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**FACULTY OF PHYSICAL EDUCATION AND SPORT**
**DOCTORAL SCHOOL IN SPORTS SCIENCE AND PHYSICAL**
**EDUCATION**
**FIELD: SPORTS SCIENCE AND PHYSICAL EDUCATION**

# DESIGN AND IMPLEMENTATION OF A PROGRAM TO COMPLIANCE WITH PHYSIOTHERAPEUTIC TREATMENT FOR REHABILITATION AFTER SPORT INJURIES

## THESIS SUMMARY

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**2022**

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**Keywords**: physical therapy, dry needling, therapeutic compliance, functional rehabilitation, severity of trauma, treatment efficiency.

# INTRODUCTION

Performance sports around the world stand out through fierce competition on the road to national and international performance. The desire to surprise and surpass others implies on the part of athletes a maximum effort of speed, strength, endurance, ability to concentrate under stress. These intense demands, close to the functional limits of the body, increase the chances of injuries during training or conducting sports competitions.

The issue of sports injuries is a crucial topic in performance sports. Each sport has a specific amalgam of risk factors for potential acute or chronic trauma. The main negative effect of injuries in performance sports is determined by the period following the trauma, which in addition to managing recovery through physical therapy, is characterized by a psychological impact that can be an obstacle for most athletes.

The role of the physiotherapist in the field of international sports is vast and is not limited to medical recovery. It occupies an essential position in achieving sports performance, being a constant and long-lasting presence during training and sports competitions.

The efficiency of the recovery plan through kinetotherapy is influenced by the quality of the specific intervention strategy by using the most appropriate techniques and kinetotherapeutic means and by the level of patient involvement.

The main fundamental indicators with the role of quantifying the efficiency of the treatment are: the values of the functional tests, the period of sports unavailability, the therapeutic compliance, the limitation of the risk of injury.

The therapeutic conduct in the recovery of performance athletes is based on a series of fundamental principles that favor the initiation and maintenance of an efficient collaboration between the physiotherapist and the patient.

# PART I - ASPECTS OF KINETOTHERAPEUTIC TREATMENT IN THE REHABILITATION OF SPORT TRAUMA

## CHAPTER 1. Particularities of sports injuries

### 1.1. Overview

Sport and physical activity are associated with multiple benefits in terms of population health, the number of followers worldwide is constantly growing (Eime et al., 2013). Whether practiced by professionals or amateurs, the sport has many advantages, but also a number of risks directly proportional to the type of sport practiced. Playing sports at the performance level has multiple biomechanical and physiological implications that can determine risk factors for potential injuries (Paterson & Chapman, 2013).

Sports injuries cause a series of unpleasant consequences that include the athlete involved and the club to which he belongs (Iacob & Cîtea, 2019). Each trauma has specific features of the injured segment and the production mechanisms, the medical recovery being a fundamental stage for the athlete's return to competition.

### 1.2. Incidence of sport injuries

The level of sport practice around the world has recently been classified into three categories: low, moderate and high (Jayanthi et al., 2015). A number of studies show that high-level athletes have a chance to present a history of trauma, especially in the lower limbs (ankle and knee). Some researchers have highlighted the possibility of associating a trauma after at least 16 hours of training / week (Myer, Jayanthi & Difiori, 2015), while in the lower limbs athletes may have an injury every 8 months (Bell et al., 2016 ).

Numerous recent studies (Jayanthi, LaBella & Fischer, 2015; Steffen et al., 2019) show the importance of minimizing the risks of injury, especially those that can have severe and long-term consequences.

In recent years, a major concern of physiotherapists and sports trainers is to reduce statistics on the incidence of sports injuries (Pereira et al., 2019), complex and innovative prevention programs being implemented in sports training (Emery & Pasanen, 2019; Cools et al., 2020).

### 1.3. The main risk factors in sport injuries

Sports injuries (direct or indirect) affect the human body and result from the practice of any sporting activity for competitive or recreational purposes and which requires prolonged physical exertion.

The first category of factors (extrinsic) is directly related to the environment and includes a series of circumstances over which the athlete can not have direct control: training errors, weather conditions, training ground / surface or competition, equipment, diet.

The second category of factors is based on a series of individual biological (anatomical and biomechanical) and psycho-social characteristics that predispose an athlete to musculoskeletal trauma (Bastos et al., 2013; Mandorino et al., 2022): anatomical variations, asymmetries, reduced mobility / flexibility, biological gender, sports kinesiology.

### 1.4. The main criteria for classifying sport injuries

The classification model developed by Brukner & Kahn (2012) is considered one of the most frequently used by sports physiotherapists. Depending on the mechanism of production and the symptoms present, sports injuries are structured in two categories: acute (A) and overload (B).

Acute lesions (A) occur suddenly and have a well-defined cause or onset. One of the principles in this case is that the force exerted at the time of the injury exceeds the resistance of that tissue.

The forces frequently involved in acute trauma are either direct or indirect. Also, these traumas can be structured according to the injured segment (bone, cartilage, ligament, muscle, bursa, tendon, joint, nerve, skin) and the type of injury (fracture, dislocation, sprain, etc.) (Mandorino et al., 2022).

Overexertion / chronic lesions (B) occur after a period of time due to repetitive and excessive tissue loading. The specific definition of this type of trauma was most often based on the absence of a single identifiable traumatic cause (Cheron, Scanff & Yde, 2017).

Depending on the particularities of the sport practiced and the set of risk factors that involve the most common demands, overload injuries can affect every segment of the human body.

The difference between acute and overload injuries is based on several biomechanical principles. Muscle action (static / dynamic) triggers an internal resistance in the structures involved in order to counteract tissue deformities / injuries (Pearson, 2019).

### 1.5. Specific considerations of muscle injuries

Muscle injuries are very common injuries in various sports such as football (Ekstrand, Hagglund & Walden, 2011), rugby (Williams et al., 2013), American football (Olson et al., 2013), Australian football (Hrysomallis, 2013) and athletics (Fedderman-Demont et al., 2014).

There is precise information that indicates that biarticular muscles, which contain a large proportion of rapidly contracting fibers, are most prone to muscle damage. A majority (90%) of injuries are caused by excessive exertion, overload or contusions following direct contact (Ekstrand, Hagglund & Walden, 2011).

According to statistics analyzing the incidence of injuries in professional European football, a team can anticipate up to 15 muscle injuries per season with a significant impact on the absence from the training ground / competition (up to 223 days, 27% of the time, approximately 37 matches). Most muscle injuries in professional football (92-97%) are located in the lower limbs: hamstrings (28-37%), quadriceps (19-32%), adductor muscles (19-23%), posterior calf ( 12–13%) (Valle et al., 2016).

#### 1.5.1. Acute muscle injuries

Acute muscle injuries have a traumatic (extrinsic) cause that causes a macro-trauma, also called muscle contusion. They occur especially in contact sports, where the dynamics of sporting events involve a high risk of collisions (with the opponent or with various objects).

Traumatic contusion is a common cause of soft tissue injuries in virtually all contact sports, being more common in men's sports (15.1%) than in women's sports (6.3%) (Trojian, 2013), more frequently in official matches, than in training (Ekstrand, Hagglund & Walden,

2011). The severity of the contusion is determined by the intensity of the traumatic agent and the extent of the injuries.

The superficial variant of contusions regularly affects the skin and subcutaneous tissue. The deep variant of contusions may present potential systemic functional disorders.

A slight contusion causes local pain, skin erythema and tenderness, without limiting the range of motion. This form of superficial contusion is called ecchymosis and is the result of capillary lesions in the area involved in the trauma.

Severe contusions can cause a significant limitation of the movement of the affected segment. The clinical picture includes the presence of an accentuated swelling and a hematoma, which can vary in size. Depending on the mechanism of production, moderate and severe contusion areas may cause plasma / blood extravasation, thus identifying the blisters.

### 1.5.2. Chronic muscle injuries

Overexertion or chronic muscle injuries have a more subtle evolution and often occur after a longer period (muscle "stretches", cramps, delayed-onset muscle pain, chronic compartment syndrome, etc.). These result from repetitive micro-traumas in the muscle or from intrinsic causes: muscle strains produced by a contraction with a tensile force superior to the resistance of the tissues. The force and speed with which muscle tension is applied can cause changes in the elastic properties of the tissue, an influence that can be exerted by fatigue or cell temperature.

Intrinsic trauma presents complex injuries suddenly felt in the form of strong or "sharp" pain during active technical procedures: sprints, running with a change of direction or hitting the ball in motion (Del Vescovo et al., 2017).

The main procedures and technical elements associated with muscle injuries in the lower limbs involve the activities of sprinting, forced stretching, or in inappropriate biomechanical conditions and over the endurance capacity of the muscles. The main muscle complex affected is that of the hamstrings. It initially shows a significant decrease in muscle function but a faster recovery in the case of sprint-related mechanisms (sudden acceleration or deceleration) (Ekstrand et al., 2012).

# CHAPTER 2. Concepts of physiotherapy in sport traumatology

## 2.1. Clinical examination of the patient

### 2.1.1. Anamnesis

Anamnesis is an essential process that the physiotherapist and the patient go through and that highlights a series of information necessary for the functional diagnosis and subsequent investigations. The anamnesis takes place in the form of an open, confidential dialogue and has a diagnostic value, providing information about: age, biological gender, sports, history of illness / trauma, history of personal history, etc.

### 2.1.2. Subjective clinical examination

Subjective clinical examination includes the evaluation of clinical signs such as pain, functional impotence, vicious attitudes and sensitivity disorders (Marcu, 2006). These indices have a very important role in the evaluation of the patient, the first stage of monitoring being performed through observation. The first contact with the patient can highlight a series of signs (facial expression, posture), attitudes, compensatory movements in walking and balance, which indicate the injured segment or the level of pain / discomfort.

Sports injuries can cause progressive partial / total functional impotence, the presence of vicious attitudes (in the spine, affected segment) and sensitivity disorders (tingling, numbness, stinging), all of which are subjective symptoms.

### 2.1.3. Objective clinical examination

Objective clinical examination of the patient is a fundamental step in determining the deficiencies of the injured segment and includes inspection, palpation, percussion, measurements and functional tests. Specialists recommend a complete, systematic examination, comparing the values of measurements and tests of the affected limb with those of the contralateral limb (Crema et al., 2015).

### 2.1.4. Imaging examination

The main priority of doctors and physiotherapists in elite sports is to optimize the return of the professional athlete on the training ground and in competition and to avoid aggravation of injuries or the danger of recurrence.

The analysis of the complexity and severity of the trauma is essential in the medical prognosis and in establishing the medical recovery strategy and through the kinetotherapeutic means. In order to achieve these objectives, it is of utmost importance to collect and interpret the available clinical and imaging information. Sports injuries can often present a complex manifestation, of multiple causes, situations in which the functional diagnosis requires the performance and interpretation of the imaging examination (X-ray, CT, MRI).

## 2.2. Biopsychosocial evaluation model

### 2.2.1. Overview

The biomedical model of patient evaluation includes the anamnesis, the subjective and objective clinical examination and follows the somato-functional evaluation, without providing information about the psycho-social factors. It suggests that in order to assess a subject's medical condition it is necessary to analyze both biological and psychological and social factors (Gatchel et al., 2007; Gritti, 2017) (Figure 1).

