

General

the influence of postural pattern on the incidence of orthopedic injuries in athletes

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Introduction

Orthopedic injuries are a common challenge in sports, often associated with inadequate postural patterns. Objective: The aim of this study was to investigate the relationship between postural biomechanics and the incidence of orthopedic injuries in athletes from different sports. Method: An exploratory and descriptive literature review was carried out, with a qualitative approach, based on the analysis of studies published between 2020 and 2024 in the following databases: PubMed, SciELO and BVS. Results: Deficits in postural control significantly increase the risk of injuries, especially in sports that involve rapid changes of direction and repetitive landings. In addition, postural correction training and continuous biomechanical monitoring have proven to be effective strategies for preventing injuries. Conclusion: Postural biomechanics directly influence the vulnerability of athletes to musculoskeletal trauma, and that the implementation of preventive interventions, such as muscle strengthening and regular postural analysis, is essential. However, there is a need for broader and longitudinal studies to deepen knowledge about the effectiveness of these approaches in reducing sports injuries.

INTRODUCTION

Postural biomechanics has been studied in the context of sports due to its impact on both injury prevention and optimization of athlete performance¹. Poor posture can compromise stability, distribution of mechanical forces, and movement efficiency, making athletes more susceptible to orthopedic injuries². Studies indicate that muscle imbalances, proprioceptive deficits, and joint instability are factors that increase athletes' vulnerability to orthopedic trauma.^{1,2}

Orthopedic injuries represent one of the main challenges in the sports context, affecting both amateur and professional athletes.³ Sports that involve impacts, rapid changes of direction and unilateral landings have a higher incidence of injuries, especially in athletes with poor postural control.⁴ In addition, biomechanical deficits can compromise the physical integrity of the athlete, directly impacting their performance and increasing the risk of withdrawal from competitions.⁵

In this context, postural correction training emerges as an effective strategy for preventing orthopedic injuries. Muscle strengthening and balance improvement programs have demonstrated positive effects in reducing the risk of injuries.^{6,7} In addition, continuous postural monitoring, performed using technologies such as posturography and stabilometry, allows for the early identification of postural deficits, enabling more effective preventive interventions.⁸

Given the relevance of the topic, this research aims to investigate the relationship between inadequate postural patterns and the incidence of orthopedic injuries in athletes of different sports. To this end, we seek to identify the main inadequate postural patterns observed, analyze the frequency and most common types of injuries, compare the incidence of injuries among athletes with adequate and inadequate postural patterns, and evaluate the effectiveness of postural correction programs in preventing these injuries.^{9,10}

With this approach, it is expected that the findings of this study will contribute to expanding knowledge about the importance of postural control in sports, providing support for coaches, physiotherapists and sports health professionals in developing more effective strategies for preventing injuries and improving athletic performance.¹¹

METHODOLOGY

This study was an exploratory and descriptive bibliographic review, with a qualitative approach.¹² The research used the formulation of the research problem following the PICO strategy (Population, Intervention, Comparison and Outcome), being structured as follows: In athletes of different sports, is the presence of inadequate postural patterns associated with a higher incidence of orthopedic injuries?

- **P (Population):** Athletes from different sports

- **I (Intervention/Exposure):** Inadequate postural patterns
- **C (Comparison):** Athletes with adequate postural patterns
- **O (Outcome):** Occurrence of orthopedic injuries

PubMed, SciELO and the Virtual Health Library were the databases used. The search was performed using the following descriptors in Health Sciences (DeCS), in English, combined by means of the Boolean operators “AND”: “Postural Control”, “Balance”, “Sport”, “Injury” and “Athlete” and Posturography”.

The inclusion criteria were: original studies; publications in Portuguese and English; availability of the full text; studies published between 2020 and 2024.

Exclusion criteria included: studies that did not directly address the relationship between postural patterns and orthopedic injuries; studies published outside the established period; studies with samples not composed of athletes; other bibliographic reviews.

