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Comprehensive systematic review: evaluating association of various movement screening tools with injury prediction in soccer athletes

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Abstract
Introduction. **Movement screening is used in soccer to evaluate an injury risk and create training regimens to prevent sports injuries. Movement screening has become popular in soccer, but there are some doubts about its accuracy. This systematic review was conducted to determine evidence supporting a relationship between various movement screening instruments and injury prediction in soccer players.** Methods. **The databases MEDLINE, CINAHL, Scopus, EMBASE, and SPORTDiscus were searched. Movement screening tests were used to evaluate athletes in prospective cohort studies. Musculoskeletal injuries were a primary outcome.** Results. **An analysis, including 14 studies with the following indicators, was conducted: diagnostic precision, relative risk, or odds ratios. There is strong evidence that some subcomponents of the Functional Movement Screening, Y Balance Test, Single Leg Drop Jump, Single Leg Countermovement Jump, and Landing Error Scoring System can predict common soccer injuries.** Conclusions. **The results suggest that screening tests can be incorporated into physical examinations to identify soccer players susceptible to an injury risk. Therefore, movement screening should be recommended as an injury prediction tool in soccer.**

KEYWORDS: injury risk classification, pre-participation examination, movement testing, Functional Movement Screening.

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Introduction

The second stage of van Mechelen's "sequence of prevention" model and Finch's "Translating Research into Injury Prevention Practice framework, or TRIPP" pertains to recognizing cause or risk factors of injuries [37, 6]. Prevention programs cannot be explicitly focused or targeted until risk factors are identified. Several risk factors, such as age, kicking leg, past injury history, hamstring strength, muscular fatigue, etc., have been associated with soccer-specific injuries [12, 1, 17]. Movement quality refers to maintaining proper joints alignment, posture, and balance while performing selected movements [18]. Soccer player's movement quality has recently been studied as a possible injury risk factor, but results are conflicting [3, 24]. A variety of movement screening tests are available for use in a clinical context; these include the Tuck Jump Analysis (TJA), Landing Error Scoring System (LESS), Functional Movement Screening (FMS™) tools, Y Balance Test (YBT), Single Leg Hop for Distance (SLHD), Single Leg Countermovement Jump (SLCMJ), Single Leg Drop Jump (SLDJ), Star Excursion Balance Test (SEBT), Soccer Injury Movement Screen (SIMS), Drop Jump Analysis (DJA), and Athletic Ability Assessment (AAA) [5]. Movement screens are intended to draw attention to problematic movement patterns instead of providing a diagnosis for them [26]. Motor performance of an athlete during these composite movement screenings is also believed to reflect their performance during more challenging sports-related movements and activities, such as running and direction changes. Thus, movement screening begins to identify what might be a risk factor or a possible issue. Practitioner's judgment determines what action, if any, should be taken in response to a result.

Most previous research has focused primarily on the FMS™, which was developed as a "general" movement assessment tool and has demonstrated high reliability, but conflicting relationships with injury risk [18, 23]. Non-contact Anterior Cruciate Ligament (ACL) injuries can be detected through biomechanical movement patterns using the LESS landing screener. A study has demonstrated that the LESS has good intrarater and interrater reliability as well as concurrent validity using a 3-dimensional motion analysis [27]. Regarding its potential to identify mechanisms associated with injury risk factors in soccer [26, 7], a few researchers have examined the LESS as a screening tool [35]. It has been suggested that a valgus mechanism is a high-risk movement pattern [22, 28], especially in male youth soccer players with a high incidence of medial collateral ligament injuries [9, 14]. Therefore, the TJA can be used to identify such players [29]. A predictive value of the SEBT for lower extremity injuries and lower back pain was demonstrated by amateur soccer players [34]. A modified version of the three-reach SEBT is the instrumented, proprietary YBT. Interrater reliability of the YBT for normalized reach distances is slightly higher than that of the SEBT [11]. Soccer players with lower YBT scores had a higher incidence of ankle injuries in both their dominant and non-dominant limbs [16]. The recently developed AAA evaluates athlete's movement patterns and consists of nine subtests. Although its injury predictive value has not been estimated, a study reported excellent intra- and interrater reliability [21]. The SIMS is an instrument designed specifically for soccer and is a valid means of evaluating movement quality [19]. According to a prospective study, the SIMS composite score did not correlate with soccer-related injuries [20]. However, the best screening test for predicting injuries remains unidentified, as there is insufficient data to support effectiveness of screening methods.

