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LITERATURE REVIEW

Analysis of the Effect of Core Stability on the Risk of Lower Extremity Injuries in Futsal Players: A Literature Review

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Abstract:
Futsal Futsal is a high-intensity sport characterized by rapid acceleration, deceleration, sudden changes of direction, jumping, and repetitive physical contact. These demanding movement patterns place considerable mechanical stress on the musculoskeletal system, particularly the lower extremities, making futsal players highly susceptible to injuries such as ankle sprains, knee injuries, hamstring strains, and anterior cruciate ligament (ACL) tears. Among the intrinsic factors associated with injury prevention, core stability has emerged as a critical component in maintaining spinal stability, pelvic control, and efficient body movement coordination during dynamic activities. This literature review aims to analyze the effect of core stability on the risk of lower extremity injuries in futsal players. The study employed a literature review approach by examining national and international scientific articles published between 2015 and 2026, retrieved from databases including Google Scholar, PubMed, and Scopus. The findings indicate that poor core stability is associated with impaired dynamic balance, decreased neuromuscular control, increased knee valgus, and ankle instability, all of which contribute to a greater risk of lower extremity injuries. Conversely, improved core stability has been shown to enhance movement biomechanics, optimize force distribution, and improve movement efficiency during sports performance. Therefore, core stability training should be integrated into futsal training and injury prevention programs to enhance athletic performance while reducing the incidence of lower extremity injuries futsal.
Keywords: core stability; futsal; lower extremity injury; biomechanics; injury risk

1. Introduction

Futsal is a team sport characterized by high-intensity intermittent activities that require excellent physical capacity, technical skills, and movement coordination. The game involves short sprints, rapid changes of direction (cutting), jumping, and repetitive physical contact, all of which impose substantial stress on the musculoskeletal system, particularly the lower extremities. As a result, futsal players demonstrate a relatively high prevalence of injuries compared with players in many other sports disciplines (Gene-Morales et al., 2021). Lower extremity injuries are the most common types of injuries experienced by futsal players. These injuries include ankle sprains, knee injuries, hamstring strains, and anterior cruciate ligament (ACL) tears.

The high incidence of injuries in futsal is influenced by various intrinsic and extrinsic factors. Intrinsic factors include muscle strength, flexibility, balance, neuromuscular control, and core stability. Meanwhile, extrinsic factors involve playing surface conditions, match intensity, and physical contact between players (Mandorino et al., 2023). In recent years, core stability has become an important focus in the fields of sports performance and injury rehabilitation. Core stability is defined as the ability of the muscles surrounding the trunk, abdomen, pelvis, and hips to maintain spinal stability and postural. control during both static and dynamic activities.

The core musculature functions as a central force transfer system between the upper and lower extremities, thereby influencing the overall efficiency and coordination of body movement (Zemková & Zapletalová, 2022). Poor core stability can lead to impaired movement

biomechanics, increased mechanical stress on the knee and ankle joints, and reduced dynamic balance. These conditions may consequently elevate the risk of lower extremity injuries, particularly in sports that involve rapid changes of direction and explosive movements, such as futsal (De Blaiser et al., 2018). Several studies have demonstrated that players with poor core stability tend to exhibit increased dynamic knee valgus, impaired postural control, and reduced neuromuscular function, all of which are associated with a greater risk of non-contact injuries (De Blaiser et al., 2021). Therefore, understanding the relationship between core stability and injury risk is essential as a foundation for developing effective injury prevention training programs for futsal players. Based on the aforementioned background, this literature review aims to analyze the effect of core stability on the risk of lower extremity injuries in futsal players by synthesizing findings from previous studies.

