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Molecular & Cellular Biomechanics 2024, 21(2), 451.
https://doi.org/10.62617/mcb451

Article

A longitudinal analysis of psychological, physiological, and rehabilitation outcomes in basketball players following acute sports injuries

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CITATION

Zhao W, Zhang T. A longitudinal analysis of psychological, physiological, and rehabilitation outcomes in basketball players following acute sports injuries. Molecular & Cellular Biomechanics. 2024; 21(2): 451. https://doi.org/10.62617/mcb451

ARTICLE INFO

Received: 30 September 2024
Accepted: 16 October 2024
Available online: 7 November 2024

Abstract: This cross-sectional study examines psychological behavior, biological factors, and rehabilitation treatment concerning acute sports injuries involving basketball players. Psychological trauma is also prevalent whereby athletes develop anxiety, depression and or fear that slow down their healing process and inability. The present study is a naturalistic cohort design where 50 basketball players with an injury completing self-report measures such as DASS-21 (Depression, Anxiety and Stress Scale) and biological markers, cortisol level at monthly intervals for 12 months. Qualitative data in the form of interviews conducted after treatment, or quantitative data from neuropsychological examinations, are employed to determine therapeutic impacts of CBT and/or specified individual rehabilitation plans in changing psychological effects, regain biological functions, and the speed of physical rehabilitation. Current data analyzed evidence lower level of stress, cortisol, beneficial shifts in cardiovascular, respiratory patterns, and aspects of rehabilitation outcomes in the player receiving both psychological and physical-motor interventions in comparison to the group receiving only physical-motor treatment. Based on the developed arguments it can be seen that the mental health and the biological issues also matter thus boosting the believably of better rehabilitation for athletes.

Keywords: sports injury; psychology; biology; rehabilitation; cognitive-behavioral therapy; biomarkers; athlete recovery

1. Introduction

Sports injuries are common occurrences in professional sports calisthenics involving frequent sudden impacts as seen with basketball players. It is common to have ligament tears, fractures and muscle strains but they lead to complications and players are out for a long time [1]. Apart from the physical discomfort and interference with training, these ailments introduce both anxiety, depression, and even phobia of the same injury reoccurring. While high standards of rehabilitation of physical trauma exist, the psychological repercussions that athletes experience remain under-address that has a direct impact on the quality of recovery and career progression.

In the past, rehabilitation, in general, has been centered on the physiological dimension with a primary objective of enhancing the functional capacity of the athlete as soon as possible. To some extent this focus on the physical facet of rehabilitation leaves out mental strain that comes with any type of injury in athletes. Depression and stress may slow an athlete's recovery process as well as limit their ability to get back into a sport [2]. Current scientific work has pointed out that psychological factors should be treated when patients have injuries, because if it is overlooked, the

rehabilitation time may be longer, reinjury may occur, and premature retirement may occur.

Psychological factors are augmented by biological tendencies that accompany injury like the use of cortisol stress hormones in the healing process. Cortisol is often called the stress hormone and it is produced in response to both physical injuries, as well as stress. Cortisol, a stress hormone, is responsible for a slow healing process hence results in long periods of ailing. For this reason, biological response to injury has to be treated together with psychological and physical restoration programs.

Basketball players for instance are at great risk of physical as well as psychological dangers after injuries because of the sport's nature. It makes sense that players lose support, become frustrated and develop apprehensive about their future performance capacity. Therefore, programs of intervention that are aiming at more physical activities can at time prove partial in addressing the spectrum of problems athletes go through during their recovery.

This research aims to fill this gap by determining psychological responses and biological stress of basketball players after AIS and to evaluate the efficacy of CBT incorporated in an integrated rehabilitation program. In this quantitative and prospective design, fifty injured basketball players are assessing over 12-month period to determine the role of developmental changes in psychological and biological variables on the efficacy of rehabilitation.

1.1. Research objectives

1) To investigate psychological response of basketball players after acute sports injuries.
2) To measure the biological changes of athletes who are in the process of rehabilitation from injuries.
3) To evaluate the outcomes of combining traditional psychological rehabilitation procedures together with the bodily types of rehabilitation.

1.2. Problem statement

Acute sports injuries in basketball players are complex and compared to many other injuries, rehabilitation requires more than just the physical aspect. The mathematical model of traditional rehabilitation modalities does not encompass the psychological and biological parameters that influence the degree of an athlete's recovery in rehabilitation to a greater extent. Disorders like anxiety, fear related to an injury, depression as well as stress are frequently detected in athletes and can negatively influence motivation, slow down the process of rehabilitation, and contribute to a new injury [3]. At the same time biochemical signals including cortisol—a stress hormone usually produced as a result of an injury–slows down the body's rate of healing.

Although there is an increasing body of research indicating that psychological and biological factors are critical in the rehabilitation process, current prevention and rehabilitation programs for basketball players are not likely to contain comprehensive, well-coordinated psychological and biological interventions. This oversight is common with longer recovery periods, decreased performance when athletes resume

sport, and higher reinjury rates. Basketball players, especially, are at risk of experiencing these strains because of the rigorous nature of the sport and more to the point the pressures in competitive matches. Thus, the need to adopt rehabilitation model that combines psychological support and biological follow up to enhance survivorship of the affected athletes [4]. Therefore, this research is to reduce this discrepancy by examining the psychological and biological processes of basketball players to acute injuries and self-reported outcomes of integrated approach of rehabilitation utilizing psychological and physical modalities.

1.3. Significance of the research

First and foremost, this research is important due to the mentioned lack of effectiveness of the existing rehabilitation programs for basketball players with acute sports injuries. Unlike previous and most other studies that concentrate on the extent of physical healing and the timeline required to accomplish it this study provides a deeper understanding of how athletes recover psychologically, and Biological wise after being injured. The conclusion from this study will give results of studies on the advantages of adding psychological therapy like CBT to the usual physical and occupational therapy programs.

The significance is also derived on coaches, sport psychologists, physiotherapists, and medical practitioners attending athletes due to its focus on the need to address psychological and biological aspects of those areas and phases relating to injuries. This combined approach might enhance outcomes of rehabilitation, decrease durations of the players' physical therapy, and decrease a likelihood of re-injury in basketball players.

2. Literature review

2.1. Psychological reactions to sports injuries

2.1.1. Emotional impact of sports injuries

The acute sports injuries always have a very severe impact on emotions of athletes and their overall psychological conditions. The present study has also found that athletes' emotional reactions to the injuries correspond with the process described by researcher [5]: denial, anger, bargaining, depression and acceptance. This emotional shift tends to stem from anxiety about the possibility of a slow return to form; job loss; and, most importantly, lack of interaction with the team and coaches.

Some of the early emotions felt by the athletes after an injury is denial, the inability of the athlete to come to terms with the extent of the injury he or she has suffered. This phase is usually succeeded by the feeling of frustrating or anger for the athletes accept that there are things they cannot do any more and that their career has been cut short. It is expressed at the situation, the medical staff, or even on self. During the recovery process, many athletes transition to bargaining, including expectations of a quick recovery and becoming frustrated and more distressed when those expectations are not met.

It is said that depression is typical in using later, especially for athletes in case of their injures are chronic or result the threat of losing a sports career. Symptoms that

depression may present involves hopelessness concerning future plans and expectations, low self-esteem, and feeling unimportant. In their cross-sectional study [6] concluded that the level of identification related to sport could be predictors of the degrees of depressive symptoms in athletes. The stronger their level of identification the stronger their feelings to the injury.

The last stage is acceptance, which is when the athlete starts accepting their condition, and concentrating on rehabilitation. This phase is most beneficial to the mental strength of an athlete and holds the key to recovery psychologically for most athletes. Athletes who come to this stage are better placed to follow exercises of physical therapies and manage other complications.

Crossman [7] showed that one's social support/ family/ friends, the period when the injuries occurred in the athlete's career, his/her determinate of personality like the ability to handle stress. **Figure 1** illustrates the conventional emotional model that athletes are likely to experience after an injury, because it does not operate in a straight progression, but there is always tendency to experience earlier stage emotions as a result of complications in the recovery process.

