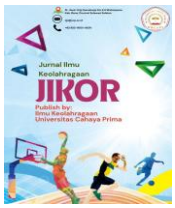

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Sports Safety: Analysis of Injury Trends and Sports Injury Prevention Strategy

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ABSTRACT

Sport has many benefits for physical, mental and social health. However, athletes, coaches and medical staff face significant challenges regarding the risk of sports injuries. This article analyzes trends in sports injuries, investigates the factors that cause them, and discusses effective prevention strategies. Trend analysis shows that in the 15 to 25 year old age group in Finland, there is an increase in injuries, as well as differences between genders. Injuries related to sports such as soccer and basketball are increasing in the United States. Studies in Europe show that hamstring injuries are increasing during matches. Injuries can be caused by inappropriate equipment, overtraining, and insufficient warm-up. This review is based on literature published between 2015–2024, collected from Google Scholar, PubMed, and ScienceDirect, focusing on sports injury trends, causal factors, and prevention strategies. Key findings highlight the effectiveness of programs such as PEP and FIFA 11+, the importance of neuromuscular training, and athlete-centered safety planning. Future sports safety policies should integrate evidence-based prevention frameworks to ensure safer and more sustainable sports participation. The purpose of this article is to analyze current injury trends, the factors that influence them, and find out strategies to reduce the risk of injury in this dynamic world of sports.

INTRODUCTION

Sports are a collection of exercises that are designed and organized with the purpose of maintaining movement (which means maintaining life) and improving movement ability (which means improving quality of life) (Giriwijoyo & Sidik, 2013). Sports are generally defined as physical and mental activities that help maintain and enhance fitness and health (Aditia, 2015).

Sports not only benefit physical growth and development but also contribute to mental and social aspects (S. A. Saputra, 2020). Sports often bring various benefits, including improved physical fitness, enhanced technical skills, and enriched social experiences (Muhtar & Lengkana, 2021). For many people, sports are more than just physical activity—they are also a source of joy, character development, and a means of building social relationships (Prianto, 2021).

However, behind this diversity of positive benefits lies a significant challenge—the risk of sports injuries. All forms of sports and physical activities carry injury risks that can affect athletes' health and performance (Pratama et al., 2024). This challenge is faced by many individuals, from athletes who directly participate in sports to coaches who manage safe technical development, and medical staff who monitor and treat injuries.

This is also supported by research Baihaqi et al. (2021), which states that athletes who excel in sports prone to injury, such as boxing, weightlifting, and powerlifting, face significant safety issues. There is a high rate of injuries in professional boxing matches (17.1 injuries per 100 bouts), with significant muscle and tendon injuries among weightlifters (20% of all injuries). In the 2008 Olympics, five athletes suffered ligament and tendon ruptures, highlighting the urgent need for policy changes and injury prevention programs to improve athlete safety at the Olympic level.

Injuries not only affect athletes' physical health but can also impact their psychological and emotional well-being. Serious injuries can alter team dynamics, decrease athletic performance, and even influence career decisions. Moreover, the traumatic experience caused by injury may weaken an athlete's long-term desire to participate.

Therefore, sports safety is becoming increasingly important. To create a safer and more sustainable sports environment, a deep understanding of current injury trends, contributing factors, and effective prevention strategies is required. By prioritizing prevention, the number of injuries can be reduced, ensuring that athletes can pursue their passion without compromising their safety and well-being. This review aims to identify major trends in sports injuries, analyze their causes, and evaluate the effectiveness of current prevention strategies to support safer and more sustainable sports participation.

METHOD

This descriptive review analyzed 25 journal articles published between 2015–2024, collected from Google Scholar, PubMed, and ScienceDirect databases. Selection focused on studies addressing sports injury trends, risk factors, and prevention strategies across different sports disciplines. Data were synthesized thematically into four categories:
(1) Injury trends,
(2) Contributing factors,
(3) Prevention strategies, and
(4) Stakeholder roles.
Earlier key studies (e.g., Tiirikainen et al., 2007) were included selectively for historical comparison of long-term trends.

DISCUSSION

Injury Trends by Region and Sport

Comparative analyses show varying injury patterns across countries and sports. Some regions report increasing trends due to intensive participation, while others show declines linked to improved safety programs.

