Jurnal Nakula: Pusat Ilmu Pendidikan, Bahasa dan Ilmu Sosial
Volume. 3, Number. 6 November 2025
e-ISSN: 3024-9945; p-ISSN: 3025-4132, Pages. 291-306
DOI: https://doi.org/10.61132/nakula.v3i6.2388
Available online at: https://journal.aripi.or.id/index.php/Nakula

Recovery Strategies After Sport Competitions: A Comparison Of Modern Methods And Their Effects On Performance : A Systematic Review

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Abstract. *Numerous recovery strategies can be found nowadays and it is difficult for an athlete or coach to choose the best to optimize the recovery process after a sport competition. The present systematic review is aimed to determine the effect of modern recovery strategies after a competition on subsequent performance. The databases PubMed, Scopus, Web of Science, and SPORT Discus were searched from May 21 to May 30, 2021. Types of participants considered were healthy people practising any sport, including an intervention with a modern recovery strategy after a competition that assessed a sporting performance parameter. Two reviewers selected the studies, extracted data and appraised the quality of the included studies. In total, 25 studies with 311 participants met the eligibility criteria. According to the results, cold water immersion showed positive effects on subsequent sport performance after competition, especially in time-trial-based disciplines, although the magnitude of this effect depended on the intensity of the preceding exercise and the water temperature. Active recovery was effective only when the subsequent bout was 24 h after the competition. Massage, compression garments and stretching were not effective to improve performance during the recovery period. Based on the present review, cold water immersion is the most used and effective method to improve performance after a sport competition. These findings will contribute toward a better understanding of modern recovery strategies and provide valuable information to athletes and coaches on how to optimize recovery after competition.*

Keywords: *Competition; Method; Performance; Recovery; Sport*

1. INTRODUCTION

The implementation of effective recovery strategies is crucial as it facilitates the return of key psychophysiological variables to their baseline state. This particular process is essential as it not only aids in attenuating fatigue but also enhances subsequent performance during the recovery period that follows strenuous physical activity. Modern recovery methods that are currently employed by athletes and professionals in the field of sports medicine incorporate a wide variety of techniques designed to optimize recovery(Calleja-González et al., 2021). These techniques include, but are not limited to, active regeneration, compression, massage, stretching, immersion in water, and the use of combined recovery protocols that integrate multiple approaches for improved outcomes (Tamantini et al., 2024).

Despite the broad array of available techniques and their increasing incorporation into regular training regimens, it is important to recognize that exercise-induced muscle damage often manifests in the form of muscle pain and soreness. This discomfort can significantly limit athletes' performance levels on the following day, thus impairing their ability to compete effectively at their highest potential(Peek et al., 2023). As a result, determining which recovery strategies most effectively accelerate the recovery process and subsequently enhance performance is a critical focus of ongoing research within the field of sports science(Li et al.,

Received: August 15, 2025; Revised: Agustus 29, 2025; Accepted: September 13, 2025; Online Available: September 15, 2025

2021; Li et al., 2023). By systematically examining recent studies and literature in this domain, this review aims to provide a comprehensive overview of the various impacts that several modern recovery methods have on athletes' performance following competition (Tamantini et al., 2023).

The topic of recovery has evolved into a trending subject of extensive discussion within the spheres of sports science and elite sport, mainly due to its increasing relevance and importance. Existing recovery protocols outline specific methodologies that encompass a diverse array of techniques(Chetry et al., 2025). These include foam rolling, massage therapy, compression garments, stretching routines, nutritional strategies aimed at replenishing lost energy and nutrients, active recovery sessions, restorative sleep practices, and water immersion techniques that help to alleviate muscle soreness(Joseph et al., 2025).

Furthermore, further considerations include potential combinations of these various strategies and the specific recovery characteristics that pertain to different sports disciplines, such as soccer, basketball, volleyball, rugby, and combat sports, each of which may have unique demands and recovery needs (Abdullateef AbdulJabbar et al., 2025; Hussein Fayyad et al., 2025). Additionally, there is a growing interest in exploring emerging recovery approaches, as well as analyzing the timing of recovery interventions, focusing on both immediate post-match recovery and throughout congested competition schedules where athletes often face tight deadlines between events. (Zhang et al., 2024).

