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The Relationship of Sports to the Incidence of Injuries in Para Sports Athletes: A Systematic Review

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ABSTRACT

***Background**: Para-sport, as a branch of sports for individuals with disabilities, has grown significantly as a platform for social inclusion and athletic achievement. However, sports activities inherently carry injury risks, which are amplified in para-sport due to physical limitations and adaptive equipment use.*
***Methods**: This study systematically reviewed injury patterns across various para-sport disciplines in multi-event competitions. Using the PRISMA framework, we analyzed 13 studies published in the last decade.*
***Results**: Results indicate that contact sports such as wheelchair basketball and rugby reported the highest injury prevalence, primarily acute injuries like shoulder dislocations and contusions. Non-contact sports such as para-swimming and para-throwing showed chronic injuries like tendinopathies due to repetitive movements. Key risk factors included biomechanical imbalances, intense training, and the use of adaptive devices.*
***Conclusions** The findings highlight the need for tailored injury prevention strategies, including biomechanical evaluation, rehabilitation programs, and ergonomic sports equipment design, to ensure athlete safety and enhance performance sustainability in para-sports.*

***Keywords**: acute injuries; adaptive sports; chronic injuries; para-sport injuries; wheelchair sports*

1. Background

Para-sports are specifically designed for people with disabilities, including those with physical, mental and sensory impairments. These sports not only promote social inclusion but also provide opportunities for athletes to compete at various levels. In addition, para-sports have an important role in physical and mental rehabilitation, improving quality of life through structured activity (Brownlow et al., 2024). With wider recognition of the rights of people with disabilities, para-sports has become a key tool in improving individual health while promoting social inclusion.

Opportunities to compete at local, national and international levels are increasingly open to para-athletes, as seen in major events such as the Paralympics. In Indonesia, the National Paralympic Games (Peparnas) have become a major platform to showcase the potential of athletes with disabilities while promoting inclusive sport (Steffen et al., 2022). This increased participation is reflected in the number of athletes competing in international events, such as the Tokyo 2020 Paralympics, which attracted more than 4,400 athletes from 162 countries, a significant increase from Rio 2016 and London 2012 (International Paralympic Committee, 2012; 2016; 2021). At the national level, Peparnas Papua 2021 recorded more than 1,900 athletes from 33 provinces, indicating the growing support of the government and society for the sport (Siregar & Nugroho, 2022).

However, as the number of athlete participation increases, the risk of injury to para-sports is an important concern, especially in contact or high-intensity sports. Injuries to para-athletes can have a significant impact on performance, prolong recovery time, or even threaten their careers. For example, sports such as wheelchair basketball and para-weightlifting present a high risk of injury due to the intense and repetitive nature of the activity, which can affect the biomechanical balance of the body (Post et al., 2023; Candra et al., 2021).

The definition of injury in para-sports varies, ranging from its impact on performance to the need for medical intervention. Some studies also consider minor injuries that may affect performance (Ridha & Rachman, 2023). However, these varied definitions often make comparisons between studies difficult, which in turn hinders the development of overarching recommendations. In addition, most studies have focused on elite athletes, so knowledge of injury patterns among amateur or recreational athletes is limited.

Therefore, systematic research is needed to understand injury patterns across all levels of para-sports. Research that includes amateur and recreational athletes will provide a more comprehensive insight into injury risk, both in terms of exercise intensity, equipment use and access to medical services. The results of this research can be used to identify key risk factors and develop effective prevention strategies. Ultimately, this will create safer training programs, support sustainable participation, and strengthen an inclusive and empowering sport environment for all athletes.

2. Method

Search strategy and Information Source

This systematic review analyzed injury patterns in para-sport athletes by searching PubMed, Scopus, Google Scholar, and Web of Science using keywords like “para-sport injuries,” “sport injury,” “athlete with disabilities,” and “summer paralympic.” Studies published in English or Indonesian in the past 10 years, including case-control, cross-sectional, and cohort studies, were eligible for inclusion. Studies on non-disabled athletes or those lacking injury data were excluded. PRISMA guidelines were followed and data on sport type, injury frequency, and severity were analyzed to identify trends and inform prevention strategies. The bibliographies of selected articles were also reviewed to identify additional relevant studies, with only articles from internationally recognized journals meeting the inclusion criteria included in the final analysis.

