34].

This process is believed to accelerate the body's natural healing response and enhance the regeneration of damaged muscle tissue. After a PRP injection, patients usually undergo a rehabilitation programme that includes special exercises, physical therapy and a gradual return to normal activities. The combination of PRP therapy and rehabilitation aims to optimise the recovery process and improve the overall function of the affected muscles [35].

An example of a famous person who has successfully used platelet-rich plasma to treat his injuries is Hines Ward, the NFL wide receiver and Super Bowl XL MVP known for his exceptional skills, including his reliable hands and impressive blocking ability. In recent years, Ward has attracted attention for his involvement in an innovative medical treatment known as platelet-rich plasma (PRP) therapy. This experimental procedure played a crucial role in his recovery from a significant medial collateral ligament injury to his right knee sustained during an AFC Championship game. Initially, the projected recovery time was four to six weeks, but Ward and his team's medical staff rejected the traditional timeline and turned to alternative treatments. The choice of PRP therapy proved to be decisive, as Ward's injury healed at an accelerated pace, allowing him to participate in the Super Bowl [36]. Brandon Roy, a prominent professional basketball player of the Portland Trail Blazers, who is considered one of the youngest talents in the NBA, chose platelet-rich plasma (PRP) therapy after arthroscopic surgery on both knees. [37]. Both athletes note that the use of this particular treatment methodology helped them return to training faster and continue their playing careers.
The use of mesenchymal stem cells (MSCs) in the treatment of muscle sports injuries is an area of active research and holds promise in the field of regenerative medicine. MSCs are versatile cells with the ability to transform into diverse cell types, including muscle cells. Beyond their differentiation potential, MSCs also exhibit immunomodulatory and anti-inflammatory properties. These unique characteristics make them valuable in various therapeutic applications, as they can not only contribute to tissue regeneration but also play a role in modulating the immune response and reducing inflammation in the surrounding environment [38].

MSCs have the ability to differentiate into myogenic cells, contributing to the repair and regeneration of damaged muscle tissue. MSCs can modulate the immune response and have anti-inflammatory effects. This may be useful in the context of sports injuries, where inflammation is a common component of the healing process. MSCs secrete various growth factors and cytokines that can stimulate tissue repair and regeneration. These factors create a microenvironment favourable to healing. Studies show that the use of MSCs can help minimise the formation of fibrous scar tissue, promoting more functional and less fibrous repair. MSCs can accelerate the overall healing process by promoting angiogenesis (the formation of new blood vessels) and enhancing the recruitment of other cells involved in tissue repair [39,40].

According to reports from the Spanish press, Rafael Nadal, the renowned tennis player, sought stem cell treatment in November 2013 as a solution to his knee issues. The initial stem cell therapy proved successful, providing relief for at least a year. Encouraged by these results, Nadal opted for stem cell treatment once again to address his back problems, specifically facet syndrome, which involves inflammation of certain lumbar vertebrae [41]. In April 2016, The Sun, a British newspaper, disclosed that Cristiano Ronaldo, the star striker for Real Madrid, also underwent stem cell treatment for a knee injury [42].

Laser therapy, alternatively referred to as low-level laser therapy (LLLT) or cold laser therapy, is a therapeutic approach employing low-level lasers or light-emitting diodes to activate cellular functions and facilitate the healing of tissues. While research on the effectiveness of laser therapy for traumatic sports muscle injuries is ongoing, there is some evidence suggesting potential benefits. However, it's important to note that results can vary, and more high-quality research is needed to establish definitive conclusions.

Laser therapy is believed to enhance cellular activity and promote the production of ATP (adenosine triphosphate), which is essential for cellular energy. This can potentially accelerate the healing process. Some studies suggest that laser therapy may have anti-inflammatory effects, helping to reduce swelling and inflammation associated with muscle injuries. Laser therapy may have analgesic (pain-relieving) effects by influencing nerve conduction and decreasing pain signals. The therapy might stimulate the production of collagen, an essential component in
the healing of connective tissues. Laser therapy is generally considered safe with minimal side effects when administered by trained professionals [43,44].