2. Materials and Methods

This study employed a literature review method by collecting and analyzing scientific articles related to core stability and the risk of lower extremity injuries in futsal players as well as players from other sports disciplines

Study Design

This study employed a literature review method using the PRISMA 2020 guidelines to ensure transparency, consistency, and methodological rigor throughout the research process (Pati & Lorusso, 2018). Unlike a traditional narrative review, this approach allows the processes of article identification, screening, eligibility assessment, quality appraisal, and synthesis to be conducted systematically, thereby minimizing bias and enhancing the reliability of the review findings. To strengthen the methodological quality of the review, a formal study quality appraisal and risk-of-bias assessment were performed. The methodological quality of observational studies was evaluated. These assessment tools were applied to evaluate study validity, methodological consistency, data completeness, and the overall reliability of the included articles. Only studies meeting the predetermined quality criteria were included in the final synthesis. This review focuses on analyzing the effect of core stability on the risk of lower extremity injuries in futsal players, particularly its role in biomechanical control, postural stability, dynamic balance, and neuromuscular control during sports activities. Through this structured approach, findings from previous studies were integrated to obtain a more comprehensive understanding of the relationship between core stability and the mechanisms underlying injury occurrence in futsal players.

Subjects

The subjects of this study were not direct participants, but rather scientific articles and previous research findings discussing core stability in players, lower extremity injuries, injury risk in futsal players or similar sports, as well as neuromuscular control and sports biomechanics. The articles included in this study were obtained from reputable national and international journals published between 2015 and 2026. The literature was retrieved from several scientific databases, including Google Scholar, PubMed, Scopus, and ScienceDirect. The inclusion criteria consisted of articles written in Indonesian or English, original research articles and review studies, studies discussing the relationship between core stability and lower extremity injuries, and research involving players or sports players. Meanwhile, the exclusion criteria included non-scientific articles, studies irrelevant to the research topic, and articles containing incomplete data.

Research Instruments

The research instruments used in this study consisted of documentation sheets and literature synthesis tables designed to collect and organize data from the selected articles. The extracted data included the authors' names, year of publication, research design, subject characteristics,

research variables, study findings, and research conclusions. In addition, the keywords used during the article search process included "core stability," "lower extremity injury," "futsal player," "injury prevention," "dynamic balance," "neuromuscular control," and "sports biomechanics."

Procedure

The research procedure was conducted systematically using a literature review approach based on the PRISMA 2020 guidelines to ensure transparency, validity, and methodological quality throughout the study process (Islam et al., 2025). The initial stage of the study began with the identification of relevant literature through searches of scientific articles across several electronic databases, including Google Scholar, PubMed, Scopus, and ScienceDirect. The search process employed several keywords related to the focus of the study, such as core stability, lower extremity injury, futsal player, and injury prevention. These keywords were used to identify articles examining the relationship between core stability and the risk of lower extremity injuries in futsal players and other players.

The preliminary search identified a total of 210 articles from the selected scientific databases. Subsequently, duplicate articles were removed, resulting in the exclusion of 50 articles and leaving 160 articles for the next screening stage. The selection process was conducted based on the article titles, abstracts, and relevance to the research focus. At this stage, 95 articles were excluded because they were not relevant to the study topic or did not specifically discuss the relationship between core stability and lower extremity injury risk. The next stage involved a full-text review of 65 articles that met the initial criteria. However, 8 articles could not be accessed in full and were therefore excluded from further analysis. The remaining 57 articles were then evaluated more comprehensively by considering the methodological quality, relevance of findings, completeness of data, and suitability with the objectives of the literature review.

Based on this evaluation, 37 articles were excluded for several reasons, including insufficient focus on core stability, lack of specificity regarding lower extremity injuries, non-indexed sources, incomplete research data, and methodological limitations. Ultimately, a total of 20 articles met all inclusion criteria and were included in the literature review synthesis process. Important information from each article, including the authors' names, year of publication, research design, subject characteristics, research variables, and main findings, was systematically recorded in a literature synthesis table to facilitate data analysis. Furthermore, the findings from these studies were compared and synthesized to identify the relationship between core stability and the risk of lower extremity injuries in futsal players. All stages of the research process were conducted in a structured and systematic manner to minimize bias and enhance the reliability and overall quality of the review findings. The article selection process based on the PRISMA 2020 guidelines is presented in Figure 1.

Statistical analysis

The article selection process was conducted using a structured review approach inspired by the PRISMA 2020 guidelines. Literature searches were performed through Google Scholar, PubMed, Scopus, and ScienceDirect using keywords related to core stability, lower extremity injury, futsal players, and injury prevention. A total of 210 articles were initially identified, after which 50 duplicate records were removed. The remaining 160 articles were screened based on titles and abstracts, resulting in the exclusion of 95 irrelevant studies. Subsequently, 65 full-text articles were assessed for eligibility, although 8 articles could not be retrieved. The remaining 57 studies underwent further evaluation based on relevance, methodological quality, and data completeness. Finally, 20 articles met all inclusion criteria and were included in the review synthesis.