Eligibility Criteria

Inclusion Criteria:

a. Study Design: Included studies include case-control, cross-sectional and cohort designs. Case-control and cross-sectional studies measure variables clearly, where cross-sectional provides prevalence data and case-control identifies risk factors. Cohort designs are used to understand the relationship of long-term variables.

b. Participation: This study focuses on athletes competing in summer sports to examine injury patterns in an environment characterized by specific weather conditions and physical demands. Athletes from various competitive levels who engage in sports relevant to the summer season will be included. This focus on summer sports aims to understand injury patterns under conditions influenced by high temperatures, humidity, and hectic competition schedules during the summer, as seen in competitions such as the Summer Paralympics.

c. Type of Sport: The study includes all para-sports classified as summer sports, such as para-swimming, para-athletics, and para-basketball. The focus on summer sports allows for the exploration of injury risks

linked to season-specific factors like temperature, humidity, and competition schedules. The study is not limited to any particular discipline within the summer sports category.

d. Language: Studies published in Indonesian or English will be included to ensure proper understanding of the content and analysis, given the language limitations of this study.

Exclusions:

Studies failing to meet the above criteria will be excluded from this analysis.

Data collection and analysis

a. Data Collection: Systematic searches were conducted in PubMed, Scopus, Google Scholar, and Web of Science for studies on injuries in summer para-sports published between 2014 and 2024. Articles in English and Indonesian were included, and PRISMA guidelines ensured a transparent selection process.

b. Data Analysis: Data were analyzed descriptively and analytically following PRISMA guidelines, with quality assessed using the JBI tool. Results were synthesized qualitatively and quantitatively, applying meta-analysis models as needed to account for data heterogeneity and minimize bias.

c. Quality Assessment: The study's methodological quality was assessed using the Joanna Briggs Institute Critical Appraisal Tool, focusing on criteria such as sampling methods, injury measurement reliability, and data analysis accuracy. Studies were scored on nine components, with low scores indicating high bias risk and high scores indicating good quality.

d. Data extraction: Data were extracted on sport type, athlete characteristics (gender, age, disability), injury definition, and injury prevalence/incidence. Associations between sports and injury types, like shoulder injuries in para-swimmers or skin injuries in amputees, were analyzed. Data were analyzed using a random-effects model to account for study heterogeneity.

3. Result

This study began with an initial search that yielded 259 journals. After applying the established inclusion criteria, 13 journals were selected for further analysis. These 13 studies were carefully evaluated using the PRISMA method, which emphasizes rigorous selection processes, transparency, and methodological quality. By adhering to the PRISMA guidelines, the study ensured that the selected journals were relevant and methodologically sound, providing a solid foundation for the systematic review. This approach enhanced the validity of the review's conclusions regarding the relationship between sport modalities and injury rates in para-sport athletes.

Identification of Studies

based on the PRISMA table, 259 journals have been found where the journals come from predetermined databases such as pubmed 81 journals, scopus 87, google scholar 61 and web of science 30. then after being selected according to the inclusion criteria, only 47 journals were obtained, after which the data was extracted and only 13 journals were obtained according to the inclusion criteria.

Injury Rates in Para-Sports

Of the 13 studies analyzed, three reported on the sports athletes participated in, while nine focused on injury incidence rates. Table 3 details the prevalence, severity, and common injury types and locations. Tendinopathies, muscle strains, and overuse injuries were the most common, often resulting from excessive training without proper recovery. Shoulder injuries were the most frequent, affecting both non-contact sports like swimming and contact sports like wheelchair basketball. These injuries significantly impact performance, highlighting the need for focused prevention, recovery, and rehabilitation strategies in training programs.