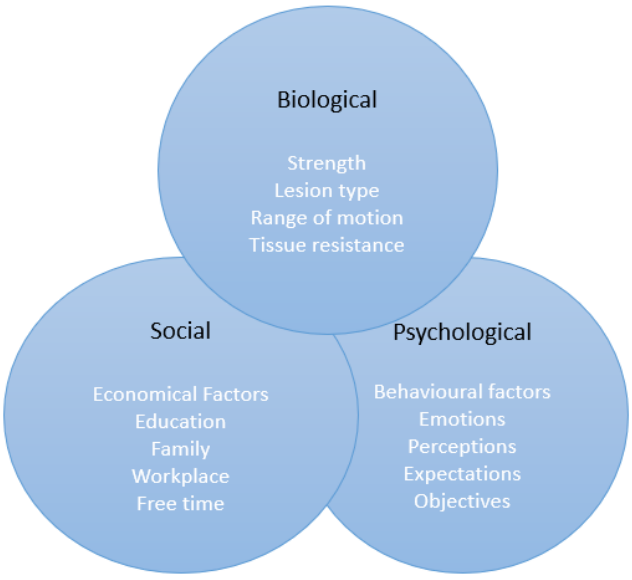


Figure 1. Biopsychosocial evaluation model (Ingraham, 2019)

This clinical evaluation model proposes the collection and analysis of the following data: pain, somatic and medical factors, cognitive factors, emotional factors, behavioral factors, social factors and motivation (Wijma et al., 2016).

### 2.2.2. Psychosocial aspects in the rehabilitation of sport injuries

Sports injuries do not only cause physical dysfunctions / injuries, they also have a negative impact on contextual and psychological aspects. In the event of an injury, the immediate consequences can place the athlete in a predominant state of negative emotions, stress, fear of injury and other mood disorders. The character of the negative impact of injuries can be influenced by the level of performance achieved by the athlete, personality and the level of emotional intelligence acquired (Alschuler & Alberts, 2020).

## 2.3. Kinetotherapeutic principles in the rehabilitation of sports injuries

The kinetotherapy treatment has a set of maneuvers and means based on physical exercise, present in different forms, their application in a correct way having an essential contribution in achieving the objectives. The establishment of the recovery strategy and plan is based on the following principles:

A. Avoiding aggravation

B. Precocity of treatment

C. Therapeutic compliance

D. Individualization of treatment

E. Sequence of treatment

F. Gradation of intensity

G. Treatment of “the whole patient

## 2.4. Methodology of the kinetotherapeutic rehabilitation plan for sports injuries

### 2.4.1. Acute phase

The first stage of recovery through physical therapy takes place immediately after the trauma and involves stabilizing the condition of the patient / injured segment and

avoiding complications.

The acute phase includes the first 4-6 days after the occurrence of sports trauma. In case of trauma, the first clinical sign is indicated by the presence of inflammation, whose main functions are to protect the body against harmful substances, to eliminate necrotic tissue and to trigger the renewal of healthy tissue (Bahr, 2012).

The treatment of the acute phase includes the systematic use of the most appropriate therapeutic means to achieve the objectives. Thus, medical recovery specialists have a wide variety of kinetotherapeutic means specific to the acute phase (Iacob et al., 2021). To these are added, as the case may be, the anti-inflammatory medication and the nutritional optimization, indicated by the collaborators (doctors, nutritionists).

### 2.4.2. Functional rehabilitation phase

Meeting the functional criteria after the first 4-6 days of medical recovery in the acute stage allows the patient to progress in the functional recovery phase. This phase continues for about 6-10 weeks (or more), depending on the severity of the trauma.

The main component of the functional recovery phase includes meeting the following objectives: increasing joint mobility, flexibility, muscle strength and improving endurance, proprioception, balance (static and dynamic) and coordination (Fournier, 2015). Progressive functional recovery involves detailed analysis of aspects of musculoskeletal trauma.

### 2.4.3. Sports reintegration

Medical recovery of athletes does not only regain the functional capacity of joint mobility, muscle strength and neuromuscular function. The phase of functional recovery continues during the advanced phase of recovery, namely, sports reintegration. This stage has in its composition the advanced functional training specific to the sport practiced and continues until the functional tests indicate the athlete's ability to return to competition (Dhillon, 2017; Fournier, 2015).

## 2.5. Particularities of Dry Needling therapy

Dry needling (DN) therapy is a minimally invasive method that uses fine dry needles or acupuncture to be inserted into the skin and muscles. The technique mainly targets trigger

points (also known as trigger points) that can be identified superficially or deeply in myofascial syndrome. Their identification is performed by palpation and the common description includes a hypersensitive palpable node located in a wide band of muscles (Ansari et al., 2020; Iacob et al., 2022).

Dry needling is a technique considered beneficial in managing the pain and flexibility of the tense muscles of the lower limb (Ansari et al., 2020; Geist et al., 2017) and other regions (Ceballos et al., 2020; Espejo-Antúnez , 2017).

Local stimulation of a trigger point causes an involuntary reflex contraction called "twitch", which triggers a chemical response with analgesic effect (pain reduction) and can contribute to increasing the body's self-healing capacity (Donelly et al., 2019 ; Gattie, Cleland & Snodgrass, 2017). Associated with this chemical response may be a reduction in the concentration of nociceptive substances in the area of painful trigger points (Cummings & White, 2011).

The list of benefits with biochemical effect also includes the ability to regenerate muscle. There is evidence that after about 7-10 days of dry needling therapy, focal microlesion causes satellite cells to migrate to replace damaged myofibrils. Another effect that combines physiological and mechanical elements is represented by the ability of mechanical pressure to influence the intrinsic electrical polarization of collagen fibers, favoring tissue remodeling (Hakim et al., 2019; Iacob & Măzăreanu, 2021).

Performing dry needling therapy on healthy adults immediately produced an increase in heart rate and a decrease in mechanical stress-induced mechanical hyperalgesia by activating the sympathetic nervous system. There is evidence that has highlighted the effects of DN therapy in reducing stress and anxiety, factors that can be analyzed in association with the level of therapeutic compliance (Lázaro-Navas et al., 2021). These favorable consequences are determined by the stimulation of neural pathways that block pain by disrupting pain messages sent to the central nervous system, releasing neurotransmitters (Pecos et al., 2019).

The resulting biochemical changes can influence the body's homeostatic mechanisms (body temperature, gas concentrations, blood pressure), endorphin secretion and determine physical and emotional well-being (Cagnie et al., 2013).

# CHAPTER 3. Particularities of therapeutic compliance in the rehabilitation of sport injuries

## 3.1. General considerations of the concept of therapeutic compliance

### 3.1.1. Conceptual delimitation

Therapeutic compliance, also present under the name of therapeutic adherence in the literature, is a basic component of the principles of medical recovery.

Terminologically, compliance can be seen both as an attitude and as a behavioral element. The desire and intention to follow the related therapeutic indications underlines a set of favorable attitudes, as the appropriate behavior presupposes their effective performance (Goddard et al., 2020).

Granquist et al. (2010) define therapeutic compliance as the behavior that an athlete demonstrates by having actions that coincide with therapeutic recommendations.

### 3.1.2. Therapeutic conduct

The design and implementation of a complex assessment based on clinical reasoning is a reference system in decision-making regarding subsequent therapeutic conduct. The analysis of psycho-social factors, additional to the evaluation of functional parameters, proposes a model of clinical evaluation in relation to the bio-psycho-social one. The ability of specialists to analyze a complex volume of factors is essential in compiling this evaluation protocol: somatic, medical, cognitive, emotional, behavioral, social and motivational (Kusnanto, Agustian & Hilmanto, 2018; Wijma et al., 2016).

There are a multitude of factors that can negatively influence the treatment, identifying and using valid measurements for the level of therapeutic compliance being a necessary option for medical recovery (Bassett, 2012; Hemmings & Soundy, 2020).

Representative elements of the level of therapeutic compliance indicate effects on the recovery protocol, home treatment recommendations and the use of adjuvant therapeutic means (drug treatment, post-exercise recovery, etc.).

## 3.2. Highlighting the factors that may influence therapeutic compliance

### 3.2.1. Duration of the rehabilitation plan

A significant factor closely related to the level of therapeutic compliance is the duration of the recovery plan. The main concern of the injured athlete is to approximate from the beginning of the protocol what will be the period of functional unavailability. This moment is of major importance, as the feedback of the therapist plays a vital role in cementing the therapist-patient cooperation. The ability to manage the initial situations can favor the correct psychological approach and the right attitude that the sports patient will issue during the recovery plan.

Sports injuries that cause a long period of functional unavailability can have multiple negative effects. The athletes involved may have difficulty maintaining motivation during treatment sessions, resulting in sub-adherent behavior.

### 3.2.2. Psychoemotional factors

Sports injuries have a negative impact on contextual and psychological aspects, the emotional responses being often represented by an unpredictable sequence even at the level of elite athletes. The nature and severity of trauma can frequently lead to a predominant state of negative emotions, stress, fear of injury, depression or lack of motivation (Alschuler & Alberta, 2020; Covassin et al., 2015).

It is obvious that many patients have difficulties in completing the therapeutic plan, taking into account the psychological peculiarities that are closely related to motivation, in the event of a severe trauma. Each sports patient may show a different response to treatment, the complexity and severity of the trauma having a potential facilitating but also restrictive role on the level of motivation (Gervis et al., 2020; Marusic, Dolenc & Sarabon, 2020).

In the field of sports psychology, motivation is the volume of resources that lead and determine a person to participate in sports, aiming to achieve individual or team performance (Chan et al., 2020; Rodriguez et al., 2020). Thus we can identify motivation as an arbitrary factor in the evolution of the effectiveness of therapeutic results.

### 3.2.3. Psychosocial factors

Psycho-social aspects can have a direct influence on the level of therapeutic compliance and, implicitly, on the efficiency of medical recovery. Each stage of treatment includes a subjective and objective clinical picture that is characterized by a functional and psychological level of the patient (San-Antolin et al., 2020).

The general belief that patients are solely responsible for how to approach the tasks of medical recovery is insufficiently perceived. The present issue reflects a partial understanding of how other factors may influence behavior and the ability to respond positively to specific requests.

The consequences of sports injuries place patients in a series of unique stages in which psycho-emotional and psycho-social factors can capitalize on different forms depending on the personality of each individual and external support. There is clear evidence of the beneficial effect of social support on the individual's ability to understand and manage the circumstances of a pathological situation or trauma.

### 3.2.4. Motivation and importance of setting goals

Psychological and behavioral factors that influence the behavior of subjects during sports competitions can have an effect on how they respond to treatment. These factors include motivation, goal setting and an appropriate attitude towards physical therapy.

The quality and duration of the medical recovery process can be positively influenced if any of these highlighted factors are present. There are studies that have identified a general perception that a recovery process is stable if it has a consistent and standardized therapeutic algorithm (Marshall, Donovan-Hall & Ryall, 2012).

Setting goals and constantly highlighting them increases the level of therapeutic compliance, compared to situations where subjects are not informed about goals and objectives (Dekker et al., 2020).

Identifying short- and long-term therapeutic goals can maintain the positive values of motivation, in the situation of providing appropriate professional and social support (Levack, 2019).

### 3.2.5. Current strategies for streamlining therapeutic compliance

A low level of therapeutic compliance can lead to non-compliance with the recovery plan and thus become a problem in practice. Previous studies (Bailey, 2018; Mallows, 2019; Naqvi, 2020; Traaen, 2016) have identified values sometimes below 40-50% regarding the rate of therapeutic compliance in the recovery of athletes.

Research that has examined therapeutic compliance or adherence to date has been predominantly quantitative in nature. Small-scale studies assessed the level of therapeutic compliance in performance athletes.

The main publications have highlighted the factors favoring therapeutic compliance, the multi-factorial interaction between personal and situational factors having a major influence on the cognitive, emotional and behavioral response (Boulton, 2019; Podlog, 2013).

The level of therapeutic compliance has been identified by a number of specialists as a significant factor in determining therapeutic outcomes. Knee and hip pathologies that occurred in athletes at the end of their careers or after retirement were addressed in order to establish a therapeutic plan (Jakobsen, Sundtrup & Brandt, 2017).

Various strategies have been proposed to improve the effectiveness of therapeutic means and exercises, but the results are inconsistent and influenced by a complex number of circumstances that are difficult for the evaluator to control.