The analysis of the selected articles was performed through critical reading and organization according to [Table 1](#), which asks for: author (year), objective, methodology, participants, and conclusion. In addition, during the reading of the studies, the following guiding questions were asked: How do postural changes influence the risk of musculoskeletal injuries in high-performance athletes? Is there a correlation between postural deviations and the prevalence of orthopedic injuries in sports? What are the main postural changes observed in injured athletes and how do they contribute to the recurrence of injuries? How does postural biomechanics interfere with sports performance and the propensity for injuries in amateur and professional athletes? Can postural correction training reduce the incidence of orthopedic injuries in athletes? Can postural monitoring during training be an effective preventive factor against orthopedic injuries in athletes?

Based on the methodology adopted, 18 articles were selected. [Figure 1](#) shows the procedure.

RESULTS

Postural biomechanics has been widely studied in the sports context due to its impact on injury prevention and optimization of athletic performance. Several studies explore the relationship between postural deficits and vulnerability to orthopedic injuries, addressing factors such as postural stability, the influence of corrective training and biomechanical monitoring as preventive strategies.

Among the most discussed topics, the following stand out: the influence of postural biomechanics on the risk of injuries,^{1,13,14} the effects of postural correction training,^{6,7,11} postural monitoring as a preventive strategy^{2,5,8} and the impact of fatigue on postural stability.^{4,10}

The main findings indicate that deficits in postural stability increase the incidence of injuries, especially in sports that involve rapid changes of direction and constant impacts. Researchers^{13,14} points out that basketball and volleyball players have greater postural instability, which

makes them more susceptible to sprains and ligament injuries. Another study³ highlights that female basketball players, especially pivots, demonstrate greater dependence on vision for postural control, a factor that can increase the incidence of falls and sprains.

Studies analyzing the effects of postural correction training show that specific muscle strengthening programs, proprioceptive exercises, and balance training are effective in preventing injuries. Researchers⁶ demonstrate that ankle stability exercises reduce postural oscillation and improve impact absorption in Taekwondo athletes. Researchers⁷ analyzed handball players and indicate that proprioceptive exercises significantly reduce the frequency of sprains. Others¹¹ emphasize that strengthening the hip and core improves functionality but may not generate significant changes in postural control in the short term.

Postural monitoring has been an effective strategy for the early detection of postural deficits. Studies^{2,5} indicate that posturography and stabilometry help identify injury risks in baseball and handball athletes, allowing personalized adjustments in training. Authors⁸ reinforce that college volleyball players who underwent regular postural control monitoring had a lower incidence of sprains.

Another relevant aspect is the impact of fatigue on postural stability. Researchers⁴ show that high-intensity exercises significantly reduce dynamic postural control, increasing the risk of non-contact injuries. Another¹⁰ analyze futsal players and suggest that fatigue accumulated throughout the season compromises postural stability, making it essential to adopt continuous preventive strategies.

Among the technological innovations discussed, the use of postural analysis platforms stands out, which allow for a detailed assessment of body stability. Authors⁵ suggest the use of motion sensors to monitor biomechanical patterns and prevent joint overload. Another study¹ demonstrates that personalized training based on postural analysis significantly reduces the risk of injuries in basketball.

Limitations of the studies are varied and include factors such as small sample size, lack of longitudinal follow-up, and the need for more research applied to different sports. Experts² mention that individual variation in postural adaptation may influence the results, while another study¹¹ suggests that future studies should consider long-term interventions to verify the effects of muscle strengthening on postural balance.

The social impact of these studies is significant, as injury prevention not only improves sports performance, but also reduces medical costs and improves the quality of life of athletes. Researchers¹ indicate that preventive training programs reduce the need for physical therapy treatments, while others⁴ demonstrate that reducing fatigue-related injuries can prolong the sports career of high-performance athletes.

Factors such as access to resources, public policies and financial support also influence the implementation of preventive training. Studies^{3,15} indicate that socioeconomic factors may impact the adoption of preventive practices, especially among grassroots and amateur athletes.