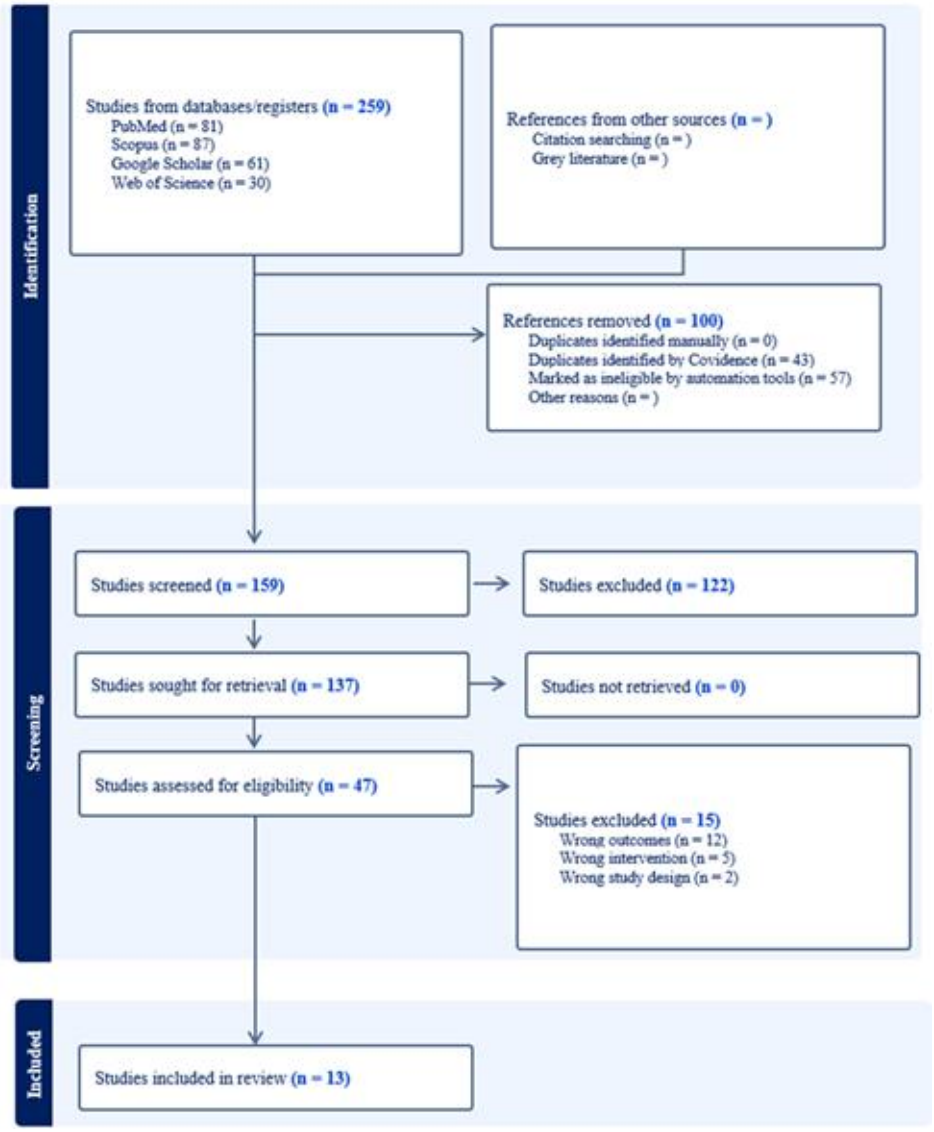

Figure 1. Prisma Flowchart

Table 1. JBI checklist for cohort study

Author	Were the two groups similar and recruited from the same population ?	Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Was follow up complete, and if not, were the reasons to loss to follow up described and explored ?	Were strategies to address incomplete follow up utilized?	Was appropriate statistical analysis used?	Total score
(Hollander et al., 2019)	No	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	9
(Garcia-Carrillo et al., 2024)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	9
(Fagher et al., 2020)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	8
(Kyritsis et al., 2020)	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	9