Kerri Walsh Jennings, the accomplished beach volleyball player and three-time Olympic champion, turned to low-level laser therapy as part of a comprehensive recovery plan in preparation for the ASICS Beach Volleyball World Series after experiencing a dislocated right shoulder injury. Describing her multifaceted approach to treatment, Walsh Jennings shared with USA TODAY Sports that she engages in a daily hour-and-a-half shoulder exercise routine. Additionally, she incorporates various therapeutic methods, including low-level laser therapy, sleeping on a magnet to stimulate blood flow, receiving platelet-rich plasma (PRP) injections for pain relief and accelerated healing, and engaging in full-body exercises throughout the day. Walsh Jennings also employs cold laser treatment and uses ice extensively, leveraging any available technology or tools to aid in her healing process [45].

There are also alternative methods of treating muscle injuries that are now used by well-known athletes, such as massage, cryotherapy, and the use of hyperbaric oxygen.

Therapeutic massage. Massage therapy involves the localized manipulation of the skin and underlying muscles through techniques such as stroking, kneading, and striking, applying pressure and stretching muscles over specific durations. Widely utilized for treating mild to moderate muscle injuries, massage aims to reduce muscle pain and expedite muscle recovery after exercise. Despite its common use as a potential therapeutic approach for enhancing muscle recovery, there is ongoing debate about its effectiveness and the underlying mechanisms. Studies examining the impact of massage on indirect markers of muscle damage and recovery, such as muscle soreness, strength recovery, and swelling in humans, have generally produced inconclusive or insignificant findings. The effectiveness of massage therapy in addressing traumatic sports injuries varies depending on factors such as the type and severity of the injury, the timing of the massage, and the specific treatment objectives. Massage has the potential to enhance blood flow, promoting the delivery of oxygen and nutrients to injured tissues, thereby aiding the healing process. It can also relieve muscle tension and tightness commonly associated with sports injuries, leading to pain relief and improved flexibility. By targeting tight or restricted areas, massage may additionally boost joint flexibility and increase the range of motion in injured muscles and joints. Moreover, by addressing the formation of scar tissue, massage may assist in breaking down and aligning collagen fibers, fostering improved healing and reducing adhesion formation. Beyond its physical benefits, massage contributes to athlete relaxation and stress management, promoting an overall sense of well-being during the recovery process [46,47]. It's important to note that while massage can be beneficial, it should be applied with caution in certain situations. For instance, in the acute phase of an injury, where there

**Note:** The text above is an excerpt from a scientific article discussing the use of laser and massage therapies in rehabilitation. The full context and intended applications might be explored further in a complete source.
is inflammation and swelling, overly aggressive massage may exacerbate the condition. In such cases, it's crucial to consult with a healthcare professional or a qualified sports massage therapist to determine the most appropriate approach.

Cryotherapy. Cryotherapy involves the application of cooling using ice packs or similar methods to the surface of the skin over the muscle to temporarily lower muscle temperature, cause vasoconstriction and suppress pain [48].

Cryotherapy, which involves the application of cold temperatures for therapeutic purposes, is commonly used in the treatment of traumatic sports injuries. Cold therapy can help constrict blood vessels, leading to a reduction in blood flow to the injured area. This can be beneficial in minimizing inflammation, swelling, and pain associated with acute injuries. Cold therapy may have an analgesic effect by numbing nerve endings and reducing pain signals. This can provide relief for athletes dealing with pain from injuries. Cryotherapy is often used in the recovery phase to enhance the overall healing process, particularly after intense training sessions or competitions. Cold therapy is generally more effective in the early stages of an injury, especially during the acute phase when there is active inflammation. It may be less effective in chronic or long-term injuries. It's crucial to follow proper guidelines for the duration and frequency of cold therapy. Prolonged exposure to extreme cold can lead to tissue damage. Cold therapy may not be suitable for everyone. Individuals with conditions such as Raynaud's disease or other circulatory disorders should exercise caution or consult with a healthcare professional before using cryotherapy [49].