Table 1. Selected studies

Author/ Year	Objective	Methodology	Participants	Main Conclusions
Albina Andreeva and al (2020)	To investigate the influence of age, sex, level of sports performance and type of footwear on the postural stability of athletes.	Observational study with 936 athletes from 41 sports and 225 non-athletes.	936 athletes from different sports and 225 non-athletes, age range from 6 to 47 years.	Age is the most influential factor in postural stability, followed by footwear type. Women demonstrated better postural control than men.
Olchowik & Czwalik (2020)	To evaluate the effect of regular soccer training on the balance system of young female athletes.	Comparative experimental study with 25 female soccer players (mean age = 18.9 years) and 50 university students (mean age = 20.7 years) without sports practice.	25 female soccer players and 50 university students without any sports practice.	Female soccer players showed better postural balance than the control group. Asymmetry in lower limb loading may indicate increased risk of injury.
Lee, Oh & Kwon (2020)	To compare the effects of plyometric and ankle stability exercises on lower limb biomechanics and dynamic balance of Taekwondo athletes with functional ankle instability (FAI).	Experimental study with random division of 14 university Taekwondo athletes into two groups (7 plyometric exercises and 7 stability exercises).	14 university Taekwondo athletes (males only, average age 22.8 years).	Both types of exercises improved dynamic balance and reduced postural sway. Ankle stability exercises were more effective in absorbing impact.
Tao Liu (2022)	To evaluate the impact of postural ergonomics on injuries and rehabilitation of taekwondo athletes.	Taekwondo athletes (5 men and 8 women), aged between 18 and 21 years.	state/national level taekwondo athletes (5 men and 8 women, 18-21 years old).	Improper postures and biomechanical imbalances increase the risk of injuries in taekwondo. Knee hyperextension and center of gravity displacement have been highly correlated with injuries.
Ali Al-Husseini and al (2022)	To investigate postural control in elite athletes who suffered mild concussion and presented persistent post-concussive symptoms.	Quantitative study with 20 elite athletes with concussion and 12 without a history of injuries.	32 elite athletes (20 with concussion and 12 healthy), average age 26.6 years.	Athletes with a history of concussion have poorer postural control and greater energy expenditure to maintain balance, increasing the risk of new injuries.
Ribas et al (2022)	Analyze the postural control of amateur athletes and identify deficits in the balance systems (visual, vestibular and somatosensory) that may influence injuries.	Cross-sectional study with 36 amateur volleyball, futsal and basketball athletes.	36 male amateur athletes, average age 22.6 years.	Basketball presented the greatest postural deficits, suggesting greater vulnerability to lower limb injuries. Proprioceptive training may reduce risks.
Charni et al. (2022)	Identify vulnerabilities in postural balance and differences between playing positions in women's basketball.	Observational study with 30 elite female basketball players (mean age 21.4 years).	30 elite female basketball players.	Centers presented greater postural instability due to height and weight. Excessive dependence on vision for balance control. Greater displacement of the center of pressure (Cop.) compared to point guards.
Ogasawara et al. (2023)	To investigate anticipated postural stability during unilateral landings under physical and cognitive	Experimental study with 22 female university handball athletes.	22 female university handball athletes (women)	Athletes with greater postural stability had lower joint impact and lower risk of anterior cruciate ligament (ACL) injuries. Training programs should include postural