Thus, a systematic review was needed to determine the efficacy of screening instruments in soccer. This was further corroborated by a statement made by Bahr [2] who expressed doubts due to a lack of research evidence regarding the efficacy of risk factor screening tools in accurately predicting injuries to a degree sufficient to reduce an injury risk [2].

The current review's objective is to discuss evidence supporting movement screening test's capacity to predict injury risk in soccer players.

Methodology

This systematic review was prepared using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and registered in PROSPERO (CRD42023485277).

Selection criteria

The studies included in this systematic review were prospective cohort studies that classified a risk of injuries in soccer using movement screening tests with no age or gender restrictions. Soccer players who competed at collegiate, national, or international levels were included.

Search strategy

The following electronic databases were searched for literature indexed within a time period of the search and the database's inception: Google Scholar, EBSCO (including Academic Search Complete, AMED, CINAHL, Health Source: Nursing/Academic Edition, MEDLINE, SPORTDiscus), and Scopus (including ScienceDirect, PubMed, and EMBASE [since 1996]). Reference lists of the included studies were examined to find more pertinent studies after evaluation of abstracts and titles of all the retrieved references; one reviewer (AS) determined which studies seemed to meet inclusion requirements, and all qualifying articles were retrieved in full. The following keywords were utilized in a search strategy: ("Movement Screening" or "Functional Screening" or "Functional Movement Screening" or "FMS™" or "Injury Screening") and ("Landing Error Scoring System" or "LESS") and ("Y Balance Test" or "YBT") and ("Tuck Jump Analysis" or "TJA") and ("Soccer Injury Movement Screening" or "SIMS") and ("Drop Jump Screening Test") and ("Star Excursion Balance Test" or "SEBT") and ("Athletic Ability Assessment" or "AAA").

Data extraction and management

Essential information was extracted from the articles using a standard data extraction tool. The author (AS) worked on this independently, extracted the relevant study data, and entered it into a Microsoft Excel database; the other author (DA) resolved any remaining inconsistencies. The following variables were extracted: participants' profiles, a sample size, a type of movement screening test, musculoskeletal injuries categorization, follow-up duration, location and a type of statistical analysis used.

Risk of bias
The Newcastle–Ottawa scale was used to analyze a risk of bias [38]. This scale assesses the following domains:

1. Selection (an assessment of exposure and verification of an intended outcome was not present at the beginning of a study), representativeness of an exposed group, and selection of an unexposed group;
2. Cohort comparison based on research design or analysis (if significant confounding variables and other variables were taken into account before results were reported);
3. Outcomes (suitable duration of a follow-up, evaluation of results, and cohort monitoring). Based on the above domains, studies are classified as Good, Fair, and Poor. Good Quality – Selection Domain: 3 or 4 stars, Comparability Domain: 1 or 2 stars, Outcome/Exposure Domain: 2 or 3 stars. Fair Quality – Selection Domain: 2 stars, Comparability Domain: 1 or 2 stars, Outcome/Exposure Domain: 2 or 3 stars. Poor Quality – Selection Domain: 0 or 1 star, Comparability Domain: 0 stars, Outcome/Exposure Domain: 0 or 1 star.

Results

Study selection
Figure 1 gives a summary of a study identification procedure. A thorough search of electronic databases yielded 246 articles. After examining the article titles and abstracts and determining which studies were duplicates, 52 and 75 studies were eliminated, respectively. Subsequently, the full texts of 119 studies were assessed; 51 were eliminated due to their cross-sectional nature and 28 were eliminated as they assessed reliability. Sixteen studies were not specific to soccer, and 10 used screening methods other than movement. This systematic review ultimately contains 14 studies.