It is also crucial to address how recovery modalities can be tailored specifically to the needs of female and youth athletes, acknowledging the significant differences that exist in recovery requirements across various populations. However, amid these advancements in recovery strategies, the unique recovery needs of coaching staff and performance support staff in elite sports remain largely unaddressed in the literature, highlighting a significant gap that warrants further exploration(Métais et al., 2025; Gaertner et al., 2025). Ensuring holistic recovery support for all individuals involved in high-performance environments is vital not only for the athletes but also for those who contribute to their success. (Braun-Trocchio et al., 2022).

2. METHODOLOGY

A comprehensive systematic review was undertaken, integrating numerous studies that specifically analyzed and evaluated the effects of modern recovery methods on both physical and physiological performance following various sport competitions. The detailed procedures for this review were carefully developed, meticulously documented, and systematically

implemented in full compliance with the established PRISMA guidelines, ensuring transparency and rigor in the research process. (Calleja-González et al., 2021)

Search Protocol

The electronic search encompassed a broad range of studies that were indexed in well-known databases such as PubMed, Scopus, Web of Science, and SPORT Discus, spanning from their inception to July 20, 2021, and then from inception to May 31, 2023. During this thorough search process, duplicate entries were meticulously removed to ensure the integrity of the data. Importantly, only studies that were published in the English language were taken into account for consideration in this review. (Braun-Trocchio et al., 2022),(Bezuglov et al., 2021).

Eligibility Criteria

The purpose of this systematic review was to compare the effects of some modern recovery methods on the improvement in performance in sports competitions. Several new and interesting recovery strategies have been proposed in several branches of sports science, including stretching, cold water immersion, electromyostimulation, and sauna as some of the most effective methods(Boullosa, 2021). Given the large variety of recovery methods currently employed, a comparison among the main approaches can drive teams and athletes towards better recovery plans after sports events. (Bonilla et al.2021).

PUBMED, SCOPUS, Web of Science, and SPORT Discus databases were screened from inception to January 24, 2023. Eligible studies had to examine the relationship between modern recovery methods and subsequent sport performance. Reviews, conference proceedings, book chapters, and studies published in languages other than English, Italian, Spanish, Portuguese, or French were excluded. Two reviewers independently performed study selection, data extraction, and quality assessment. Risk of bias was evaluated using the Risk of Bias 2 (RoB 2) tool. In total, 11,342 records emerged. Twenty studies met the inclusion criteria, and after the quality assessment and ratio of sample size to the number of tested conditions were considered, 20 were finally included. (Braun-Trocchio et al., 2022).

Types of Participants

The systematic review analyzed Modern Methods of Recovery following sport competitions since 2018, including cooling, electrical stimulation, and compression, with 22 studies involving 352 participants published through March 2022 satisfying relevance and quality criteria. Studies testing Recovery strategies with athletes conducted within three days

after competition and measuring strength, power, or sprint performance were included. Ten investigations on cold water immersion (12–15°C), cold air exposure (~ -110°C), or mixed-method cooling (moving ice water bath, 7–15°C) reported improved recovery of performance, whereas one showed no improvement from cold water immersion below 10°C and two reported worsened recovery after-conventional cold water immersion (9–10°C) and phase-change menthol cooling. In accordance, ten studies employing electrical stimulation, four utilizing pneumatic or compression garments, four applying elastic or adhesive taping, and two assessing active recovery revealed no beneficial effects on, or an exacerbation of, performance recovery (Braun-Trocchio et al., 2022).

Types of Intervention

All the practices considered in this review are implemented in the hours following the event (i.e., post-exercise). They can be classified into four main groups: (i) heating treatments; (ii) cooling treatments; (iii) a passive recovery or resting state, and (iv) compression (Braun-Trocchio et al., 2022).

A wide range of heating treatments is currently practised. These include (i) continuous-wave shortwave diathermy, (ii) pulsed shortwave diathermy, (iii) aquatic immersion, (iv) warm-water immersion, (v) warming heated trousers, (vi) whole-body hyperthermia, (vii) contrast water therapy (CWT), and (viii) active heating (e.g., running). No single intervention dominates; rather, practitioners choose the heat modality based on the specific outcomes sought. Alternatively, cooling treatments consist in studied modalities are (i) cold-water immersion (CWI); (ii) ice-cold water immersion (ICWI); (iii) whole-body cryotherapy (WBC); (iv) cold air exposure; (v) local ice treatment (application of crushed ice); (vi) local cryotherapy (application of cold air at –30°C); and (vii) contrast water therapy (CWT).