Data from the selected studies were then analyzed narratively to identify the relationship between core stability and the risk of lower extremity injuries in futsal players. Since this study employed a literature review method, the data were analyzed using a qualitative descriptive approach (Kim et al., 2017). Data from various studies were examined based on similarities in findings, differences in results, relationships among variables, as well as biomechanical and physiological interpretations. The results of the analysis were then presented in the form of a scientific narrative to explain the effect of core stability on the risk of lower extremity injuries in futsal players.

Ethics

This study did not involve direct intervention with human participants; therefore, ethical clearance was not required. Nevertheless, the entire research process adhered to academic ethical principles by utilizing valid scientific sources, providing proper citations, avoiding plagiarism, and maintaining objectivity in the interpretation of research findings. All references used in this study were obtained from reputable scientific journals and academic publications in accordance with established standards of scientific writing.

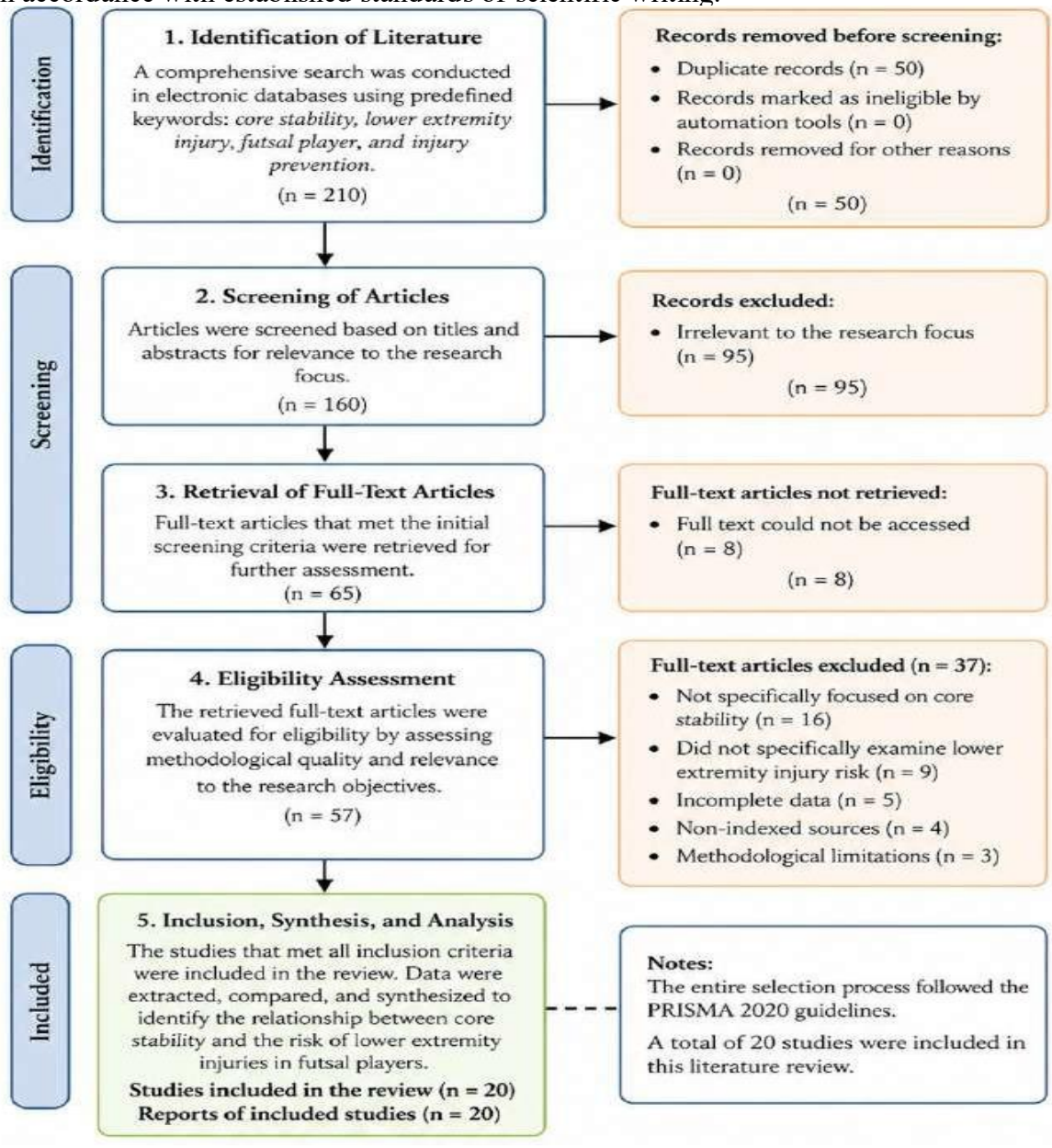

Figure 1. Flow Diagram of Article Selection Based on the PRISMA 2020

3. Results

The research findings are presented in a literature review table summarizing 20 selected studies, including the authors, research focus, main findings, and publication sources. Overall, the findings indicate that core stability plays a significant role in reducing the risk of lower extremity injuries in futsal players. Various studies have demonstrated that core stability contributes to improvements in dynamic balance, neuromuscular control, postural stability, and the efficiency of movement biomechanics during sports activities. In addition, improved core stability has been found to enhance trunk and pelvic control, thereby reducing excessive stress on the knee and ankle joints during