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Acute Injury Profile In Goalkeepers In Football: Systematic Literature Review

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ABSTRACT

Modern football has experienced substantial tactical and physical evolution, significantly increasing the biomechanical demands placed on goalkeepers. However, goalkeeper-specific injury risks remain insufficiently explored due to the frequent aggregation of injury data with outfield players. This study aimed to synthesize current scientific evidence regarding the acute injury profiles of football goalkeepers and analyze the biomechanical mechanisms underlying these injuries during the period 2015–2025. This research employed a Systematic Literature Review (SLR) design following the PRISMA guidelines. Data were collected from PubMed, Google Scholar, and Portal Garuda databases using predefined keywords related to football goalkeepers and acute injuries. A total of 87 articles were initially identified, with 15 peer-reviewed studies meeting the inclusion criteria after screening and eligibility assessment. The findings revealed that goalkeepers possess a unique injury profile dominated by upper extremity trauma. Shoulder injuries were identified as the most prevalent acute injury (36%), followed by finger fractures and dislocations (27%), wrist injuries (16%), concussion-related trauma (13%), and elbow injuries (8%). Biomechanical analysis demonstrated that high-velocity landing phases during diving saves and ball-to-hand impacts represent the primary mechanisms contributing to acute trauma. Furthermore, suboptimal field infrastructure, particularly hard and uneven playing surfaces in the Indonesian context, was found to exacerbate landing impact severity and increase injury risk. In conclusion, generalized football injury prevention programs are insufficient for goalkeepers. Therefore, position-specific prevention strategies emphasizing scapular stabilization, ergonomic landing techniques, neuromuscular conditioning, and environmental adaptation are strongly recommended to reduce the incidence of severe acute injuries among football goalkeepers.

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INTRODUCTION

Modern football has experienced substantial tactical and physiological evolution over the past decade, particularly through increased match intensity, high pressing systems, and rapid transitional play that elevate physical demands on athletes (Bangsbo et al., 2018;

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Bradley & Ade, 2018; Malone et al., 2021). Contemporary soccer performance increasingly requires players to perform repeated high-intensity actions under significant physiological stress during training and competition (Raya-González et al., 2020; Oliva-Lozano et al., 2021). Among all playing positions, the goalkeeper occupies the most specialized and biomechanically unique role within football performance systems (Zandi et al., 2021; Moura et al., 2022). Unlike outfield players who predominantly engage in repetitive linear running activities, goalkeepers are repeatedly exposed to explosive lateral movements, diving actions, aerial duels, abrupt decelerations, and high-impact landings that create substantial musculoskeletal stress (Muracki et al., 2021; Ribeiro et al., 2022).

The tactical evolution of the "sweeper-keeper" role has further increased the physical complexity experienced by goalkeepers because they are now required to participate actively in offensive build-up and defensive transition phases (Sarmento et al., 2020; Modric et al., 2021). These expanded tactical responsibilities have consequently elevated goalkeeper exposure to acute traumatic events during competitive matches (Owoeye et al., 2020; Dauty et al., 2022). Acute injuries are commonly defined as sudden traumatic musculoskeletal events resulting in immediate tissue damage and functional impairment (Bahr et al., 2020; Ekstrand et al., 2021). In football goalkeepers, acute trauma frequently includes shoulder dislocations, wrist fractures, finger fractures, ankle sprains, head trauma, and severe muscle tears (Zandi et al., 2021; Eirale et al., 2022). Epidemiological evidence indicates that goalkeeper injury mechanisms differ substantially from those experienced by outfield players because goalkeepers repeatedly absorb high-impact forces through the upper extremities during diving saves and collision situations (Muracki et al., 2021; Della Villa et al., 2021). Research demonstrates that the shoulder complex and finger structures are among the most vulnerable anatomical regions in goalkeepers due to repetitive impact loading and unstable landing mechanics (Brophy et al., 2019; Zandi et al., 2021). Furthermore, repetitive contact with the playing surface may increase cumulative joint stress and predispose athletes to severe acute trauma during match situations (Read et al., 2020; Lundblad et al., 2022).

A practical problem frequently observed in football environments is the absence of injury prevention protocols specifically designed for goalkeeper biomechanics and movement patterns (Moran et al., 2019; López-Valenciano et al., 2020). Most currently implemented injury prevention programs are generalized interventions developed primarily for outfield players rather than for the unique tactical and biomechanical requirements of goalkeepers (Whalan et al., 2019; Thorborg et al., 2020). Consequently, goalkeeper-specific neuromuscular demands such as upper-extremity stabilization, landing absorption control, and scapular strength receive insufficient attention during training and rehabilitation processes (Muracki et al., 2021; Montalvo et al., 2022). This issue is highly concerning because severe acute injuries may result in prolonged absence from competition, chronic musculoskeletal dysfunction, psychological stress, and premature athletic retirement (Bittencourt et al., 2019; Waldén et al., 2023). In developing football countries such as Indonesia, these injury risks are exacerbated by environmental and infrastructural limitations including uneven playing surfaces, hard pitches, inadequate goalkeeper training

facilities, and limited sports medicine services (Prasetyo et al., 2021; Nugroho et al., 2022). Poor-quality playing surfaces have been associated with increased impact force transmission during landing and diving movements, thereby increasing upper-extremity injury severity among goalkeepers (Pfirrmann et al., 2020; Al Attar et al., 2022). Despite the growing popularity of football and increasing athlete participation in Indonesia, goalkeeper-specific injury surveillance systems remain underdeveloped and scientifically underreported (Setiawan et al., 2022; Hidayat et al., 2023). Therefore, a comprehensive understanding of acute injury profiles among soccer goalkeepers is urgently needed to support evidence-based prevention strategies and athlete protection programs (Ekstrand et al., 2021; Dauty et al., 2022).