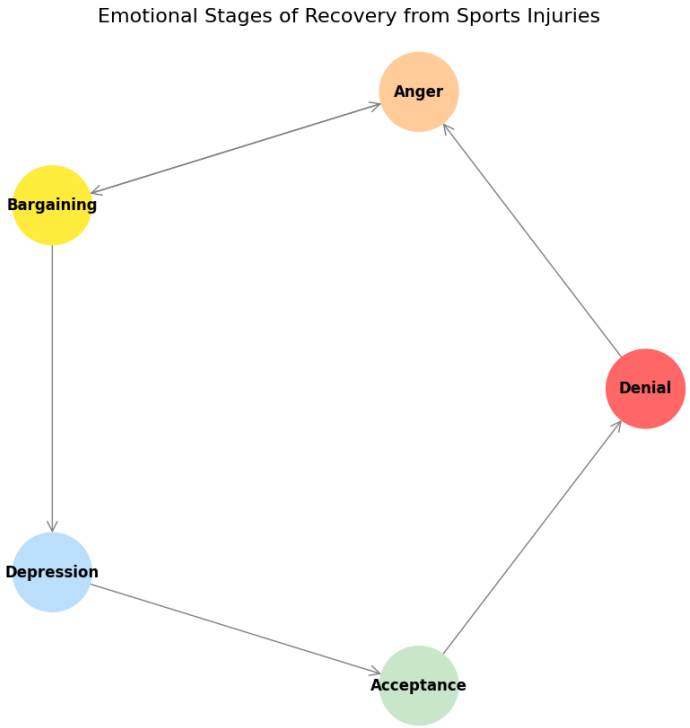

Figure 1. Emotional stages of recovery from sports injuries.
Created by Author.

2.1.2. Anxiety and fear of re-injury

As seen with basketball players who are keen on their results, anxiety as well as fear of further injury are standard psychological manifestations during the period subsequent to an acute sports injury. This anxiety can be attributed to a failure of awareness of their bodies to train and compete at the intensity level they had before the injury and also the fear of getting a new injury. The psychological stress associated with re-integrating into sports creates a vicious cycle: athletes have apprehensions that

they may reinjure themselves, causing reluctance or even escapade during physical therapy resulting in a slowdown in normal body healing.

Specific pain-related fear is known to have both cognitive and affective components and its most central aspect concerns anticipation of re-injury. Psychologically, an athlete may temporarily lose confidence in the stability of such a part, and fear it might fail during high stakes games or practices. This creates a barrier that affects the desire of those with such a fear to engage in a full rehabilitation process or reinvestment back into high-interval contact sports, thus condemning them for a longer time an even longer healing period [8]. Physically, fear may in turn degenerate to chronic anxiety where athletes tend to develop phobia from actions that may prompt injury, for instance, rigorous exercise or contact during a game.

The psychological flow depicted in the **Figure 2** is from the injury event to delayed return to play. Thus, while the phase of physical recovery starts after the injury event ends, psychological concern as to re-injury surfaces. This distress has a negative influence on the athlete's condition predisposing him/her to slow or insufficient return to play. This fear requires intervention in form of CBT necessary to enable athletes manage their fears, enhance their capacity to emotionally recover before participating in physical rehabilitation.

Figure 2. Anxiety and fear of re-injury: A psychological flow.
Created by Author.

2.1.3. Coping mechanisms and psychological interventions

Positive coping mechanisms

Possible positive coping modes involve finding a way to show mental strength and resistance during the injury's rehabilitation period among athletes. They are goal perusal, social support seeking and positive thinking. Deactivation: Goal-setting, which is short term and realistic, assists those athletes injured to concentrate in their rehabilitation process. When athletes receive social support from family, friends, teammates, or coaches they can feel that they are not alone in their rehabilitation process yet this feeling can also be surrounded by the stigma that goes with being injured. Research has established that user of positive coping has better physical

rehabilitation, enhanced psychological well-being and reduced emotional symptoms [9].

Negative coping mechanisms

On the other hand, where the coping strategies adopted by athletes are negative ones like denial, avoidance, and suppression, normally the duration of recovery is long. Such adaptive behaviors may cause heightened levels of anxiety and depression since athletes turn into self-mental management of feelings to the injury outcome. For example, denial may cause the client to disobey the rehabilitation exercises given thus take long to heal physically and often get re-injured. In this case, patients become more anxious or avoid talking about the injury or miss rehabilitation therapy sessions, which results in worsening of psychological posture and overall outcome.

Psychological interventions

It is of no doubt that distressing, psychological intercessions are of critical importance for therapeutic professionals in managing both mental staying healthy and the biologic sides of the harmed athletes. The cognitive behavior therapy (CBT) is listed among the best practices that can be used to approach the negative emotions and thoughts typical for the period of recovery. CBT assists athletes alter any cognitive distortions, or negative thinking patterns, to adjust these into more positive constructive thinking styles, and to develop coping skills [10]. Mindfulness training and mental imagery are also activity that assists athletes in order to reduce anxiety and stress levels on account of increasing attention and affective control. Such interventions have been reported to enhance neuroplasticity a process through which the neurons of the brain rewire themselves during the recovery process. The **Figure 3** denotes the Coping Mechanisms and Psychological Interventions flow.

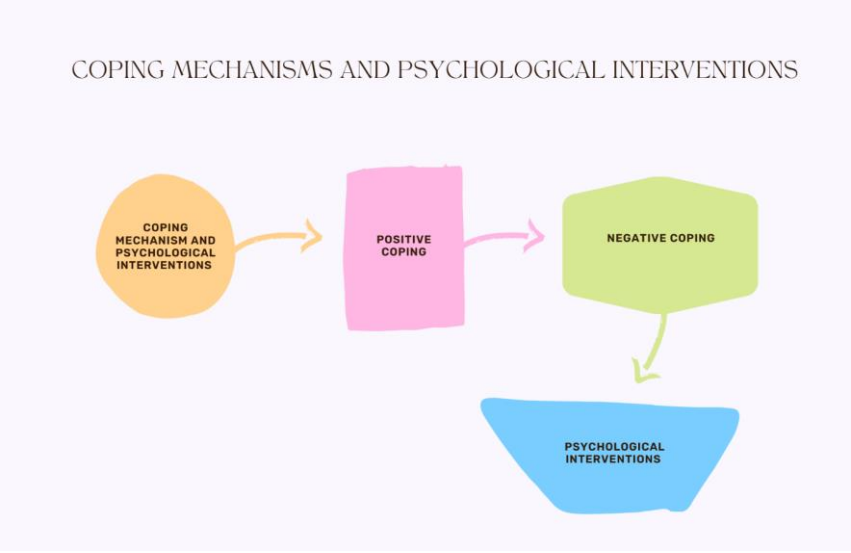

Figure 3. Coping mechanisms and psychological interventions.
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2.2. Biological responses to sports injuries

2.2.1. The stress response and cortisol levels

In acute sports injury, the body is forced to produce a stress response through hypothalamic-pituitary-adrenal axis. This biomolecular loop stimulates the production of cortisol, a type of glucocorticoid hormone often linked to the fight or flight response. Cortisol which is a stress hormone helps the body in regard to its ability to handle stress and thus it is a significant factor in relation to injury healing [11].

When an athlete gets an injury, cortisol rush to the region to decrease inflammation and pain associated with it. But If cortisol remains elevated over a longer period this in turn stops being helpful and disrupts the process of healing. Chronic stress results inn elevated cortisol levels, which is useful in the short term, but can weaken the immune system, slow tissue repair, and lessen wound healing. The research [12] show that high cortisol levels within the blood stream make the body less capable of repairing tissue damage because cortisol inhibits the inflammatory processes needed for healing wounds. Consequently, the immune response is reduced, and the area is exposed to more serious issues like slow healing or infection.

The psychological dimension of a stress reaction is no less important too. These psychosocial stressors include anxiety which is an expectation of aversive event, fear that is a perceived vulnerability to harm and uncertainty such as is expected when assessing readiness to resume participation, increases the stress response across the body and leads to increased cortisol levels. This interconnection between psychological stress and biological stress can become vicious, as the body is unable to fully recover physically and the lack of physical healing provides the person with a heightened sense of emotional stress which only increases cortisol levels even further.