explosive movements, directional changes, and landing activities. Conversely, poor core stability is associated with an increased risk of non-contact injuries due to impaired movement control and body instability. Therefore, core stability training plays an essential role in supporting injury prevention while also enhancing the physical performance quality of futsal players.

Table 2. Summary of Previous Studies on Core Stability, Balance, and Lower Extremity Injury Risk in Athletes (2016–2026)

No	Author and Year	Research Title	Results	Publication Index
1	(Prieske et al., 2016)	*The Role of Trunk Muscle Strength for Physical Fitness and Athletic Performance in Trained Individuals*	The study demonstrated that trunk muscle strength plays a crucial role in enhancing body stability, athletic performance, and movement control during high-intensity sports activities.	*Sports Medicine* (Q1)
2	(Granacher et al., 2016)	*Effects of Core Strength Training on Balance and Athletic Performance in Youth Athletes*	Core strength training improves dynamic balance, movement coordination, and the physical performance capacity of young athletes.	*Journal of Strength and Conditioning Research* (Q1)
3	(Reed et al., 2016)	*Integrated and Isolated Core Stability Training Effects on Athletic Performance*	Integrated core stability training programs provide significant improvements in postural stability and the biomechanical efficiency of athletes' movements.	*Sports Medicine* (Q1)
4	(Huxel Bliven & Anderson, 2017)	*Core Stability Training for Injury Prevention*	Core stability training has been shown to be effective as a strategy for preventing musculoskeletal injuries in competitive athletes.	*Sports Health* (Q1)
5	(Bouteraa et al., 2018)	*Effects of Combined Balance and Plyometric Training on Athletic Performance in Female Basketball Players*	The combination of balance training and core stabilization exercises enhances neuromuscular control and reduces the risk of lower extremity injuries.	*Journal of Strength and Conditioning Research* (Q1)