There is currently a lack of evidence based on adequate psychometric properties of a valid monitoring process that can lead to organized efficiency of therapeutic compliance (Bailey et al., 2018; Hall et al., 2015; Jordan et al., 2010; McLean et al. , 2017).

## 3.3. Methods of measuring therapeutic compliance

### 3.3.1. Therapeutic compliance parameters

Identifying the low or high level of therapeutic compliance requires investigating the categories of parameters with measurable potential. One of the most common quantifiable aspects is the frequency of medical recovery exercises or sessions. A number of reviews suggest this parameter as relevant, but recommend a complex approach, in different ways: number of repetitions, framing in a time interval (days or weeks). The accuracy and quality with which patients performed the indications and therapeutic exercises were presented as

representative parameters in a series of studies. The observation of the mentioned elements is essential and results from the therapist-patient collaboration, these aspects being measured by means of topical scales.

The conclusions of the conducted research suggest the existence of an increased volume of relevant parameters in assessing the level of therapeutic compliance. Depending on the group of subjects analyzed and the factors that may influence the response and behavior during the recovery plan, different methods can be identified for measuring the present parameters.

### 3.3.2. The importance of assessing the level of therapeutic compliance

Recent systematic reviews aimed at measuring and managing athletes' response to medical recovery show variable results. Currently, several therapeutic compliance assessment scales or other sources such as questionnaires, self-monitoring journals or functional test results can be identified (Hall et al., 2015).

Depending on the highlighted parameter, several methods and means of measuring therapeutic compliance can be identified. Studies that evaluated the frequency of attendance parameter during recovery sessions proposed the use of an information log, an interview, and a constantly updated self-monitoring journal (Boulton, 2020; Taft & Ennion, 2021; Traaen, 2016).

### 3.3.3. Standardized methods for measuring therapeutic compliance in the recovery of sports injuries

The identification of the level of therapeutic compliance is based on a program of constant analysis and monitoring of the subjects.

A complementary approach may be suggested by the small number of qualitative, compared to quantitative, studies on understanding the concept of therapeutic compliance and its effect on the medical recovery process.

To measure therapeutic compliance in injured athletes, studies have identified several methods. Surveys, interviews, questionnaires and updated reports are a number of test methods used. The main concern is generated by identifying the most appropriate evaluation method. The use of multiple methods can provide additional information specific to a

parameter but can cause differences between studies, samples and the period to which they relate.

The SIRAS Scale (The Sport Injury Rehabilitation Adherence Scale) is a means of assessment commonly used in assessing the level of therapeutic compliance. It is based on clinical information observed and evaluated by the physiotherapist. The SIRAS questionnaire is characterized by 3 functional items and a Likert scale with 5 specific values to assess the intensity with which sports patients followed the therapeutic indications.

The RAdMAT scale (The Rehabilitation Adherence Measure for Athletic Training Scale), developed by Granquist (2010), has been proposed as an improved variant of the SIRAS scale. The use of subscales favors the accumulation of additional information and which is not limited only to the level of intensity during the performance of therapeutic exercises. The RAdMAT scale highlights through the 16 items the level of communication and the attitude in relation to the physiotherapist, along with the frequency of treatment sessions.

### 3.4. The role of therapeutic compliance in the recovery of sports injuries

Sports injuries can vary in severity: from minor injuries that are clinically characterized by mild inflammation without requiring complex treatment, to serious injuries that cause the athlete to stop taking part in sports activities (Davies et al. ., 2020; Skelley et al., 2021).

A small number of studies identify the effects of a high level of compliance and how it may influence the treatment plan (Boulton, 2020; Krause, 2020). An investigation into the perceptions of sports recovery specialists revealed that world-class athletes have a high level of treatment compliance. A feasible argument may be due to strategies for adapting to the new circumstances imposed by trauma, a stage in which the effective overall contribution of the entire multidisciplinary team takes place (Kotelnikova & Kukshina, 2016).

According to the researchers, the effectiveness of the recovery process depends on the active participation of patients during each treatment session. This can be influenced by the desire for commitment to medium and long-term treatment, adequate motivation and the development of skills needed to manage the circumstances of trauma (Aravitska & Lazareva, 2019; Brych & Taras, 2020).

# Theoretical conclusions

The general and universal goal of physical therapy is to identify and streamline the potential for movement in order to prevent and recover a wide range of diseases caused by: direct / indirect trauma, pathological conditions, degenerative processes, environmental factors, etc.

Sports injuries cause an unpleasant stage in the career of athletes, regardless of the level of performance achieved or planned. The ability to understand the mechanism of injury is an active mission for the multidisciplinary team that accompanies career athletes.

Each branch of sport has a multitude of risk factors for a wide range of injuries. Each type of injury is characterized by a series of individual features that determine the consequences on the career of athletes and personal life.

Therapeutic compliance has a specific and complex applicability character in the sphere of recovery of performance athletes. The common variant of defining the concept of therapeutic compliance includes the ability of patients to follow and follow therapeutic guidelines to prevent or treat trauma.

The level of therapeutic compliance can determine a series of consequences with multi-factorial actions and which can influence the results of the medical recovery plan. In order to constantly monitor and evaluate the patient, a complex approach to the factors that intervene during the treatment sessions is necessary.

Acquiring a realistic perception of the consequences of sports trauma and the steps needed to successfully complete the treatment plan is an essential goal.

The active participation of patients during each treatment session can be a favorable factor in the evolution of medical recovery. The desire for commitment and the development of intrinsic motivation at a high and constant level are examples of skills needed by the athlete to manage the circumstances of the trauma.

Awareness of the factors that can influence the level of therapeutic compliance gives specialists in the field of physical therapy and medical recovery an advantage towards an effective therapeutic approach.

# PART II – OWN CONTRIBUTIONS

## CHAPTER 4. Preliminary research - Identifying the current level of therapeutic compliance in the rehabilitation of sports injuries

### 4.1. Research premises

Performing performance sports requires an amalgam of biomechanical and physiological implications that can determine risk factors for potential sports injuries.

Severe sports injuries that require treatment in the medium term (3 months) or long (minimum 6 months) determine a volume of specific consequences in the behavior of athletes. Fluctuations in motivation, frequency and involvement of patients during treatment, the intensity of recovery exercises are some of the components that can influence the effectiveness of recovery through physical therapy. These parameters also describe the main features analyzed and which determine the level of therapeutic compliance.

The level of therapeutic compliance encountered is not exactly a unitary behavior, patients having multiple tasks of participation in institutionalized medical recovery programs and at home.

Identifying the level of therapeutic compliance and how its parameters affect the organization of the recovery plan is a relevant component in the development of the field of recovery through physical therapy.

### 4.2. Purpose, objectives, tasks, hypotheses

#### 4.2.1. The purpose of the research

The aim of the research is to highlight the correlations between the level of therapeutic compliance, the severity of trauma and the duration of the recovery plan, with the role of identifying significant factors involved in the evolution of physical therapy.

At the same time, the research aims to identify issues related to the quality of the therapeutic act in athletes, which can be substantially improved through a systematic involvement in accordance with physical and psycho-emotional parameters.

### 4.2.2. Research objectives

- identifying the importance of therapeutic compliance on physiotherapy treatment in relation to previous research;
- establishing the current level of therapeutic compliance in the recovery of athletes with muscle injuries at the thigh;
- analysis of the parameters that intervene on the score of the scales for evaluating the therapeutic compliance;
- presentation of the multi-factorial contribution that intervenes in the development of performance athletes;
- identification of the effects of the level of therapeutic compliance on the effectiveness of the physiotherapy treatment.

### 4.2.3. Research tasks

- the analysis of the researches carried out so far in order to identify the parameters and the particularities of the topical issue of the field;
- finalizing the structure of the study and the research stages;
- identifying the criteria for inclusion and exclusion of research subjects;
- the use of appropriate means of measuring and evaluating the necessary parameters;
- constant monitoring of the evolution of the individualized recovery plan;
- presentation and interpretation of general and specific data of groups of subjects;
- establishing the conclusions of the preliminary research;
- capitalizing on research results.
-

### 4.2.4. Research hypotheses

The current research is based on three main hypotheses and six secondary ones, as follows:

Hypothesis 1 .: We assume that a low level of therapeutic compliance is associated with a high degree of severity of the trauma and that it requires a longer duration of the recovery plan.

Hypothesis 1.1 .: The degree of severity of sports injuries is a parameter that significantly influences the level of therapeutic compliance.

Hypothesis 1.2 .: The current level of therapeutic compliance has different values depending on the duration of the medical recovery plan through physical therapy.

Hypothesis 2 .: We assume that the results of the therapeutic compliance assessment scales are not influenced by the location of the trauma.

Hypothesis 2.1 .: The particularities of the affected region are not an obvious factor influencing the level of treatment compliance.

Hypothesis 2.2 .: The location of the trauma at the level of the dominant or non-dominant lower limb does not influence the level of compliance.

Hypothesis 3 .: We assume that age and position in the field may influence the level of therapeutic compliance.

Hypothesis 3.1 .: The level of compliance with treatment shows low results for subjects of all ages.

Hypothesis 3.2 .: The level of therapeutic compliance varies depending on the position of the subjects in the field.

Null hypothesis: We assume that there are no statistically significant differences between the analyzed parameters or that their existence is purely accidental.

### 4.3. Research variables

Table 1. Presentation of research variables

| **Independent variables** | **Dependent variables** |
|---|---|
| Age | RAdMAT TOTAL |
| Position in the field | RAdMAT PART |
| Affected region | RAdMAT COM |
| Affected limb | RAdMAT ATT |
| Severity of injury | SIRAS |
| Rehabilitation period | |

Identifying the ability of independent variables to influence or not the score of treatment compliance assessment scales is an advantage in establishing scientific perspectives for the preliminary study (Table 1).

### 4.4. Research methods

- Study of specialized literature
- Observation method
- Survey method
- Statistical method

### 4.5. Organizing and conducting research

The preliminary research was conducted between April 2020 and January 2021, during which the data on the particularities of the physiotherapy treatment and the level of therapeutic compliance were centralized and interpreted (Table 2).

### 4.6. Research subjects

Table 2. Information about subjects

| **Variables** | | **Percentage** | **N = number of subjects** |
|---|---|---|---|
| **Age** | **18-23** | 23% | 16 |
| | **24-29** | 20% | 14 |
| | **≥30** | 57% | 18 |
| **Position in the field** | **Goalkeeper** | 4.2% | 2 |
| | **Defender** | 25% | 12 |
| | **Midfielder** | 27.1% | 13 |
| | **Winger** | 20.8% | 10 |
| | **Forward** | 22.9% | 11 |
| **Affected area** | **Anterior** | 27.1% | 13 |
| | **Posterior** | 50% | 24 |
| | **Medial** | 22.9% | 11 |
| **Affected limb** | **Right dominant** | 43.8% | 21 |
| | **Right support** | 18.8% | 9 |
| | **Left dominant** | 16.7% | 8 |
| | **Left support** | 20.8% | 10 |
| **Severity of the injury** | **I** | 22.9% | 11 |
| | **II** | 56.2% | 27 |

| | | | |
|---|---|---|---|
| | **III** | 20.8% | 10 |
| **Rehabilitation period** | **0-2 weeks** | 27.1% | 13 |
| | **2-4 weeks** | 29.2% | 14 |
| | **>4 weeks** | 43.8% | 21 |

### 4.7. Results and discussion

#### 4.7.2. Interpretation of the results of the compliance scales according to the severity of the trauma - Hypothesis Testing 1.1.