Table 1. Summary of Injury Trends by Region and Sport

Author/Year	Sport/Population	Key Findings	Trend/ Implication
Tiirikainen et al. (2007)	Youth (15–25), Finland	64% of injuries occurred in football/floorball; males higher risk	Increasing trend among males and youth
Bayt & Bell (2016)	U.S. children & adolescents	Decline in baseball/golf injuries; rise in football & basketball	Mixed trend; indicates partial prevention success
Ekstrand et al. (2023)	European elite football	Hamstring injuries rose from 12% to 24% (2001–2022)	Sharp increase; workload and recovery imbalance
Baihaqi et al. (2021)	Indonesian elite athletes	High muscle/tendon injuries in boxing & weightlifting	High-risk sports require targeted managemen
Fraser et al. (2017)	NCAA (USA) 11 sports	17% of injuries from ball contact	Highlights importance of protective gear

Overall, the data suggest that contact sports and high-intensity training environments remain the main contributors to rising injury rates, while non-contact sports show modest improvement due to preventive interventions.

It is crucial to conduct a recent and in-depth analysis to gain a comprehensive understanding of injuries in the world of sports. This involves collecting the latest data and statistics from various amateur and professional sports disciplines. The analysis not only provides numerical data but also seeks to uncover underlying trends and patterns behind each injury incident.

From 1988 to 2003, the number of sports injury cases in Finland increased, particularly among the 15–25 age group. Most of these injuries were sports-related, with about 64% occurring while playing football or floorball. Injury locations were often at home or during leisure time, with 25% of injuries occurring at home and another 10% during leisure activities. In terms of gender,

approximately 60% of injury victims were male. This difference was more noticeable in sports injuries, where women had a lower risk. Except in 1988, age group analysis showed that individuals aged 15–19 experienced higher injury rates compared to those aged 20–25. Over time, there was a significant increase in injury incidence, especially among males and the 15–19 age group, although the incidence among women also rose to a lesser extent (Tiirikainen et al., 2007).

Additionally, a study by Bayt & Bell (2016) investigated sports injury trends among children and adolescents in the United States from 2001 to 2013. The main finding was that several sports such as basketball, baseball, and golf showed a significant decline in injury cases, while football, basketball, cheerleading, and various other sports showed an increase. Among the 5–18 age group, football, basketball, and baseball were identified as the sports with the highest estimated injury rates nationwide. Common injuries included strains/sprains (33.4%), fractures (20.2%), and contusions/abrasions (18.0%). However, during the study period, there was an increase in internal organ injuries and brain injuries (concussions). Children aged 5–10 also experienced a significant rise in injuries to the head and neck, lower torso (waist), and upper torso, differing from the 11–14 and 15–18 age groups who tended to experience injuries in other body areas.

To determine how often elite male football players in Europe experience injuries, the Union of European Football Associations (UEFA) launched the Elite Club Injury Study (ECIS) in 1999. The main goal of this project was to improve player safety and reduce injury incidence. The study found that hamstring injuries accounted for 12–17% of all time-loss injuries among professional male football players, making them the most common recurring injury. From the 2001/02 to 2013/14 seasons, match-related hamstring injury incidence remained stable; however, training-related hamstring injury incidence increased by an average of 4% per year (Ekstrand et al., 2023).

The ECIS recorded 2,636 hamstring injuries among professional male football players over 21 seasons (2001/02–2021/22), increasing the proportion of hamstring injuries from 12% to 24%, representing 19% of the 14,057 total injuries during the period. Hamstring injuries accounted for 14% of total absence days, rising from 10% to 20%, and were ten times more frequent during matches than training. While there was no significant trend in overall football injuries across the 21 seasons, from 2014/15 to 2021/22 there was a marked increase in both the incidence and burden of hamstring injuries during matches and training (Ekstrand et al., 2023).

Sports injury trend analysis also enables comparisons of injury rates between different sports, genders, and age groups. The objective is to determine why certain groups experience higher injury rates. Mapping and interpreting these trends provide a solid foundation for developing prevention strategies that enhance participant safety and well-being while responding to current conditions.

Factors Contributing to Sports Injuries

According to Tenenbaum (2020), a sports injury is damage to body tissue or a functional impairment caused by physical activity—whether through competitive or recreational sports, exercise, dancing, or outdoor play.