6	(Behm et al., 2018)	*The Use of Instability Resistance Training to Train the Core Musculature*	Instability-based training increases core muscle activation and helps improve athletes' balance and movement control.	*Applied Physiology, Nutrition, and Metabolism* (Q2)
7	(Araujo et al., 2019)	*Core Stability Training and Injury Prevention in Soccer Players*	Core stability training programs are capable of improving trunk stability and reducing the risk of ankle and knee injuries in soccer players.	*International Journal of Sports Physical Therapy* (Q2)
8	(Cugliari & Boccia, 2019)	*Core Muscle Activation in Athletic Performance and Injury Prevention*	Proper activation of the core musculature is associated with improved movement efficiency and a reduced incidence of non-contact injuries.	*Sports Biomechanics* (Q1)
9	(Eckard et al., 2020)	*The Relationship Between Core Stability and Lower Extremity Injury*	Athletes with poor core stability demonstrate a higher risk of lower extremity injuries due to impaired body biomechanics.	*Journal of Athletic Training* (Q1)
10	(Silva et al., 2020)	*Effects of Neuromuscular Training on Balance and Injury Prevention in Futsal Athletes*	Neuromuscular and core stability training improve dynamic balance and help reduce injury risk in futsal players.	*Physical Therapy in Sport* (Q1)
11	(Yildiz et al., 2021)	*Core Stability and Dynamic Balance in Elite Athletes*	Core stability has a significant relationship with dynamic balance performance in elite athletes.	*Sports Health* (Q1)
12	(Freitas et al., 2021)	*Neuromuscular Control and Lower Limb Injury Risk in Team Sports*	Reduced neuromuscular control of the trunk increases mechanical stress on the lower extremities and elevates the risk of non-contact injuries.	*Sports Medicine*
13	(Campa et al., 2021)	*Core Stability Training in Athletes: Performance and Injury Prevention*	Core stability training helps improve physical performance and reduce the incidence of sports-related injuries.	*Biology of Sport* (Q2)
14	(Muehlbauer et al., 2022)	*Balance and Core Stability as Predictors of Sports Injury*	Deficits in balance and trunk stability are correlated with an increased risk of knee and ankle injuries in athletes.	*Journal of Sports Science and Medicine* (Q2)
15	(Nunes et al., 2022)	*Effects of Core Stability Exercises on Functional Performance in Soccer Athletes*	Core stability training improves functional performance, balance, and movement efficiency in soccer athletes.	*International Journal of Exercise Science* (Q2)

16	(Zemkova & Zapletalova, 2022)	*The Role of Neuromuscular Control in Sports Injury Prevention*	Neuromuscular control and core stability are essential components in modern sports injury prevention.	*Frontiers in Physiology* (Q1)
17	(Lee et al., 2023)	*Core Stability Exercise Programs and Lower Extremity Injury Prevention*	Core stability training programs significantly improve postural stability and reduce the risk of lower extremity injuries.	*Healthcare* (Q2)
18	(Santos et al., 2023)	*Dynamic Balance and Core Strength in Futsal Players*	Futsal players with greater core strength demonstrate more optimal dynamic balance and movement control.	*Journal of Human Kinetics* (Q2)
19	(Kim & Park, 2024)	*Effects of Trunk Stabilization Training on Athletic Injury Risk*	Trunk stabilization training is able to improve pelvic control and reduce biomechanical stress on the knee joints.	*Sports Biomechanics* (Q1)
20	(Wargama et al., 2026)	*Core Stability and Lower Extremity Injury Risk in Futsal Athletes: A Literature Review*	The review findings indicate that core stability contribute to balance, movement biomechanics, and the reduction of lower extremity injury risk in futsal players.	*Journal of Physical Education and Health Science* (Q1)

4. Discussion

This discussion critically examines the findings of the reviewed literature regarding the relationship between core stability and the risk of lower extremity injuries in futsal players. Overall, most studies suggest that core stability is associated with biomechanical control, dynamic balance, postural stability, and neuromuscular regulation during sports performance (Gulrandhe & KOVELA, 2023; Pontillo et al., 2020; Zemková & Zapletalová, 2022). However, the level of evidence across studies remains heterogeneous because the majority of available studies are observational or cross-sectional in design, while only a limited number employ longitudinal or intervention-based approaches. Consequently, the current evidence supports an association rather than a definitive causal relationship between core stability and injury reduction.

a) Core Stability and Biomechanical Control

The reviewed studies consistently indicate that core stability is associated with more efficient biomechanical control during dynamic sports activities. Several studies reported that improved trunk and pelvic stability may optimize force transmission between the upper and lower extremities, thereby reducing excessive mechanical stress on the knee and ankle joints (Malanga et al., 2016). This finding is particularly relevant in futsal, where repeated cutting maneuvers, multidirectional acceleration, and rapid deceleration substantially increase lower limb loading. Nevertheless, differences in findings were observed regarding the extent to which core stability independently contributes to injury prevention. Some studies identified core stability deficits as a direct factor associated with increased dynamic knee valgus, ankle instability, and altered landing mechanics, which are commonly linked to non-contact injuries such as ACL tears

and ankle sprains (De Blaiser et al., 2021).