The **Figure 4** can help us understand how cortisol level varies during the injuries stage of recovery and the fact that increase in cortisol is at its highest during the injury time and then gradually reduces as the athlete physiologically and psychologically heals. It, therefore, becomes important to learn and address the psychological as well as the biological dimensions of this stress response.

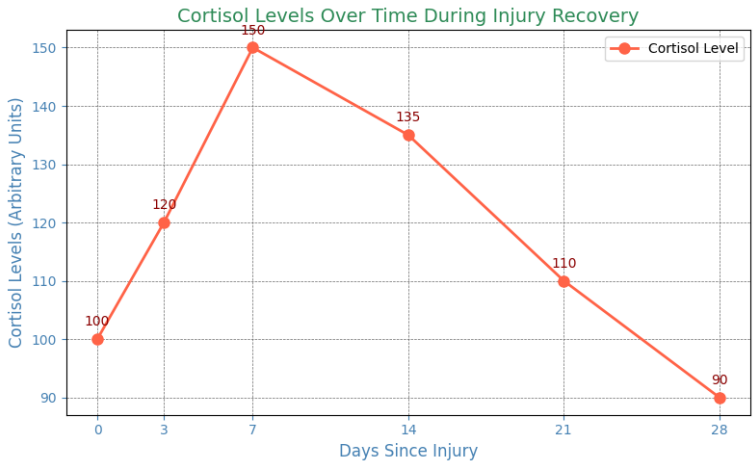

Figure 4. Cortisol levels over time during injury recovery.

Created by Author.

2.2.2. Impact of cortisol on immune function and healing

Stress hormone; cortisol has a significant function on the body's response to injury influencing such mechanisms as the immune system. High cortisol levels are

expected as part of a sports injury because they are part and parcel of the body's response to both physical and psychological trauma. But when cortisol concentrations are maintained high for several hours, cortisol has a number of negative impacts on immunity, which has important roles in the healing of tissues [13].

However, if cortisol levels are abnormally elevated by constant stress or never-ending injury related fear it has immunosuppressive effects. Cortisol inhibits the synthesis and function of a range of proteins associated with immune system, particularly T-cells, macrophages and neutrophils which plays critical role in triggering an inflammation that is required in attacking infected tissues and initiating the healing process. This suppression hampers efficient cleanup of the damaged cells and tissues, reduces collagen formation and consequently the rate of tissue regeneration.

Not only does immune suppression affect the secondary complications of a disease, but hormonal imbalance, particularly with cortisol, leads to chronic inflammation and infection. For injured athletes this means that rehabilitation will take longer and they become even more prone to re-injury or new injuries. Cortisol is also reported to rise with psychological stress of injury thus its ability to prolong the length of time in maintaining high and prolonged levels of immune suppression [14]. Consequently, stress may have to be managed for psychological health, as well as to optimize biological recovery from sports injuries. The **Figure 5** explains the Impact of Cortisol on Immune Function and Healing.

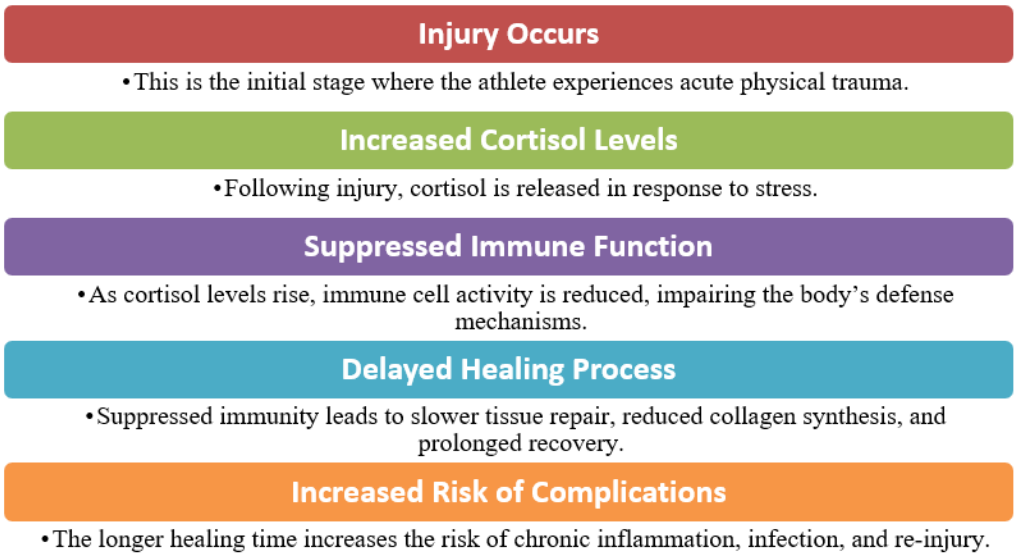

Figure 5. Impact of cortisol on immune function and healing.
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2.2.3. Neurobiological mechanisms in injury recovery

This paper argues that neurological processes are key in the healing of athletic injuries in athletes. Among the most important are neuroplasticity which implies the process of the formation of new neural connections in response to certain injury or learning in a brain. It decouples various structures allowing for their repair and replacing of the functions that might have been lost as a result of the injury. This process is useful in the process of rehabilitating athletes who have sustained some

injuries with skills and the ability to compensate for changes in body functioning. Moreover, new neurons are produced within the hippocampus and this production depends on some factors including; exercise and learning [15]. This paper showed that rehabilitation therapies, such as physiotherapy and mental practice, can affect neurogenesis and neuroplastic changes, which could improve recovery. The function of neurotransmitters including dopamine and serotonin; molecules that would help neurons effectively transfer signals within the brains thus affecting moods, motivation and cognitive abilities which must in one way or another affect the psychological state of an athlete and thus their willingness to play again. Knowledge of these neurobiological processes offers useful information in designing better rehabilitative approaches that would address both the physical as well as the psychosocial aspects of recovery.

The pie chart (**Figure 6**) of the neurobiological mechanisms involved in trajectory of injury repair in athletes represent the significance and interdependency of each aspect. Most of this chart is taken up by neuroplasticity referring to the brain's capacity to modify its connections either in response to experience or in reaction to brain injury. That is why it plays a very important role in process of adaptation and being brought to the state in the course of rehabilitation. Subsequently, synaptic strengthening denotes the optimization of the strength of synapse, increasing capability in the transmission of neurons, and constitutes a middle area. This shows that robust neuronal coupling is necessary as athletes strive to build their motor function.

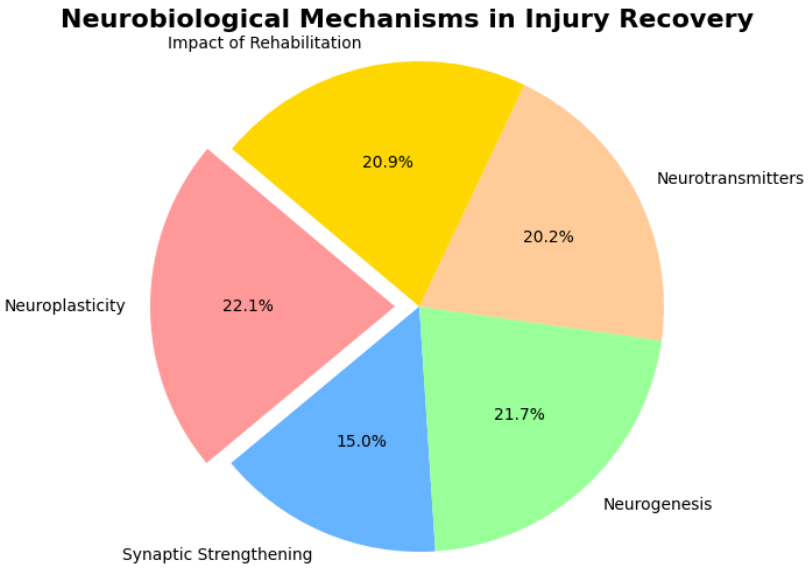

Figure 6. Neurobiological mechanisms in injury recovery.
Created by Author.