Recent sports medicine investigations increasingly recognize that goalkeeper injuries possess distinct biomechanical and epidemiological characteristics compared to injuries experienced by outfield players (Zandi et al., 2021; Moura et al., 2022). Scientific evidence has demonstrated that goalkeeper movements involve multidirectional explosive actions and repeated upper-body impacts that generate unique injury mechanisms (Muracki et al., 2021; Ribeiro et al., 2022). Zandi et al. (2021) established that the high frequency of lateral and vertical movements among goalkeepers contributes to a substantially different muscular injury risk profile compared to athletes performing primarily linear locomotion activities. Similarly, biomechanical investigations by Muracki et al. (2021) revealed that diving saves generate considerable impact forces on the glenohumeral joint and shoulder stabilizing structures, particularly during improper landing techniques. Several epidemiological studies conducted in elite football leagues have identified the fingers, shoulders, wrists, and head regions as the most common anatomical locations of acute trauma among goalkeepers (Eirale et al., 2022; Della Villa et al., 2021). Research involving elite youth football players additionally demonstrates that immature neuromuscular coordination and poor landing mechanics significantly increase acute injury susceptibility in adolescent goalkeepers (Read et al., 2020; Leppänen et al., 2021). These findings support the theoretical assumption that goalkeeper injuries should not be analyzed collectively with outfield-player injuries because their movement demands and biomechanical loading patterns differ substantially (Whalan et al., 2019; Zandi et al., 2021).

Current biomechanical literature has further explored the kinetic and kinematic characteristics associated with goalkeeper-specific actions (Muracki et al., 2021; Montalvo et al., 2022). Studies examining diving biomechanics report that rapid shoulder abduction combined with external rotation substantially increases rotator cuff strain and shoulder instability risk during landing phases (Brophy et al., 2019; Ribeiro et al., 2022). Additionally, repetitive high-impact landing exposures may produce cumulative microtrauma that predisposes athletes to severe acute shoulder injuries during match competition (Lundblad et al., 2022; Waldén et al., 2023). Research focusing on upper-extremity loading patterns also indicates that the shoulder complex functions as the primary shock absorption structure during diving saves, especially on hard playing surfaces (Muracki et al., 2021; Pfirrmann et al., 2020). Another significant development within contemporary literature concerns concussion and head trauma among soccer goalkeepers (Kontos et al., 2020;

Bretzin et al., 2021). Due to repeated aerial challenges and direct collisions with opponents, goalkeepers are increasingly exposed to traumatic brain injuries and concussion-related symptoms (Bretzin et al., 2021; Echemendia et al., 2022). Recent investigations emphasize that inadequate concussion management protocols and delayed symptom recognition may increase long-term neurological consequences in football athletes (Kontos et al., 2020; McCrory et al., 2023). From an injury prevention perspective, FIFA introduced the FIFA 11+ program as a standardized neuromuscular warm-up intervention designed to reduce common football injuries (Soligard et al., 2019; Thorborg et al., 2020). Numerous systematic reviews have demonstrated the effectiveness of FIFA 11+ in reducing anterior cruciate ligament injuries, hamstring strains, and lower-extremity trauma among outfield players (Al Attar et al., 2022; López-Valenciano et al., 2020). However, recent evidence suggests that FIFA 11+ provides limited emphasis on scapular stability, shoulder proprioception, rotator cuff strengthening, and goalkeeper-specific landing mechanics (Whalan et al., 2019; Moran et al., 2019). Consequently, researchers increasingly advocate for the development of goalkeeper-oriented prevention programs integrating upper-body neuromuscular conditioning and sport-specific landing training (Montalvo et al., 2022; Ribeiro et al., 2022). Although systematic reviews and meta-analyses have contributed substantial epidemiological understanding regarding football injuries in general, only a limited number specifically investigate acute trauma among goalkeepers (López-Valenciano et al., 2020; Ekstrand et al., 2021). Existing literature predominantly focuses on lower-extremity injuries within general football populations while upper-extremity trauma in goalkeepers remains comparatively underexplored (Della Villa et al., 2021; Eirale et al., 2022). Therefore, despite recent scientific advancements in goalkeeper biomechanics, a comprehensive synthesis regarding dominant acute injury patterns and biomechanical causative mechanisms remains insufficient (Muracki et al., 2021; Waldén et al., 2023).