Table 3. Descriptive statistics for assessing the current level of therapeutic compliance according to the severity of the lesions

| **Severity (deg)** | **N** | **Dependent variable (units)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **RAdMAT TOTAL** | | **RAdMAT PART** | | **RAdMAT COM** | | **RAdMAT ATT** | | **SIRAS** | |
| | | **AM** | **SD** | **AM** | **SD** | **AM** | **SD** | **AM** | **SD** | **AM** | **SD** |
| **1 (1)** | 11 | 52.82 | 4.51 | 16.64 | 1.28 | 10.09 | .701 | 25.91 | 3.59 | 11.91 | 1.70 |
| **2 (2)** | 27 | 44.74 | 14.48 | 14.48 | 2.29 | 7.96 | 1.74 | 22.30 | 3.47 | 10.22 | 1.86 |
| **3 (3)** | 10 | 41.90 | 3.14 | 14.50 | 1.26 | 6.70 | 1.88 | 20.40 | 1.50 | 9.30 | 1.70 |
| **Total** | *48* | *46* | *6.31* | *14.98* | *2.09* | *8.19* | *1.95* | *22.73* | *3.67* | *10.42* | *1.97* |

The mean values of the scales that assessed the level of therapeutic compliance identified a number of differences depending on the level of severity of the trauma (Table 3).

The TOTAL RAdMAT scale indicates a significant difference of approximately 8.08 units between group 1 and 2, and 10.92 units between group 1 and group 3. The values of the RAdMAT scale prove to be the highest in the group 1 situation, where the research subjects are characterized by a first-degree trauma.

According to the ANOVA analysis, statistically significant differences between the groups of subjects created depending on the severity of the muscle injuries are confirmed. The results obtained using the RAdMAT scale [F (2.45) = 14.135, p = .000] show differences in the average results for the 3 groups.

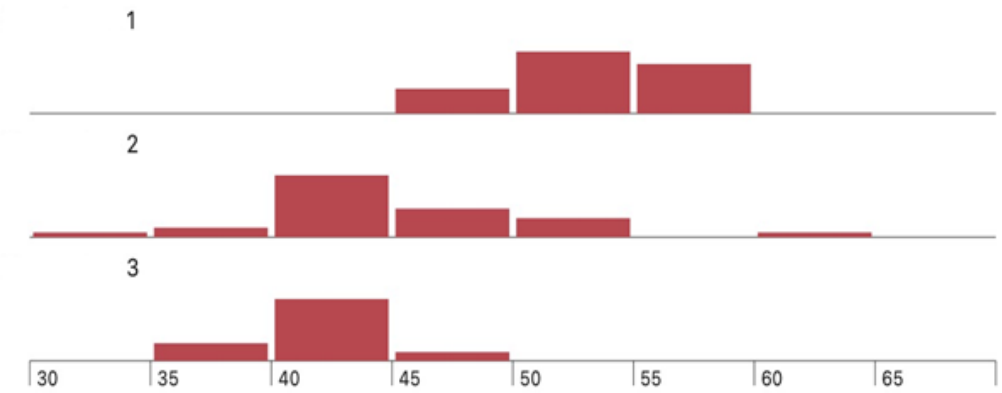


Figure 2. RAdMAT scale score according to the severity of the trauma

The decreasing trend of the representative final score for each scale includes the criterion of the degree of severity of the trauma (Figure 2).

Table 4. Post-hoc analysis according to the severity of the trauma

| **(I) Severity (degrees)** | **(J) Severity (degrees)** | **p** | | | | |
|---|---|---|---|---|---|---|
| | | **RAdMAT TOTAL*** | **RAdMAT PART**** | **RAdMAT COM*** | **RAdMAT ATT**** | **SIRAS *** |
| **1** | **2** | .000 | .002 | .002 | .028 | .031 |
| | **3** | .000 | .003 | .000 | .001 | .005 |
| **2** | **1** | .000 | .002 | .002 | .028 | .031 |
| | **3** | .292 | .999 | .096 | .068 | .357 |
| **3** | **1** | .000 | .003 | .000 | .001 | .005 |
| | **2** | .292 | .999 | .096 | .068 | .357 |

*Tukey; **Games-Howell

However, the level of therapeutic compliance represented by the RAdMAT scale does not show significant differences, according to the post-hoc analysis between group 2 and group 3 ($p = .292 > 0.05$). These interpretations confirm the superior expression of the group of subjects who presented a grade I muscle injury (Table 4).

The RAdMAT PART and RAdMAT ATT subscales confirm the significant differences between the groups of subjects analyzed and in the result of the main RAdMAT scale. Interpretation of RAdMAT ATT results according to the post-hoc analysis expresses the most significant differences between group 1 and the other two groups ($p < 0.05$). The interpretation of the results according to figure 2 shows differences of the average results between group 2 and group 3, but without a relevant statistical expression following the post-

hoc analysis (p = .068> 0.05). RAdMAT PART presents the least significant differences for the average score between group 2 and group 3 (p = .999). This interpretation suggests that the level and frequency of participation in recovery sessions is one of the parameters that shows the most insignificant changes in situations where the subjects have a higher degree of severity.

The analysis of the results confirms the tendency to decrease the values of the RAdMAT scale and its subscales depending on the severity of the trauma, a higher level of severity being associated with a lower level of therapeutic compliance.

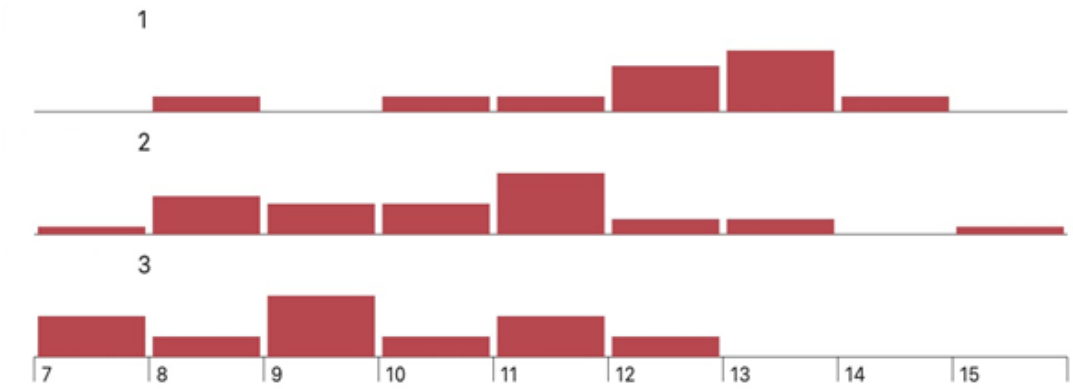


Figure 3. Score of the SIRAS scale according to the severity of the trauma

Results that signify a decreasing trend the higher the severity level can be identified in the SIRAS scale (Figure 3).

The importance of the differences between the groups of subjects is also confirmed by the analysis of the average results through the ANOVA test, [F (2.45) = 5.868, p = .005].

According to the interpretation made by the post-hoc analysis, the most significant differences of the SIRAS scale are found between group 1 and group 3 (p = .005). The significant difference in the SIRAS scale expresses the decrease in the intensity of participation in treatment especially for subjects with grade II and III muscle injuries.

The previous graphical representations confirm the inverse proportional relationship between a high level of severity of muscle injuries and the final score which means the level of compliance with treatment.

### 4.7.3. Interpretation of the results of compliance scales according to the recovery period - Hypothesis testing 1.2.

Table 5. Descriptive statistics for assessing the level of therapeutic compliance according to the recovery period

| Rehabilitation period (weeks) | N | Dependent variable (points) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RAdMAT TOTAL | | RAdMAT PART | | RAdMAT COM | | RAdMAT ATT | | SIRAS | |
| | | AM | SD | AM | SD | AM | SD | AM | SD | AM | SD |
| **0-2 (1)** | 13 | 50.31 | 4.51 | 16.15 | 1.34 | 9.08 | 1.49 | 24.92 | 3.70 | 11.15 | 1.77 |
| **2-4 (2)** | 14 | 47.50 | 6.95 | 14.64 | 2.84 | 8.36 | 1.58 | 24.29 | 3.77 | 11.07 | 2.05 |
| **>4 (3)** | 21 | 42.33 | 4.01 | 14.48 | 1.66 | 7.52 | 2.22 | 20.33 | 1.82 | 9.52 | 1.75 |
| **Total** | *48* | *46* | *6.31* | *14.98* | *2.09* | *8.19* | *1.95* | *22.73* | *3.67* | *10.42* | *1.97* |

The results in Table 5 confirm the differences between the values obtained by each group. Group 1 is characterized by the highest values both within the RAdMAT scale (MA = 50.31; AS = 4.51) and for the SIRAS scale (MA = 11.15; AS = 1.77).

Through post-hoc analysis, statistically significant differences can be identified between group 1 and group 3 ($p = .001 < 0.05$). The differences are determined by all the parameters that analyze the therapeutic compliance, but the attitude and the level of involvement show the most significant changes ($p = .002 < 0.05$).

The longer-term recovery plan is thus associated with a lower level of therapeutic compliance. The decrease in the level of compliance is also associated with a medium-term therapeutic plan, but without a statistical relevance ($p = .484 > 0.05$).

The SIRAS scale confirms the tendency to interpret the results to the detriment of a longer therapeutic plan. Interpretation of the results of the SIRAS scale through ANOVA analysis confirms the existence of statistically significant differences in the mean results of the groups of subjects, [$F(2.45) = 4.359$, $p = .019$].

The results suggest the association of a low level of therapeutic compliance for all groups of subjects. The barriers that intervene in the situation of a medium or long-term treatment plan compose a set of parameters that significantly influence the current level of therapeutic compliance.

Table 6. Results of linear regression between RAdMAT scale, severity and rehabilitation period

| Model | | Variable coefficients | | Standard coefficients | t | p | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 58.062 | 2.153 | | 24.259 | .001 | 53.72 | 61.98 |
| | Severity | -3.856 | 1.138 | -.408 | -2.634 | .004 | -5.90 | -1.40 |
| | Rehabilitation period | -2.045 | 1.054 | -.270 | -1.744 | .054 | -4.26 | -0.79 |
| a. Dependent variable: *RAdMAT TOTAL* | | | | | | | | |

Statistical interpretation means changes in the level of therapeutic compliance associated with the gradual increase in the severity of muscle injuries.

According to Table 6, the disposition of a medium or long-term therapeutic plan will establish an inversely proportional relationship with the level of therapeutic compliance, which will present diminished results.

Table 7. Results of linear regression between SIRAS scale values, severity and rehabilitation period

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Variable coefficients | | Standard coefficients | t | p | 95% Confidence interval | |
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 13.188 | .826 | | 15.50 | .001 | 11.45 | 14.72 |
| | Severity | -1.062 | .480 | -.359 | -2.04 | .028 | -1.941 | -.053 |
| | Rehabilitation period | -.309 | .400 | -.131 | -.742 | .438 | -1.103 | .489 |
| b. Dependent variable*: SIRAS* | | | | | | | | |

Subjects with a higher degree of severity will have a lower level of compliance (Table 7). Each gradual increase in the severity level will cause the result of the SIRAS scale to decrease by about one unit.

### 4.7.4. Interpretation of the score of therapeutic compliance assessment scales according to the affected region - Hypothesis Testing 2.1.

Table 8. Descriptive statistics for the interpretation of therapeutic compliance according to the affected region

| Affected region | N | Dependent variable (units) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RAdMAT TOTAL | | RAdMAT PART | | RAdMAT COM | | RAdMAT ATT | | SIRAS | |
| | | AM | SD | AM | SD | AM | SD | AM | SD | AM | SD |
| **ANT(1)*** | 13 | 46 | 5.74 | 14.31 | 2.52 | 8.54 | 1.26 | 22.77 | 3.34 | 10 | 2 |
| **POS(2)*** | 24 | 45.46 | 6.29 | 15.17 | 1.83 | 7.83 | 2.18 | 22.46 | 3.50 | 10.63 | 1.92 |
| **MED(3)*** | 11 | 47.18 | 7.37 | 15.36 | 2.11 | 8.55 | 2.11 | 23.27 | 4.60 | 10.45 | 2.16 |
| **Total** | *48* | *46* | *6.31* | *14.98* | *2.09* | *8.19* | *1.95* | *22.73* | *3.67* | *10.42* | *1.97* |

* ANT = group 1 (anterior region); POS = group 2 (posterior region); MED = group 3 (medial region)

Results close to the mean score of the SIRAS scale were identified for each group of subjects and confirmed by the ANOVA test [F (2.45) = .062, p = .940].