Table 2. JBI checklist for case control study

Author	Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?	Were cases and controls matched appropriately?	Were the same criteria used for identification of cases and controls?	Was exposure measured in a standard, valid and reliable way?	Was exposure measured in the same way for cases and controls?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were outcomes assessed in a standard, valid and reliable way for cases and controls?	Was the exposure period of interest long enough to be meaningful?	Was appropriate statistical analysis used?	Total score
(Grindem et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	9
(Zaras et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
(Ramirez-Campillo et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	9

Table 3. JBI checklist for cross sectional study

Author	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total score
(Stares et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
(Boehnert et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8

Table 4. Injuries in all sports branch

Author	Title	Sports	Design Study	Population	Injury Rates	Location of Injury	Type of Injury	Comparison	Outcomes
(Hollander et al., 2019)	Epidemiology of injuries during the Wheelchair Basketball World Championship 2018 : a prospective cohort study	Wheelchair Basketball	Prospective cohort study	336 players from 28 teams representing 19 different countries. This included 192 male players from 16 teams and 144 female players from 12 teams	25 injuries per 1,000 athlete hours	Shoulder (25%), wrist (15%)	Tendinopathy, shoulder dislocation	injury rates of 79 injuries per 100 athletes and 71% of players sustaining injuries throughout their careers. The WBWC study found a similar injury rate of 75.8 injuries per 100 players, but noted that the overall injury rate during the championships was substantially higher at 68.9 injuries per 1000 player-days	100 injuries, with an overall injury rate of 75.8 per 100 players. Among these, eight were classified as time-loss injuries, which equates to 6.1 injuries per 100 players. The injuries included fractures, ligament ruptures, sprains, contusions, and muscle spasms, with about half being due to overuse
(Garcia-Carrillo et al., 2024)	Prevalence of sports injuries in Para-Athletics throwers – a restrospective cohort	Para-Throw	Retrospective cohort study	60 Para Athletics throwers (PATs), consisting of 42 men (70%) and 18 women (30%)	40% injury prevalence in the last 12 months	Elbows (25.3%), shoulders (22.8%), lower back	Strain, tendinopati	sub-groups based on sex, age, impairment type, and prior experience as a thrower	The study found a 12-month injury prevalence of 40% among PATs, higher in men (47.6%) than women (22.2%). Common injuries included muscle strains (30%) and tendinopathies (25%), mainly affecting the shoulders (22.8%) and elbows (25.3%). Most injuries (88.6%) occurred during training, highlighting the need for targeted prevention. No significant

Author	Title	Sports	Design Study	Population	Injury Rates	Location of Injury	Type of Injury	Comparison	Outcomes
									differences in injury prevalence were found based on sex, age, or impairment, though men reported more new injuries than women.
(Fagher et al., 2020)	Injuries and illnesses in Swedish Paralympic athletes—A 52-week prospective study of incidence and risk factors	Para-Athletics (Running)	Prospective cohort	Swedish Paralympic athletes	30.6% of athletes reported annual injuries	Knee (35%), ankle (25%)	Ligament sprains, fractures	Injury incidence rates (IR) were compared across subgroups based on sex, age, sport type (team vs. individual), and previous severe injuries.	179 injuries, resulting in an overall injury incidence rate of 6.9 injuries per 1000 hours of sports exposure
(Yung et al., 2022)	Characteristics of Complex Systems in Sports Injury Rehabilitation: Examples and Implications for Practice	Goalball	Qualitative	Para-athletes undergoing rehabilitation for sports injuries (muscle, ligament or bone injuries) with a complex systems-based rehabilitation approach.	19 injuries per 1,000 athlete hours	Face (30%), shoulders (20%)	Contusio, dislocation	Traditional rehabilitation approaches focus only on physical physiotherapy and medical treatment without integration of psychological and technological factors.	The primary outcomes of interest include the success of rehabilitation, likelihood of reinjury, and overall readiness for full training.
(Silva et al., 2023)	The relationship between injury types and sports modalities in	Rugby Wheelchair	Meta Analysis	The group of individuals being studied	21 injuries per 1,000 athlete hours	Shoulder (40%), wrist (30%)	Tendinopati, muscle strain	prevalence and incidence rates of injuries without contrasting them with a control group or	prevalence (40.8 injuries per 100 athletes) and incidence (14.3 injuries per 1000 athlete-days) of musculoskeletal injuries among para athletes