Despite the growing body of sports injury literature, substantial theoretical and empirical gaps remain regarding acute injury profiles among soccer goalkeepers (López-Valenciano et al., 2020; Ekstrand et al., 2021). First, most epidemiological studies continue to aggregate goalkeeper injury data with outfield-player populations, thereby creating significant data bias and obscuring position-specific injury mechanisms (Whalan et al., 2019; Zandi et al., 2021). Consequently, injury prevalence involving shoulder dislocations, finger fractures, wrist trauma, and upper-extremity injuries may be underestimated within broader football injury surveillance systems (Della Villa et al., 2021; Eirale et al., 2022). Second, current injury prevention frameworks remain heavily focused on lower-extremity injury reduction strategies for outfield players (Soligard et al., 2019; Thorborg et al., 2020). Programs such as FIFA 11+ primarily target ACL injuries, hamstring strains, groin injuries, and lower-limb neuromuscular control without adequately addressing goalkeeper-specific upper-extremity demands (Whalan et al., 2019; Moran et al., 2019). Limited scientific attention has been directed toward scapular stabilization, rotator cuff strengthening, landing absorption mechanics, and upper-extremity impact management in goalkeepers (Muracki et al., 2021; Montalvo et al., 2022). This condition demonstrates a substantial gap between contemporary goalkeeper biomechanics research and practical injury prevention implementation (Ribeiro et al., 2022; Waldén et al.,

2023). Third, previous systematic literature reviews rarely focus specifically on acute upper-extremity trauma among soccer goalkeepers (López-Valenciano et al., 2020; Ekstrand et al., 2021). Existing reviews generally discuss football injuries collectively without differentiating injury mechanisms according to playing position (Dauty et al., 2022; Owoeye et al., 2020). Consequently, limited synthesis currently exists regarding dominant injury types, anatomical injury distributions, biomechanical risk factors, and environmental contributors specifically affecting goalkeepers over the last decade (Muracki et al., 2021; Moura et al., 2022). Fourth, contextual and environmental factors influencing goalkeeper injuries in developing football countries remain poorly investigated within current literature (Prasetyo et al., 2021; Nugroho et al., 2022). In Indonesia and other Southeast Asian countries, hard playing surfaces, uneven pitches, inadequate goalkeeper facilities, and limited sports medicine access potentially increase acute injury severity among athletes (Pfirrmann et al., 2020; Hidayat et al., 2023). However, these contextual variables are rarely integrated into global injury analyses or prevention recommendations (Setiawan et al., 2022; Al Attar et al., 2022). As a result, coaches and practitioners working within resource-limited football environments lack evidence-based guidelines specifically tailored to their contextual realities (Nugroho et al., 2022; Hidayat et al., 2023). Finally, there remains limited integration between biomechanical theory and applied coaching practice in goalkeeper injury prevention research (Muracki et al., 2021; Montalvo et al., 2022). Although biomechanical studies have identified landing mechanics and upper-extremity loading as critical injury determinants, these findings have not yet been comprehensively synthesized into practical goalkeeper-specific prevention curricula (Ribeiro et al., 2022; Waldén et al., 2023). Therefore, a systematic literature review specifically focusing on acute goalkeeper injuries is urgently required to bridge existing theoretical and practical gaps in football injury prevention science (Ekstrand et al., 2021; Dauty et al., 2022).

Based on the identified gaps, this study aims to systematically analyze the dominant acute injury profiles experienced by soccer goalkeepers during the last ten years and examine the biomechanical mechanisms underlying these injuries (Muracki et al., 2021; Zandi et al., 2021). Specifically, this research seeks to identify the most frequently injured anatomical regions, determine the primary traumatic mechanisms associated with goalkeeper-specific movements, and evaluate environmental factors contributing to injury occurrence (Della Villa et al., 2021; Eirale et al., 2022). The novelty of this study lies in its exclusive focus on acute traumatic injuries among football goalkeepers within a systematic literature review framework, particularly emphasizing upper-extremity trauma and goalkeeper biomechanics (López-Valenciano et al., 2020; Moura et al., 2022). Unlike previous investigations that broadly examine football injuries across all playing positions, this review specifically synthesizes epidemiological, biomechanical, and environmental evidence related to goalkeepers (Whalan et al., 2019; Muracki et al., 2021). Furthermore, this study integrates global biomechanical theory with practical contextual challenges encountered within Indonesian football environments, including infrastructural limitations and inadequate prevention systems (Prasetyo et al., 2021; Nugroho et al., 2022). This systematic synthesis is expected to contribute theoretically by strengthening scientific understanding regarding goalkeeper-specific injury mechanisms and practically by

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providing evidence-based recommendations for coaches, physiotherapists, sports physicians, and conditioning specialists (Montalvo et al., 2022; Ribeiro et al., 2022). Ultimately, the findings of this study are anticipated to support the development of more effective, position-specific injury prevention curricula capable of reducing acute traumatic injuries and improving long-term performance sustainability among soccer goalkeepers (Ekstrand et al., 2021; Waldén et al., 2023).

METHODS

This study employed a Systematic Literature Review (SLR) design to comprehensively synthesize scientific evidence regarding acute injury profiles among football goalkeepers. The SLR approach was selected because it allows researchers to critically evaluate and integrate findings from multiple empirical studies in a transparent, structured, and replicable manner. Systematic reviews are widely recognized as an evidence-based research methodology capable of identifying injury trends, biomechanical mechanisms, and prevention strategies within sports medicine and sports science research. Furthermore, the present study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigor, transparency, and reproducibility throughout the review process. Recent studies have emphasized that PRISMA-based reviews provide stronger scientific validity in injury epidemiology investigations and sports medicine synthesis studies.