The interpretation of the results shows slight differences of the average results but without an obvious trend supported by statistically significant differences (Table 8).

### 4.7.5. Interpretation of the score of therapeutic compliance assessment scales according to the affected limb - Hypothesis Testing 2.2.

Table 9. Descriptive statistics for compliance level by affected limb

| Variables | Group 1 (n=29) | | Group 2 (n=19) | | | |
|---|---|---|---|---|---|---|
| | AM | SD | AM | SD | t(46) | p |
| **RAdMAT TOTAL** | 46.90 | 6.00 | 44.63 | 6.68 | 1.195 | .240 |
| **RAdMAT PART** | 15.17 | 1.85 | 14.68 | 2.45 | .741 | .464 |
| **RAdMAT COM** | 8.52 | 1.55 | 7.68 | 2.40 | 1.339 | .192 |
| **RAdMAT ATT** | 23.03 | 3.84 | 22.26 | 3.44 | .708 | .473 |
| **SIRAS** | 10.86 | 1.78 | 9.74 | 2.10 | 1.921 | .063 |

Subjects who presented with muscle injury at the level of the support member obtained the lowest results for the RAdMAT and SIRAS scales. The difference of one unit

can be observed in the case of the average results of the SIRAS scale, t (46) = 1.921, p = .063> 0.05, where group 2 (MA = 9.74; AS = 2.10) has a lower intensity from the athletes compared of therapeutic indications and which affected the response to treatment (Table 9).

The statistical interpretation of suggests that the different results in favor of group 1 do not have a statistical significance to confirm the influence of the affected limb on the current level of therapeutic compliance.

### 4.7.6. Interpretation of the score of the therapeutic compliance assessment scales according to age - Hypothesis testing 3.1.

Table 10. Descriptive statistics for the level of compliance by age

| Age (years old) | N | Dependent variable (units) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RAdMAT TOTAL | | RAdMAT PART | | RAdMAT COM | | RAdMAT ATT | | SIRAS | |
| | | AM | SD | AM | SD | AM | SD | AM | SD | AM | SD |
| **18-23 (1)** | 16 | 46.63 | 6.03 | 15.06 | 2.29 | 8.56 | 1.45 | 22.88 | 3.84 | 10.94 | 1.91 |
| **24-29 (2)** | 14 | 45.57 | 7.27 | 14.50 | 2.53 | 8.29 | 1.93 | 22.57 | 3.85 | 10.64 | 1.90 |
| **≥30 (3)** | 18 | 45.78 | 6.08 | 15.28 | 1.52 | 7.78 | 2.34 | 22.72 | 3.57 | 9.78 | 2.01 |
| **Total** | *48* | *46* | *6.31* | *14.98* | *2.09* | *8.19* | *1.95* | *22.73* | *3.67* | *10.42* | *1.97* |

The comparison of the averages indicates a higher score for the group of subjects aged 18-23 years, except for the results of the RAdMAT PART subscale (MA = 15.06; AS = 2.29). According to Table 10, lower mean results of the main scale score (RAdMAT, SIRAS) can be observed for the group ≥30 years, compared to the groups of subjects aged 18-23 and 24-29 years.

The results indicate that there are no significant effects on the level of therapeutic compliance assessed by the RAdMAT scale according to age [F (2.45) =. 117, p = .890]. Interpretation of the results of the SIRAS scale identifies slight differences in averages between age categories, where the group of subjects ≥30 years of age obtained the lowest score (MA = 9.78; AS = 2.01), but without a statistically significant difference according to ANOVA analysis: [F (2.45) = 1.630, p = .207].

### 4.7.7. Interpretation of the score of the therapeutic compliance assessment scales according to the position in the field - Hypothesis Testing 3.2.

Table 11. Descriptive statistics for compliance level by field position

| Position in the field | N | Dependent variable (units) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RAdMAT TOTAL | | RAdMAT PART | | RAdMAT COM | | RAdMAT ATT | | SIRAS | |
| | | AM | SD | AM | SD | AM | SD | AM | SD | AM | SD |
| **GK** | 2 | 47 | 9.89 | 14 | 4.24 | 8.5 | .70 | 24.50 | 4.95 | 11 | .00 |
| **DEF** | 12 | 44.92 | 6.31 | 14.50 | 1.93 | 8 | 1.50 | 22.42 | 4.10 | 10.25 | 2.34 |
| **MID** | 13 | 47.08 | 4.73 | 15.54 | 1.66 | 8.46 | 1.39 | 22.92 | 2.87 | 10.85 | 1.62 |
| **WIN** | 10 | 44.30 | 8.12 | 14.20 | 2.65 | 7.40 | 2.95 | 22.40 | 4.27 | 9.50 | 2.06 |
| **ATT** | 11 | 47.27 | 6.27 | 15.73 | 1.73 | 8.73 | 1.55 | 22.82 | 3.89 | 10.82 | 1.99 |
| **Total** | *48* | *46* | *6.31* | *14.98* | *2.09* | *8.19* | *1.95* | *22.73* | *3.67* | *10.42* | *1.97* |

The result of the ANOVA analysis expresses the lack of statistically significant differences between the average results of the groups and for the subscales RAdMAT PART [F (4.43) = 1.212, p = .320] and RAdMAT ATT [F (4.43) =. 157, p = .959]. According to the interpretation of the average results according to the criterion of the independent variable position in the field, there were no statistically significant differences for the results of the SIRAS scale [F (4.43) =. 859, p = .496] (Table 11

## Partial conclusions

Preliminary research had the main objective of highlighting the particularities of sports injuries that can be identified as factors that influence the level of therapeutic compliance.

The correlations established between the independent variables (severity, recovery period) and the dependent variables (RAdMAT scale, SIRAS scale) demonstrate the presence of different results depending on the organization of the group of subjects.

The severity of the trauma is a significant factor that can be correlated with changes in the level of therapeutic compliance. Decreasing results of the RAdMAT and SIRAS scales were associated with an increase of at least one unit in the severity of trauma.

The analysis and interpretation of the data confirms that the medium and / or long-term recovery plan is a factor that can be associated with low values of the level of therapeutic compliance in the recovery of athletes.

The current research allows the identification of the multi-factorial contribution that intervenes in the evolution of the kinetotherapeutic treatment. Therapeutic compliance is a fundamental element in the recovery of sports injuries and can be influenced by a number of parameters.

The confirmation of secondary hypotheses implicitly determines the confirmation of the main hypotheses, so that future research directions will focus on addressing quantifiable parameters that can influence the values of therapeutic compliance.

Identifying a low level of treatment compliance may be associated with a volume of barriers that may affect treatment effectiveness.

Following the analysis of the results of the study and the outlining of the most significant conclusions that emerge from them, we note the importance of developing a strategy for optimizing therapeutic compliance in the recovery of sports injuries.

Based on the results obtained in this research, future directions will present the design and implementation of a recovery protocol adapted to the particularities of sports patients and to promote the increase of the level of therapeutic compliance.

# CHAPTER 5. Fundamental research - Implementing the program to increase compliance in the rehabilitation of sports injuries

## 5.1. Research premises

The period of functional unavailability caused by a sports injury can include multiple negative effects. The systematic analysis of the physical, functional and psycho-emotional parameters can highlight the risk factors that can affect the level of compliance with the treatment and, implicitly, the efficiency of the medical recovery process. A low level of therapeutic compliance may be associated with a volume of barriers that may lead to decreased patient involvement in the act of medical recovery.

Dry needling therapy can be a very effective therapy in the management of myofascial pain syndrome and muscle injuries located in the lower limbs, but it is necessary to focus on anatomical considerations and precautions in the area, being considered a minimally invasive method.

The choice of dry needling therapy as a means of intervention in the program to increase compliance and streamline treatment is based on the two modes of action of medical technology: mechanical and biochemical. There are currently no studies performed on a representative group of subjects attesting to the effects in the recovery of grade II muscle injuries as part of a combined treatment.

## 5.2. Purpose, objectives, tasks, hypotheses

### 5.2.1. The purpose of the research

The aim of the research is to verify the correlations between the level of therapeutic compliance, the treatment plan through physical therapy and its duration, with the role of highlighting the effectiveness of the program to increase therapeutic compliance in athletes.

### 5.2.2. Research objectives

- analysis of the factors that influence the level of therapeutic compliance in the recovery of performance athletes;
- identification of the evolution of the physical parameters during the recovery plan;

- establishing and implementing the therapeutic plan appropriate to the particularities of the patients;
- identification of the level of therapeutic compliance according to the characteristics of the trauma;
- presentation and interpretation of data resulting from the implementation of the compliance program adapted to the recovery of grade II muscle injuries.

By setting clear objectives, developed in chronological order, it was possible to highlight the effect of the intervention plan on the group of subjects, following the interpretation of the results associated with the monitored and tested parameters.

### 5.2.3. Research tasks

- analysis of the research carried out so far in order to identify the means of intervention on the level of therapeutic compliance;
- finalizing the structure of the study and the research stages;
- identifying the criteria for inclusion and exclusion of research subjects;
- monitoring and testing of the physical parameters that have the role of evaluating the therapeutic progress within the phases of the recovery plan;
- use of means to assess the level of therapeutic compliance;
- presentation and interpretation of general and specific data of groups of subjects;
- capitalizing on research results;
- establishing the conclusions of the fundamental research;
- presentation of the limits and future directions of research.
-

### 5.2.4. Research hypotheses

The current research is based on three main hypotheses and seven secondary hypotheses, as follows:

Hypothesis 1 .: The therapeutic plan within the program of increasing the therapeutic compliance will optimize the efficiency of the treatment both in the acute phase and in the functional recovery phase.

Hypothesis 1.1 .: The therapeutic intervention will streamline the recovery plan regardless of the location of the trauma: the affected region, the affected limb.

Hypothesis 1.2 .: The analyzed functional parameters can predict the evolution of the kinetotherapeutic treatment.

Hypothesis 1.3 .: We assume that age and position in the field are factors that can influence the efficiency of the recovery plan.

Hypothesis 2: We assume that a combined therapeutic program based on dry needling therapy, exercise and the use of physiotherapy procedures will improve the level of therapeutic compliance in the recovery of performance athletes.

Hypothesis 2.1 .: The level of compliance with the treatment will present optimal values regardless of the particularities of the trauma: the affected region, the affected limb.

Hypothesis 2.2 .: The level of therapeutic compliance may differ depending on age and position in the field.

Hypothesis 3: The level of therapeutic compliance is an essential parameter that influences the efficiency of recovery through physical therapy.

Hypothesis 3.1 .: The efficiency of the treatment determined by the results of the functional parameters is associated with an optimal level of compliance with the treatment.

Hypothesis 3.2 .: The level of therapeutic compliance can predict the evolution and effectiveness of the therapeutic plan.

Null hypothesis: We assume that there are no statistically significant differences between the analyzed parameters or that their existence is purely accidental.

### 5.3. Research variables

Table 12. Presentation of research variables

| **Independent variable** | **Dependent variable** |
|---|---|
| Age | RAdMAT TOTAL |
| Position in the field | RAdMAT PART |
| Affected region | RAdMAT COM |
| Affected limb | RAdMAT ATT |
| | SIRAS |
| | Rehabilitation period |
| | VAS scale |
| | Range of motion |

### 5.4. Research methods

- Study of specialized literature
- Observation method
- Survey method
- Method of measurements and tests
- Statistical method

### 5.5. Organizing and conducting research

The basic research was conducted between February 2021 - February 2022.