Author	Title	Sports	Design Study	Population	Injury Rates	Location of Injury	Type of Injury	Comparison	Outcomes
	para-sport athletes: A meta-analysis							alternative interventions	
(Ardern et al., 2020)	Overuse injuries in para-swimming: Epidemiological evidence and prevention strategies	Para-Swimming	Descriptive	Para-swimming athletes with different types of disabilities (e.g., amputees, paraplegia, neuromuscular disorders) who participate in competitions or intensive training.	15% annual injury prevalence	Shoulder (35%), upper back (25%)	Overuse injury	Athletes without intervention or who undergo training and competition without any special adjustments or prevention strategies.	Decreased prevalence of overuse injuries (especially shoulder and back injuries). Improved athlete performance and comfort in training or competition. Improved athlete quality of life due to reduced risk of injury.
(Robertson et al., 2020)	Cycling biomechanics and injury risk in para-sport athletes	Para-Cycling	Observational	Para-sport athletes who use handcycles or other adaptive bicycles, with various types of disabilities, such as amputation, paraplegia, or neuromuscular disorders.	18% of athletes get injured in a season	Knees (28%), lower back (20%)	Tendinopati, stress fracture	Use of a bike without biomechanical adjustments (default settings), or athletes who do not use a biomechanical approach in their training.	Decreased risk of repetitive injury, such as shoulder pain, back injury or muscle imbalance. Improved biomechanical efficiency in pedaling. Improved athlete performance, such as average speed and endurance during races.
(Grindem et al., 2021)	Risk factors for overuse injuries in para-powerlifting: Evidence from elite athletes	Powerlifting	Case control	Elite para-powerlifting athletes with various types of disabilities, who actively participate in weightlifting training or competition.	25.5% annual injury prevalence	Lower back (40%), shoulders (20%)	Overuse injury, acute injury	Athletes who do not follow an injury prevention program or who undergo a standard training program without adjustments.	Decreased prevalence of overuse injuries (e.g., shoulder pain, elbow tendinitis, or back pain). Improved athlete performance in powerlifting. Increased comfort and sustainability in training.
(Zaras et al., 2023)	Tendinopathy risk in para-badminton: A	Para-Badminton	Case control	Para-badminton athletes with varying degrees of	10 injuries per 1,000	Shoulder (30%),	Muscle strain, tendinopati	Athletes who do not use biomechanical	Decreased prevalence of tendinopathy (e.g.,

Author	Title	Sports	Design Study	Population	Injury Rates	Location of Injury	Type of Injury	Comparison	Outcomes
	biomechanical perspective			disability, who actively participate in training or competition.	athlete hours	wrist (20%)		adjustments or who train with standard techniques and tools without modification.	shoulder, elbow or wrist pain). Improved athlete performance in games. Increased comfort during training and competition.
(Ramirez-Campillo et al., 2023)	Prevalence and risk factors of upper extremity injuries in para-table tennis athletes	Para-Table Tennis	Case control	Table tennis para-athletes with physical disabilities who are actively competing.	12% of athletes report annual injuries	arm (25%), elbow (20%)	Tendinopati, muscle strain	Standard playing techniques without customization.	Decreased prevalence of upper extremity injuries such as tendinitis or shoulder pain. Increased playing comfort.
(Kyritsis et al., 2020)	Injury rates in para-tennis wheelchair athletes: Evidence from international tournaments	Para-Wheelchair Tennis	Cohort study	Wheelchair para-tennis athletes participating in international tournaments.	22 injuries per 1,000 athlete hours	Shoulders (35%), lower back (20%)	Overuse injury	Athletes without modification of technique or equipment.	Decreased injury rates, especially to the shoulders and lower back. Increased comfort and endurance during matches.
(Stares et al., 2021)	Acute injuries in para-judo athletes during national championships	Para-Judo	Cross sectional	Para-judo athletes competing in national championships with various types of physical disabilities.	15 injuries per 1,000 athlete hours	Face (20%), wrist (15%)	Contact injury, dislocation	Athletes who do not use customized techniques or equipment.	Decreased prevalence of acute injuries (e.g., dislocations, fractures). Improved safety and effectiveness of judo techniques.
(Boehnert et al., 2022)	Overuse injuries in para-volleyball athletes: A survey-based analysis	Para-Volleyball Sitting	Cross sectional	Para-volleyball athletes with various types of disabilities who are actively competing.	18% annual injury prevalence	Shoulders (25%), lower back (20%)	Overuse injury, strain otot	Athletes with standard training patterns (no adjustments to duration or technique).	Decreased prevalence of overuse injuries (e.g., tendinitis or joint pain). Increased effectiveness of game techniques and safe practice duration.