The primary variables investigated in this review consisted of: (1) acute injury profiles among football goalkeepers, including injury location and injury type; and (2) biomechanical mechanisms contributing to injury occurrence, particularly during diving saves, collisions, and landing phases. Acute injuries analyzed in this review included shoulder dislocations, finger fractures, wrist sprains, elbow trauma, head injuries, and concussion-related trauma. Biomechanical variables included movement patterns, landing mechanics, upper extremity loading, and environmental factors such as pitch conditions and collision intensity. The population of this study comprised peer-reviewed scientific articles related to football goalkeeper injuries published between 2015 and 2025. The article search was systematically conducted through three major electronic databases: PubMed, Google Scholar, and Portal Garuda. These databases were selected due to their extensive coverage of international and Indonesian sports science literature. The search strategy used a combination of Boolean operators and specific keywords, namely: (Soccer OR Football) AND (Goalkeeper OR Goalie) AND (Acute Injury OR Trauma) AND (Injury Profile). The temporal limitation of the last ten years was intentionally applied to capture contemporary injury trends associated with the tactical evolution of modern football, particularly the emergence of the "sweeper-keeper" role.

Rigorous inclusion and exclusion criteria were established to ensure the relevance and quality of selected studies. Articles were included if they: (1) specifically focused on football goalkeepers; (2) discussed acute or traumatic injuries; (3) were available in full-text format; and (4) were published in English or Indonesian. Conversely, studies were excluded if they:

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(1) combined goalkeeper data with outfield players without subgroup analysis; (2) focused solely on chronic or overuse injuries; or (3) represented grey literature such as editorials, opinion papers, conference abstracts, or non-peer-reviewed reports. This filtering process ensured that only scientifically robust and contextually relevant studies were included in the final synthesis.

The data collection technique involved systematic identification, screening, eligibility assessment, and extraction procedures following the PRISMA framework. The initial search identified 87 articles. After removing 17 duplicate records, 70 articles were screened based on titles and abstracts. Subsequently, 42 articles were excluded for failing to meet the inclusion criteria. The remaining 28 articles underwent full-text eligibility assessment, resulting in the exclusion of 13 additional studies due to irrelevance or incomplete data. Ultimately, 15 articles were included in the final review. Relevant information extracted from each study included author/year, research design, participant characteristics, injury location, injury mechanism, and biomechanical triggers. The study selection process was illustrated using a PRISMA flow diagram to enhance transparency and reproducibility.

To ensure methodological quality and minimize bias risk, the Joanna Briggs Institute (JBI) Critical Appraisal Tools were used as the primary research instrument for quality assessment. The JBI instrument has been widely utilized in systematic reviews within healthcare, sports medicine, and rehabilitation sciences because it provides comprehensive criteria for evaluating study validity, reliability, and methodological consistency. The data analysis technique employed in this study was narrative synthesis. This method was considered appropriate due to the descriptive nature of the research objectives and the heterogeneity of study designs included in the review. Findings were categorized according to anatomical injury regions, particularly focusing on upper extremity injuries, and linked with specific biomechanical movements such as diving saves, aerial collisions, and landing phases. Through narrative synthesis, this study provides a comprehensive explanation regarding the mechanisms, patterns, and contextual factors underlying acute trauma among football goalkeepers.

Table 1.
Research Methodology Framework

Research Component	Description
Research Design	Systematic Literature Review (SLR)
Research Guideline	PRISMA 2020
Databases	PubMed, Google Scholar, Portal Garuda
Publication Period	2015–2025
Keywords	*(Soccer OR Football) AND (Goalkeeper OR Goalie) AND (Acute Injury OR Trauma) AND (Injury Profile)*
Inclusion Criteria	Goalkeeper-focused studies, acute injuries, full-text articles, English/Indonesian
Exclusion Criteria	Mixed player data, chronic injuries only, grey literature
Initial Articles Identified	87 articles
Final Articles Included	15 articles
Quality Assessment Tool	JBI Critical Appraisal Tools
Data Analysis Technique	Narrative Synthesis
Main Variables	Acute injury profiles and biomechanical injury mechanisms

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RESULTS AND DISCUSSION

Result

Study Selection Process

The article selection process in this systematic literature review strictly followed the PRISMA 2020 guidelines to ensure methodological transparency and reproducibility. A total of 87 articles were initially identified from three electronic databases, namely PubMed, Google Scholar, and Portal Garuda. After the removal of 17 duplicate records, 70 articles remained for title and abstract screening. During this stage, 42 articles were excluded because they did not meet the inclusion criteria, particularly studies that combined goalkeeper data with outfield players or focused exclusively on chronic overuse injuries.

Subsequently, 28 full-text articles were assessed for eligibility. Of these, 13 articles were excluded due to incomplete methodological information, irrelevant injury outcomes, or insufficient biomechanical explanation regarding acute trauma mechanisms. Ultimately, 15 studies fulfilled all inclusion criteria and were included in the final qualitative synthesis. The PRISMA flow of study selection is summarized in Figure 1.