Ilham et al (2023), identified several common causes of injury: (1) Failure to warm up, which makes muscles unresponsive and prone to strain; warming up before exercise or competition is essential; (2) Overtraining, which increases long-term injury risk due to continuous body stress, excessive intensity, and inappropriate repetitions; (3) Neglecting safety precautions, or ignoring sports rules, increases the risk of accidents; (4) Accidents, which often occur suddenly and are caused by impacts or collisions; and (5) Inappropriate equipment, which fails to provide adequate support or shock protection.

Wibowo (2008) in Herfinanda & Rahmandani (2019) outlined three main injury causes: (1) External violence, caused by external factors such as sports equipment and environment; (2) Internal violence, caused by internal factors such as poor warm-up, lack of focus, or weak physical and mental condition; and (3) Overuse, injuries from excessive muscle use or fatigue.

Whittaker et al. (2015) highlighted several risk factors increasing sports injury likelihood: (1) Previous injury; (2) Playing at higher competitive levels; (3) Specific muscle weaknesses (e.g., hip adductor weakness); (4) Lack of sports training. The most influential factor is a history of previous injuries, as insufficient rehabilitation increases the risk of re-injury.

Ryan et al (2014), grouped four non-modifiable risk factors related to groin or hip injuries: (1) Previous injury history (sevenfold higher risk); (2) Older age (due to less elastic collagen tissue); (3) Early physical maturation (linked to increased groin/hip injury risk); and (4) Smaller femoral diameter (affecting muscle efficiency and stress adaptation). They also identified four modifiable risk factors: (1) Hip abductor muscle weakness; (2) Body mass (both high and low BM linked to risk); (3) Reduced hip range of motion (ROM); and (4) Strength imbalance between hip adductors and abductors. Maintaining balanced muscle strength around the hip joint is key to preventing injury.

Asker et al (2018), found that shoulder injury risk factors include gender, playing position, external load, previous injury history, and shoulder range of motion. Meanwhile, Aicale et al (2018) noted that training load, athlete preparedness, intrinsic/extrinsic factors (e.g., obesity, insulin resistance), and lifestyle (e.g., nutrition, oxidative stress) also influence injury risk and healing response.

Effective Injury Prevention Strategies

Sports injury is defined as the loss or abnormality of body structure or function caused by isolated physical energy exposure during sports training or competition, diagnosed by a medical professional after examination (Timpka et al., 2014).

Athletes will inevitably experience the effects of injuries they sustain Herfinanda & Rahmandani (2019). Johnston dan Carrol in Ardern et al. (2016) stated that severe injuries can lead to anger, depression, anxiety, lack of self-confidence, and fear of being injured again. Therefore, it is very important to create useful injury prevention strategies.

This is supported by Sukarmin (2004) in Dharmadi (2015), who stated that the best way to deal with sports injuries is to prevent them. This is very appropriate because prevention is the most important effort to create a safe and smooth environment for any activity, including sports.

According to Stevenson (2000) in Mustafa (2022), actions that need to be taken to prevent sports injuries include: (1) preliminary examination before exercising to determine whether there are contraindications to exercise, (2) exercising according to proper, correct, measurable, and regular principles, (3) using equipment appropriate to the type of sport, (4) paying attention to the condition of sports facilities, and (5) considering physical environmental factors such as temperature and humidity.

One aspect of sports injury prevention is the effort to reduce or avoid any type of injury that can result in harm to athletes. However, athletes who do not use protective equipment must have comfortable gear and equipment so they can exercise in a more ergonomic way. In addition, this helps prevent minor injuries caused by equipment and gear used. Improved rules and protective equipment can help reduce sports injurie (Fraser et al., 2017).

The use of specific exercises, appropriate intensity, correct technique, and sound training practices are required to prevent injury; if any of these elements are neglected, their effectiveness may be compromised. In other words, to effectively prevent injury, it is important to pay attention to and combine all these elements (Potach & Meira, 2023). Much attention has been given to the implementation of injury prevention research in the real world, because the "best" injury prevention programs can only be adopted and maintained by athletes, coaches, and sports organizations (Emery & Pasanen 2019).

As an initial step, sports warm-up as an injury prevention strategy is very important to reduce the risk of injury in athletes. After general warm-up, specific warm-up is carried out on vulnerable body parts with non-fatiguing exercises. This is intended to reduce the risk of injury according to the type of sport performed. First, programs such as PEP (Prevent Injury and Enhance Performance), which were originally designed for soccer players and involve warm-up, stretching, strengthening, plyometric, and sport-specific agility exercises to address strength and coordination deficiencies around the knee joint. Second, 11+ (formerly known as FIFA 11+) is another popular ACL injury prevention program recommended by FIFA and focused on soccer. It includes running, strengthening, plyometric, and balance exercises, making it an effective program for reducing the risk of ACL injury. The 11+ is recommended before every training session and match. Both programs

last about twenty minutes and have been proven to successfully reduce injury risk for athletes who perform them (Potach & Meira, 2023).