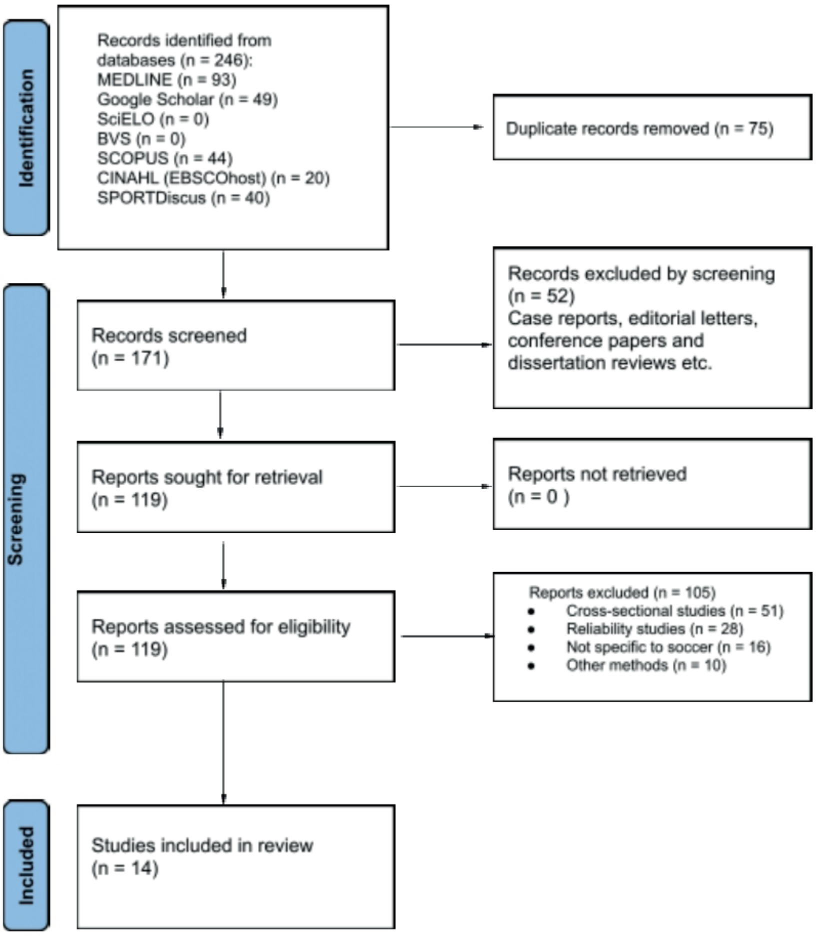

Figure 1. Identification of studies by databases and registers

Study characteristics
The 14 studies included 481 female participants and 2672 male participants with a mean age of 21.82 (SD = 8.41) years. Three studies did not report the mean age. Mean duration of follow-ups in the studies was 13.98 months; four studies did not report duration of a season in months and were therefore excluded from the calculation. Table 1 displays key characteristics of the studies in this systematic review. A statistical analysis of the studies included in this systematic review is shown in Table 2.

Risk of bias
The risk of bias analysis for each of the included studies is shown in Table 3. All 14 studies had an average Newcastle–Ottawa score of 6.93 ± 1.13 (Mean ± SD), indicating intermediate quality. Two of the 14 studies were of low quality [33, 34]. A study by Sklempe Kokic et al. [34] did not properly define an injury in terms of time loss or performance restriction, and injuries were self-reported by athletes. Another study with a higher risk of bias was by Schroeder et al. [33]. Data about injury was collected by assistant

Table 1. Characteristics of the 14 included studies

Author	Sample	Intervention	Follow-up duration	Procedure	Outcome	Injury classification criteria	Location
Padua et al. [26]	829 elite youth soccer athletes; male – 348, female – 481 (mean age = 13.9 ± 1.8 years)	LESS	2 years 5 months	Each participant underwent 3 trials of a jump-landing task as a part of their baseline pre-season testing. To diagnose ACL injuries, the participants were prospectively observed during their soccer seasons (1217 seasons to follow up).	non-contact and indirect-contact ACL injuries	I, II	USA
Hammes et al. [13]	238 male veteran soccer players (mean age = 44 ± 7 years)	FMS™	9 months	Eighteen veteran soccer teams were recruited and prospectively monitored for 9 months. The players executed the FMS™ at the beginning of the study period. Players' injuries and exposure hours were noted. A distinction in an overall FMS™ score between players with injuries and those without was evaluated.	non-contact and contact lost-time injuries	I, II	Norway
McCunn et al. [20]	306 male soccer players (mean age = 22 ± 4 years)	SIMS	1 season	The SIMS was completed by soccer players from 12 clubs in an off-season as a part of this prospective cohort study. Individual training/match exposures and non-contact lost-time injuries were prospectively recorded for the entire 2016 season.	non-contact lost-time LL injuries	I, II	Australia
Newton et al. [24]	84 youth soccer athletes (mean age = 13.0 ± 1.3 years)	FMS™	1 season	During the 2013-2014 soccer season, players were screened during a pre-season, and non-contact injuries were prospectively recorded. Club physiotherapists also tracked and documented all injuries sustained during practices and games.	non-contact lost-time injuries	I, II	UK
Sklempe Kokic et al. [34]	42 amateur male soccer players (mean age = 25.5 ± 6 years)	SEBT	3.5 months	Baseline data, which included leg dominance, health history, duration of soccer practice, training loads during the previous 6 months, presence of injuries and lower back pain during that time, and demographic data, were completed by participants in a questionnaire. Leg length of each lower limb was measured. The participants warmed up for 10 minutes before performing the SEBT, following an initial interview. A follow-up questionnaire was given to the participants 3.5 months after the initial interview. The questionnaire	contact and non-contact lost-time and performance restriction injuries	II	Croatia