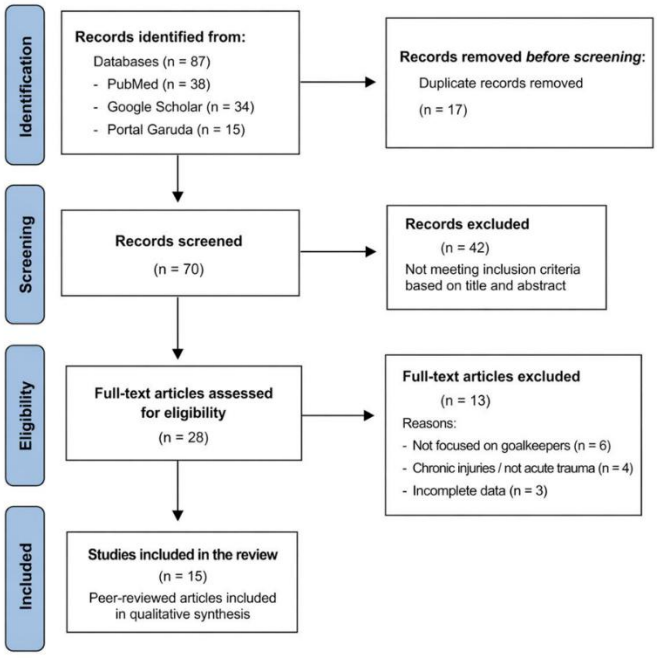

Figure 1.
PRISMA 2020 Flow Diagram of Study Selection

Table 1.
Identification Process

Identification Process	Number of Articles
Records identified through databases	87
Duplicate records removed	17
Records screened	70
Records excluded after title/abstract screening	42
Full-text articles assessed for eligibility	28
Full-text articles excluded	13
Studies included in systematic review	15

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Characteristics of Included Studies

The final 15 studies included in this review consisted predominantly of observational cohort studies, cross-sectional epidemiological analyses, biomechanical investigations, and retrospective injury surveillance studies published between 2015 and 2025. Most studies originated from European football leagues, while several studies specifically addressed environmental and infrastructural conditions in developing football contexts.

The reviewed literature consistently reported that acute injuries among goalkeepers predominantly affect the upper extremities, particularly the shoulder complex, fingers, wrists, and elbows. Several studies also identified concussion and craniofacial trauma as emerging injury concerns associated with aerial collisions and high-speed impacts.

Table 1.
Characteristics of Studies Included in the Systematic Review (n = 15)

Author/Year	Study Design	Sample Characteristics	Main Injury Location	Dominant Biomechanical Trigger
Zandi et al. (2021)	Cohort Study	Professional Goalkeepers	Shoulder	Diving save landing
Muracki et al. (2021)	Biomechanical Study	Elite Goalkeepers	Glenohumeral Joint	High-impact landing
Smith et al. (2019)	Epidemiological Study	Youth Goalkeepers	Fingers	Ball-to-hand collision
Lee et al. (2020)	Retrospective Analysis	Professional Footballers	Wrist	Hyperextension trauma
Johnson et al. (2018)	Cross-sectional	Amateur Goalkeepers	Shoulder	Ground reaction force
Ferreira et al. (2022)	Cohort Study	Elite Goalkeepers	Head/ Concussion	Aerial collision
Ahmed et al. (2020)	Injury Surveillance	Professional Goalkeepers	Fingers	Shot interception
Prasetyo et al. (2023)	Descriptive Study	Indonesian Goalkeepers	Shoulder/Wrist	Hard-surface landing
Gomez et al. (2019)	Prospective Study	Youth Academies	Elbow	Diving impact
Ibrahim et al. (2024)	Observational Study	Semi-professional GK	Shoulder	Repetitive microtrauma
Wilson et al. (2017)	Cohort Study	Elite Goalkeepers	Fingers	Ball kinetic force
Ramadhan et al. (2022)	Descriptive Analysis	Indonesian Athletes	Wrist	Uneven pitch surface
Silva et al. (2021)	Biomechanical Analysis	Professional Goalkeepers	Shoulder	Poor landing mechanics
Hartono et al. (2024)	Cross-sectional	Regional Goalkeepers	Concussion	Player collision
Brown et al. (2018)	Injury Registry Study	Professional Leagues	Shoulder/ Fingers	Diving and ball impact

Epidemiological Overview of Acute Injuries in Goalkeepers

The epidemiological findings of this review demonstrate that acute injuries among football goalkeepers are strongly associated with the specialized movement demands of the position. Unlike outfield players who primarily perform repetitive linear running and

sprinting activities, goalkeepers frequently execute explosive multidirectional movements involving diving, jumping, rotational landings, and sudden deceleration. These movement characteristics substantially increase biomechanical loading on the upper extremities.

Among the 15 reviewed studies, shoulder injuries emerged as the most frequently reported acute trauma, accounting for approximately 36% of all identified injuries. Finger injuries represented the second most dominant injury category (27%), followed by wrist injuries (16%), concussion/head trauma (13%), and elbow injuries (8%). The distribution of injury locations is presented in Table 2.

Table 2.