Current trends emphasize primary prevention, especially among adolescents and young adults. Neuromuscular training (NMT), rule modifications, and equipment recommendations have been shown to reduce the risk of musculoskeletal injuries by more than 35% in team and youth sports. In addition, there has been a significant reduction in the number of injuries due to policy changes such as restrictions on contact practice in youth American football and the ban on body checking in youth ice hockey. There is evidence that bracing and taping should be used in high-impact sports to reduce the risk of recurrent ankle sprains. Moreover, wrist guards have been shown to provide protection during snowboarding. Future research is needed to evaluate the maintenance of NMT programs, optimize compliance, assess the benefits of workload modification, and evaluate rule changes in other sports (Emery & Pasanen, 2019).

A study conducted by McCall et al (2015), stated that several key exercises used by national soccer teams are part of sports injury prevention strategies. The following are five types of effective sport-based injury prevention exercises: (1) Core exercises, one of the five main prevention exercises used by national soccer teams is core training. There is no direct scientific evidence supporting the claim that core exercises can reduce injury risk for elite soccer players, but this suggests that core training is considered important and may be useful in injury prevention; (2) Balance/Proprioception exercises, these are considered part of injury prevention strategies, although scientific evidence is still lacking to support their effects; (3) Eccentric exercises, although some studies support eccentric training, there is insufficient scientific evidence to determine specific preventive effects of this type of exercise; (4) Combination of contraction types, in injury prevention programs, using a combination of contraction types is considered to reflect a more multidimensional approach, especially in real-life contexts; and (5) Flexibility, although flexibility is considered important, studies show there is no evidence supporting stretching as an injury prevention method. However, there is no sufficient reason to exclude flexibility training from exercise programs.

Potach & Meira (2023) classified five main steps used in the design of sports injury prevention programs as follows: (1) athlete needs analysis; (2) exercise selection; (3) frequency; (4) timing; (5) intensity; and (6) training volume. Athletic evaluation, anatomy, injury history, and athlete goals are part of the needs analysis. Exercise types such as strength, plyometric, and sport-specific exercises are included in exercise selection, with frequency and timing adjusted to the sports season. Exercises can be performed before or after matches or training sessions. To achieve desired outcomes and avoid fatigue, exercise intensity and volume are regulated. It is expected that injury prevention programs can be tailored to the needs and individual characteristics of athletes to reduce the risk of sports injuries and improve overall athletic performance.

According to Emery & Pasanen (2019), although sports injuries cannot be completely eliminated, they can be prevented and predicted. Injury prevention strategies can reduce the number and severity of injuries. Scientific evidence focuses primarily on preventing musculoskeletal injuries in the lower body. Over the past ten years, epidemiological research has examined how injury prevention strategies can help prevent lower body musculoskeletal injuries in young and elite athletes. The three main themes involved in these strategies are: (1) training strategies, (2) changes in sports policies and rules, and (3) equipment recommendations.

Evaluation of injury prevention strategies is targeted at different sports populations. This includes specific sports populations (e.g., team sports) and general sports populations (e.g., school sports). Most of these strategies focus on modifying intrinsic risk factors related to athletes—such as strength, endurance, and balance—through training, especially neuromuscular exercises. In addition, in certain sports, rules and equipment strategies have been modified to address extrinsic (environmental) risk factors. Examples include avoiding body checking in youth ice hockey, non-contact practices in American football, using wrist guards for snowboarding, and ankle braces (Emery & Pasanen, 2019).

The Role of Athletes, Coaches, and Medical Staff

In the world of sports, coaches and medical staff play a crucial role in ensuring that athletes remain both successful and healthy. In the context of sports injuries, effective collaboration between athletes, coaches, and medical teams is essential to maintain safety, prevent injuries, and optimize performance.