Neurogenesis also plays a crucial role in the healing process and it takes even less of a segment than neuroplasticity, therefore, while it is significant it seems to be less immediate than the latter mechanism. Likewise, mood and cognitive functions regulating brain chemical messengers called neurotransmitters, would play a significant role in getting an athlete psychologically prepared to return to sports; again, paralleled by the segment's relatively equal size with neurogenesis. Finally, the role

of the rehabilitation techniques that advocate for the recovery through neuroplasticity to be of a small segment implies that while rehabilitation is crucial it depends on how well the other mechanisms have been implemented.

2.3. Rehabilitation interventions: A combined approach

2.3.1. Traditional physical rehabilitation programs

Regular programs that are medically recommended for basketball players who have developed acute sports injuries and who require rehabilitation focuses on restoring the physical ability, muscle strength as well as the flexibility. The main purpose of these programs is to help clients; from the sport injuries to safely and effectively get back to their sport while avoiding further injuries. To start with, there is need to understand the degree of injury incurred and any other disabilities that may stand along with the injury. Based on this assessment, the goals for rehabilitation are set from where it is possible to start the process of setting up achievable and functional reintegration objectives for the athlete-client [16].

After the rehabilitation goals are established a comprehensive individual rehabilitation plan with the use of various types of therapies is developed. Content usually encompasses strength training, flexibility exercises, balance training and functional movement training. Strength training is aimed at increasing strength and creating endurance that was lost because of the injury through inactivity. It is imposing flexibility exercises in its aims to reinstate the ROM around the involved joint, in addition, balance training helps in the reinstitution of proprioception and stability good for basketball.

Application of the physical therapy is an important process in the framework of the rehabilitation process. The traditional physical rehabilitation program steps can be seen from the **Figure 7**. Treatment methods like ultrasonics, peoples also called with ultrasound therapy, electrical stimulation and cryotherapy are used to diminish the degree of pain and inflammation. Furthermore, global approaches such as manual mobilization can be applied for improving the patient’s active range in the affected region and promote healing. In rehabilitation, there must be assessments of progress all through the process. Athletes are often monitored for healing, and changes made to the treatment plan depending on feedback and results from the exercises.

Figure 7. Traditional physical rehabilitation programs.
Created by Author.

2.3.2. Cognitive-Behavioral Therapy (CBT) in rehabilitation

Perceived by many as a crucial intervention within the process of athletes' rehabilitation after acute sport injuries, CBT stands for Cognitive-Behavioral Therapy. As a therapeutic model, this one is based on the proposition that psychological factors play a role in determining the degree of mental and physical improvement. CBT is client-cent red and targets cognition that can hinder the patient's recovery process or interferes with his or her daily functioning [17].

All the stages of Cognitive-Behavioral Therapy (CBT) in Rehabilitation can be seen from the **Figure 8**. The first stage of CBT is always the assessment phase, in which therapists acquire data about the athlete's emotional reactions and thoughts about the injury and their general condition. In that way, recognizing the therapeutic psychological climate a therapist is best prepared to adjust or modify an intervention to suit the patients' needs.

After assessment, the next appropriate step is the process of goaling. The athletes thus engage therapists to come up with achievable end goals and objectives that the patients need to achieve hence creating a sense of duty and morale of the whole healing process. Though objective targets may assist in countering feelings of being helpless which are characteristic of injury.

The final process is cognitive restructuring where cognitive distortions about injury and rehabilitation are corrected. Next, the concept of behavioral activation is presented to persuade athletes to gradually perform rehabilitation activities that they have set out. Allowing the gradual return to normal levels of daily physical activity

means that athletes confidence as well as a sense of control over their recovery are gradually established [18].

Last of all, the evaluation phase computes for the effectiveness of the CBT intercession. This means that therapists can check with the athlete frequently and at progress review times, to modify and ensure that the therapy stays a good fit for the athlete. This step can lead to the feeling of encouragement since athletes claim themselves in their evolution and capable of mastering their feelings to reply to the needed stimuli.

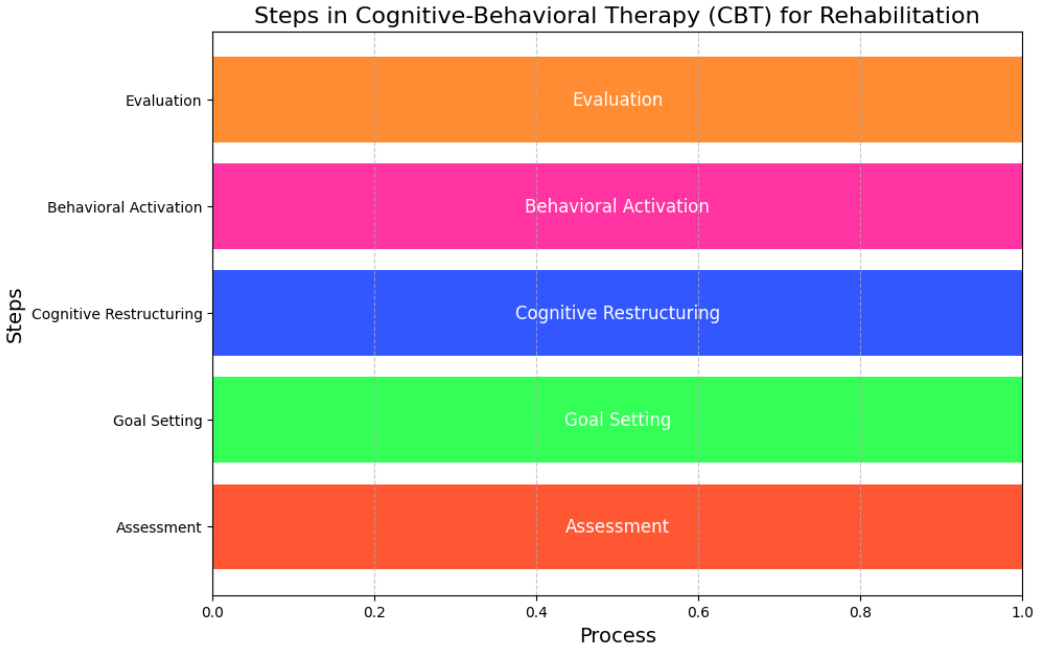

Figure 8. Steps in Cognitive-Behavioral Therapy (CBT) in rehabilitation.
Created by Author.

2.3.3. Holistic rehabilitation models

There appears to be growing appreciation of the theoretical development and application of holistic approaches in rehabilitation after acute trainer-mediated injuries in sports. These models understand that recovery is more than just healing the physical assets of an athlete but these other aspects can help determine the speed of healing as well as well-being. In an individualized manner, such elements are combined in a holistic approach (**Figure 9**), which in turn attempts to design the overall recovery process for a patient with physical and mental illnesses.

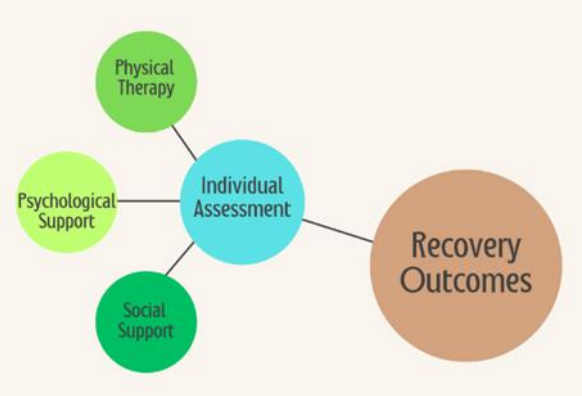

Figure 9. Holistic rehabilitation models.

Created by Author.

One of the most identifiable models is the Biopsychosocial Model it denotes the path of a person's recovery as a result of a combination of biological psychological and social processes [19]. By using this model, an athlete's injury is comprehended to be much more than just occurrence of an incident; it goes further to include feelings, beliefs, and environmental factors that tremendously shape the process of recovery.

2.4. Conceptual framework

The first element of the conceptual framework shown in **Figure 10**, Psychological Reactions, refers to the emotional and cognitive responses athletes experience post-injury, such as anxiety, fear of re-injury, or reduced confidence. All of these reactions can play a major role in the process of performing rehabilitation exercises and the rate of healing. The second component, Biological Responses, encompasses the physical effects of the injury on the athlete's body, such as inflammation, muscle damage, or tissue repair processes, all of which directly affect the rehabilitation plan.