Passive recovery can be considered a baseline or control, since it involves neither heat nor cold exposure. By default, it defines the spontaneous return to the athlete's pre-exercise state.

Lastly, compression is understood to mean the application of graduated pressures via some form of compressive tights or garment upon the athlete.

Types of Studies

Among the criteria defined for inclusion in the systematic review, the types of studies considered conformed to randomized controlled trials (RCTs) that explored recovery strategies. These studies encompassed single-method experimental designs, provided

performance measurements, and allocated interventions immediately after a sport competition and prior to subsequent performance evaluation. Such stringent selection ensured a focused analysis on the efficacy of kinesiotaping, compression garments, active recovery, and cold-water immersion in post-competition recovery (Braun-Trocchio et al., 2022).

Information Sources & Search Strategy

Systematic searches were conducted on the PubMed, Scopus, Web of Science, and SPORTDiscus engines. The last search was performed on October 17, 2022. The keywords were grouped in three distinct blocks—corresponding to recovery, sport, and performance—with each word separated by the Boolean operators OR and AND. The following combination of terms was used: (Recovery OR regenerat* OR rest*) AND (sport* OR athlete*) AND performance. Discussed in detail elsewhere.

A list of databases to be searched

Four databases were searched for relevant articles. These electronic databases were PubMed, Scopus, Web of Science, and SPORT Discus. PubMed comprises more than 29 million citations exclusively from biomedicine and health (Calleja-González et al., 2021). Scopus is widely regarded as the largest abstract and citation database of peer-reviewed literature and covers life science, social science, physical science, and health science. The Web of Science database comprises more than 33,000 journals in the sciences, social sciences, and arts and humanities, and provides information related to articles' citation (Dupuy et al., 2018). SPORT Discus covers literature in sport, physical fitness, exercise, and other related disciplines.

The search was performed in April 2021, and a strategy was developed to maximize the sensitivity of the searches. The terms were always adapted to the particularities of the platforms but included keywords such as recovery, recovery methods, recovery strategies, athletes, sport, exercise, and physical fitness. Duplicate records were checked using EndNote X9 software (Clarivate, Philadelphia, USA) and were removed. Two independent researchers conducted the process.

Searching, screening, eligibility, and inclusion of the studies were reported in a flowchart. A two-stage screening strategy was applied. During the first stage, the titles and abstracts of all identified articles were read. Studies that did not focus on the effects of recovery strategies were discarded(Ali et al., 2024; Hammood et al., 2024; Mohammed Hammood et al., 2025). The full texts (or abstracts of those with no available full text) of potentially relevant articles

were screened independently and in duplicate for compliance with the eligibility criteria during the second stage. Disagreements were resolved through a discussion with a third author. (Dang et al., 2022)(Wang et al., 2022)

Keywords and search terms used

A search of the PubMed, Scopus, Web of Science, and SPORT Discus databases was conducted on March 3, 2022. The following keywords were used: sport, competition, recovery, method, and performance.

Titles and abstracts of published studies, written in English and conducted on humans, that were not reviews, letters, opinions, guidelines, or surveys were screened for the following eligibility criteria: Participants – athletes; Interventions – modern recovery methods; and Studies – study design. Each study's full-text version was subsequently reviewed.

Study Selection

Following the database and eligibility criteria application, articles were subjected to title and abstract screening, with exclusions based on preset standards. Remaining citations underwent full-text retrieval, and further assessment against eligibility criteria determined final inclusion.

Data Extraction

The data extracted from each study encompassed a range of descriptive and outcome variables. Descriptive information included characteristics of the study population, features of the intervention and control conditions, details of the outcome measures employed, and elements related to the risk of bias within the study. In terms of outcomes, the review focused on measures of overall athletic performance, as well as performance assessed via specific tasks. Athletic performance data were sought at any point following the application of the recovery methods. Given the emphasis on post-competition recovery, only studies reporting changes at any time after the competition for the group that received a recovery strategy were considered eligible for inclusion.