				questions regarded training loads, injuries, and lower back pain during that time.			
Zalai et al. [39]	20 elite male soccer players (mean age = 23 ± 3 years)	FMS™	6 months	The Beighton scale was used to evaluate joint hypermobility in each player. Functional movement patterns were noted, and anthropometric factors were evaluated using the FMS™. The soccer players under examination had their injuries measured over a period of months, from August 2012 to January 2013. A standardized injury register was used to track the participants' injuries.	non-contact and contact injuries	I, II	Hungary
Smith and Hanlon [36]	89 senior male players (mean age = 23.2 ± 4.4 years)	FMS™	1 season	Prior to a screening process, which took place at each club's indoor facility, each player submitted information about their playing position, dominant foot, and history of injuries over the past 5 years. Anthropometric tests were conducted. The FMS™ was performed on each player. Following the screening process, injury occurrence rates of the participants' were monitored for the duration of the season. The injury data was recorded by clubs' physiotherapists.	non-contact lost-time injuries	I, II	Ireland
Bakken et al. [3]	362 male soccer players (mean age = 26.0 ± 4.7 years)	9+ Screening Test	2 years	Information on player's age, date of birth, position, and history of injuries (including lower extremity, groin, hamstring, quadriceps femoris, knee, and ankle injuries) was gathered using the FIFA pre-competition medical assessment form, which was completed during a medical part of the PHE on the same day as the 9+ test. Every day throughout a season, a head physiotherapist (or a team doctor in the absence of a physiotherapist) tracked every injury as well as each player's exposure to individual training and matches.	non-contact lost-time LL injuries	I, II	Qatar
Read et al. [30]	357 elite male youth soccer players (mean age – NR)	TJA, SLHD, SLCMJ	10 months	Elite male youth soccer players were evaluated prior to a season and subsequently observed throughout the season, documenting any non-contact lower limbs injuries. Screening tests included the TJA, SLCMJ, and SLHD. The players were divided into smaller groups based on their age.	non-contact lost-time LL injuries	I, II	UK
Schroeder et al. [33]	96 male soccer players (mean age = 23.7 ± 3.5 years)	FMS™	1 season (10 weeks)	An evaluation of potentially disrupted coordination patterns was conducted using a functional diagnostic tool (FMS™) prior to monitoring of exposure and injuries occurence. If participation in a training or a competition required a one-day absence from an activity, followed by at least 3 days of recovery, that injury was recorded. Assistant coaches completed injury documentation.	non-contact injuries with time loss of more than 3 days	II, III	Germany
Rusling et al. [32]	120 male youth soccer players (mean age = 13.6 ± 3.29 years)	FMS™	9 months	Subjects were soccer players from an academy of a professional soccer club. After completing the FMS™, the players were observed for duration of the study to document and determine an incidence of injuries in terms of rates per 1000 training and game hours.	non-contact lost-time injuries	I, II	UK

Gonell et al. [10]	74 male soccer players (mean age = 20.89 ± 5.31 years)	YBT	1 season	Soccer player's limb lengths and anterior, posteromedial, and posterolateral YBT reach distances had been measured before a season began. A number of days a player was unable to play due to injury was recorded by an athlete's physical therapists. Each of the reach distances, differences between the right and left reach distances, and the composite reach distance were assessed after normalizing for lower limb length.	non-contact injuries with time loss of 1 training day	I, II	Spain
Read et al. [31]	346 elite male youth soccer players (mean age – NR)	Anterior reach YBT	11 months	Players were observed for duration of a season to prospectively record all injuries sustained in soccer training and competitions at their respective clubs following a baseline YBT anterior reach injury risk screening during a pre-season.	non-contact lower extremity injuries with time loss of more than 2 days	II, III	UK
Fransz et al. [8]	190 male soccer players (mean age – NR)	SLDJ	3 years	Elite soccer players conducted Single Leg Drop Jump landing tests. Six outcome measures were calculated based on ground-reaction forces in order to reflect an impact and stabilization phase: peak force V, peak force AP, RMS ML 0.4, Hor GRF dyn, Hor GRF late dyn, and TTS VRAW 1.5. During a 3-years follow-up, lateral ankle sprains were noted.	non-contact ankle sprains	I, II	Nether-lands