The implementation of the therapeutic intervention and the recovery protocol was carried out in direct collaboration with the physiotherapists of a significant volume of football teams from the first 3 football leagues in Romania. The proposal and phasing of the recovery program followed a systematic plan based on the identification of benefits and potential beneficial effects on both the effectiveness of treatment and the level of therapeutic compliance.

### 5.6. Research subjects

The research included a number of 28 subjects, professional football players, with official matches played in the 2020/2021 and / or 2021/2022 season in League 1, League 2 or League 3 in Romania (Table 13).

Table 13. Information about subjects

| **Parameter** | | **Percentage** | **N = number of subjects** |
|---|---|---|---|
| **Age** | **18-23 (1)** | 17.9% | 6 |
| | **24-29 (2)** | 39.3% | 11 |
| | **≥30 (3)** | 39.3% | 11 |
| **Position in the field** | **Goalkeeper** | 0% | 0 |
| | **Defender** | 32% | 9 |
| | **Midfielder** | 32% | 9 |
| | **Winger** | 22% | 6 |
| | **Forward** | 14% | 4 |

| | | | |
|---|---|---|---|
| **Affected region** | **Anterior (1)** | 43% | 12 |
| | **Posterior (2)** | 57% | 16 |
| | **Medial (3)** | 0% | 0 |
| **Affected limb** | **Right dominant** | 47% | 13 |
| | **Right support** | 14% | 4 |
| | **Left dominant** | 18% | 5 |
| | **Left support** | 21% | 6 |

### 5.7. Intervention plan

#### 5.7.1. Intervention plan methodology

#### 5.7.2. Acute phase

The acute recovery phase included the first 7 days of the therapeutic program and included a daily treatment session (50-60 minutes) (Figure 4):

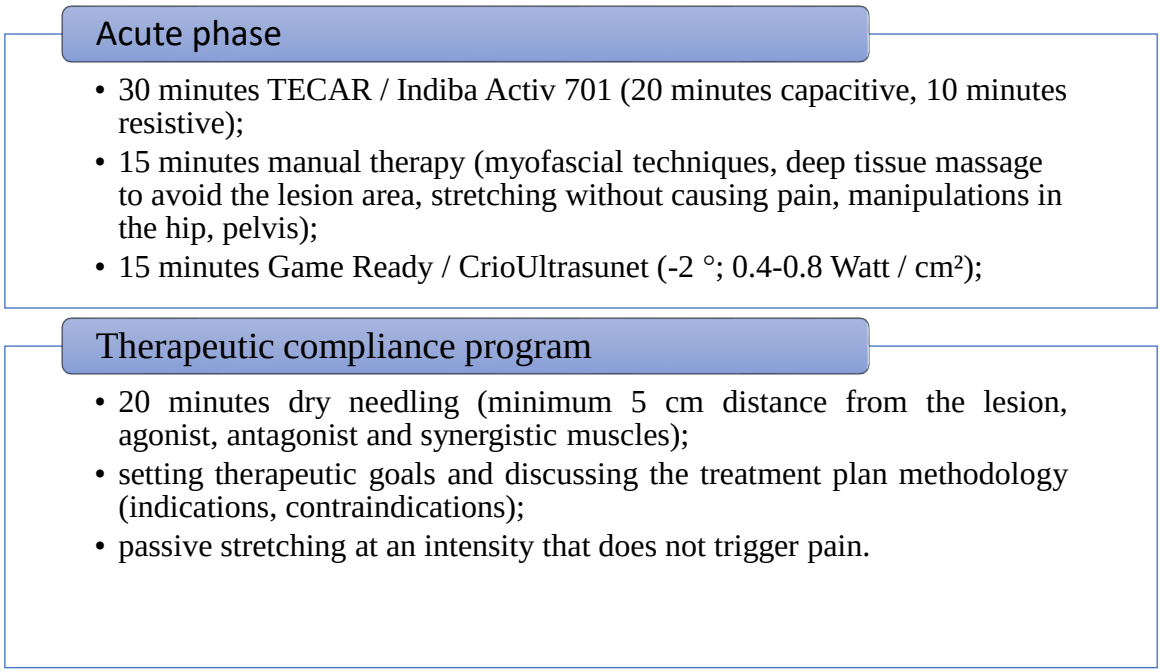


Figure 4. Methodology of intervention in the acute phase of the recovery plan

#### 5.7.3. Functional rehabilitaton phase

This took place over 21-35 days, depending on the therapeutic progress of each subject and included 4 sessions per week (Figure 5). Each meeting was structured in two

stages. The progressive increase of the involved muscular load and the appearance of moderate stretching (initially, without signs of pain) were common elements in the therapeutic approach specific to the research subjects. The main therapeutic means, physical exercise has been combined with the systematic use of physiotherapy devices and manual therapy techniques (deep tissue massage techniques / trigger point, myofascial techniques, stretching, mobilizations and manipulations, etc.

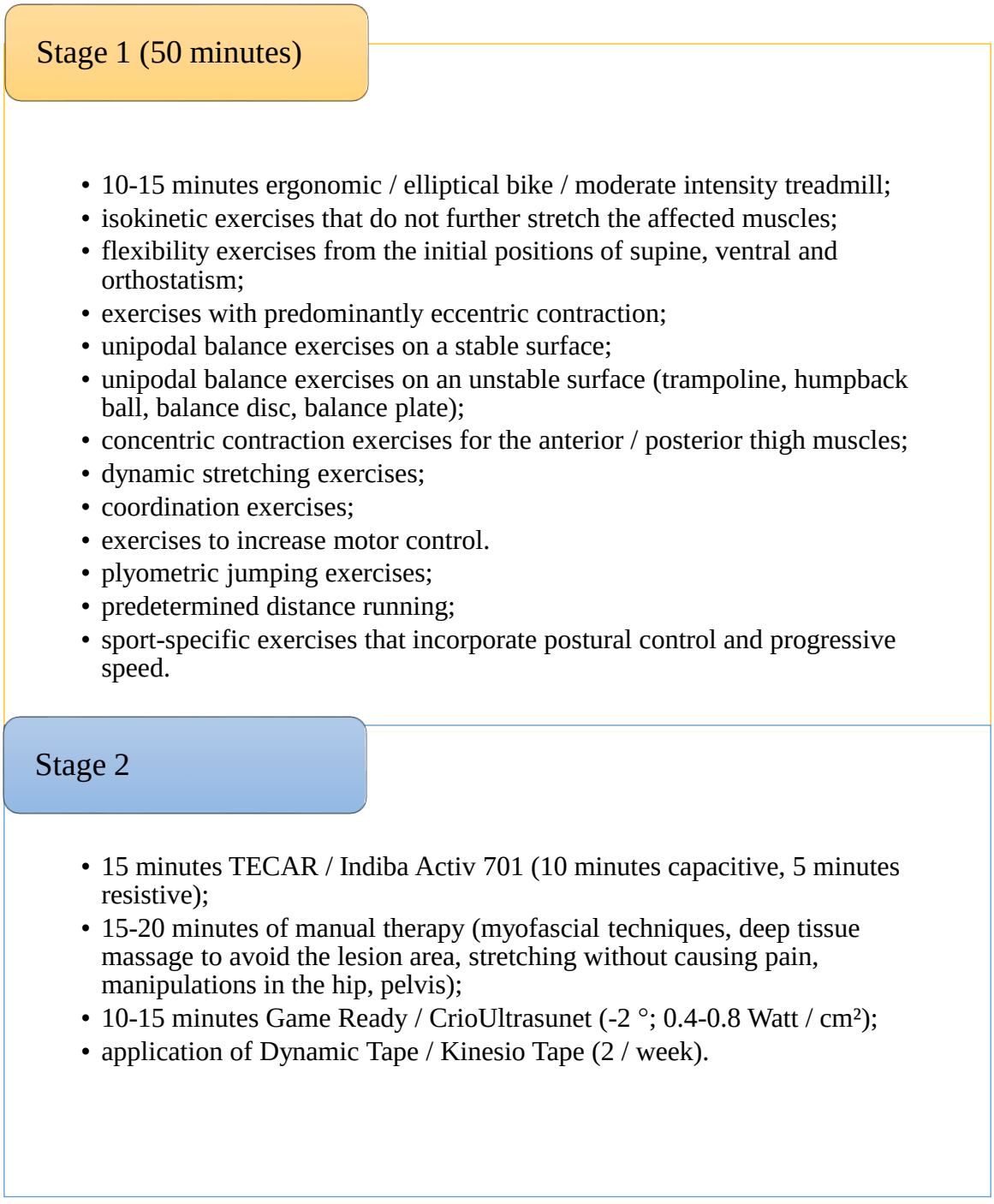


Figure 5. Therapeutic means in the functional recovery phase

In order to achieve the intervention based on dry needling therapy, it was necessary to understand and implement additional inclusion criteria: the full agreement of the subjects related to the acceptance of dry needling therapy; lack of basic contraindications in dry needling therapy performed safely (phobia, mental illness, lymphedema, infectious diseases, other medical emergencies, etc.) (Figure 6).

**Therapeutic compliance increase program for the functional recovery phase**

- 20-30 minutes dry needling (minimum 5 cm distance from the lesion, agonist, antagonistic and synergistic muscles, back muscles);
- establishing the therapeutic objectives and discussing the methodology of the treatment plan and the stage of sports reintegration (indications, contraindications);
- passive stretching at an intensity that does not trigger pain.

Figure 6. Methodology of intervention in the functional recovery phase

### 5.8. Results and discussion

#### 5.8.2. Analysis of functional parameters that determine the efficiency of recovery through physical therapy - Hypothesis Testing 1.1.

Location of muscle injury:

• Group A - hamstrings

• Group B - the anterior region of the thigh

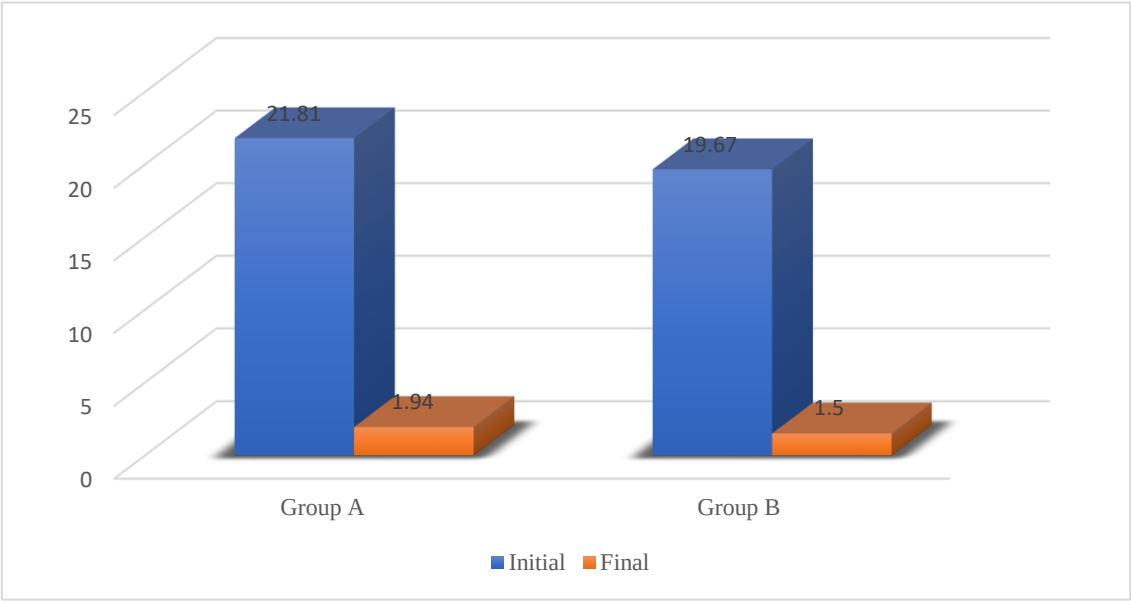

Figure 7. Flexibility deficit resulting from knee joint balance on active flexion (group B) and extension (group A) movements

The group of subjects registered a significant decrease in the deficit of mobility and flexibility (approximately 19 degrees); t (15) = 14,360, p = .000. Comparison of the results with those reported at the period of 10-30 days after trauma in the studies developed by Reurink (2015), Silder (2013), determines an advantage for group A in the current research (Figure 7).