Athletes have several responsibilities in preventing injuries. First and foremost, they should train regularly, systematically, and comprehensively, including skill, strength, and endurance training. Second, it is essential for athletes to maintain good physical and mental health to ensure proper movement and full concentration. Third, to avoid injuries caused by rule violations, athletes must comply with game and competition regulations. Fourth, routine health examinations are important to ensure there are no anatomical or anthropometric abnormalities. Fifth, athletes should use protective equipment appropriate for their sport. Sixth, proper warm-up before and cool-down after training are also vital for preparation and injury prevention. By following these steps, athletes can improve their performance and reduce the risk of injury during training or competition (Komaini, 2012).

If an athlete sustains an injury, proper recovery management is crucial so that they can return to performing well in their sport. The athlete's role in injury management is significant and should not be overlooked. This includes having knowledge and making appropriate choices regarding post-injury management. Such knowledge is often gained through observation, listening, or reasoning. In many cases, athletes tend to be more familiar with traditional treatments than with modern sports rehabilitation methods. However, traditional approaches generally yield less optimal results compared to modern sports rehabilitation treatments (N. Saputra et al., 2022).

Meanwhile, the role of a strength and conditioning coach extends beyond observing and correcting training techniques or designing athletic development programs. They also bear responsibility for injury prevention by considering factors that may contribute to sports injuries, such as training load management, adequate recovery, stress management, and monitoring overall athlete health (Talpey & Siesmaa, 2017).

Strength and conditioning coaches are responsible for preventing athlete injuries in several ways: (1) Encouraging injury reporting, coaches should build a team culture that supports the reporting and documentation of injuries, ensuring that athletes feel comfortable disclosing their conditions; (2) Engaging with the medical team, open communication among all supporting staff, including sports coaches, conditioning coaches, and medical personnel, is necessary. Conditioning coaches should collaborate with medical staff and sports coaches to discuss athlete health and performance issues to find effective solutions; (3) Integrating sports medicine practices, it is essential for conditioning coaches to work in harmony with sports medicine professionals to enhance training methods and reduce injury risk. This includes understanding physiotherapy trends, athletic training, and other health-related professions (Talpey & Siesmaa, 2017).

Additionally, coaches have other roles, including: (a) Integration with coaching staff, strength and conditioning coaches and sport-specific coaches must work together to ensure the right balance between training and recovery. Conditioning coaches should be aware of the training volume prescribed by sport-specific coaches and adapt their programs accordingly; (b) Providing education to others, conditioning coaches are also expected to teach athletes and sport-specific coaches how to design, supervise, and perform exercises that enhance physical performance. Mentoring has been found to be an effective method for improving understanding of injury and implementing prevention practices (Talpey & Siesmaa, 2017).

Beyond the roles of athletes and coaches, medical staff are also essential in preventing and managing sports injuries. The health team is responsible for maintaining athlete health, conducting pre-training evaluations, providing health education, preventing and treating injuries, rehabilitation, conditioning, and monitoring doping. Physicians, particularly sports medicine specialists play a vital role in both recreational and elite sports. They are responsible for preventing and treating injuries while leading the sports health team. Doctors also help athletes improve or

maintain their performance, even when they are uninjured. This responsibility is closely linked to exercise physiology. Therefore, sports health professionals must master the science of injury prevention and management while supporting athletes during training and competition (Humaid & Apriyanto, 2023).

CONCLUSION

Sports injuries are an inherent risk that accompanies physical activity, impacting both the physical and psychological health of athletes. Analyzing injury trends provides valuable insight into the patterns and factors influencing injury incidence across various sports. Many factors can contribute to injuries, such as inadequate warm-ups, overtraining, accidents, improper use of equipment, and individual factors like muscle weakness or previous injuries. To make sports participation safer, injury prevention strategies are essential. Proper warm-up routines, specific training programs, rule modifications, and the use of protective equipment can all help reduce the risk of injury. Moreover, prevention strategies aimed at adolescents and young adults, such as neuromuscular training, rule changes, and equipment recommendations have been shown to effectively lower injury risk.

In addition, the design of injury prevention programs should include an analysis of athletes' needs to select appropriate exercises and regulate training frequency, duration, intensity, and volume. All athletes, coaches, and sports organizations must collaborate to create environments that minimize injury risk. By thoroughly understanding the trends, causes, and preventive methods of sports injuries, it is hoped that safer sporting environments can be established, allowing athletes to pursue their passion without compromising their safety and well-being. Further research should evaluate long-term adherence and outcomes of prevention programs, especially among youth athletes in Indonesia, to build culturally appropriate safety frameworks.

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