Author/ Year	Objective	Methodology	Participants	Main Conclusions
	perturbations.		only, average age 20.9 years).	anticipation exercises.
Zhang & Wu (2023)	To analyze the risks of injuries in basketball and investigate the effects of postural balance training on their prevention.	Controlled experimental study with 90 college basketball players (initial injury research) and 40 players in the training experiment.	90 college basketball players in the initial study; 40 players in the training experiment.	Ankle and knee injuries are the most common injuries in basketball. Postural balance training significantly reduced the risk of injury and improved athletic performance. Regular balance monitoring is essential in preventing injuries.
Jean-Philippe Viseu et al (2023)	To compare postural control in judokas, horse riders and non-athletes to understand how different sports affect sensory adaptation.	Experimental research with 34 judokas, 27 horse riders and 21 non-athletes.	82 participants (34 judokas, 27 horse riders and 21 non-athletes).	Horse riders showed better postural stability, while judokas demonstrated greater dependence on proprioception . The type of sport influences postural control.
Heil ; Busch (2023)	To assess the impact of dynamic postural control on the risk of sports injuries, especially in situations of high physical load.	Experimental study with repeated measures in 128 sports students submitted to physical load tests.	128 sports students (64 men and 64 women), average age 23.6 years.	Fatigue induced by high-intensity exercise compromises dynamic postural control, increasing the risk of non-contact injuries.
Villarón-Casales and al (2023)	To evaluate static postural control during single-leg stance in endurance, team and combat sports athletes.	Comparative experimental study with 61 young athletes (12 to 16 years old) of endurance, collective and combat sports.	61 young athletes (29 boys and 32 girls), between 12 and 16 years old.	Endurance athletes had worse postural stability than combat sports athletes, suggesting a higher risk of injury due to less exposure to balance training.
Harper et al (2023)	Glenohumeral (shoulder) range of motion and dynamic postural control to identify elbow injury risks in college baseball pitchers.	Preliminary prospective case series of 15 college baseball pitchers (mean age: 19.8 years).	15 NCAA college baseball pitchers (men only, average age 19.8 years).	College pitchers with less shoulder mobility had greater postural instability and a higher risk of elbow injury.
Vaneska Rios dos Santos et al (2024)	To analyze the postural control of female futsal athletes before and after a season and evaluate the impact of a preventive program on balance.	Longitudinal study with 10 amateur female futsal athletes, monitored pre- and post-season.	10 amateur female futsal athletes, average age 22.3 years.	The postural control of female futsal athletes did not change significantly pre- and post-season, suggesting that accumulated fatigue may impact balance.
Antohe & Panaet (2024)	To evaluate the impact of proprioceptive exercises on postural control of handball players with chronic ankle instability (CAI).	Non-randomized clinical trial with control group. 22 handball players (16.4 ± 0.52 years), divided into experimental group (n = 11) and control group (n = 11).	22 junior handball players (16 to 18 years old), both sexes.	Proprioceptive exercises significantly improved postural control and reduced the frequency of sprains in handball players with CAI.
Marcioli , Cunha & Macedo (2024)	Trochanteric pain syndrome (GTPS).	Randomized clinical trial with 26 women with GTPS, divided into two groups: hip strengthening (n=12) and hip + core strengthening (n=14).	26 adult women with GTPS, divided into two intervention groups.	Hip and core strengthening reduced pain and improved functionality, but did not result in significant improvements in postural control.
Özdemir & Yazici-Mutlu (2024)	To investigate the differences between ankle functions and postural control in	Observational case-control study with 40 women (21.18 ± 0.27 years); 20 college	40 young adult women, 20 college	Female volleyball players showed better postural control and greater ankle muscle strength than the control group. Regular

Author/ Year	Objective	Methodology	Participants	Main Conclusions
	female university volleyball players compared to a control group.	volleyball players and 20 control group participants.	volleyball players and 20 non-athletes.	monitoring of postural control may be essential to reduce the risk of sprains.
Jankaew (2024)	To investigate the impact of hamstring injuries (HSI) and vision on muscle recruitment and postural control in athletes with HSI.	Comparative experimental study with 28 male track and field athletes (14 with HSI and 14 healthy - control group).	28 college track and field athletes (male only, average age 22).	Athletes with HSI showed persistent deficits in hamstring activation and greater postural instability. Vision significantly influences postural stability.

In terms of relevance to the review, these studies contribute significantly to the understanding of the relationship between postural biomechanics and injury prevention. They fill gaps by demonstrating the effectiveness of different preventive approaches and reinforce the need for continuous monitoring of postural balance to reduce the incidence of injuries. In addition, they highlight the importance of personalizing training to meet the individual needs of athletes.

Therefore, the findings indicate that postural biomechanics is a determining factor in vulnerability to injuries and that strategies such as postural correction training and biomechanical monitoring are essential for prevention. Advances in postural analysis technologies and the implementation of personalized training programs can contribute to reducing injuries, improving sports performance and promoting the health of athletes.