The value of the knee joint balance on the active flexion movement showed significant differences between the initial measurement (MA = 19.67; AS = 3.114) and the final one (MA = 1.50; AS = 1.243), t (11) = 17.413, p = .000 .

The score of the visual analogue scale of pain at the passive stretching movement of the posterior thigh muscles showed significant differences between the initial test (MA = 6.69; AS = .873) and the final one (MA = 1.31; AS = .479); t (15) = 20.982, p = .000, evolution also confirmed by figure 8.

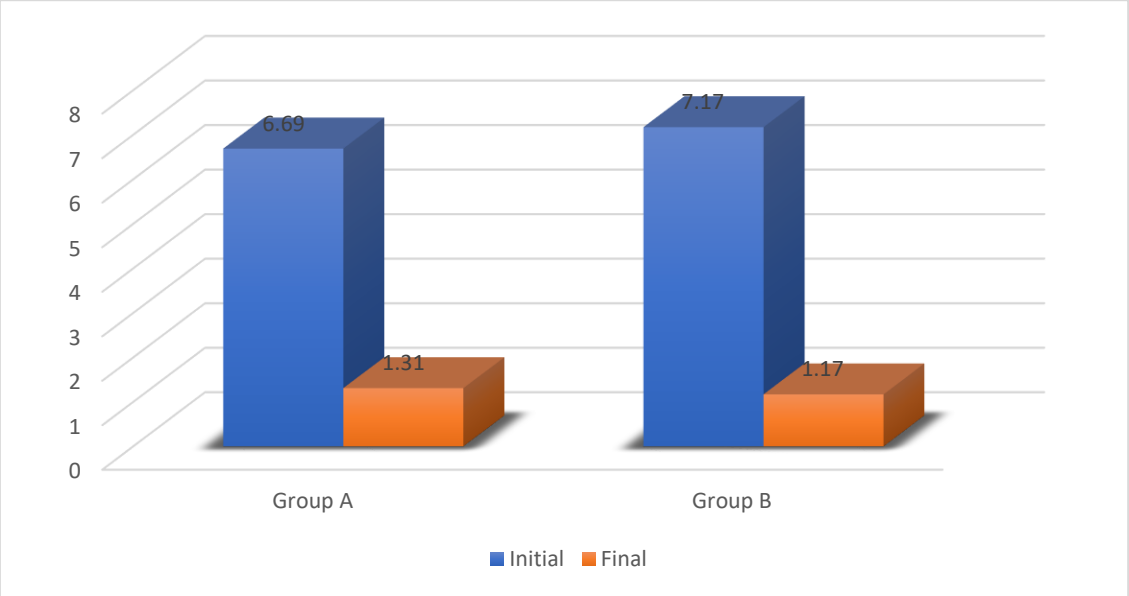


Figure 8. The value of the VAS scale evaluated when performing passive stretching

Table 14. Interpretation of the final average results of the parameters of the recovery plan according to the affected region

| **Variabile** | **Group A** | | **Group B** | | | |
|---|---|---|---|---|---|---|
| | **AM** | **SD** | **AM** | **SD** | **t(26)** | **p** |
| **Range of motion (degrees)*** | 1.94 | 1.48 | 1.50 | 1.24 | .848 | .404 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **VAS** | 1.31 | .479 | 1.17 | .389 | .888 | .383 |
| **Rehabilitation period (days)** | 30.63 | 5.64 | 30.33 | 5.44 | -.138 | .891 |

* Range of motion (degrees) = represents the deficit of mobility resulting from active movements in the knee joint (using goniometry)

Table 14 confirms that there are no statistically significant differences between the final mean results of the two groups of subjects.

Location of the trauma according to the affected limb:

• Group 1 - dominant limb

• Group 2 - non-dominant limb (support)

Table 15. Interpretation of the final average results of the parameters of the recovery plan according to the affected limb

| **Variable** | **Group 1** | | **Group 2** | | | |
|---|---|---|---|---|---|---|
| | **AM** | **SD** | **AM** | **SD** | **t(26)** | **p** |
| **Range of motion (degrees)*** | 1.83 | 1.46 | 1.60 | 1.26 | .442 | .663 |
| **VAS** | 1.22 | .428 | 1.30 | .483 | -.425 | .676 |
| **Rehabilitation period (days)** | 30.33 | 5.36 | 30.80 | 5.90 | -.207 | .838 |

* Range of motion (degrees) = represents the deficit of mobility resulting from active movements in the knee joint (goniometry)

There were no significant differences between the two groups regarding any of the parameters analyzed. Negative values of the T-Test (Independent-Samples T test) for the duration of the recovery plan, t (26) = -. 207, p = .838 and compared to the results of the SIRAS scale, t (26) = -. 199, p =. 844, indicates a slight reversal of the direction of the effect, which does not have an influence on the significance of the difference between the groups (Table 15).

The therapeutic plan assigned to the research subjects ensures an efficient evolution regardless of the location of the muscle injury.

### 5.8.3. Interpretation of the association between functional parameters and the evolution of kinetotherapeutic treatment - Hypothesis testing 1.2.

The functional parameters analyzed above represent a reference system in monitoring research subjects and also significant indicators on their ability to complete the stage of functional recovery and initiate the stage of sports reintegration.

Table 16. Linear regression between the final values of the VAS scale and the duration of the rehabilitation plan

| Model | | Variable coefficients | | Standard coefficients | t | p | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 21.333 | 2.589 | | 8.241 | .000 | 16.012 | 26.654 |
| | VAS_F* | 7.333 | 1.957 | .592 | 3.748 | .001 | 3.311 | 11.356 |
| a. Dependent variable: *Rehabilitation period* | | | | | | | | |

*VAS_F – the final score of the VAS scale for the whole group of subjects

The variable coefficients and the value of p = .001 confirm the significant influence of the final score of the VAS scale on the treatment period. Compared to the recovery plan, the conclusion indicates that a higher value of the VAS scale will automatically lead to an exponential increase in the duration of the recovery plan (Table 16).

Table 17. Linear regression between the final values of the joint balance and the duration of the recovery plan

| Model | | Variable coefficients | | Standard coefficients | t | p | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 26.078 | 1.325 | | 19.689 | .000 | 23.355 | 28.801 |
| | Range of motion_F* | 2.527 | .599 | .638 | 4.220 | .000 | 1.296 | 3.758 |
| a. Dependent variable: *Rehabilitation period* | | | | | | | | |

*Range of motion_F – the final result expressing the knee mobility deficit for the whole group of subjects (using goniometry)

Depending on the final values of the joint balance, there is a predictive analysis on which we identify a statistically significant transposition in the therapeutic context (Table 17).

The conclusion of the statistical interpretation attests to the influence of the functional parameters, presented as independent variables, on the duration of the recovery plan, an element considered main in the description of the treatment efficiency.

In order to avoid prolonging the period of unavailability of athletes, it is essential to optimize the therapeutic approach that includes eliminating the symptoms and increasing the functionality to the necessary parameters.

### 5.8.4. Interpretation of final results according to age and position in the field - Hypothesis testing 1.3.

Table 18. Descriptive statistics for assessing the effectiveness of the recovery plan by age

| Age (years old) | N | Dependent variable (units) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Range of motion final (degrees) | | VAS final (0-10) | | Rehabilitation period (days) | |
| | | AM | SD | AM | SD | AM | SD |
| **18-23 (1)** | 6 | 1.67 | 1.96 | 1.33 | .516 | 32.67 | 7.23 |
| **24-29 (2)** | 11 | 1.18 | .982 | 1.18 | .405 | 28 | .000 |
| **≥30 (3)** | 11 | 2.36 | 1.20 | 1.27 | .467 | 31.82 | 6.53 |
| **Total** | *28* | *1.75* | *1.37* | *1.25* | *.441* | *30.50* | *5.46* |

The obvious association of the functional parameters also influenced an optimal period of the recovery process for group 2 (MA = 28; AS = .000). The comparison of the average results suggests that the most effective recovery plan specific to the acute and functional phase required 28 days (Table 18).

According to the interpretation of the post-hoc analysis, the only relevant analysis that identifies a difference in the final assessment of the knee joint balance includes group 2 and 3 ($p = .052$).

The difference between the two groups confirms the increased efficiency of subjects aged 24-29 years after the intervention plan, but the result has no fully accepted statistical relevance. The interpretation for the other parameters that describe the effectiveness of the

treatment does not show significant differences, the values being optimal for all groups of subjects.

Table 19. Descriptive statistics for assessing the effectiveness of the recovery plan by position in the field

| **Position in the field** | **N** | **Dependent variable (units)** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Range of motion final (degrees)** | | **VAS final (0-10)** | | **Rehabilitation plan (days)** | |
| | | **AM** | **SD** | **AM** | **SD** | **AM** | **SD** |
| **GK** | - | - | - | - | - | - | - |
| **DEF** | 9 | 1.56 | 1.33 | 1.11 | .333 | 29.56 | 4.66 |
| **MID** | 9 | 2.22 | 1.56 | 1.44 | .527 | 34.22 | 7.37 |
| **WIN** | 6 | 1.33 | 1.63 | 1.17 | .408 | 28 | .000 |
| **ATT** | 4 | 1.75 | .500 | 1.25 | .500 | 28 | .000 |
| **Total** | *28* | *1.75* | *1.37* | *1.25* | *.441* | *30.50* | *5.46* |

Scores indicating functional parameters improved almost completely after treatment are found next to each group of subjects oriented according to the position in the field. This group of subjects, together with the attackers, also presented the fastest completion of the treatment plan (28 days) (Table 19). The analysis of the efficiency of the recovery plan having as a criterion the subjects distributed according to the position in the field identifies a series of minimal differences of the average final results.

### 5.8.5. Analysis of the level of therapeutic compliance according to the affected region - Hypothesis testing 2.1.

Table 20. Descriptive statistics for compliance level by affected region

| **Variables** | **Group A (n=16)** | | **Group B (n=12)** | | | |
|---|---|---|---|---|---|---|
| | **AM** | **SD** | **AM** | **SD** | **t(26)** | **p** |
| **RAdMAT TOTAL** | 61.69 | 3.70 | 61.17 | 3.27 | .394 | .697 |
| **RAdMAT PART** | 19.44 | .964 | 19.17 | 1.52 | .539 | .597 |
| **RAdMAT COM** | 15 | 1.78 | 15 | 1.27 | - | - |
| **RAdMAT ATT** | 27.19 | 1.27 | 27 | 1.41 | .362 | .721 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **SIRAS** | 14 | 1.54 | 14.08 | 1.16 | -.162 | .872 |

Analysis by Independent-Samples T test demonstrates the absence of significant differences (p> 0.05) between the mean results of group A and B. The interpretation of the results expresses an almost similar evolution for the measurements performed and confirms that the affected region (independent variable) does not represent a factor that influences the level of compliance or efficiency of the recovery plan through physical therapy (Table 20).

Table 21. Descriptive statistics for compliance level by affected member

| **Variables** | **Group 1 (n=18)** | | **Group 2 (n=10)** | | | |
|---|---|---|---|---|---|---|
| | **AM** | **SD** | **AM** | **SD** | **t(26)** | **p** |
| **RAdMAT TOTAL** | 61.61 | 3.71 | 61.20 | 3.15 | .310 | .760 |
| **RAdMAT PART** | 19.72 | .669 | 18.60 | 1.64 | 2.564 | .064 |
| **RAdMAT COM** | 14.83 | 1.79 | 15.30 | 1.05 | -.866 | .394 |
| **RAdMAT ATT** | 27 | 1.57 | 27.30 | .675 | -.702 | 489 |
| **SIRAS** | 14 | 1.53 | 14.10 | 1.10 | -.199 | .844 |

However, a minimal positive value of the T-Test was obtained only for the RAdMAT scale, t (26) = .310, p = .760, but the advantage of group 1 is not statistically representative. Moreover, the statistical interpretation in Table 21 confirms the homogeneity of the group of subjects, the oscillations of the main evaluated parameters not being significant depending on the affected limb.