The efficacy of cryotherapy for athletes is well-established, particularly in addressing soreness and injuries common in their line of work. Floyd Mayweather's use of cryotherapy before his 2015 fight with Manny Pacquiao exemplifies this trend, with whole-body cryotherapy sessions becoming a post-training routine. Renowned athletes like LeBron James and Steph Curry have also incorporated cryotherapy into their post-training regimens, attesting to its benefits. Even Usain Bolt, the fastest short-distance runner globally, attests to the positive impact of this treatment. In summary, athletes embrace cryotherapy to not only feel better but also to expedite the recovery process, making it a proven and effective approach for treating injuries [50].

Hyperbaric oxygen therapy (HBOT) involves breathing pure oxygen in a pressurized room or chamber, and it is primarily known for its use in treating conditions such as decompression sickness and chronic non-healing wounds. While there is ongoing research and some positive anecdotal evidence, the effectiveness of hyperbaric oxygen therapy specifically for traumatic sports injuries is not definitively established [51]. The increased pressure in the hyperbaric chamber allows a higher concentration of oxygen to dissolve in the blood plasma, potentially promoting increased oxygen delivery to injured tissues. Oxygen is crucial for cellular metabolism and the healing process. HBOT may have anti-inflammatory
effects, helping to mitigate swelling and inflammation associated with sports injuries. Hyperbaric oxygen can stimulate the formation of new blood vessels (angiogenesis), which may support the healing process by improving blood flow to injured areas. In cases of tissue damage, reduced blood flow and oxygen supply (hypoxia) can impede healing [52]. HBOT aims to counteract this by providing an oxygen-rich environment. Some studies suggest that HBOT may enhance cellular recovery and reduce oxidative stress, which could benefit injured tissues [53].

However, it's important to note that the scientific evidence supporting the use of hyperbaric oxygen therapy for sports injuries is mixed, and the effectiveness may vary depending on the type and severity of the injury. The medical community generally agrees that more high-quality research is needed to establish clear guidelines for its application in the context of sports injuries.

In 2010, there was one of the most anticipated interviews in the recent history of sport, where it was announced that Tiger Woods was returning to the game of golf. When asked about his rapid recovery from the numerous injuries he had suffered over the years, he revealed that he had been using hyperbaric oxygen therapy, which is becoming increasingly popular among professional athletes [54].

Conclusions. The comprehensive exploration of sports-related muscle injuries reveals a multifaceted landscape encompassing causes, classifications, and treatment modalities. The primary causes, including inadequate warm-up, improper training techniques, and overtraining, underscore the importance of preventive measures in sports and training regimens. The healing process, intricately involving destruction, repair, and remodeling phases, sheds light on the complexity of muscle recovery.

Treatment approaches span a spectrum of methodologies, from traditional non-steroidal anti-inflammatory drugs (NSAIDs) to cutting-edge interventions like PRP and MSC therapy. Moreover, alternative therapies like laser therapy, cryotherapy, and hyperbaric oxygen therapy present additional dimensions to the treatment landscape.

Prospects for further research. Due to the significant impact of this issue, it is imperative to intensify research efforts focused on the customization and adaptability of approaches aimed at enhancing functionality and expediting the recovery of muscle tissue following traumatic injuries. Developing individualized strategies tailored to the specific needs of patients can enhance the effectiveness of interventions, leading to more targeted and efficient methods for improving muscle function and facilitating a speedier recovery from injuries.

Conflict of interest
The authors declare no conflict of interest.

Sources of funding
None

Authors’ contributions
All authors have made significant contributions to the preparation of the original and revised versions of this paper.

References:


Література:


