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## The Role of Sports Field and Equipment Quality in the Incidence and Types of Injuries among Athletes: A Systematic Review of Studies Published between 2010 and 2024

"دور جودة الملاعب والمعدات الرياضية في معدل حدوث وأنواع الإصابات بين الرياضيين: مراجعة  
منهجية للدراسات المنشورة بين عامي 2010 و2024"

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### Abstract:

This study aims to conduct a systematic review of studies published between 2010 and 2024 that addressed the relationship between the quality of sports fields and

equipment and the frequency and type of injuries among athletes. A scientific screening methodology was adopted, which included examining titles, abstracts, and full texts, resulting in the inclusion of seven studies that met the specified inclusion criteria.

The results showed that factors related to the physical environment, such as the type of flooring, the quality of protective equipment, maintenance, and ventilation, play an important role in preventing or causing injuries. It was found that fields with synthetic turf are associated with higher rates of joint injuries, while the absence of shade and good ventilation increases heat-related injuries. The studies also showed that poor equipment quality, especially in high-risk sports, leads to a significant increase in injuries.

The study concluded that improving the quality of sports fields and equipment can effectively contribute to enhancing athlete safety, and called for the integration of environmental safety standards into the design of sports facilities and equipment. It also recommended expanding research in this area through long-term experimental studies to assess the effectiveness of these factors in reducing injuries.

**Keywords:** sports injuries, pitch quality, sports equipment, physical safety, artificial turf, injury prevention, sports environment, systematic review .

#### خلاصة :

تهدف هذه الدراسة إلى إجراء مراجعة منهجية للدراسات المنشورة بين عامي 2010 و2024 والتي تناولت العلاقة بين جودة الملاعب والمعدات الرياضية وتكرار ونوع الإصابات بين الرياضيين. وقد تم اعتماد منهجية فحص علمية شملت دراسة العناوين والملخصات والنصوص الكاملة، مما أسفر عن إدراج سبع دراسات استوفت معايير الإدراج المحددة.

أظهرت النتائج أن العوامل المتعلقة بالبيئة المادية، مثل نوع الأرضية وجودة معدات الحماية والصيانة والتهوية، تلعب دورًا هامًا في الوقاية من الإصابات أو التسبب بها. ووجد أن الملاعب ذات العشب الصناعي ترتبط بمعدلات أعلى من إصابات المفاصل، بينما يؤدي غياب الظل والتهوية الجيدة إلى زيادة الإصابات المرتبطة بالحرارة. كما أظهرت الدراسات أن رداءة جودة المعدات، وخاصة في الرياضات عالية الخطورة، تؤدي إلى زيادة ملحوظة في الإصابات.

وخلصت الدراسة إلى أن تحسين جودة الملاعب والمعدات الرياضية يمكن أن يسهم بشكل فعال في تعزيز سلامة الرياضيين، ودعت إلى دمج معايير السلامة البيئية في تصميم المنشآت والمعدات الرياضية. كما أوصت الدراسة بتوسيع نطاق البحث في هذا المجال من خلال دراسات تجريبية طويلة الأمد لتقييم فعالية هذه العوامل في الحد من الإصابات.

**الكلمات المفتاحية:** الإصابات الرياضية، جودة أرضية الملعب، المعدات الرياضية، السلامة البدنية، العشب الصناعي، الوقاية من الإصابات، البيئة الرياضية، مراجعة منهجية.

## 1.1 Introduction and Significance

The sports environment plays a pivotal role in protecting athletes from injuries and enhancing their performance. This environment encompasses sports fields—including their surface types and quality—as well as the equipment used during training and competition. In recent years, there has been increasing interest in the indirect impact of these factors on the incidence, frequency, and nature of sports injuries, particularly in competitive and professional sports.

Some studies suggest that fields with poor or inappropriate surfaces for a given sport may significantly contribute to higher injury rates, especially those involving joints and muscles. Likewise, the use of unsuitable or non-standardized sports equipment can increase injury risks or alter injury patterns. Despite this, the relationship remains insufficiently explored through comprehensive systematic reviews.<sup>(ii)(i)</sup>

Recent literature indicates that the quality of playing surfaces, their maintenance, and suitability for specific sports are critical factors influencing injury occurrence and recurrence—particularly in team sports that involve sprinting, abrupt stops, and jumping, such as football and basketball. For instance, hard or uneven surfaces may raise the risk of joint injuries and ligament tears, while poorly manufactured artificial turf may lead to repetitive muscular strain.<sup>(iii)</sup>

In addition, sports equipment—such as footwear, balls, and training devices—plays a significant role in either preventing or causing injuries, depending on their compliance with standardized criteria and suitability for the athlete's characteristics (e.g., age, sex, experience, and sport type). Although individual studies in the literature point to this association, a systematic and integrative approach to evaluating the available evidence remains limited.<sup>(iv)</sup>

This study is significant in that it highlights a crucial but often overlooked aspect of sports injury prevention: the quality of the physical environment surrounding athletes, including fields and equipment. Unlike studies focusing primarily on physiological or training-related factors, this review aims to examine the relationship between design, maintenance, and suitability of facilities and equipment, and the frequency and type of sports injuries. The study provides scientific evidence that can inform the development of design and policy standards to reduce injury rates. It also has practical importance for guiding decision-makers in sports institutions, schools, and municipalities to improve sports infrastructure in cost-effective and feasible ways. Furthermore, it raises awareness among coaches and medical staff regarding the need to consider environmental factors when designing training programs and injury prevention strategies. This research also seeks to fill a knowledge gap in the current literature by systematically reviewing and categorizing the available

evidence according to sport type, injury type, and surface characteristics, thus contributing to improved sports performance environments and supporting future research in the field.

## 1.2 Study Objectives

This study aims to:

1. Analyze studies published between 2010 and 2024 that investigated the relationship between the quality of sports fields and equipment and injury rates among athletes.
2. Identify the effects of field characteristics (e.g., surface type, ventilation, maintenance, shading) on the type and frequency of sports injuries across various disciplines.
3. Evaluate the role of equipment quality (e.g., protective gear, training devices, technological tools) in either preventing or causing injuries.
4. Classify common sports injuries associated with the physical environment of training or competition, including muscular, joint-related, and heat/friction-induced injuries.
5. Compare the results of the included studies in terms of methodology and quality, identifying areas of agreement and divergence using standardized assessment tools.
6. Derive practical recommendations to improve the quality of sports fields and equipment with the goal of enhancing athlete safety and reducing injury incidence.

## 2. Theoretical Background

## 2.1 The Importance of Sports Field and Equipment Quality

The quality of sports fields and equipment is one of the fundamental pillars for ensuring athlete safety and enhancing athletic performance. Fields designed according to proper engineering and health standards contribute directly to reducing the likelihood of injuries—especially in sports that involve rapid, sudden movements such as sprinting, jumping, and frequent stopping. Uneven, hard, or poorly maintained surfaces may lead to joint injuries, muscle tears, and ligament damage. On the equipment side, the use of inappropriate gear—such as ill-fitting footwear, poorly designed balls, or non-compliant training devices—can significantly increase the risk of injuries and negatively affect performance efficiency. Equipment quality must also be aligned with the athlete's characteristics, including age, gender, fitness level, and type of sport. Therefore, investing in improved sports infrastructure and higher-quality equipment is not a luxury but a preventive and developmental necessity. It contributes to athlete protection and supports the creation of a healthy, safe, and sustainable sports environment.<sup>(v)</sup>

Sports tools and devices also play a vital role in enhancing training quality and ensuring athlete safety. Equipment is no longer just a means of practice but has become a critical element in injury prevention and physical rehabilitation. Training devices designed with precise biomechanical standards help perform movements correctly and reduce undue stress on joints and muscles, thereby decreasing the risk of chronic or acute strain. Moreover, the compatibility of tools—such as balls, rackets, and strength machines—with the athlete's attributes (e.g., height, age, experience, and sport type) helps distribute physical effort more evenly and reduce excessive pressure. Conversely, using unsuitable or low-quality equipment may lead to unnatural movements or uneven load distribution, increasing the likelihood of

muscular or structural injuries. Hence, focusing on equipment quality, regular maintenance, and adaptation to each sport's specific requirements is a critical factor in building a safe and effective training environment that supports performance development and minimizes injury risk.<sup>(vi)</sup>

### 3. Methodology

#### 3.1 Study Type

This study adopts a **systematic review** methodology to analyze previous research on the impact of sports field and equipment quality on athletic injuries.

#### 3.2 Data Sources

The following scientific databases were searched:

**PubMed – Scopus – Web of Science – Google Scholar**

#### 3.3 Inclusion Criteria

Studies were included based on the following criteria:

- Published between **2010 and 2024**.
- Investigate the **impact of sports field or equipment quality**.
- Address the **type or frequency of sports injuries**.
- Published in **peer-reviewed journals** or as academic **theses/dissertations**.

#### 3.4 Exclusion Criteria

- Studies focusing solely on **internal causes of injury** (e.g., lack of fitness or genetic factors).

- Studies that do not include **quantitative data** or **causal analysis**.
- **Unpublished works** or **non-peer-reviewed articles**.

### 3.5 Screening Process

The screening was conducted through a stepwise review of: **titles → abstracts → full texts**.

**Table (1)** illustrates the study screening process.

N o.	Reference	Title	Title Screenin g Result	Abstract Screening Result	Full-Text Screening Result	Final Decisi on
1	Bellows & Wong (2018) <sup>(vii)</sup>	The Effect of Bracing and Balance Training on Ankle Sprain...	Relevant	Discusses the role of equipment in ankle injury prevention	Meta-analysis linking equipment to injuries	Includ ed
2	Han & Jia (2023) <sup>(viii)</sup>	Safety and Prevention in Ice and Snow Sports	Relevant	Focuses on safety and the role of equipment	Comprehen sive analysis of risks and equipment	Includ ed
3	Schneider et al. (2012) <sup>(ix)</sup>	Sports Injuries Among Adolescents	Appears relevant	Does not address field or equipment quality	Focuses only on injury statistics	Exclud ed
4	Petridou et al. (2002) <sup>(x)</sup>	Injuries in Public and Private Playgrounds	Relevant	Discusses equipment	Despite being older (2002), provides	Includ ed

				and structural factors	rich analysis on facilities and equipment	
5	IBIKUNLE (2018) <sup>(xi)</sup>	Risk Management and Insurance Policy in Nigerian Universities	Administrative, not technical	Focuses on policies, not physical environment	No analysis of field quality or injuries	Excluded
6	Chow (2013) <sup>(xii)</sup>	Outdoor Fitness Equipment in Parks	Possibly relevant	Focuses on perceptions of older adults	No direct link to injuries	Excluded
7	Pfautsch et al. (2022) <sup>(xiii)</sup>	Outdoor Playgrounds and Climate Change	Highly relevant	Discusses effects of surface shading on injuries	Clear analysis of heat-related injuries linked to environment	Included
8	Jastifer et al. (2019) <sup>(xiv)</sup>	Synthetic Turf – Athlete Safety	Relevant	Addresses athlete safety and artificial turf	Comprehensive analytical study	Included
9	Qaxxorovich (2025) <sup>(xv)</sup>	Technological Innovations in Sports Equipment	Relevant	Discusses modern equipment technologies and potential effects	Despite technical nature, addresses safety implications	Included
10	Zarei et al. (2017) <sup>(xvi)</sup>	Prioritization of Sport Facility	Relevant	Analyzes safety factors	Links facility	Included

		Safety Factors (AHP)		in infrastructure	quality to injury risk	
11	Shuman & Meyers (2015) <sup>(xvii)</sup>	Skateboarding Injuries: An Updated Review	Appears relevant	Does not address environment or equipment	Focuses only on injury patterns	Exclud ed
12	Maffulli et al. (2011) <sup>(xviii)</sup>	Sports Injuries: A Review of Outcomes	General	General medical review	Not related to fields or equipment	Exclud ed
13	Bjørndal & Rudd (2024) <sup>(xix)</sup>	Systems for Youth Sport and Physical Education	Organiza tional and educatio nal	Does not discuss injuries or physical quality	No direct relevance to topic	Exclud ed

### 3.4 Quality Assessment of Included Studies

The quality of the included studies was assessed using the following tools:

- **PRISMA** guidelines to organize and report the systematic review process.
- **Cochrane Risk of Bias Tool** to evaluate potential sources of bias in the included studies.

The **PRISMA 2020** framework was adopted for structuring and writing this systematic review to ensure transparency and clarity throughout the data collection and analysis stages. A **PRISMA flow diagram** was used to illustrate the number of studies identified, screened, excluded, and ultimately included, with justifications provided for exclusion at each stage.

To assess the methodological quality of the included studies, the **Cochrane Risk of Bias Tool** was applied. Each study was evaluated across six key domains:

1. **Random sequence generation** (selection bias)
2. **Allocation concealment** (selection bias)
3. **Blinding of participants and personnel** (performance bias)
4. **Incomplete outcome data** (attrition bias)
5. **Selective reporting** (reporting bias)
6. **Other sources of bias**

Each domain was rated as having a "low," "unclear," or "high" risk of bias.

**Table (2)** presents the quality assessment results of the included randomized controlled trials based on these.

No.	Study Title	Random Sequence Generation	Allocation Concealment	Blinding of Participants	Incomplete Outcome Data	Selective Reporting	Overall Rating
1	The Effect of Bracing and Balance Training on Ankle Sprain...	Applicable	Not reported	Not reported	Applicable	Applicable	Moderate to Good
2	Safety and Prevention in Ice and Snow Sports	Not applicable	Not reported	Not reported	Applicable	Applicable	Moderate – Non-experimental

3	Sports Injuries Among Adolescents	Not applicable	Not reported	Not reported	Applicable	Applicable	Good Survey-based
4	Injuries in Public and Private Playgrounds	Not applicable	Not reported	Not reported	Applicable	Applicable	Good Field Study
5	Risk Management and Insurance Policy in Nigerian Universities	Not applicable	Not reported	Not reported	Applicable	Applicable	Good Non-randomized
6	Outdoor Fitness Equipment in Parks	Not applicable	Not reported	Not reported	Applicable	Applicable	Qualitative – Not fully assessable
7	Outdoor Playgrounds and Climate Change	Not applicable	Not reported	Not reported	Applicable	Applicable	Good Descriptive Analytical
8	Synthetic Turf – Athlete Safety	Not applicable	Not reported	Not reported	Not reported	Applicable	Low Opinion Review
9	Technological Innovations in Sports Equipment	Not applicable	Not reported	Not reported	Applicable	Applicable	Descriptive Review
10	Prioritization of Sport Facility	Not applicable	Not reported	Not reported	Applicable	Applicable	Very Good Systematic

	Safety Factors (AHP)						ic Analysis
11	Skateboarding Injuries: An Updated Review	Not applicable	Not reported	Not reported	Applicable	Applicable	Moderate
12	Sports Injuries: A Review of Outcomes	Not applicable	Not reported	Not reported	Applicable	Applicable	Moderate
13	Youth Sport and Physical Education Systems	Not applicable	Not reported	Not reported	Applicable	Applicable	Good Contextual Analysis

### 3.4 Quality Assessment (continued)

The quality assessment results showed that most studies exhibited **low to moderate risk of bias** across the majority of domains, reflecting a **moderate to good level of reliability** in the evidence derived from this review.

### 3.5 Analysis Approach

A **descriptive analysis** was employed to compare the findings of the included studies and to classify injuries based on the **type of surface**, **type of equipment**, and **severity of injury**.

### 4.1 Study Results

**Table (3)** presents a summary of the studies included in this review.

No.	Reference	Rationale for Inclusion
1	Bellows & Wong (2018)	A systematic review on the impact of protective equipment (bracing) and balance training on ankle injuries — directly related to equipment quality.

2	Han & Jia (2023)	Addresses safety and injury prevention in ice and snow sports — includes discussion of equipment and environmental factors.
3	Petridou et al. (2002)	Focuses on the role of playground structure, equipment, and human factors in injuries — highly relevant to the study topic.
4	Pfautsch et al. (2022)	Analyzes the effect of surface materials in outdoor playgrounds on heat-related injuries — related to field surface quality.
5	Jastifer et al. (2019)	Comprehensive review of synthetic turf and its impact on athlete safety — falls under the scope of field quality.
6	Qaxxorovich (2025)	Discusses technological innovations in sports equipment — related to equipment quality and potential injury implications.
7	Zarei et al. (2017)	Categorizes factors influencing safety in sports facilities — directly analyzes quality and environmental design elements.

## 4.2 Summary of Included Studies

This systematic review included seven primary studies, selected based on their direct relevance to the impact of sports field and equipment quality on the type and frequency of injuries among athletes. These studies varied in design, including systematic reviews, descriptive analyses, and observational studies, with most focusing on the relationship between environmental characteristics and injury rates.

The study by Bellows & Wong (2018) highlighted the significant role of protective equipment—such as ankle braces and balance training—in reducing the incidence of sprain-related injuries. This underscores the importance of equipment design quality and functional suitability in preventing common sports injuries.

From a different perspective, Han & Jia (2023) analyzed winter sports, revealing that poor-quality protective equipment in icy environments contributes to higher injury

rates. Their findings emphasize the need for sport-specific adaptation of equipment based on environmental conditions.

Petridou et al. (2002) investigated injuries in public and private playgrounds and found that structural design and equipment quality play a critical role in injury rates, especially among children. These findings align with those of Pfautsch et al. (2022), who demonstrated that surface material and shade coverage in outdoor sports areas significantly influence the rate of heat-related injuries, particularly in warmer climates. This highlights the need to integrate climatic considerations into sports flooring design.

Jastifer et al. (2019) focused on synthetic turf and its implications for athlete safety. The study concluded that artificial surfaces are associated with a higher rate of joint injuries compared to natural grass, supporting the hypothesis that surface type is a determinant factor in injury type and frequency.

In the realm of technological advancement, Qaxxorovich (2025) explored the role of technological innovations in sports equipment, suggesting that advanced gear can help reduce risk when properly designed and utilized, reinforcing the value of modern, evidence-informed equipment design.

Finally, Zarei et al. (2017) applied the Analytic Hierarchy Process (AHP) to evaluate safety factors in sports facilities, identifying ventilation, lighting, and technical installations as key elements in injury prevention. Their findings bridge engineering, organizational, and health aspects of athlete safety.

**Table 4:** Excluded Studies and Reasons for Exclusion.

No.	Reference	Title	Reason for Exclusion
1	Schneider et al. (2012)	Sports Injuries Among Adolescents	Focuses on injury statistics only; does not address field or equipment quality.
2	IBIKUNLE (2018)	Risk Management and Insurance Policy in Nigerian Universities	Administrative focus; does not analyze physical environment or technical injury factors.

3	Chow (2013)	Outdoor Fitness Equipment in Parks	Centers on elderly perceptions of equipment; lacks direct relevance to injury occurrence.
4	Shuman & Meyers (2015)	Skateboarding Injuries: An Updated Review	General injury review without focus on environmental or equipment-related causes.
5	Maffulli et al. (2011)	Sports Injuries: A Review of Outcomes	Broad medical review; does not address facility or equipment quality.
6	Bjørndal & Rudd (2024)	Youth Sport and Physical Education Systems	Focuses on structural and educational systems; no direct discussion of injury causes or environments.

#### 4. Excluded Studies

Six studies were excluded from the current systematic review due to their failure to meet the primary inclusion criterion, which required a direct investigation of the relationship between the quality of sports facilities or equipment and the type or frequency of sports injuries. For example, Schneider et al. (2012) focused on analyzing injury rates and causes among adolescents without addressing environmental or physical factors related to sports surfaces or equipment, making it inconsistent with this review's objectives. Similarly, IBIKUNLE (2018) examined risk management and insurance policies—administrative issues that are not directly linked to the physical quality of sports environments.

Chow (2013) explored elderly perceptions of outdoor fitness equipment in public parks but did not analyze injury-related aspects, rendering it unsuitable for inclusion. Shuman & Meyers (2015) presented a general review of skateboarding injuries without analyzing the influence of skate equipment or surfaces. Maffulli et al. (2011) offered a broad medical overview of sports injury outcomes, without a clear connection to environmental or equipment factors. Lastly, Bjørndal & Rudd (2024) discussed youth sports and physical education systems without addressing sports infrastructure or equipment use.

As such, these studies did not establish a direct link between the physical quality of sports surfaces or equipment and health outcomes or sports-related injuries, and were excluded to preserve the review's thematic coherence.

#### 4. Study Results

The systematic review ultimately included seven studies published between 2002 and 2025, focusing on the relationship between the quality of sports fields and equipment, and the frequency and nature of injuries among athletes. These studies varied in their methodologies and focal areas, yet all agreed on the pivotal role of the physical environment in either mitigating or exacerbating injury risks.

Three studies specifically emphasized the quality of protective and training equipment—such as ankle braces, helmets, and specialized footwear. Bellows & Wong (2018) found that ankle bracing and balance training significantly reduced ankle sprains, highlighting the protective potential of well-designed sports gear. Similarly, Han & Jia (2023) reported that low-quality protective equipment in winter sports environments was associated with increased head and torso injuries, reinforcing the need for sport-specific equipment standards. Qaxxorovich (2025) addressed technological innovations in equipment design, suggesting that advanced devices can enhance both performance and injury prevention if implemented according to precise standards.

Regarding playing surfaces, three studies emphasized that surface type significantly influences injury types. Jastifer et al. (2019) found that artificial turf was associated with a higher incidence of joint injuries compared to natural grass—particularly knee and ankle injuries. Pfautsch et al. (2022) showed that outdoor fields with high surface temperatures and no shading increased the risk of heat-related injuries, especially in hot climates. Petridou et al. (2002) highlighted the impact of poor playground design and equipment on severe injuries among children. Finally, Zarei et al. (2017) found that infrastructural safety factors—such as lighting, ventilation, and flooring—were critical in injury prevention, particularly when evaluated using decision-analysis methods like AHP.

Collectively, these studies support the hypothesis that the quality of sports facilities and equipment significantly influences injury prevalence and type, and underscore the need for integrating ergonomic and preventive design in sports infrastructure planning.

## 4.2 Analysis of Study Results by Objective

### **Objective 1: Analyze studies published between 2010 and 2024 examining the relationship between sports field/equipment quality and injury rates.**

The review revealed that only seven studies directly addressed this relationship, indicating a research gap despite the topic's practical importance. The studies employed diverse methodologies—ranging from systematic reviews to field studies and technical analyses—offering a multi-dimensional perspective on the target relationship. Most studies confirmed a clear association between physical environment quality and injury incidence, warranting further structured investigation.

### **Objective 2: Determine the impact of sports field characteristics (e.g., surface type, ventilation, maintenance, shading) on the type and frequency of sports injuries.**

Findings revealed that surface type was a decisive factor in injury outcomes. Jastifer et al. (2019) found higher joint injury rates on artificial turf than natural grass. Pfautsch et al. (2022) noted that heat-related injuries increased on uncovered outdoor fields. While few studies addressed ventilation and maintenance directly, Zarei et al. (2017) highlighted the importance of infrastructure features like flooring and lighting in injury prevention.

### **Objective 3: Evaluate the role of sports equipment quality (protective, training, technological) in injury prevention or causation.**

Evidence showed a dual effect of equipment: high-quality, activity-appropriate gear reduced injury risks—as in Bellows & Wong (2018), which linked braces and balance training to fewer ankle injuries. In contrast, Han & Jia (2023) reported that poor-quality equipment increased injury rates in winter sports. Qaxxorovich (2025) emphasized that technological innovations in equipment design have preventive potential if standardization is ensured.

### **Objective 4: Categorize common sports injuries associated with the physical training or competition environment.**

Injury types varied based on physical environment quality. Joint injuries (especially knees and ankles) were recurrent on artificial surfaces (Jastifer et al. 2019). Heat-related injuries occurred in poorly ventilated, unshaded fields (Pfautsch et al. 2022). Petridou et al. (2002) linked poor playground design to collision and fall-related injuries in children, emphasizing the material environment's role in injury typology.

**Objective 5: Compare study methodologies and identify areas of agreement and divergence.**

Methodologies ranged from systematic reviews (Bellows & Wong) to descriptive analyses (Han & Jia; Jastifer) and decision-based field research (Zarei). While most studies agreed on the environment-injury link, evidence strength varied by study design. Some relied on observational and comparative data (Petridou, Pfautsch), while others used quantitative models, affecting the depth of conclusions.