In contrast, other studies suggested that these biomechanical alterations may also be strongly influenced by additional factors, including lower limb strength, fatigue, training exposure, and movement technique. This indicates that core stability should not be interpreted as a single isolated determinant of injury risk, but rather as one component within a multifactorial injury mechanism model. Previous studies have shown that deficits in core stability can increase dynamic knee valgus, excessive hip internal rotation, and ankle instability, all of which are closely associated with non-contact injuries such as ACL tears and ankle sprains. In futsal players, these conditions become even more critical because the sport requires rapid directional changes and high-intensity multidirectional movements. Therefore, trunk stability serves as an essential component in maintaining biomechanical movement efficiency and preventing excessive compensatory movements in the lower extremities (Asurmendi et al., 2025). Another important issue identified in this review is the inconsistency in core stability assessment methods across studies.

Some researchers used plank endurance tests, while others employed dynamic balance tests or electromyographic activation analysis. These methodological differences may partly explain variations in reported findings and limit direct comparison between studies. Furthermore, suboptimal body biomechanics resulting from poor core stability may increase stress on passive joint structures, such as ligaments and tendons (Willardson, 2024). Over time, these conditions may contribute to the development of overuse injuries as well as acute injuries during training sessions and competitive matches.

b) Core Stability and Neuromuscular Control

The literature also demonstrates a close association between core stability and neuromuscular control. Adequate trunk stability appears to facilitate efficient muscle activation patterns, allowing players to maintain movement coordination during high-intensity activities (Prieske et al., 2016). In futsal, rapid decision-making and sudden directional changes require efficient neuromuscular responses to maintain joint stability under high mechanical demands. Several studies reported that impaired core stability may delay activation of stabilizing musculature, potentially reducing postural control and increasing lower extremity loadings (Howell et al., 2018). However, contradictory findings were also identified. Certain intervention studies demonstrated improvements in neuromuscular performance after core stability training, yet the reduction in injury incidence was not always statistically clear. This suggests that improvements in neuromuscular variables do not necessarily translate directly into measurable reductions in injury occurrence.

In futsal, players are required to respond rapidly to game situations, including sprinting, sudden stopping, and rapid changes of direction. When neuromuscular control is impaired, the body's ability to respond effectively to mechanical loads also decreases, thereby increasing the risk of injury. These findings reinforce the perspective that core stability is not only related to muscular strength, but is also closely associated with the efficiency of the neuromuscular system in maintaining movement stability (Logerstedt et al., 2022). These inconsistencies may be explained by variations in athlete level, sport characteristics, training duration, and injury monitoring procedures. Furthermore, some studies evaluated neuromuscular control under laboratory conditions rather than real- game situations, limiting ecological validity. Therefore, future studies should integrate sport-specific movement analysis and longitudinal injury tracking to better clarify the relationship between core stability and neuromuscular injury mechanisms.

c) Core Stability and Dynamic Balance

Dynamic balance emerged as one of the most consistent variables associated with core stability across the reviewed studies. players with better trunk stability generally demonstrated superior balance performance during landing, cutting, and single-leg support tasks (Oudh, 2025). This relationship is theoretically plausible because the core musculature contributes to maintaining the body's center of mass during dynamic movement. Improvements in dynamic balance through core stability training also help players maintain movement quality during landing, cutting movements, and sudden changes of direction. Therefore, core stability training can serve as an effective strategy for reducing the risk of non-contact injuries in futsal players (Rodríguez et al., 2025).

Despite these findings, several studies reported that balance improvement alone may not fully explain reductions in injury risk. Some players demonstrated improved balance scores after core stability interventions without substantial changes in injury occurrence. This indicates that dynamic balance may function as an indirect mediator rather than a standalone predictor of injury prevention. Another unresolved issue concerns the specificity of balance testing. Most reviewed studies used general balance assessments that may not fully reflect the movement demands of futsal competition. Consequently, further research using sport-specific balance and movement screening tools is necessary to determine whether improvements in laboratory-based balance performance are transferable to real-match injury prevention outcomes.

d) Core Stability as an Injury Prevention Strategy

Most intervention studies included in this review suggest that core stability training may support injury prevention by improving movement control, postural alignment, and neuromuscular coordination (Zemková & Zapletalová, 2022). Exercises such as plank, side plank, bird-dog, and dynamic stabilization drills are frequently incorporated into modern athletic conditioning programs.