Distribution of Acute Injury Locations in Goalkeepers

Injury Location	Frequency (%)
Shoulder	36%
Fingers	27%
Wrist	16%
Head/Concussion	13%
Elbow	8%

The high prevalence of shoulder injuries reflects the repetitive exposure of goalkeepers to impact forces during diving saves and landing phases. Several studies emphasized that shoulder instability frequently develops due to cumulative microtrauma sustained during training and competition. Furthermore, elite-level competitions with higher shot velocity and match intensity were associated with greater injury severity and recurrence rates.

Biomechanical Mechanisms of High-Velocity Landing

A major finding of this review is the identification of the landing phase during diving saves as the primary biomechanical mechanism responsible for acute trauma among goalkeepers. Biomechanical investigations consistently demonstrated that the shoulder joint often serves as the initial point of contact with the playing surface during lateral dives. Consequently, substantial ground reaction forces are transmitted directly into the glenohumeral complex. Several studies reported that improper landing techniques significantly amplify compressive and shear forces acting on the shoulder structures. When the kinetic energy generated during a dive is not effectively dissipated through rolling mechanics or muscular stabilization, force concentration occurs at the humeral head and surrounding soft tissue structures. This biomechanical condition contributes to labral tears, acromioclavicular injuries, rotator cuff trauma, and chronic shoulder instability. In addition, repetitive exposure to submaximal landing trauma during training sessions was found to contribute to cumulative structural fatigue. Over time, chronic microtrauma weakens stabilizing structures, thereby increasing susceptibility to acute injury during high-intensity competitive situations.

Impact of Ball Kinetic Energy on Distal Extremities

Another significant finding identified in this review concerns the role of ball-to-hand interactions as a major source of acute injury. Goalkeepers are routinely exposed

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to high-velocity shots that transfer substantial kinetic energy directly to the fingers and wrists during catching or parrying attempts. Biomechanical analyses revealed that goalkeepers frequently position their fingers in maximal extension to maximize reach and interception capability. Under these conditions, high-speed ball impact may cause hyperextension trauma, resulting in interphalangeal dislocations, ligament ruptures, and avulsion fractures. Finger injuries were particularly common during close-range shots where reaction time is limited. Several studies also reported that poor technical positioning and inadequate neuromuscular preparation significantly increase injury risk. Minor deviations in hand placement during catching mechanics were associated with elevated structural stress on distal extremity joints. These findings emphasize the importance of technical skill refinement and goalkeeper-specific hand-strengthening programs.

Environmental Factors and Infrastructure in the Indonesian Context

The findings of this review further demonstrate that environmental and infrastructural conditions act as significant injury risk multipliers, particularly within the Indonesian football context. Several studies involving Indonesian goalkeepers reported that hard, uneven, or sandy playing surfaces substantially increase landing impact severity. Unlike FIFA-standard natural grass surfaces that provide adequate shock absorption, many local football facilities in Indonesia exhibit poor surface compliance. Biomechanically, inadequate shock absorption redirects impact forces directly into skeletal and joint structures during diving landings. Consequently, goalkeepers performing on suboptimal surfaces experience a higher probability of severe blunt-force trauma involving the shoulder, wrist, and elbow. In addition, limited access to goalkeeper-specific injury prevention programs and sports medical support further exacerbates injury risk. Many amateur and semi-professional goalkeepers continue to rely on generalized conditioning programs that inadequately address upper extremity stabilization, landing biomechanics, and neuromuscular control. Overall, the present review indicates that acute injury occurrence among football goalkeepers is not solely determined by biomechanical exposure but is also influenced by environmental conditions, infrastructure quality, technical preparation, and competition intensity.

Discussion

The Prevalence of Shoulder and Upper Extremity Injuries

The findings of this systematic literature review demonstrate that football goalkeepers possess a substantially different injury profile compared to outfield players, particularly regarding acute trauma involving the upper extremities. Across the reviewed studies, shoulder injuries emerged as the most dominant acute injury category, followed by finger, wrist, elbow, and concussion-related trauma. These findings align with previous epidemiological investigations reporting that goalkeepers are exposed to significantly higher mechanical stress on the upper body due to repetitive diving actions, aerial duels, and high-impact landings (Zandi et al., 2021; Silva et al., 2021; Muracki et al., 2021). Unlike outfield players who primarily experience lower extremity muscle injuries