Note: LESS – Landing Error Scoring System, FMS™ – Functional Movement Screening, YBT – Y Balance Test, SEBT – Star Excursion Balance Test, TJA – Tuck Jump Analysis, SLHD – Single Leg Hop for Distance, SLCMJ – Single Leg Countermovement Jump, SIMS – Soccer Injury Movement Screen, SLDJ – Single Leg Drop Jump, NR – not reported, LL – lower limb, PHE – periodic health evaluation, peak force AP – peak force anteroposterior, RMS ML 0.4 – root mean square of the force in the mediolateral direction, Hor GRF dyn – mean resultant horizontal ground reaction force during the dynamic phase (0.4-2.4 sec), Hor GRF late dyn – mean resultant horizontal ground reaction force during the late dynamic phase (3.0-5.0 sec), TTS VRAW 1.5 – time to stabilization with the raw signal in the vertical direction, the threshold set at ±5% body weight, and the signal to remain within threshold for 1.5 sec
Determining factors for injuries: (I) a healthcare professional made a diagnosis; (II) reported injuries were related to training or competition; and (III) only musculoskeletal injuries that resulted in a loss of function lasting more than 24 hours were taken into consideration.

Table 2. Statistical analysis of the 14 included studies

Author	Statistical analysis
Padua et al. [26]	AUC – 0.78 (95% CI = 0.61, 0.95), s – 0.86, c – 0.64, PPV – 0.014, NPV – 0.99
Hammes et al. [13]	injured vs uninjured ($p = 0.29$)
McCun et al. [20]	RR – 0.98 (0.96, 1.00), $p = 0.07$
Newton et al. [24]	AUC – 0.59 (95% CI = 0.47-0.72), $p = 0.14$, RR – 0.66 (0.40-1.10)
Sklempe Kokic et al. [34]	dominant LL – OR – 1.49 (1.124-1.962), $p = 0.005$, non-dominant LL – OR – 1.56 (1.15-2.10), $p = 0.004$
Zalai et al. [39]	ankle injuries and FMS™ Hurdle Step ($p < 0.05$), FMS™ Deep Squat and knee and hip injuries ($p < 0.05$)
Smith and Hanlon [36]	OR – 0.63 (95% CI = 0.19-2.07), $p = 0.45$
Bakken et al. [3]	AUC – 0.48 (95% CI = 0.43-0.54), $p = 0.53$ for lower extremity injuries
Read et al. [30]	U11 and U12 players – TJA = OR – 2.11 (95% CI = 1.06-4.18), $p < 0.05$, SLHD = OR – 0.86 (95% CI = 0.99, 0.92), $p = 0.04$, SLCMJ = OR – 0.85 (95% CI = 0.78-0.94), $p < 0.001$
Schroeder et al. [33]	injured vs uninjured – $r_{pb} = 0.093$, $p = 0.367$
Rusling et al. [32]	AUC – 0.73, OR – 1.13 (95% CI = 0.47, 3.43)

Gonell et al. [10]	OR – 2.24 (95% CI = 0.89, 5.86), p = 0.001
Read et al. [31]	pre-PHV – OR – 0.94 (95% CI = 0.91-0.98), p < 0.05, circa-PHV – OR – 1.06 (95% CI = 1.05-1.10), p < 0.05, post-PHV – OR – 1.49 (95% CI = 1.04-2.13), p < 0.05
Fransz et al. [8]	RMS ML 0.4 (p = 0.017)

Note: AUC – Area Under Curve, s – specificity, c – sensitivity, PPV – Positive Predictive Value, NPV – Negative Predictive Value, CI – confidence interval, RR – relative risk, LL – lower limb, FMS™ – Functional Movement Screen, OR – odds ratio, TJA – Tuck Jump Analysis, SLHD – Single Leg Hop for Distance, SLCMJ – Single Leg Counter Movement Jump, r_{pb} – point biserial correlation coefficient, PHV – Peak Height Velocity, RMS ML 0.4 – root mean square of the force in the mediolateral direction with regard to the first 0.4 sec after landing