**Objective 6: Derive practical recommendations to improve facility and equipment quality.**

Based on cross-study synthesis, the following recommendations emerged:

1. Upgrade artificial turf with environmentally certified materials to protect joints.
2. Install shade structures and cooling systems in outdoor fields to prevent heat-related injuries.
3. Enhance protective gear quality, especially in high-risk sports and extreme climates.
4. Improve facility maintenance routines and infrastructure assessments.
5. Integrate modern technology in equipment design, accompanied by training on proper use.

**Discussion**

This systematic review highlights the critical role of sports facility and equipment quality as key determinants in the frequency and type of injuries across different sports disciplines and age groups. The seven included studies collectively underscore those physical components of the sports environment—such as surface type, shading, equipment quality, and technological innovations—serve not only as performance enablers but also as essential safeguards against injury.

These findings align with studies like Bellows & Wong (2018) and Han & Jia (2023), which demonstrate that quality training and protective gear significantly reduce joint and muscle injuries, particularly in high-impact sports. Moreover, results from Jastifer et al. (2019) and Pfautsch et al. (2022) reveal how surface type and environmental conditions (e.g., absence of shade) can exacerbate injury risks, indicating an interaction between physical design and ambient conditions.

These outcomes resonate with current trends in sports medicine and environmental engineering, which advocate for injury-preventive designs in facilities and equipment. However, the field remains underdeveloped in terms of high-quality experimental studies; most included works were descriptive or analytical, lacking longitudinal or randomized designs to establish strong causal inferences.

Qaxxorovich (2025) uniquely addressed the technological dimension of equipment design, highlighting its promise in performance enhancement and injury mitigation—albeit with a need for standardized real-world implementation. Meanwhile, Zarei et al. (2017) demonstrated that decision-analytic models (e.g., AHP) offer valuable tools for evaluating safety-related infrastructure factors.

Despite the richness of insights, this review has limitations, chiefly the small number of studies meeting inclusion criteria and significant methodological heterogeneity among them, which may limit generalizability. Additionally, the exclusion of older yet relevant studies (e.g., Petridou et al. 2002) due to the temporal cutoff suggests a need for future reviews with broader timeframes.

In conclusion, the results support integrating sports facility and equipment quality enhancements not only for performance purposes but also for injury prevention—an imperative that should inform training policies and infrastructure design in sports settings.

## 5-1 Conclusions

1. The quality of the sports environment, including both facilities and equipment, plays a critical role in reducing the incidence of sports injuries. Studies showed a clear association between poor design or maintenance and increased injury rates.
2. The type of playing surface—particularly artificial turf versus natural grass—is linked to different injury patterns, with higher rates of joint and friction injuries recorded on synthetic surfaces.
3. Poor quality of protective equipment such as helmets, braces, and specialized footwear contributes to higher rates of serious injuries, especially in harsh environments like ice sports or open fields.
4. Environmental factors such as lack of shading, poor ventilation, and irregular maintenance contribute to heat-related injuries and overuse stress, particularly in hot climates or facilities with inadequate infrastructure.

5. Modern technological advances in sports equipment design may improve safety and performance, but require regulation and standardized criteria to ensure their effectiveness in practice.
6. There remains a shortage of experimental studies with longitudinal or randomized designs, limiting the ability to conclusively establish causal relationships between physical environment quality and injury characteristics.
7. Reviewing the physical environment constitutes a fundamental part of injury prevention strategies and should be integrated into facility development plans and athlete training programs.

## 5-2 Recommendations

1. Improve the quality of playing surfaces by using materials that reduce friction and joint stress, such as natural grass or advanced certified synthetic surfaces.
2. Provide adequate shading and ventilation in outdoor sports fields, especially in hot climates, to reduce heat-related injuries and stress caused by direct sun exposure.
3. Conduct regular inspections and continuous maintenance of sports facilities and equipment to ensure their readiness and safety in compliance with international sports safety standards.
4. Adopt and use high-quality protective equipment—such as helmets, braces, and sport-specific footwear—tailored to the athlete's age group and sport type.
5. Incorporate environmental safety standards into the design and construction plans of sports facilities, including lighting, ventilation, emergency exits, and accessibility.
6. Raise awareness among athletes and coaches about the importance of the physical environment and equipment in injury prevention through ongoing educational and training programs.

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