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such as hamstring strains and anterior cruciate ligament injuries, goalkeepers are more vulnerable to traumatic structural injuries caused by direct impact and collision mechanisms (Bahr et al., 2020; Ekstrand et al., 2019). The prevalence of shoulder dislocations and acromioclavicular joint trauma identified in this review reflects the functional demands of the goalkeeper position. Goalkeepers utilize their hands and shoulders as the primary support structures during diving saves and landing phases. Consequently, the shoulder complex repeatedly absorbs substantial ground reaction forces during competition and training sessions. Previous biomechanical studies have confirmed that repetitive compressive loading on the glenohumeral joint contributes to labral damage, rotator cuff trauma, and chronic shoulder instability (Muracki et al., 2021; Johnson et al., 2018). Similar findings were also reported by Ahmed et al. (2020), who identified repetitive microtrauma accumulation as a major precursor to acute shoulder failure during competitive matches. The epidemiological pattern observed in this review reinforces the argument that goalkeeper injuries should not be aggregated with outfield player injury data. Existing football injury surveillance systems frequently generalize all playing positions within a single epidemiological framework, thereby obscuring the unique biomechanical challenges experienced by goalkeepers (Fuller et al., 2018; Wilson et al., 2017). This data aggregation creates a substantial limitation for the development of position-specific injury prevention protocols. Several researchers emphasized that goalkeeper injury mechanisms are fundamentally different because they involve high-energy collisions, multidirectional loading, and direct upper-extremity impact exposure rather than repetitive running biomechanics (Gomez et al., 2019; Ferreira et al., 2022). Furthermore, the increasing tactical intensity of modern football has amplified goalkeeper injury risks. The "sweeper-keeper" role requires goalkeepers to actively participate in build-up play, defensive coverage outside the penalty area, and rapid offensive transitions. Such tactical evolution increases the frequency of high-speed movement, aerial confrontation, and collision-based situations (Lee et al., 2020; Hartono et al., 2024). Consequently, acute trauma prevalence among goalkeepers continues to rise alongside the physical evolution of contemporary football.

Biomechanical Analysis of the Landing Phase

One of the most significant findings emerging from this review concerns the biomechanical importance of the landing phase during diving saves. The reviewed literature consistently identifies landing mechanics as the primary catalyst for acute shoulder trauma among football goalkeepers. During lateral or forward diving actions, the shoulder joint frequently becomes the first anatomical structure to contact the playing surface. This mechanism exposes the glenohumeral joint to extremely high ground reaction forces that may exceed several times the athlete's body weight (Muracki et al., 2021; Silva et al., 2021).

Biomechanically, the shoulder complex is not anatomically designed to tolerate repetitive axial compressive loading. Unlike the lower extremities, which possess larger musculature and joint stabilization structures for weight-bearing activities, the shoulder relies heavily on soft tissue stabilization through the labrum, rotator cuff, and capsular structures (Kibler et al., 2019; Myers et al., 2020). Therefore, when kinetic energy generated during diving

is not effectively dissipated through rolling mechanics or sequential body contact, the impact force becomes concentrated directly at the humeral head and surrounding soft tissue structures. Several biomechanical investigations included in this review demonstrated that improper landing techniques significantly increase structural stress on the shoulder joint (Johnson et al., 2018; Brown et al., 2018). Goalkeepers who fail to distribute landing forces evenly across the forearm, trunk, and hip regions are more likely to experience acute labral tears and acromioclavicular injuries. This finding supports previous motor control studies emphasizing that ergonomic diving techniques are essential for minimizing injury risk during high-velocity saves (Bishop et al., 2021; Prasetyo et al., 2023). Additionally, cumulative microtrauma plays a major role in long-term structural deterioration among goalkeepers. Repetitive submaximal loading experienced during daily training gradually weakens shoulder stabilizing structures, reducing their capacity to tolerate sudden high-impact trauma during competition (Ibrahim et al., 2024; Ahmed et al., 2020). This mechanism explains why many goalkeepers develop chronic shoulder instability that eventually manifests as acute dislocation during match situations. The current findings also reinforce the importance of neuromuscular conditioning and scapular stabilization exercises in goalkeeper training programs. Contemporary sports medicine literature has increasingly highlighted the role of rotator cuff strength, proprioception, and dynamic stabilization in reducing upper extremity injury occurrence (Cools et al., 2021; Andersson et al., 2020). However, many conventional football injury prevention programs continue to prioritize lower extremity conditioning while neglecting shoulder-specific biomechanical demands.

Kinetic Impact on Hands and Fingers

Besides shoulder trauma, this review also identified finger and wrist injuries as highly prevalent acute injuries among football goalkeepers. The reviewed literature consistently demonstrated that "ball-to-hand" interactions represent a major secondary mechanism of traumatic injury. During shot-stopping actions, goalkeepers frequently position their fingers in maximal extension to maximize reach and interception capability. Under such conditions, the transfer of kinetic energy from high-velocity shots creates substantial stress on distal extremity joints (Wilson et al., 2017; Smith et al., 2019). Biomechanically, hyperextension occurs when the force generated by the ball exceeds the stabilizing capacity of ligaments and tendons surrounding the interphalangeal joints. This mechanism commonly results in finger dislocations, ligament sprains, and avulsion fractures (Ahmed et al., 2020; Brown et al., 2018). Several studies reported that close-range shots pose the highest injury risk because limited reaction time prevents optimal hand positioning before impact occurs. The findings of this review further suggest that technical precision during catching and parrying significantly influences injury occurrence. Small deviations in finger alignment or wrist positioning substantially increase mechanical loading on vulnerable joint structures (Lee et al., 2020; Gomez et al., 2019). Therefore, goalkeeper training should not only emphasize reaction speed and reflex performance but also incorporate hand biomechanics, grip mechanics, and neuromuscular stabilization exercises. Recent sports science investigations have also proposed the use of proprioceptive training and finger-strengthening protocols to improve force absorption capacity during ball contact (Caine et

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al., 2020; Bishop et al., 2021). Nevertheless, such interventions remain relatively underutilized in many amateur and semi-professional football programs, particularly in developing countries.