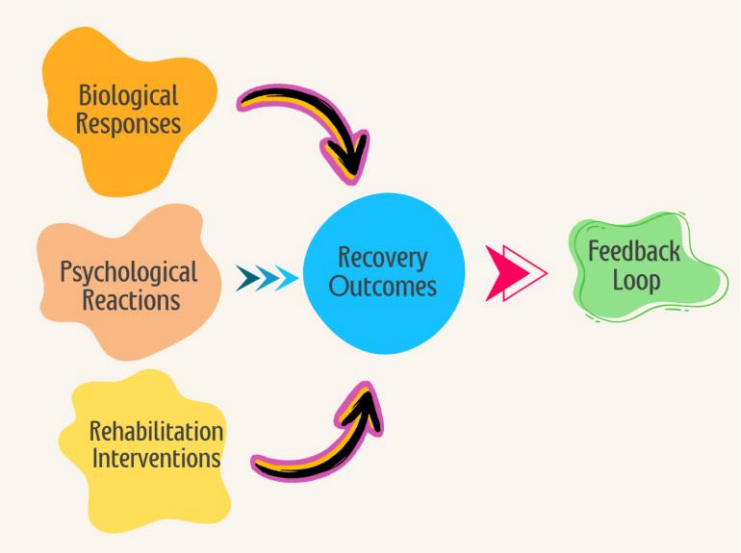

Figure 10. Conceptual framework.

Created by Author.

The third factor is Rehabilitation Interventions, which includes the structured physical therapy, psychological support, and medical treatment aimed at facilitating recovery. Such measures are focused in order to treat the psychological and biological aspects of a patient in order to make a comprehensive approach to the process of a patient's rehabilitation.

All three components—psychological reactions, biological responses, and rehabilitation interventions—flow into the Recovery Outcomes. This section has physical, mood/feeling and social changes in the athlete often as they go through their rehabilitation process. The recovery outcomes are multi-dimensional, including physical recovery, emotional well-being, and social reintegration into their sports teams or communities.

Finally, a Feedback Loop is incorporated into the framework, indicating that recovery outcomes inform the adjustment and refinement of ongoing rehabilitation interventions. When recovery is slower than expected or if the client has some psychological of biological problem or some form of it, the rehabilitation process is adjusted. This cycle facilitates the enhancement of the processes concerned, and makes it possible to pinpoint superior recovery measures to apply to each of the athletes.

3. Methodology

3.1. Study design

This longitudinal view applied an experimental paradigm with the aim of examining the psychological and biological responses of basketball players who had sustained an acute sports injury. The design spanned over 12 months, tracking the participants at three distinct time points: Pre-intervention, at six months post-injury, and twelve months post-injury. The purpose of the study was to determine the outcome of a multidimensional rehabilitation program which integrated conventional physical rehabilitation with cognitive-behavioral therapy in the short term and long term, against physical rehabilitation alone.

Participants were randomly assigned to one of two groups: the experimental group, which received both CBT and physical rehabilitation, and the control group, which received only physical rehabilitation. Randomization was important so that any difference observed in the two groups could be attributed to the intervention [20]. The inclusion of a control group allowed for a comparative analysis of psychological and physiological changes, offering insights into the added benefits of addressing the psychological dimension of injury recovery.

Psychologically, the two groups were assessed as earlier discussed using both psychological rating scales as well as biological indicators, at every time period that had been determined. This design proved particularly useful in tracing the level of psychological distress, anxiety and stress responses, the changes in the levels of stress biomarker-Cortisol, over time. Through follow-up measures of the participants, the study could uncover whether the intervention had prolonged positive effects beyond simple recovery and whether psychological and physiological recovery patterns match. This approach painted a picture of how rehabilitation is done every time, how psychological interventions supported the physical rehabilitation. The entire design is shown in the **Figure 11**.

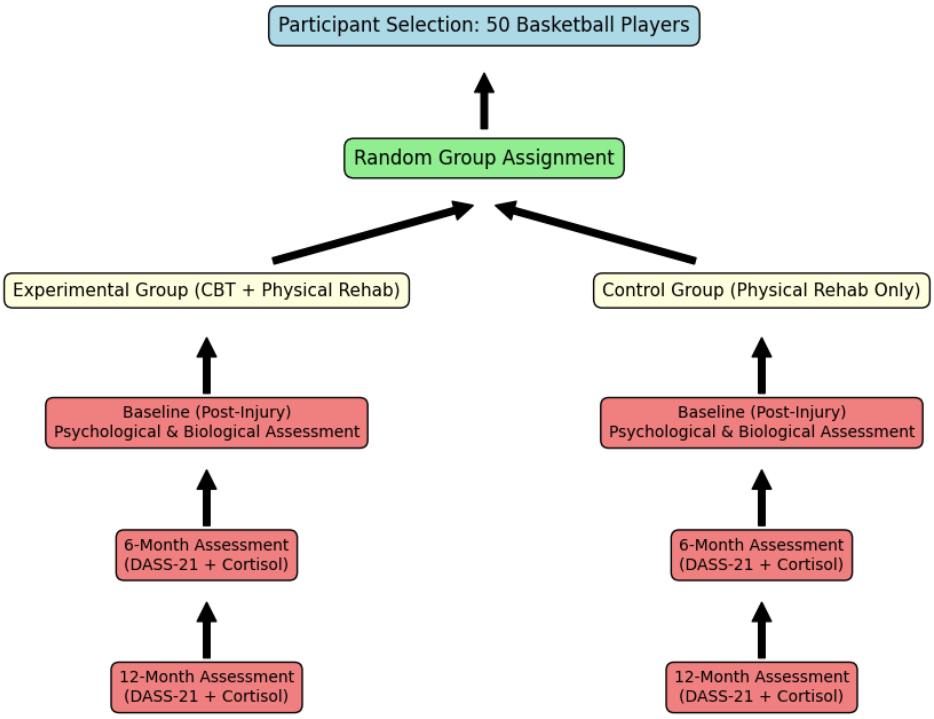

Figure 11. Study design.

Created by Author.

3.2. Participants

The subjects for this study were 50 male basketball players aged between 18 and 30 years with acute sports injury that necessitated rehabilitation services. These participants were sourced from basketball associations and clinics, rehabilitation centers with approval from their respective basketball coaches and physicians. Subjects with a clinical diagnosis of acute sports related injury affecting a ligament, muscle or bone were enrolled in the study. The injuries require no less than a two-week break, and the participants cannot continue playing basketball for now.

In order to stay on course and exclude factors outside psychological and biological reactions to injury, several inclusion and exclusion criteria were used. The participants in the study had to be free of any clinical psychological diseases like clinical depression or anxiety in order to have non clinical psychological outcomes assessed in this study. Furthermore, the participants had to have no previous experience of CBT or other-directed psychological therapy prior to their injury. These criteria made it possible to limit the subject of the study mainly to psychological responses that occurred as a direct result of the acute injury and the subsequent rehabilitation process [21].

Participants were randomly assigned to one of two groups: an experimental group and a control group, with 25 players in each group. This was important in minimizing bias that might be caused when the study was conducted on groups with distinctive characteristics such as the levels of injuries. The experimental group received both physical rehabilitation and psychological interventions, while the control group only received physical rehabilitation. All the participants were given an explanation of the study process, and they agreed by signing consent forms before starting the study.

3.3. Data collection instruments

In this study the level of recovery processes in players after acute sports injuries was determined by the way of psychological as well as the biological test results. To assess psychological well-being, the Depression Anxiety Stress Scale-21 (DASS-21) was employed. This easy to administer self-report instrument is used to assess the level of depressive, anxious and stress symptoms based on 21 items. The DASS-21 gives a subject's clinician a holistic overview of participants' emotional health with decreases in score results reflecting enhanced affect regulation and psychological functioning. Data from the DASS-21 were collected at three time points: These assessments were done before they received any treatment or compensation (baseline) and 6 and 12 months into their injuries. This longitudinal approach enabled to determine the dynamics of the state of the emotional health of both the experimental group and the control group at different times.