DISCUSSION

Athletes from various sports exhibit different postural control patterns, which directly affect their susceptibility to injuries. One study¹⁴ found basketball players showed greater postural deficits than futsal and volleyball athletes, correlating with a higher incidence of ankle and knee injuries. Poor postural control impacts joint and neuromuscular stability, reducing an athlete's capacity to absorb impact and adjust posture dynamically.

Specifically, basketball players with poor postural control were more prone to both acute injuries (ankle sprains) and chronic overuse injuries.¹³ Impaired dynamic balance hinders safe directional changes and landings, increasing joint stress. In previously injured athletes, especially post-ACL reconstruction, proprioceptive reweighting deficits hinder postural adaptation and increase reinjury risk.¹⁶ An overreliance on ankle strategies without sufficient proprioceptive input from the lumbar and hip areas leads to compensations and joint overload.

Fatigue also significantly influences postural control. A study⁴ demonstrated that high physical load impairs dynamic balance, elevating the risk of non-contact injuries like ligament tears. Consequently, stability training under fatigue conditions is essential for injury prevention. For example, in women's futsal, accumulated end-season fatigue reduced motor responsiveness, increasing injury risk.¹⁰

This underscores the need for season-long monitoring of postural stability.

Postural compensations can also raise injury risk. Taekwondo athletes with trunk tilt, COG shifts, and knee hyperextension had higher rates of lower-limb injuries.¹⁷ These deviations result from imbalanced force distribution, causing joint overload and injury recurrence. Similarly, hamstring-injured track athletes had impaired posterior chain activation, resulting in increased center of pressure (COP) oscillation and instability.¹⁸

In impact sports like baseball, pitchers with limited dominant shoulder mobility exhibited greater postural instability and elbow injury risk.⁵ Postural instability can lead to maladaptive movement patterns and repetitive strain injuries. In judo, although athletes rely less on vision for balance—an advantage in dynamic situations—poor postural adaptation still increases fall and injury risk.¹⁹

Given these findings, preventive training to correct postural deficits is critical. Studies^{7,20} show that balance and proprioceptive-focused protocols improve postural control and reduce sprains and musculoskeletal injuries. Continuous monitoring also aids prevention; college volleyball players with better ankle dorsiflexion exhibited reduced sway, linking ankle mobility to improved stability.⁸

The literature consistently links postural deviations to higher orthopedic injury prevalence.¹³ Athletes in high-demand sports requiring abrupt movements and joint impacts—such as basketball,¹⁴ soccer, and volleyball—are particularly affected. When posture is compromised, force misdistribution leads to compensatory mechanisms, regional overload, and increased injury risk.¹⁷

For example, athletes with excessive COP sway are more likely to suffer ankle and knee injuries.¹³ In ACL-reconstructed athletes, a wider sway area and poor proprioceptive adjustment raised reinjury risks.¹⁶ Chronic ankle instability (CAI) is another well-documented condition related to postural deficits. In handball players, CAI was associated with greater sway and reduced neuromuscular control, heightening reinjury probability.⁷

In taekwondo, frequent unilateral landings exacerbate ankle instability. One study⁶ compared plyometric and stability exercises, concluding reduced postural stability increases recurrent sprain risk. Upper-body injuries also relate to posture. For instance, baseball pitchers with poor