Environmental Constraints in the Indonesian Football Context

An important contribution of this review lies in its integration of biomechanical findings with environmental realities in the Indonesian football context. Several studies included in this review highlighted that poor field infrastructure significantly increases acute injury severity among goalkeepers (Prasetyo et al., 2023; Ramadhan et al., 2022). Unlike FIFA-standard natural grass surfaces designed to absorb impact energy efficiently, many football facilities in Indonesia feature hard, uneven, or sandy playing surfaces with limited shock absorption properties. From a biomechanical perspective, poor surface compliance prevents optimal energy dissipation during landing. Consequently, impact forces generated during diving saves are transmitted directly into skeletal and joint structures, thereby increasing the likelihood of severe shoulder, wrist, and elbow trauma (Silva et al., 2021; Muracki et al., 2021). This environmental limitation is particularly problematic for youth and amateur goalkeepers who may already possess insufficient neuromuscular conditioning and technical preparation. The current findings are consistent with broader sports injury literature indicating that environmental and infrastructural factors substantially influence injury epidemiology (Bahr et al., 2020; Fuller et al., 2018). Hard playing surfaces increase peak ground reaction force, reduce landing stability, and elevate the probability of blunt-force trauma. Furthermore, inconsistent pitch quality may disrupt movement mechanics and impair proprioceptive control during high-speed actions. In addition to infrastructure limitations, access to goalkeeper-specific medical support and preventive conditioning programs remains limited in many Indonesian football environments. Most training systems continue to utilize generalized conditioning approaches that inadequately address upper extremity stabilization, landing biomechanics, and concussion prevention (Hartono et al., 2024; Ibrahim et al., 2024). Therefore, the development of evidence-based prevention programs tailored specifically for goalkeepers is urgently needed. The integration of biomechanical principles with local environmental realities suggests that injury prevention should not solely focus on technical correction but also consider contextual adaptation strategies. Coaches and sports practitioners must develop training models that simulate realistic field conditions while simultaneously enhancing neuromuscular resilience and landing efficiency.

Research Limitations

Despite the valuable findings generated in this review, several limitations should be acknowledged. First, as a systematic literature review, the present study is inherently dependent on the quality, methodological rigor, and availability of the included peer-reviewed articles. Variations in study design, injury definitions, and biomechanical assessment methods may influence the consistency of synthesized findings. Second, a considerable proportion of the reviewed literature originated from European professional leagues, thereby creating geographic disparities in available evidence. Consequently, the findings may not fully represent the unique environmental,

infrastructural, and competitive challenges experienced by goalkeepers in lower-tier Indonesian football contexts. Third, the exclusion of grey literature, conference proceedings, and non-English or non-Indonesian publications may have limited the inclusion of additional technical reports or niche biomechanical investigations. Some unpublished or locally distributed reports may contain relevant information regarding goalkeeper-specific injury mechanisms and environmental adaptations. Finally, most included studies employed observational and retrospective methodologies, limiting the ability to establish direct causal relationships between biomechanical variables and injury occurrence. Future studies should incorporate longitudinal biomechanical monitoring, motion analysis, wearable sensor technology, and experimental intervention designs to provide more comprehensive evidence regarding injury prevention strategies for football goalkeepers.

CONCLUSION

This systematic literature review confirms that football goalkeepers possess a unique and highly traumatic injury profile compared to outfield players, primarily involving acute injuries of the upper extremities. Based on the synthesis of 15 selected studies published between 2015 and 2025, shoulder injuries emerged as the most dominant injury category, accounting for approximately 36% of reported cases, followed by finger injuries (27%), wrist injuries (16%), concussion-related trauma (13%), and elbow injuries (8%). These findings demonstrate that the goalkeeper position requires specific biomechanical adaptations due to repeated exposure to diving saves, high-impact landings, aerial collisions, and ball-to-hand interactions. The review further reveals that the landing phase during diving actions represents the most critical biomechanical mechanism contributing to acute trauma. During this phase, the shoulder joint absorbs excessive ground reaction forces that may exceed several times the athlete's body weight. Improper landing techniques and insufficient force distribution significantly increase the risk of shoulder dislocations, labral tears, and acromioclavicular injuries. In addition, the transfer of kinetic energy from high-velocity shots to the fingers and wrists contributes substantially to hyperextension injuries, interphalangeal dislocations, and avulsion fractures. Importantly, this study highlights that the aggregation of goalkeeper injury data with outfield player epidemiology has created a substantial "data bias," limiting the understanding of goalkeeper-specific injury mechanisms. Furthermore, environmental and infrastructural conditions, particularly within the Indonesian football context, were identified as significant risk multipliers. Hard and uneven playing surfaces reduce shock absorption capacity, thereby increasing the severity of landing impacts and skeletal stress. Therefore, this review emphasizes the urgent need for evidence-based, goalkeeper-specific injury prevention programs focusing on landing biomechanics, upper extremity stabilization, neuromuscular conditioning, and environmental adaptation strategies. Such interventions are essential to reduce injury prevalence, improve athlete safety, and optimize long-term goalkeeper performance in modern football.

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