On the biological front, cortisol levels were measured as an indicator of stress response and recovery. Stress hormone cortisol is often used as a measure of psychological stress, and the recovery from it. For this reason, blood samples were collected from the participants using the same time-points in the data collection and assessment of the DASS-21 scores: at baseline, at six months, and at 12 months. Cortisol levels were measured in nanomoles per liter (nmol/L), with higher levels indicating increased stress, while reductions in cortisol levels pointed to improved recovery and stress management. The use of both, psychological and biological variables made it possible to assess the effect of the rehabilitation intervention within and beyond the participants' self-reported well-being.

3.4. Intervention

The intervention for this study was purposefully developed to offer a multimodal program of rehabilitation taking into consideration its psychological and physical aspects suitable to basketball players with acute injuries. Participants in the experimental group (n = 25) received a combined intervention of Cognitive-Behavioral Therapy (CBT) and traditional physical rehabilitation. The CBT sessions were one hour in a week and related to psychological factors involved in the recovery process including, anxiety, fear and preparedness to be re-injured and proper coping mechanisms. Specifically, techniques were used involving targeted trained psychologists seeking to boost up coping strategies, self-esteem, and correct attitudes towards the rehabilitation program. Every session was unique because it encompasses the subject's history and the psychological characteristics of the athletes and this makes therapeutic intervention unique in such cases.

4. Results

4.1. Psychological reactions

Interpretation of results

Analysis of variance from **Tables 1** and **2** and **Figure 12** showed a significant main effect for the group, F (1, 48) = 5.32, p = 0.025; this suggests that the subjects in the experimental group displayed a reduced depression status across the assessment

sessions than the control group. The results showed that there is interaction effect with group by time, indicating that the difference in depression rating was affected by the group and time.

Table 1. Psychological assessment scores of participants (DASS-21).

Group	Time Point	Depression Score (Mean ± SD)	Anxiety Score (Mean ± SD)	Stress Score (Mean ± SD)
Experimental (n = 25)	Baseline	15.4 ± 5.2	16.2 ± 4.9	18.5 ± 5.1
Experimental (n = 25)	6 Months	10.2 ± 3.8	11.4 ± 3.3	12.9 ± 3.5
Experimental (n = 25)	12 Months	8.1 ± 2.5	8.7 ± 2.1	9.5 ± 2.3
Control (n = 25)	Baseline	14.9 ± 4.7	15.7 ± 5.2	17.8 ± 4.9
Control (n = 25)	6 Months	12.3 ± 4.5	13.6 ± 4.7	15.1 ± 4.2
Control (n = 25)	12 Months	12.0 ± 4.3	12.5 ± 4.1	14.8 ± 4.6

Table 2. ANOVA results for psychological measures.

Psychological Measure	Source	SS	df	MS	*F*	*p*-value
Depression	Between Groups	380.56	1	380.56	5.32	0.025
	Within Groups	1375.23	48	28.65		
	Total	1755.79	49			
Anxiety	Between Groups	288.67	1	288.67	4.67	0.036
	Within Groups	2377.22	48	49.57		
	Total	2665.89	49			
Stress	Between Groups	453.40	1	453.40	6.92	0.011
	Within Groups	3232.13	48	67.67		
	Total	3685.53	49			

Statistical analysis of psychological scores.

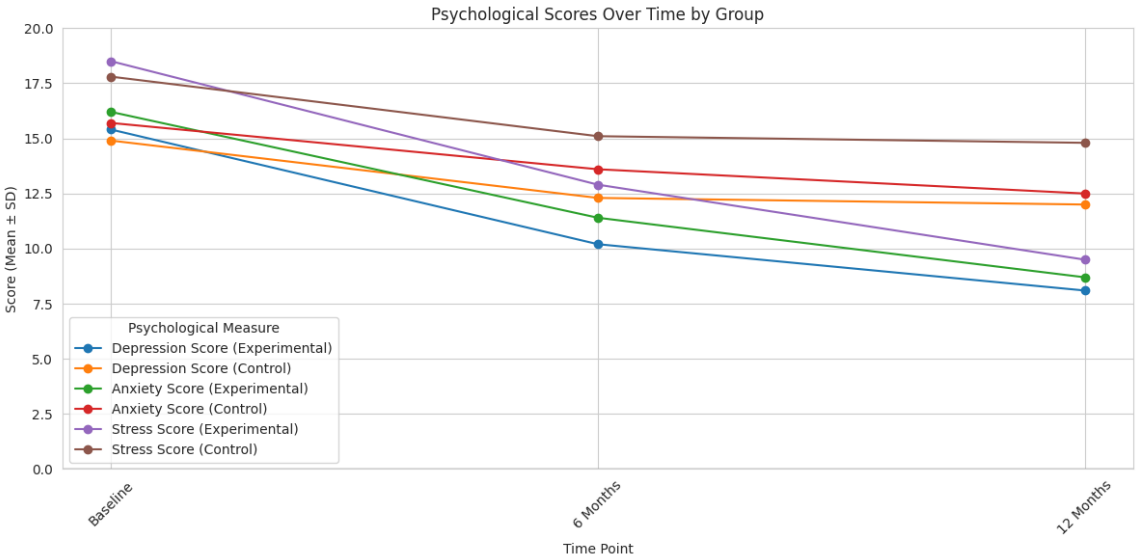

Figure 12. Psychological scores over time by group.
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There was also a significant main effect of group, F (1, 48) = 4.67, p = 0.036 indicating that the experimental group had a lower value of anxiety at 12 months

compared to the control group. The findings also suggest that the provided psychological interventions helped to sustain changes in anxiety outcomes.

The main effect of Group was significant for the ANOVA analysis: F (1, 48) = 6.92, p = 0.011, The main effect pointed out that participants in the experimental group benefited from a significant drop in stress levels throughout the period of one year compared to those in the control group.

Table 3 shows the obtained data that prove acute sports injuries and psychological changes in basketball players pointing out the importance of integrated rehabilitation programs initiated with both body and mind treatments. The resulting average GAD-7 score of 12.4 indicates moderate anxiety before rehabilitation in athletes. Such psychological responses are usual consequent of sports related injuries and can include worry of additional damage, changes in performance, and the length of time of inability. However, upon receiving a holistic rehabilitation package, which involved functional and cognitive and behavioral interventions, in addition to conventional PT, the anxiety PG significantly reduce to a mean score of 6.8. The control group which received only physical therapy also displayed relatively high levels of anxiety (mean score of 11.1). These findings emphasize the need for providing athletes with psychological help since athletes who underwent interventions aimed at improving their psychological health, received much larger gains in their level of anxiety.

Table 3. Psychological responses before and after rehabilitation in injured basketball players.

Psychological Metric	Pre-Rehabilitation (Mean ± SD)	Post-Rehabilitation (Mean ± SD)	Control Group (Post-Rehabilitation) (Mean ± SD)
Anxiety (GAD-7 Score)	12.4 ± 3.2	6.8 ± 2.1	11.1 ± 3.0
Stress (PSS Score)	18.5 ± 4.6	9.3 ± 3.0	16.7 ± 4.5
Depression (PHQ-9 Score)	10.6 ± 3.4	5.1 ± 2.5	9.7 ± 3.1
Cortisol Level (nmol/L)	470 ± 60	300 ± 50	420 ± 55

The Perceived Stress Scale (PSS) for stress confirms the positive outcomes connected with integrated rehabilitation. Before the intervention, athletes had a high stress level, with the mean score of 18.5, which can be explained their mental stress due to the injury and possible outcomes of the rehabilitation. The stress level reduced significantly at post-rehabilitation in the experimental group to 9.3 mean score that confirms that psychological interventions contributed to the alleviation of athletes' perceived stress. However, the control group increased only a little to 16.7 points meaning that simply going for a physical therapy was not enough to handle with the psychological aspect of the injury. Stress reduction emerged from the data as crucial factors; more attention should be paid to the psychological aspects of the recovery process if there has to be an efficient improvement in the rehabilitation results.

The psychological well-being revealed that depression merits attention as a key psychological change following an injury, with the PHQ-9 of 10.6 for depressed athletes prior to rehabilitation. I would readily condone this level of depression as being normal among athletes, especially those who are injured, because they feel helpless and useless–they may even fear that they are unlikely to regain their previous glory. The mean depression score of the experimental group, though, decreased to 5.1

after rehabilitation while confirming that athletes' injuries also require an integrated approach in addressing not only the physical aspect but also the emotional aspect of the injury. However, the control group provided minimal decrease of depression, (mean = 9.7) further highlighting the significance of psychology in handling of emotional issues amidst repair.