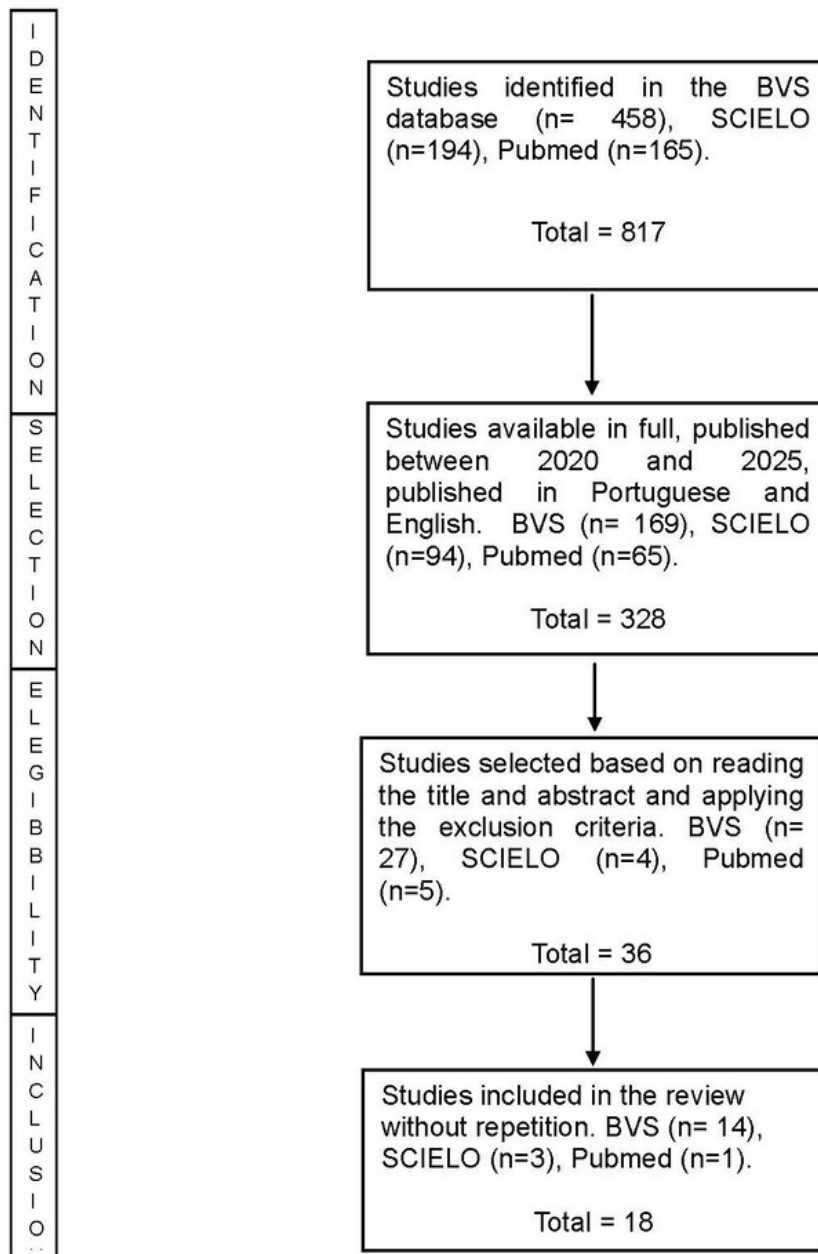


Figure 1. Flowchart

shoulder mobility and postural instability had higher elbow stress and tendinopathy rates.⁵

In women's basketball, taller and heavier centers demonstrated worse postural control and greater reliance on vision for balance. This instability was linked to more falls and ligament injuries.¹ Proprioception is also a key factor in injury prevention; athletes with postural deviations often have impaired proprioception, limiting automatic corrective responses during play. A study² on unilat-

eral landings found poor COP control increased ACL injury risk.

Endurance athletes, including runners and swimmers, demonstrated greater postural sway than combat sports athletes, possibly due to a lack of specific balance training.⁹ Injured athletes frequently exhibit increased COP sway and visual dependence for balance, especially basketball pivots¹ and female endurance athletes.⁹

Functional ankle instability, particularly in sports involving rapid direction changes (taekwondo), is a recurring

theme. Athletes with dorsiflexion limitations showed increased anteroposterior COP movement and higher risk of knee and hip injuries.^{6,8} In post-ACL surgery cases, excessive reliance on ankle strategy hinders adaptive responses, promoting reinjury.¹⁶

Greater postural sway and pelvic instability were found in athletes with greater trochanteric pain syndrome (GTPS), compromising load distribution and contributing to knee and back injuries.¹¹ Similarly, hamstring-injured athletes had diminished muscle activation, impairing stability and raising reinjury risks.¹⁸

Weight distribution asymmetries are common in injured athletes. In female soccer players, overloading the non-dominant leg during kicks and dribbles increased chronic injury risks.¹⁵ In landing sports like basketball and handball, injured athletes showed reduced joint flexion during landings, increasing joint impact and injury recurrence.²