### 5.8.6. Interpretation of the level of therapeutic compliance according to age and position in the field - Hypothesis testing 2.2.

Table 22. Descriptive statistics for compliance by age – fundamental research

| **Age (years old)** | **N** | **Dependent variable (units)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **RAdMAT TOTAL** | | **RAdMAT PART** | | **RAdMAT COM** | | **RAdMAT ATT** | | **SIRAS** | |
| | | AM | SD | AM | SD | AM | SD | AM | SD | AM | SD |
| **18-23 (1)** | 6 | 59 | 5.44 | 19.33 | 1.03 | 13.67 | 2.65 | 26 | 2.36 | 13.50 | 2.07 |
| **24-29 (2)** | 11 | 62.91 | 1.13 | 19.64 | .674 | 15.64 | .674 | 27.64 | .505 | 14.18 | 1.07 |
| **≥30 (3)** | 11 | 61.36 | 3.23 | 19 | 1.67 | 15.09 | 1.04 | 27.18 | .751 | 14.18 | 1.25 |
| **Total** | *28* | 61.46 | 3.46 | 19.32 | 1.21 | 15 | 1.56 | 27.11 | 1.31 | 14.04 | 1.37 |

The absence of statistical significance of the compliance score between the groups of subjects indicates that age is not a relevant arbitrary parameter in calculating the level of treatment compliance (Table 22).

Table 23. Presentation of the level of therapeutic compliance according to field position through post-hoc analysis

| **(I) Position in the field** | **(J) Position in the field** | **p** | | | | |
|---|---|---|---|---|---|---|
| | | **RAdMAT TOTAL**** | **RAdMAT PART**** | **RAdMAT COM*** | **RAdMAT ATT*** | **SIRAS**** |
| **DEF** | **MID** | .231 | .034 | .384 | .802 | .098 |
| | **WIN** | .493 | .992 | .781 | .271 | .344 |
| | **ATT** | .645 | .753 | .883 | .998 | .791 |
| **MID** | **DEF** | .231 | .034 | .384 | .802 | .098 |
| | **WIN** | .041 | .042 | .104 | .271 | .009 |
| | **ATT** | .052 | .025 | .213 | .811 | .020 |
| **WIN** | **DEF** | .493 | .992 | .781 | .721 | .344 |
| | **MID** | .041 | .042 | .104 | .271 | .009 |
| | **ATT** | .876 | .757 | 1.000 | .898 | .762 |
| **ATT** | **DEF** | .645 | .754 | .883 | .998 | .791 |
| | **MID** | .052 | .025 | .213 | .811 | .020 |
| | **WIN** | .876 | .757 | 1.000 | .898 | .762 |

*Tukey; **Games-Howell

The comparison of the groups identifies a series of statistically significant differences for the RAdMAT scale (p = .041), between extremes (MA = 63.50; AS = .548) and midfielders (MA = 58.67; AS = .433). The analysis of the RAdMAT PART subscale identifies significant differences between the group of midfielders (MA = 18.11; AS = 11.53) and all other groups (.025 <p <.042).

The post-hoc analysis for the SIRAS scale also places the middlemen as having a lower result (MA = 12.78; AS = 1.48) than the other groups of subjects (p <0.05). The results interpreted in Table 5.20 no longer express other significant differences from the comparison of the average results of the other groups (Table 23).

The interpretation of the results suggests that the midfielders were the least compliant of all research subjects, the differences being also statistically accepted.

### 5.8.7. Interpretation of correlations between therapeutic compliance and functional parameters - Hypothesis testing 3.1.

Table 24. Correlation matrix between therapeutic compliance scales and final parameters of the functional recovery plan

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **1.RAdMAT TOTAL** | | | | | | | |
| **2.RAdMAT PART** | .673** | | | | | | |
| **3.RAdMAT COM** | .942** | .447** | | | | | |
| **4.RAdMAT ATT** | .882** | .301 | .883** | | | | |
| **5.SIRAS** | .805** | .546** | .759** | .695** | | | |
| **6.Rangeofmotion_F** | -.556** | -.281 | -.533** | -.578** | -.367 | | |
| **7.VAS Stretch_F** | -.514** | -.224 | -.483** | -.559** | -.504** | .716** | |
| **8.Rehab. period** | -.885** | -.671** | -.790** | -.761** | -.773** | .638** | .592** |

**p<0.05

Favorable correlations between scales and subscales to assess the level of therapeutic compliance confirm their validation as recommended measurements for patients following a recovery plan by physical therapy, similar to the study by Clark, Bassett & Siegert (2018).

The inverse proportional correlation means that a high score of the RAdMAT and SIRAS scales is associated with a low value of flexibility deficit and painful sensitivity to passive stretching.

Therapeutic compliance and measurements for pain and flexibility can be considered interdependent due to the beneficial effect on the treatment plan. The statistical significance related to the evolution of the recovery plan determines that the research subjects (N = 28) with a high score of therapeutic compliance (measured with both RAdMAT, SIRAS scales) showed significantly lower values for the VAS scale and knee joint balance at the end of the stage. functional recovery.

The statistical interpretation transposed in the context of the treatment plan suggests that high values of the RAdMAT and SIRAS scales are associated with a shorter period of physiotherapy recovery. The tendency of a strong inversely proportional correlation requires the interpretation of the potential impact that the level of therapeutic compliance may have on the duration of the treatment plan.

### 5.8.8. Interpretation of the associations between therapeutic compliance and recovery period - Hypothesis testing 3.2.

Table 25. Results of linear regression between therapeutic compliance and duration of recovery plan

| Model | | Variable coefficients | | Coeficienți standard | t | p | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 116.087 | 8.857 | | 13.107 | .000 | 97.880 | 134.293 |
| | RAdMAT TOTAL | -1.392 | .144 | -.885 | -9.678 | .000 | -1.688 | -1.097 |
| a. Dependent variable: *Rehabilitation period* | | | | | | | | |

Transposition into the therapeutic sphere has a significant effect of optimizing and reducing the duration of the recovery plan when therapeutic compliance (calculated by the RAdMAT scale) increases (Table 25).

Table 26. Linear regression between SIRAS scale values and recovery plan duration

| Model | | Variable coefficients | | Standard coefficients | t | p | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | B | SE | Beta | | | Min | Max |
| 1 | (Constant) | 73.601 | 6.977 | | 10.549 | .000 | 59.259 | 87.942 |
| | SIRAS | -3.071 | .495 | -.773 | -6.206 | .000 | -4.088 | -2.054 |
| a. Dependent variable: *Rehabilitation period* | | | | | | | | |

Depending on the values of therapeutic compliance measured through the SIRAS scale, there is a predictive analysis on which we identify a statistically significant transposition in the context of the intervention strategy.

A constant increase in the level of therapeutic compliance (measured by SIRAS) will determine according to the predictive analysis a decrease in the duration of the treatment plan and implicitly a faster fulfillment of the therapeutic objectives.

## Partial conclusions

The fundamental research, entitled Implementation of the program to increase compliance in the recovery of sports injuries, included the main objective of highlighting the intervention program on the level of therapeutic compliance and, implicitly, on the effectiveness of treatment.

The main parameters analyzed during the treatment plan (pain on passive stretching, flexibility) showed a statistically significant difference between the initial and final averages, regardless of the affected region.

The favorable evolution of the functional parameters was also confirmed by the Pearson correlation coefficient, which indicated a simultaneous adjustment of the recovery of flexibility and the decrease of pain to minimum values.

The duration of the recovery plan is a parameter that can be influenced by the particularities of the treatment and the level of therapeutic compliance.

The values of the RAdMAT and SIRAS scales confirm the existence of a high level of therapeutic compliance for the whole group of subjects, the differences being significant compared to the results of the preliminary research. The existence of an inversely proportional correlation between RAdMAT, SIRAS scales and functional parameters indicates an interdependence relationship that can benefit recovery efficiency and reduce the period of functional unavailability.

The effectiveness of the means of intervention based on a wide range of principles (mechanical, physiological, biochemical) is proven by the optimization effect of the treatment and the prediction of rapid progress in accordance with the principles of recovery.

The confirmation of the secondary hypotheses implicitly determines the confirmation of the main hypotheses, according to which the therapeutic program that includes dry needling, physical exercises and physiotherapy procedures determines the increase of compliance with the treatment.

The statistical analysis highlights the favorable contribution of a high level of therapeutic compliance on the recovery plan through physiotherapy, dry needling and physiotherapy. The strong inversely proportional correlation between the RAdMAT, SIRAS scales and the recovery period confirms the significant impact on the reduction of the duration of the medical recovery plan and implicitly the increase of the medical recovery efficiency.

# FINAL CONCLUSIONS

Preliminary research has identified a number of features that may influence the level of therapeutic compliance in the recovery of athletes. The degree of severity and the recovery period are two variables associated with changes in the level of therapeutic compliance.

Following the interpretation of the most significant results from the preliminary study, a low level of therapeutic compliance was identified regardless of the parameters that formed the basis of the distribution of the group of subjects.

The intervention program determined an optimal level of compliance for all groups of subjects structured according to the location of the trauma and the other characteristics (age, position in the field).

The parameters indicating the functionality represent favorable indicators on the final score of the treatment efficiency expressed by the duration of the recovery period.

Comparison of the final results of the functional parameters (pain on passive stretching, flexibility) compared to the same treatment period with those of other studies, confirms the decrease of the deficit on the active movements of the knee by 5-10 degrees more significantly.

The groups of subjects presented much more significant results than in other specialized studies for the VAS scale that express the ability to tolerate passive stretching, regardless of the affected region.

The interpretation of the results confirms the importance of an optimal level of therapeutic compliance in the recovery of performance athletes. The most significant results of the level of therapeutic compliance were associated with adequate results for the parameters that evolved the therapeutic efficacy.

Statistical interpretations that highlighted strong associations and correlations inversely proportional between the scales of evaluation of therapeutic compliance and the recovery period, confirm the statistically significant and practical impact on the optimization of treatment.

The program of increasing compliance based on the choice of the most appropriate techniques and means that included dry needling therapy, exercise and the use of physiotherapy procedures intervened favorably, including the reduction of the recovery period.

# LIMITATIONS OF RESEARCH

1. Impossibility to initiate collaborations with the maximum number of football teams that are engaged in the first two or three leagues in Romania (or specialists in the field of physiotherapy), in order to centralize the necessary information and to report the research to a much more significant group. This element has been restricted by the fact that a large part of physiotherapists do not practice dry needling therapy, this being an element of novelty at national and international level.
2. Unfavorable consequences of the pandemic context which prevented a larger number of subjects from going through the intervention program.

# FUTURE RESEARCH DIRECTIONS

Based on the results obtained in this research, future directions may present the implementation of the program to increase therapeutic compliance for subjects with different features of trauma (location, severity).

The beneficial effects of optimizing the level of therapeutic compliance can capitalize on the considerations on the modern therapeutic approach through a combined recovery plan.

Further research can be conducted to identify the association between the current level of therapeutic compliance and how it is a factor in therapeutic efficacy for different categories of subjects.

Therapeutic efficiency is for the field of recovery of performance athletes the equivalent of sports performance in national and international competitions.

# DISSEMININATION OF RESULTS

The dissemination of the results was achieved through a series of scientific publications that included theoretical data and interpreted results in order to further analyze the topic of the doctoral thesis.

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