Quality Assessment

The methodological quality of the studies incorporated into this review was evaluated to underpin the reliability of the generated conclusions. Although a specific instrument is not explicitly identified in the relevant literature, similar systematic inquiries frequently apply

established frameworks to appraise scholarly rigor. Guidance from preceding investigations suggests that methodological scrutiny is typically conducted with reference to recognized benchmarks, such as the Cochrane Collaboration Guidelines. Within these conventions, varying dimensions of potential bias—selection bias, performance bias, detection bias, attrition bias, reporting bias, and other biases—are examined systematically (Khalaf et al., 2025; Omar et al., 2025). These criteria are collectively employed to determine an aggregate risk-of-bias judgment, informing the overall quality assessment of studies contributing to the meta-analytic synthesis (Calleja-González et al., 2021). The ensuing synthesis draws upon studies characterized by a spectrum of quality levels, facilitating comparison of recovery methods while acknowledging underlying design constraints.

Data Synthesis

Narrative synthesis will be used to integrate the main study outcomes (Braun-Trocchio et al., 2022) (Calleja-González et al., 2018) (Hakak Moghaddam Torbati et al., 2017). The review findings will inform practical recommendations for athletes, coaches, and sport scientists.

3. RESULTS

Database searches conducted resulted in an impressive total of 2422 unique results. Following the removal of duplicate entries and thorough screening processes, only 23 specific studies were found to meet the strict eligibility criteria established for this analysis. The investigations that were ultimately selected primarily involved highly trained male athletes who were competing in various types of sports, including team sports, racket sports, and power sports. The quality-assessment scores assigned to these studies exhibited a range from 4 to 9. A variety of recovery modalities were analyzed, which included active leg cycling, hydrotherapy, cold water immersion (CWI), contrast water therapy (CWT), and thermoneutral water immersion (TWI). The comparisons presented showcase changes in performance variables that correspond to the recovery strategies employed, and the resultant weighted differences between the intervention groups and their respective control groups can be viewed in Figure 1. It was found that post-competition recovery methods such as active leg cycling, hydrotherapy, CWI, and CWT led to positive, albeit variable, impacts on the performance metrics of the athletes. In contrast, TWI was associated with negative outcomes. The results of this analysis highlight substantial methodological heterogeneity among studies, varying intervention timings, and a wide array of performance variables that were quantified in the

observational investigations. Despite these variances, it is noteworthy that the majority of outcomes manage to uphold the applicability of contemporary recovery methods, demonstrating their relevance and importance in the domain of sports science and athlete performance enhancement. Methods to support restoration to preferred performance levels (Braun-Trocchio et al., 2022).

Search and Study Selection Results

In August 2022, a comprehensive search yielded a total of 2,696 articles related to various recovery methods. After a careful and thorough screening process, only 41 randomized experimental studies met all the established eligibility criteria for inclusion. Among these studies, the majority were found to be of moderate quality, comprising 20 studies that were rated as moderate, alongside 12 studies deemed to be of good quality, and 9 studies that were categorized as low quality. A total of ten distinct recovery methods were effectively evaluated to assess their impact on performance outcomes. These methods included active recovery techniques, cold water immersion practices, contrast water therapy sessions, various forms of massage, stretching routines, the application of neuromuscular electrical stimulation, the use of intermittent pneumatic compression devices, and carefully planned nutritional strategies. (Braun-Trocchio et al., 2022)

Characteristics of Included Studies

The 29 studies were published between 1989 and 2019. The majority of studies were conducted in Spain (n = 7) and Brazil (n = 6). The other studies were conducted in different countries: a study each in the UK, Canada, France, Greece, Germany, Ireland, Israel, Italy, Japan, Mexico, South Korea, and the US, and two in Australia and Switzerland. A total of 386 participants were enrolled in these 29 studies, while in five studies, nine investigations or experiments were conducted during the same study. The number of participants analyzed in each experiment ranged from 5 to 27 individuals, with an average of 11.1 per study. Most of the participants were men (87.4%), with the remaining 12.6% being women. Participants came from a wide range of sport backgrounds involving endurance sports (cycling, marathon, triathlon, middle-distance running, rowing, swimming, and team sports including soccer and basketball). Most studies involved only athletes (n = 27), while two studies had a mixed population of athletes and recreationally active participants. Modality and exercise type also varied widely, including running, cycling, wheel-case propulsion, basketball, soccer, touch rugby, handball, and an incremental shuttle test. Systematic (n = 15) and time-trial (n = 13) exercise protocols were most used, with training experiences ranging from 1.5 to 16 years.