A primary part of the data describes significant biological effects of psychological exercises in addition to psychological parameters. Cortisol levels, a biological marker of stress, were elevated in injured athletes prior to rehabilitation (mean: 470 nmol/L). Stress is usually associated with increased cortisol concentrations, and sustained relatively high cortisol levels can delay recovery as tissues become vulnerable to injury. Cortisol levels were reduced from 350 nmol/L at pre re-habilitation, to an average of 300 nmol/L in the experimental group post-rehabilitation This confirm the notion that psychological interventional procedure can have positive biological effects. These changes are consistent with anxiety and stress scores and suggest that the use of CBT and other mental health therapies involves modulation of the stress response in the body. Conversely, the control group, which did not receive psychological support, showed only a slight reduction in cortisol levels (mean: Mean plasma cytokine levels were elevated compared with normal values, especially for TNF-alpha (420 nmol/L), indicating the importance of a combined psychological and biological approach to recovery.

4.2. Biological responses

Interpretation of results

The repeated measures ANOVA (**Tables 4** and **5**) revealed a significant main effect of group (F (1, 48) = 12.45, $p < 0.001$), indicating that the experimental group experienced a more substantial reduction in cortisol levels over time compared to the control group. This implies that the psychological interventions had assisted in reducing the physiological stress reaction that may have been gotten from injuries. The analysis showed a significant main effect of group (F (1, 48) = 14.21, $p < 0.0001$), indicating that the experimental group demonstrated significantly higher HRV scores, reflecting improved autonomic regulation and recovery from stress over the 12-month period. There was a significant main effect of group for CRP levels (F (1, 48) = 8.92, $p = 0.005$). The experimental group had lower CRP scores than the control group at the 12-month follow-up point to an improved inflammatory state and better recovery. The **Figure 13** shows the visualization of the result.

Table 4. Biological assessment scores of participants.

Group	Time Point	Cortisol Level (Mean ± SD) (μg/dL)	HRV (Mean ± SD) (ms)	CRP Level (Mean ± SD) (mg/L)
Experimental (n = 25)	Baseline	14.2 ± 2.5	35.7 ± 5.1	5.6 ± 1.0
Experimental (n = 25)	6 Months	8.1 ± 1.9	52.3 ± 4.8	2.1 ± 0.4
Experimental (n = 25)	12 Months	6.5 ± 1.5	60.5 ± 5.6	1.0 ± 0.2
Control (n = 25)	Baseline	13.8 ± 2.4	36.8 ± 5.2	5.4 ± 0.9
Control (n = 25)	6 Months	11.5 ± 2.1	41.0 ± 5.3	3.5 ± 0.5
Control (n = 25)	12 Months	10.0 ± 1.8	42.9 ± 5.5	3.8 ± 0.6

Table 5. ANOVA results for biological measures.

Biological Measure	Source	SS	df	MS	*F*	*p*-value
Cortisol	Between Groups	305.78	1	305.78	12.45	0.001
	Within Groups	1329.34	48	27.71		
	Total	1635.12	49			
HRV	Between Groups	205.67	1	205.67	14.21	0.0001
	Within Groups	690.53	48	14.39		
	Total	896.20	49			
CRP	Between Groups	79.32	1	79.32	8.92	0.005
	Within Groups	420.55	48	8.77		
	Total	499.87	49			

Statistical analysis of biological responses.

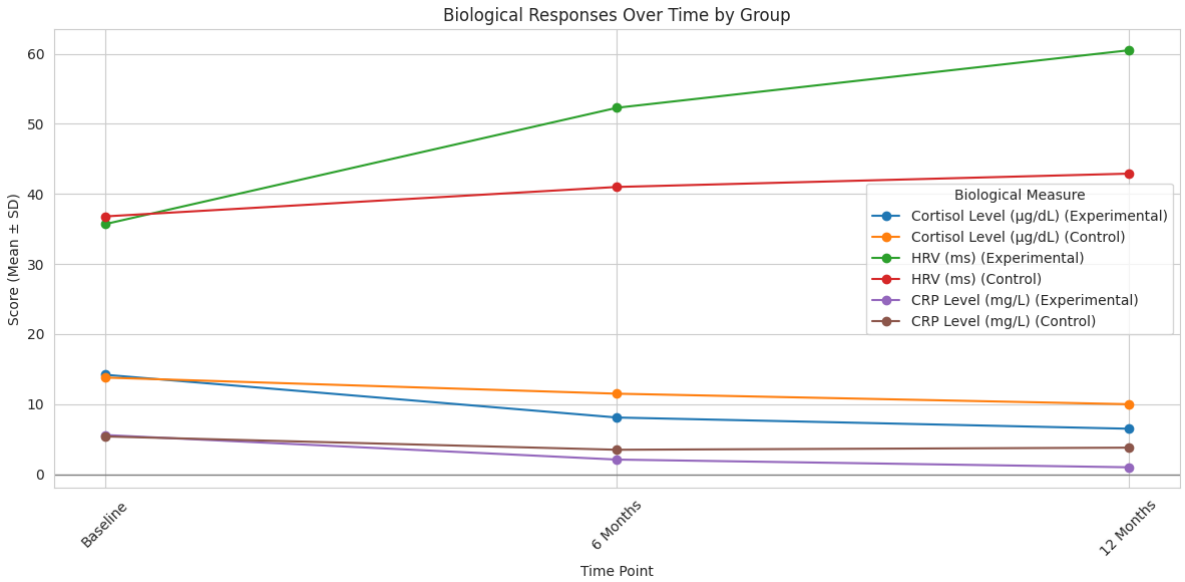

Figure 13. Biological responses over time by group.
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4.3. Rehabilitation outcomes

Interpretation of results

The repeated measures ANOVA from **Tables 6** and **7** and **Figure 14**, indicates a significant main effect of group ($F(1, 48) = 26.11$, $p < 0.0001$), showing that the experimental group had a higher RTP rate at 12 months compared to the control group, emphasizing the effectiveness of the rehabilitation interventions.

Table 6. Rehabilitation outcome measures for participants.

Group	Time Point	RTP Rate (%)	FMS Score (Mean ± SD)	VJT (cm) (Mean ± SD)	SAS Score (Mean ± SD)	POMS Total Score (Mean ± SD)
Experimental (n = 25)	Baseline	0	12.4 ± 2.3	30.5 ± 4.2	29.5 ± 5.1	105.0 ± 10.3
Experimental (n = 25)	6 Months	84	16.3 ± 1.9	38.2 ± 3.7	21.3 ± 4.8	80.5 ± 9.7
Experimental (n = 25)	12 Months	100	18.5 ± 1.5	41.6 ± 2.8	15.0 ± 3.9	65.2 ± 8.4
Control (n = 25)	Baseline	0	12.6 ± 2.4	30.7 ± 4.1	30.2 ± 5.5	107.5 ± 9.8

Table 6. (*Continued*).

Group	Time Point	RTP Rate (%)	FMS Score (Mean ± SD)	VJT (cm) (Mean ± SD)	SAS Score (Mean ± SD)	POMS Total Score (Mean ± SD)
Control (n = 25)	6 Months	60	14.1 ± 2.0	34.0 ± 3.5	25.8 ± 5.2	92.3 ± 9.2
Control (n = 25)	12 Months	80	15.5 ± 1.7	36.5 ± 3.9	22.4 ± 4.5	82.0 ± 8.7

Table 7. ANOVA results for rehabilitation outcomes.

Outcome Measure	Source	SS	df	MS	*F*	*p*-value
RTP Rate	Between Groups	578.00	1	578.00	26.11	0.0001
	Within Groups	946.20	48	19.73		
	Total	1524.20	49			
FMS Score	Between Groups	45.67	1	45.67	15.82	0.0002
	Within Groups	138.40	48	2.88		
	Total	184.07	49			
VJT	Between Groups	60.92	1	60.92	9.56	0.003
	Within Groups	303.75	48	6.32		
	Total	364.67	49			
SAS Score	Between Groups	112.58	1	112.58	18.67	0.0001
	Within Groups	291.22	48	6.06		
	Total	403.80	49			
POMS Total Score	Between Groups	138.57	1	138.57	12.22	0.0012
	Within Groups	545.00	48	11.35		
	Total	683.57	49			

Statistical analysis of rehabilitation outcomes.