Table 3. Risk of bias in the studies, measured using the Newcastle–Ottawa Scale

Study	Selection	Comparability	Outcome	Total	Quality of study
Padua et al. [26]	****	*	**	7	intermediate
Hammes et al. [13]	***	*	***	7	intermediate
McCun et al. [20]	***	**	***	8	high
Newton et al. [24]	***	*	***	7	intermediate
Sklempe Kokic et al. [34]	**	*	*	4	low
Zalai et al. [39]	***	*	**	6	intermediate
Smith and Hanlon [36]	****	*	***	8	high
Bakken et al. [3]	****	*	***	8	high
Read et al. [30]	***	*	***	7	intermediate
Schroeder et al. [33]	***	*	*	5	low
Rusling et al. [32]	****	*	***	8	high
Gonell et al. [10]	****	*	***	8	high
Read et al. [31]	***	*	***	7	intermediate
Fransz et al. [8]	***	*	***	7	intermediate

Nine is the highest possible score. A score of less than 6 indicates a low-quality study, a score of 6 to 7 indicates an intermediate-quality study, and a score of 8 to 9 indicates a high-quality study.

coaches, which can lead to misinterpretations as they are not experts, follow-up duration was much shorter (10 weeks), and if participation in a competition or training had to be discontinued for an entire day with a minimum three-day delay afterward, the injury was recorded, which is inconsistent with other studies. Five studies were of high quality [3, 10, 20, 32, 36] and seven were of intermediate quality [8, 13, 24, 26, 30, 31, 39].

Results of individual movement screening tools

FMS™

Six FMS studies were included in the review. Considering the high-quality studies by Smith and Hanlon [36] and Rusling et al. [32], no statistically significant relationship exists between a total FMS score and an injury. Rusling et al. [32] showed that a trunk stability push-up (p = 0.0621) and a deep squat (p = 0.0128) were highly significant predictors of non-contact injuries. A study by Hammes et al. [13] showed that an injury incidence in comparison to intermediate overall scores (10-14 points) was 1.9 times higher. A significant difference between ankle injuries and an FMS Hurdle Step exercise (p < 0.05), and knee and hip injuries and an FMS Deep Squat exercise (p < 0.05) was demonstrated by Zalai et al. [39]. A study with a high risk of bias showed an association of the hurdle step task specifically with ankle injuries, with a point biserial correlation coefficient r_{pb} = 0.209 (p = 0.041) [33].

LESS

Only one prospective study regarding soccer was found to use the LESS method. The receiver operator characteristic curve analyses suggested that five was an optimal cut-off for the LESS, generating sensitivity of 86% and specificity of 64% [26]. Very few (seven) ACL injuries are included in this analysis, so caution should be taken when interpreting these results.

YBT and SEBT

Two studies investigated an association of the YBT with ankle injuries [10, 31]. Read et al. [31] have found that absolute reach scores of a dominant leg correlate with likelihood of future injuries. Applying between-limb symmetry thresholds (>4 cm) could not distinguish between injured and non-injured players. Gonell et al. [10] have showed that players were nearly twice as likely to be injured if their scores in each reach direction were below mean. One study explored an injury predictive value of the SEBT in soccer players, but there was a high risk of bias in this study [34]. Injuries were self-reported by the players and not documented by a healthcare professional, also a definition of injury was not clear in the study. This study failed to account for additional confounding factors that might have affected the likelihood of injury. The results concluded that injuries were linked to shorter distances in all directions, but the anterior reach was also linked to lower back pain.

9+ Screening Test

A risk of lower extremity injury was not correlated with a total score of 9+ Test, with the hazard ratio (HR) of 1.02 (95% CI [0.99, 1.05]), $p = 0.13$ [3]. When injuries to a hip/groin, thigh, knee, lower leg, and ankle were evaluated, results remained the same.

SIMS

The SIMS composite score did not correlate with low extremity injuries [20]. Most individual subtest results of the SIMS showed weak to ambiguous relationships. Still, an increased risk of an ankle sprain may be associated with a higher SLHD score, the relative risk (RR) = 1.11 (95% CI [1.00, 1.23]), $p = 0.10$ and a Single-Leg Deadlift (SLDL) score was associated with likelihood of a hamstring strain, RR = 0.90 (95% CI [0.80, 1.02]), $p = 0.15$.