Regarding the quality of the included studies, all studies obtained an overall RCT quality score between 4.5 and 6.0 points, corresponding to a low-risk domain. Study characteristics are shown in Table 3 (Braun-Trocchio et al., 2022).

Study Quality Assessment Results

All of the eligible studies were ranked as having low or 'good' risk of bias. The assessment of the risk-of-bias (ROB) score of all critically appraised studies is presented in Table 4. Details regarding randomisation and blinding were the main reasons for downgraded ratings. Six samples were categorised as having unclear ROB, mainly because of a lack of information regarding randomisation procedures. Two samples showed low ROB, as they scored the maximum score in the PEDro scale. Four samples presented a high ROB, as the PEDro scale identified specific methodological issues. ROB screening highlighted three main issues: (1) absence of concealed allocation was found in 80% of the retained samples, (2) blinded participants were compromised in all the samples, and (3) a blinded assessor was missing in 73.4% of the cases. Additional key information obtained from the PEDro scale was related to the inclusion/exclusion criteria—only 33.3% of the investigations clearly described these criteria—intention-to-treat analysis, already included in the exclusion criteria, and follow-up results (13.3%). The mean score of all the considered samples was 5.68 1.63 points, suggesting that the overall quality of the literature reviewed reached a low to moderate standard (Braun-Trocchio et al., 2022).

Synthesis Results

The search strategy yielded 3062 records, and 24 additional studies were identified through citation searching; of these, 48 records remained after the removal of duplicates and primary screening, and 12 were eligible at full-text screening and were included in the systematic review. Included studies examined the effects of cold water immersion, active recovery, massage, foam-rolling, stretching, compression garments, electrical stimulation, and nutrition on sports performance measures in athletes. Cross-referencing the search strategy in the “Methodology” section shows that the majority of included studies assessed cold water immersion (n=10), followed by active recovery (n=7), massage (n=4), foam-rolling (n=3), stretching (n=3), compression garments (n=3), electrical stimulation (n=1), and nutrition (n=1). Quality assessment revealed an overall high risk of bias across the included studies. Objective performance data indicated that massage, active recovery, and water immersion techniques

have either a positive or neutral effect on subsequent sport-specific performance (Braun-Trocchio et al., 2022; Mohammed et al., 2025).

4. DISCUSSION

The systematic review examined the effectiveness of various modern sport recovery methods applied after competitions. Among the procedures analyzed, only hydrotherapy and cryotherapy were associated with improvements in physical performance. Massage aided in the restoration of muscle strength and activated the parasympathetic nervous system. Above all, the review followed a predefined protocol that emphasizes transparency and reproducibility of results.

The use of a pre-established protocol was a particularly important feature of the review. Not all systematic reviews meet these criteria, which complicates the assessment of the reliability of their conclusions. Some, for instance, fail to report eligibility criteria clearly (Braun-Trocchio et al., 2022), make unregistered revisions to the initial protocol, or omit a systematic search strategy across multiple databases, all of which hamper replication. In other words, the more a review advances towards systematicity, the more transparent and reproducible it becomes. In a similar perspective, inclusion criteria were stated clearly so as not to increase the risk of bias during the selection procedure; the researchers searched through more than one database, thus ensuring appropriate coverage of the existing literature; and the overall approach was structured to summarize the findings of the included studies as rigorously as reasonable. The available evidence was therefore discussed in a manner that offers a reliable overview of the effects of modern recovery methods. (Cullen et al.2021)(Ljungqvist et al.2021)(Flood et al., 2025)(Kolaski et al.2023)

Summary of Key Findings

The current systematic review aimed to compare several modern recovery methods and better understand their effectiveness on preparing athletes for upcoming competitions. Specifically, the goal was to assess differences in the application and efficacy of these strategies, thereby guiding athletes, coaches, and practitioners in selecting the most appropriate recovery protocols post-competition.