In baseball, shoulder mobility restrictions led to postural instability, joint compensations, and increased elbow injury incidence.⁵ Furthermore, fatigue accumulated throughout a season impairs postural control and raises the risk of injuries, as shown in women's futsal players.¹⁰

Postural rehabilitation is essential but often requires time. In GTPS cases, core and hip strengthening improved endurance and pain but didn't immediately enhance postural control, suggesting longer intervention periods may be necessary.¹¹

Overall, the key postural issues in injured athletes include balance deficits, compensatory strategies, and muscle weakness in stabilizing regions. Effective rehabilitation and ongoing postural monitoring are critical for reducing reinjury and improving performance.¹³

Both amateur and professional athletes experience postural control deficits. In amateur athletes, sport-specific factors influence posture. Basketball players, due to their height and limb length, showed more postural imbalance and injury vulnerability.¹⁴ This compromises rapid motor responses and performance.

Elite athletes are also affected. ACL-injured individuals exhibit rigid strategies and excessive ankle reliance, increasing recurrence.¹⁶ In high-speed contact sports like hockey and soccer, concussed athletes showed higher energy expenditure to maintain balance and poorer adaptation, raising injury risk.²¹

Landing sports highlight postural impact clearly. Rigid landing with minimal joint flexion results in greater load and ACL injury risk.² In baseball pitchers, poor shoulder mobility led to compensatory postural patterns and increased elbow stress.⁵

Corrective training can mitigate injury incidence and optimize performance. Proprioceptive exercises effectively enhance balance and joint stability, reducing sprain rates in handball and taekwondo athletes.^{6,7} Ongoing postural assessments during training are essential for early identification of deviations.¹³

Proprioceptive protocols also benefit those with chronic instability. For instance, handball players with FAI improved stability and reduced sprain rates after targeted interventions.⁷ In taekwondo, postural correction training

improved impact absorption during landings, minimizing joint overload and reinjury.⁶

In soccer and basketball—sports with abrupt direction changes—postural preparation helps prevent ACL injuries. In volleyball and handball players, better postural control correlated with fewer injuries.² Thus, core strengthening and balance work are vital orthopedic prevention components.

Monitoring posture during training allows early deficit detection and implementation of corrections. Athletes with instability or asymmetry are more prone to musculoskeletal injuries.⁵ In high-impact sports like basketball and soccer, such monitoring is crucial to reduce recurrence.¹

Technologies like stabilometric platforms and posturography help assess COP and detect compensations. These tools, used in taekwondo and handball, improved postural control and reduced injury recurrence.^{16,18} In baseball, analyzing shoulder mobility and COP oscillation enabled injury prediction and training adjustments.⁵

In athletes with prior injuries, postural monitoring is especially important. Female futsal players showed balance impairment from season-long fatigue, increasing injury likelihood.¹⁰ Therefore, regular proprioceptive and stability evaluations are key to protecting high-intensity athletes.

CONCLUSION

This study investigated the link between inadequate postural patterns and orthopedic injuries in athletes from various sports. The literature review revealed that poor postural control is strongly associated with increased musculoskeletal injury risk, particularly in sports involving rapid directional changes and high-impact landings.^{13,14} Fatigue accumulation during the season also compromises balance, increasing vulnerability to injuries.¹⁰ Proprioceptive training and muscle strengthening have been shown to significantly reduce injury rates,^{6,7} while technologies like posturography and stabilometry allow early detection of deficits.^{5,8} The study emphasizes the importance of preventive strategies, such as postural correction programs and continuous monitoring. However, limitations include small sample sizes, lack of longitudinal data, and varied assessment methods across studies, reducing generalizability. Future research should explore broader populations and long-term interventions. Integrating emerging technologies like wearable sensors may further personalize training and enhance orthopedic injury prevention efforts.^{11,21}

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CONFLICTS OF INTEREST

We declare that there are no conflicts of interest of a personal, commercial, academic, political and /or financial nature in the process of evaluating and publishing the aforementioned article.

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