TJA, SLHD, SLCMJ, SLDJ

The most frequently mentioned risk factor was a SLCMJ landing force asymmetry, although there were differences between various age groups based on chronology [30]. In U11 and U12 players results of the TJA were as follows: RR = 2.11 (95% CI [1.06, 4.18]), $p < 0.05$; SLHD results were: odds ratio (OR) = 0.86 (95% CI [0.99, 0.92]), $p = 0.04$; and SLCMJ results were: OR = 0.85 (95% CI [0.78-0.94]), $p < 0.001$. According to a multivariate analysis, the greater landing force asymmetry during the SLCMJ was the only risk factor significantly associated with an increased risk of a lower extremity injury. A study assessed drop-jump landing performance as a predictor of a lateral ankle sprain, and mediolateral stability for the first 0.4 seconds (RMS ML 0.4); a higher value indicates more force exerted in a mediolateral direction, resulting in rapid lateral stabilization, which has a significant predictive capacity for all ankle sprains ($p = 0.017$) [8]. The RMS ML 0.4 ($p = 0.012$) and two additional risk factors, peak force V ($p = 0.026$) and horizontal ground reaction force, during a late dynamic phase, which is 3-5 seconds ($p = 0.016$), demonstrated a noteworthy predictive ability for severe ankle sprains.

Discussion

This review aimed to assess the relationship between the risk of musculoskeletal injuries and the various movement screening tests in soccer. Following the comprehensive literature search, the review considered the quality assessment of the 14 prospective cohort studies. Only one review with the same objective was conducted in 2021; however, the present review included more studies and the new screening tools. Furthermore, the analysis demonstrates the variation in the methodologies of the included studies. The results of the studies in this systematic review indicate that a movement dysfunction, as measured by the FMS™ cut-off value of 14, is not associated with an athlete's risk of injury; however, the specific tasks, such as deep squats, hurdle steps, trunk stability push-ups, and a very low score (<10), can contribute to determining the likelihood of injury. The YBT, SLDJ, and SLCMJ help determine the risk of ankle sprains in soccer. The ACL, the most common knee injury, can be predicted by the LESS, as shown by Padua et al. [26], but this cannot be ascertained due to a small number of ACL injury cases in this analysis. An ACL injury risk was not correlated with a LESS score in a related study involving basketball, volleyball, rugby, football, field hockey, gymnastics, lacrosse, and soccer athletes [35]. Because a number of ACL injuries in these two studies (Smith and Hanlon [36] and Padua et al. [26]) was small, the differences between the two datasets could simply be the result of random variation. Thus, considering the paucity of data, the screening value of the LESS needs further investigation in soccer populations. All other screening tools like the SEBT, SIMS, 9^+ Screening Test, TJA, and SLHD did not help determine the injury risk. The interpretation can be limited by a statistical analysis based on measures of OR calculation [4]. The studies assessing the reliability of an index test in comparison to a reference standard include diagnostic accuracy indicators. High-risk individuals may not sustain an injury if they are not exposed to a risk factor. Therefore, using a reference pattern of injury occurrence in injury prediction studies may limit an interpretation of results [15, 25]. An application of OR assesses likelihood of injuries in high-risk athletes. However, frequency of injuries is not taken into account. Thus, an RR calculation is the most appropriate, but only three studies in the review used the RR. The absence of a baseline injury assessment and the lack of blinding the evaluators monitoring the samples were noted in some studies [33, 34].

The limited number of the research assessing the LESS, TJA, SIMS, and DJA was a limitation of this study. Many currently available studies are also of poor methodological quality, making it difficult for them to meet the present study's inclusion requirements. Therefore, researchers and sports professionals must concentrate more on carefully well-designed studies to ascertain precision of screening instruments for frequent soccer injuries.

Conclusions

Even after accounting for the certain experimental limitations, only some subcomponents of the FMS™, LESS, YBT, SLDJ, and SLCMJ have strong evidence for predicting common soccer injuries. However, the remaining screening tests may be helpful in other contexts. They could be useful to professionals in identifying physical attributes that need to be developed from a performance enhancement standpoint, such as limb asymmetries related to strength and/or flexibility.

Conflict of Interest

The authors declare no conflict of interest.

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