4. Discussion

The relationship between sport modality and injury incidence in para-sport athletes shows significant variability based on the nature of each sport. Contact sports, such as wheelchair rugby, have higher injury rates due to the physical demands and repetitive impacts that put strain on joints and soft tissues. Based on this, non-contact sports such as swimming or athletics have received many reported injuries due to overuse from tendinopathy and muscle strain (Post et al., 2023; Candra et al., 2021). Furthermore, there are injuries in certain areas, such as the shoulder that occur due to biomechanical and environmental factors due to repetitive loading and strain on the shoulder joint (Brownlow et al., 2024). Thus, a more focused prevention strategy is needed with exercise modifications that pay attention to proper technique and ergonomic adaptations to the equipment used.

Biomechanical and environmental factors play a role in injury risk. In contact sports, repetitive collisions put strain on joints, while in non-contact sports, the use of assistive devices may lead to overuse injuries (Candra et al., 2021). Preventive measures, such as ergonomic equipment and training modifications, can reduce injury risks (Candra et al., 2021). High-intensity training, inadequate recovery, and poor equipment design can exacerbate injuries, emphasizing the importance of gradual training and proper equipment (Post et al., 2023; Ridha & Rachman, 2023). Individual characteristics, such as age and previous injuries, affect injury patterns, highlighting the need for personalized prevention programs. Younger or less experienced athletes may be more prone to injury from improper technique, while athletes with certain types of disabilities may face greater biomechanical challenges. Therefore, injury prevention approaches should be personalized, taking into account the individual characteristics of the athlete (Steffen et al., 2022).

This study stresses the need for a comprehensive injury prevention approach, including tailored training, structured rehabilitation, and ergonomic equipment design. These strategies will help reduce injury risk, support recovery, and enhance athlete performance. Understanding biomechanics, environmental factors, and individual characteristics is key to refining injury prevention for para-athletes (Brownlow et al., 2024).

5. Conclusion

This study shows that injury patterns in para-sport athletes vary greatly based on the type of exercise and the intensity of physical activity. Contact sports such as wheelchair basketball and wheelchair rugby have the highest injury rates, especially acute injuries such as shoulder dislocations and contusions. In contrast, non-contact sports such as swimming and throwing are dominated by chronic injuries, including tendinopathy and injuries due to repetitive muscle use. The main risk factors found included suboptimal biomechanical adaptation, high intensity during competition, and additional stress caused by the use of adaptive assistive devices.

The results of this study emphasize the importance of a comprehensive approach to injury prevention in para-sport athletes, which includes customized training programs, structured rehabilitation, and ergonomic sports equipment design tailored to the athlete's physical condition and type of disability to reduce the risk of injury. Furthermore, structured rehabilitation focuses not only on physical recovery, but also mental and emotional support. In addition, appropriate ergonomic sports equipment design can alleviate biomechanical stress and improve comfort, ultimately supporting the athlete's overall safety and performance. With the implementation of evidence-based strategies, it is hoped that the risk of injury can be minimized, athletes' performance can be improved, and the sustainability of para-sport athletes' careers in national and international competitions can be guaranteed. These findings make an important contribution in supporting the development of safe and sustainable inclusive sports.

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