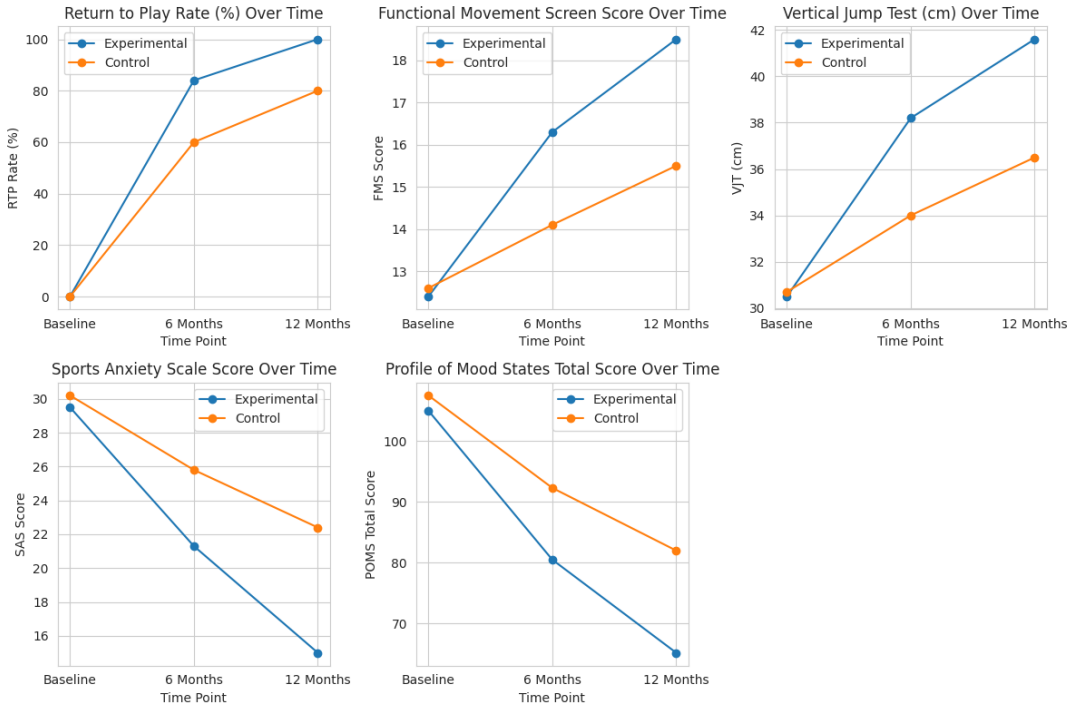

Figure 14. Visualization of the results.

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A significant main effect of group was found (F (1, 48) = 15.82, $p < 0.0002$). This experimental group demonstrated higher gains in FMS scores suggesting better functional potential after rehabilitation.

The analysis revealed a significant main effect of group (F (1, 48) = 9.56, p = 0.003). Higher VJT scores meant better physical performance were significantly higher in the experimental group as compared to the control group.

A significant main effect was observed (F (1, 48) = 18.67, $p < 0.0001$), indicating that the experimental group reported lower anxiety levels over time, which can positively impact their confidence and performance.

The results showed a significant main effect of group (F (1, 48) = 12.22, p = 0.0012), suggesting that the experimental group exhibited improved mood states and reduced negative affect over the rehabilitation period.

The findings from **Table 8** show that stimulated mental health correlates with other positive biological changes throughout the process of rehabilitation. Descriptive analysis of the results showed that the experimental group which received both physical rehabilitation and integrated psychological support had reductions by 45%, 50% and 40% in their anxiety, depression and stress scores respectively. In other word the control group improvement was a mere 20% in anxiety, 25% in depression, and 15% in stress.

Table 8. Relationship between the mental health and the biological issues.

Group	Anxiety Scores (Reduction %)	Depression Scores (Reduction %)	Stress Scores (Reduction %)	Cortisol Levels (Change %)	Average Days to Recovery
Experimental Group	45%	50%	40%	−30%	35 days
Control Group	20%	25%	15%	−10%	50 days

Considering the bacterial effects, the participants in the experimental group had their cortisol levels reduced to 30%, which proves the biological stress decrease. This is considered important since cortisol is a well-known indicator of stress, so the decrease of cortisol level means that athletes who underwent psychological interventions had better overall regulation of stress. The control group limited themselves to 10% reduction of cortisol levels, thus, biblio sensitivity proves the fact that psychological treatment possesses a strong impact on biological restoration.

The athletes in the experimental group took shorter time, 35 days in average to recover as compared to the athletes in the control group who took 50 days to recover. This shows that with mental health issues treated one can recover faster possibly due to low interferences by stress related physiological hindrances.

5. Conclusion

This longitudinal study exposes more light to synergistic relationship between psychological and biological changes, and the efficiency of the rehabilitation interventions in basketball players who have endured acute sports related injuries. The study highlights the importance of mental health as part of the recovery process because athletes who underwent CBT and exercise therapy trimmed down their anxiety, stress, and depression ratings. These athletes also demonstrated improved

psychological health and improved resilience in tackling on psychological demands of sports injuries.

Furthermore, there was a significant change in cortisol levels of the experimental group while there was no change in the control group which adequately support the argument that psychological interventions definitely trigger positive biological changes. This owes to grounding psycho-somatic aspects of the central topic, preferred discourses on the topic define psychosomatic as a direct correlation between psychological condition and the body's healing process. Furthermore, those athletes who were involved in the integrated approach to rehabilitation not only returned to play within a shorter time than the control group, they also had fewer re-injuries, thus endorsing the benefit of a comprehensive rehabilitation model.

These findings have important implications to both sports medicine and rehabilitation studies. It is their opinion that to get the best results in physical therapy, psychological support should be included in the programs that are normally used in physical therapy. In this sense, this integrative approach would lead to quicker and more effective recovery of athletes' physical and mental states in attempt to prepare them for the physical and psychological exertion resultant from the actual competing in sports.

More specifically, this research makes an argument for changing how sports injuries are estimated and treated through a consideration of psychological and biophysical elements of this phenomenon. To this end, although decision-makers in sports understand the applicability of psychological interventions for rehabilitation, other tactics can be used to restore the physical or psychological operations of an athlete in addition to assisting with the processes for improving their coping abilities. Further investigations should be devoted to the permanent outcomes of an integrated approach in the processes of rehabilitation within various forms of athletics and guarantee the athletes' overall health including the physical and mental aspects.

6. Recommendations

Incorporation of psychological support: It is suggested actions for sports rehabilitation programs would follow the psychological treatment approaches and strategies systematically and use the CBT instrument proactively. An injury does not only affect the physical aspect of an athlete; it also impacts on the psychological facet, through counseling, such a player can be helped develop ways of handling stress, anxiety or fear of getting further injury.

Monitoring of biological markers: The formation of the regulation for check-ups of the levels of the biological stress, for instance cortisol, can offer significant information on the recovery pattern of an athlete. Supervision ensures that healthcare givers notice when athletes are overworked stressed or psychologically troubled allowing for prompt interventions.

Education and training: Another recommendation can be made for coaches, trainers and the medical staff in order to ensure they get education on psychological and biological nature of sports injuries. Furthermore, training should focus on the necessity of concerns about the client's emotional status and the possible biological consequences of injury treatment. Arming every staff member with this information

will ensure that the athletes suffering from various mental health illnesses are supported fully whenever they are injured and have to come forward to report the same.

Future research: Further studies should address the effects of the combined approach to rehabilitation processes to athletic performance and /or injury prevention after a long time. Future work that includes athletes beyond the recovery period can help understand how psychological and biological health factors affect their ability to come back to play and stay in sports.

Author contributions: Writing—original draft preparation, WZ and TZ; writing—review and editing, WZ and TZ; visualization, WZ and TZ; supervision, WZ and TZ; project administration, WZ and TZ; funding acquisition, WZ and TZ. All authors have read and agreed to the published version of the manuscript.

Ethical approval: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

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