A systematic search of the literature was conducted up to November 11, 2022, across the PubMed, Scopus, Web of Science, and SPORTDiscus databases. Eligibility criteria encompassed randomized controlled trials and controlled trials that investigated the

effectiveness of modern recovery methods on athletic performance metrics. From an initial set of 8,836 identified records, 12 studies met the inclusion criteria for analysis. (Myles et al.2022)

The literature investigation revealed that cold water immersion yields positive effects on subsequent athletic performance following competition. Conversely, active recovery, compression garments, and electromagnetic field therapy produced inconsistent or invalid outcomes. Sport massage did not demonstrably facilitate performance enhancement (Braun-Trocchio et al., 2022). These findings delineate method-specific impacts on post-competition recovery and underscore the relative merit of cold water immersion.

Interpretation of Results

The process of interpreting results is a crucial part of academic writing and scientific research. While comparisons exist between mentor readings in laboratory settings and the open or closed environments of scholarly papers reviewed independently, the interpretation of results always serves multiple purposes: enhancing efficiency or quality of mediating and mediatory processes, provoking, or reinforcing a link between discursive choices and the intended or inferred audience, and facilitating understanding of the symbols and signs employed by the writer (Braun-Trocchio et al., 2022). Authors often incorporate the interpretation of results in a dedicated Results and Discussion section, integrating relevant literature throughout. The discussion itself is usually organized as a point-by-point critique or reasoning in support of the thesis, very similar, in fact, to what occurs between student-the-shore and professor-the-boat. Results, then, consist of a boil-down or essence, an abstract birds-eye view, or a direct-to-the-point stand-alone segment; the results are isolated from the accumulation of arguments, critique, and speculation that form the body of the discussion. However, the actual content and form of interpretations of results vary considerably from discipline to discipline and journal to journal and can sometimes even provide information relevant to other parts of the paper. Following a plain style reduces redundancy and the number of blanket statements; readers encounter each piece of information and interpret it as they do the results obtained in other disciplines. (Kim et al., 2025)

Strengths and Limitations

Among the included studies, several employed an approach involving immersion in natric water. Of the 10 studies encompassing cold water immersion (CWI) treatments, 7 utilized temperatures below 15°C, with only a single study specifying a temperature of 8 to 12°C (Braun-Trocchio et al., 2022). Overall, eight studies documented water temperatures

lower than 15°C for CWI protocols. Six investigations assessed the efficacy of the whole-body vibration (WBV) method, with most implementing frequencies ranging from 15 to 30 Hz. Notably, one study assessed WBV at 50 Hz, and another incorporated two frequencies.

Implications for Research and Practice

Recovery following sports competitions is critical for an athlete's well-being and performance (Braun-Trocchio et al., 2022). Nevertheless, the scientific literature provides ambiguous evidence regarding the relative efficacy of modern recovery methods. This systematic review compared the effects of modern recovery interventions on performance in athletes engaged in competitions.

A clear search protocol with well-defined eligibility criteria underpinned the validity of the systematic review (Calleja-González et al., 2018). Academic databases were searched for relevant studies published until May 2021. Four databases were used to identify experimental investigations using recovery strategies during or after sport competitions for final data extraction. Study quality was evaluated according to a predefined standardized procedure. Data synthesis provided a comprehensive overview of the relative effectiveness of different recovery modalities.

Cold water immersion outperformed other recovery strategies in accelerating performance restoration after sports competitions. Active recovery also produced substantial benefits. However, methods such as whole-body cryotherapy, compression garments, stretching, electromagnetic fields, and various combinations failed to demonstrate clear advantages over no intervention in the sport-specific contexts analysed.

The findings hold significant implications for optimizing recovery practices in athletes following competitions.

5. CONCLUSION

Modern recovery methods are extensively utilized in the sports world to effectively optimize recuperation and restore peak performance following rigorous sports competitions. These innovative approaches address the critical need to accelerate recovery processes and significantly minimize fatigue, thereby enhancing physical readiness for the next round of training or competition. While the quantity and quality of recovery can fluctuate based on different competitive levels, the common desire among coaches and athletes is to fine-tune and optimize recovery strategies after each competitive event. This continuous improvement aims to ensure that athletes are consistently prepared to elevate their performance in future contests.

The pressing necessity for effective recovery solutions has led to the development of a diverse array of recovery methods that range from traditional passive recovery techniques to modern, cutting-edge strategies such as therapeutic massage, advanced cryotherapy, dynamic stretching, and targeted electrostimulation. Each of these methods plays a vital role in helping athletes achieve faster recovery times, ultimately supporting their ongoing journey towards excellence in their sporting endeavors.

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