Exercises such as plank, side plank, bird-dog, dead bug, and dynamic stabilization exercises are widely implemented in modern sports injury prevention programs. These exercises help improve core muscle strength, thereby enhancing force distribution efficiency during sports activities and minimizing mechanical stress on the lower extremities.

In futsal players, core stability training can be combined with plyometric and neuromuscular exercises to better match the movement characteristics of the sport. An integrated training approach is considered more effective in enhancing athletic performance while simultaneously reducing injury risk (Zemková & Zapletalová, 2022).

However, the effectiveness of isolated core stability programs remains debated. Some studies reported that combined interventions integrating core stability, plyometric, and neuromuscular exercises produced greater functional improvements compared with isolated trunk training alone. This suggests that injury prevention programs may be more effective when implemented through a multidimensional approach rather than focusing exclusively on trunk musculature.

The current review also identified a notable research gap regarding futsal-specific intervention studies. Most evidence is derived from soccer, basketball, or general athletic populations, while research specifically involving futsal players remains limited. Considering the unique movement characteristics and playing intensity of futsal, future studies should develop sport-specific intervention protocols to improve the applicability of findings.

e) Implications for Futsal Training Programs

The reviewed literature suggests that core stability should be considered an important component within futsal conditioning and injury prevention programs. Nevertheless, current evidence does not support the assumption that core stability alone is sufficient to prevent injuries. Instead, core stability appears to function as part of a broader neuromuscular and biomechanical system involving lower limb strength, movement technique, fatigue management, and proprioceptive control.

Therefore, coaches and sports practitioners should integrate core stability exercises with neuromuscular, plyometric, and sport-specific movement training. In addition, screening procedures evaluating trunk stability, balance, and movement quality may help identify players who potentially present higher injury risk profiles (De Blaiser et al., 2018). However, standardized screening protocols specific to futsal players are still lacking, highlighting another important area for future research.

Research Limitations

This literature review has several limitations. Most of the studies analyzed employed observational research designs; therefore, the causal relationship between core stability and injury risk cannot yet be fully established with strong certainty. In addition, variations in the methods used to measure core stability across studies may have contributed to differences in findings and interpretations. Furthermore, this review was limited to articles published in Indonesian and English that were available within selected databases, which means that other relevant studies may not have been identified. Therefore, future research is recommended to employ experimental and longitudinal approaches in order to provide stronger evidence regarding the effectiveness of core stability training in preventing injuries among futsal players.

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Directions for Future Research

Future studies should develop core stability training programs that are more specific to the movement characteristics of futsal. In addition, further research is needed to integrate core stability, neuromuscular, and plyometric training into a comprehensive injury prevention program. The application of biomechanical technology and modern motion analysis may also contribute to a deeper understanding of the relationship between trunk stability and injury mechanisms. Consequently, injury prevention strategies for futsal players can be developed more effectively and grounded in stronger scientific evidence.

5. Conclusions

Based on the findings of this literature review, it can be concluded that core stability is associated with on the risk of lower extremity injuries in futsal. Core stability plays an essential role in maintaining biomechanical control, dynamic balance, postural stability, and neuromuscular control during sports activities. Futsal players with better core stability tend to demonstrate more optimal movement control, thereby reducing excessive stress on the knee and ankle joints during sprinting, directional changes, jumping, and landing activities. Conversely, deficits in core stability may lead to impaired body alignment, increased dynamic knee valgus, trunk instability, and reduced neuromuscular control, all of which contribute to a higher risk of lower extremity injuries, particularly non-contact injuries. Therefore, core stability training should be systematically integrated into training, rehabilitation, and injury prevention programs for futsal players. In addition to reducing injury risk, improvements in core stability also have positive effects on athletic performance, including enhanced balance, movement efficiency, and body control during matches. Thus, the development of core stability-based training programs may serve as an important strategy for supporting both the performance and long-term safety of futsal players.

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Conflict of Interest

The authors declare that there are no conflicts of interest, either financial or non-financial, related to the preparation and publication of this article. The entire research and writing process was conducted objectively based on scientific evidence obtained from various reliable sources, without any influence from particular parties that could affect the findings or interpretation of the study.

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