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The lack of standardized outcome measures following lower extremity injury in elite soccer: a systematic review

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Abstract

Purpose Sport-specific, performance-based outcomes are increasingly used to improve evaluation of treatment efficacy in elite athletes; however, its usage in elite soccer may be limited. The purpose of this investigation is to (1) assess current outcome reporting in elite soccer; (2) identify any variability in reporting of outcomes; and (3) determine how sport-specific performance-based outcomes are utilized to assess treatment efficacy in elite soccer.

Methods A systematic review of the Pubmed, MEDLINE, and Embase, Scopus, SportDiscus, CINAHL and HealthSource: Nursing databases was performed without limitation on publication year. Inclusion criteria were (1) reporting of outcomes after a (2) lower extremity injury in (3) elite soccer players. The study's population, type of injury, return to play, as well as functional, objective, and sport-specific performance-based outcomes were extracted from each article. The methodological index for nonrandomized studies was used for quality assessment.

Results Twenty-one studies were selected after application of the inclusion and exclusion criteria. Objective outcomes were reported by 6 (29%) studies, and 6 (29%) employed patient-reported outcomes. The visual analog scale, Lysholm, and Tegner scores were the most common patient-reported outcomes (PROs). Return to play was reported by 18 (86%) studies, and only 2 (10%) utilized sport-specific performance-based outcomes. Despite the majority of studies reporting return to play, variation was seen in the definitions, and 15 (71%) studies reported the activity level of the players at final follow-up.

Conclusion Assessment of treatment efficacy is limited in elite athletes, and PROs lack the sensitivity to identify residual performance deficits after an injury. Although performance-based measures are available at the elite level, these outcomes were seldom used for evaluation of treatment efficacy.

Clinical relevance When treating elite soccer players, patient-reported outcome measures lack the sensitivity to detect changes in patient function, thus performance-based metrics may be more efficacious in assessing return from injury in these patients.

Level of evidence IV.

Keywords Elite soccer · Major league soccer · Outcomes · Return to play · Performance-based outcomes

Introduction

Soccer is the team sport with the highest rates of participation worldwide from adolescence through adulthood [18]. With high demands for agility, endurance, and dynamic movements combined with the contact nature of the sport, there is a substantial risk of injury. The incidence of injury in soccer is estimated to be approximately 10–35 per 1000 playing hours [7]. Players are most likely to suffer lower-extremity injuries [2, 29, 38]; which have the greatest consequences in terms of days of absence [41]. Injuries requiring surgical treatment can detract the player's contributions to the team upon return. The physician's

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responsibility is to accurately assess treatment efficacy and outcomes.

Outcome measurements in orthopedics are most reliant on pain and function and are integral to assessing treatment efficacy in the general population [4, 26]. However, patient-reported outcomes (PROs) have limitations when applied to elite athletes [17, 23]. Despite satisfactory PROs, inferior athletic performances may be evident after return to play, and thus, more sensitive metrics could better assess the athlete's recovery. Return to play is often used as an outcome measure in athletes but its definition is highly variable [9]. Furthermore, return to sport does not specifically convey the effects of a treated injury on the athlete's performance.

Patient-reported outcomes are effective in evaluating baseline impairment and treatment effectiveness following various orthopaedic procedures. Attempts have been made to validate PROs in elite athletes; however, a ceiling effect prevents differentiation of elite athletes from the general population [17, 23]. The baseline function in the athletic population is higher than the general population, thus PROs may not fully recapitulate treatment effectiveness in higher functioning individuals. To address this population of high-level athletes, several studies have utilized sport-specific outcomes to evaluate treatment efficacy [10, 14, 45]. Assessment of treatment efficacy is measured by an individual's performance in sport-specific metrics. For example, American football uses sacks, interceptions, touchdowns, rushing yards, receptions, etc; [12, 19, 24, 34] baseball has used innings pitched, earned run average, walks, hits, etc [14, 26]; hockey has used assists, points scored, shots, etc. [10] to evaluate an individual's performance following return to play. To date, these sport-specific metrics have not been validated, but the presence of extensive performance data recording in professional sports facilitates comparison of pre- and post-injury performance.

With the high injury rate in soccer, the impact of treatment on player performance should be appropriately measured to manage expectations and assist with team management. In addition to the challenge of assessing treatments in the elite athlete, an array of outcome measurements exist, which substantiates the difficulty of synthesizing the available literature [25, 26]. Standardizing outcome reporting in terms of individual sport-specific metrics allows for assessment of treatment efficacy by providing insight into patient function and performance upon return to sport. The purpose of this review is to provide an up-to-date assessment of currently utilized outcome measurements in professional soccer. The hypothesis of this investigation is that functional and objective outcomes as well as sport-specific outcomes are variably reported in elite soccer.

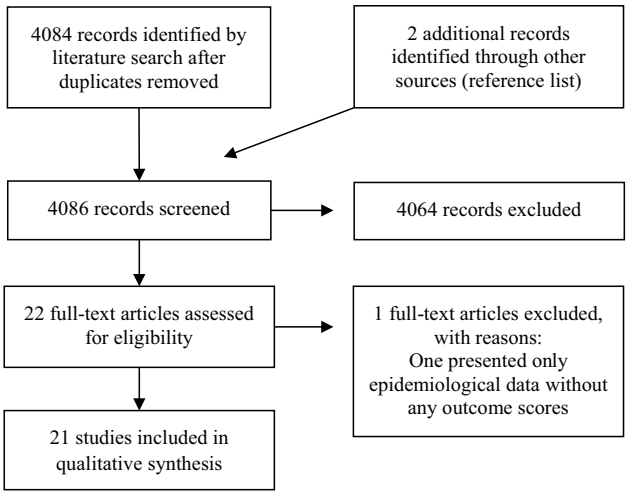

Fig. 1 PRISMA flow diagram demonstrating inclusion and exclusion criteria

Materials and methods

Literature search and selection criteria

A systematic, electronic review of the literature was performed using MEDLINE, EMBASE, Scopus, SportDiscus, CINAHL and HealthSource: Nursing in December 2016. The following terms were used to identify all articles relevant to elite level soccer: "professional soccer" OR "elite soccer" OR "professional football" OR "elite football" OR "major league soccer". The search was limited to the English language. After duplicates were removed, the resulting titles and abstracts were reviewed by two authors to select articles relating to lower-extremity (foot, ankle, knee, and hamstring) injuries or ailments requiring intervention in professional soccer players. References of selected articles were manually searched to capture articles missed in the primary literature search. If a discrepancy occurred, a third author was consulted for final inclusion.

Criteria for inclusion in this systematic review were (I) reporting of outcomes after a (II) lower-extremity injury in (III) elite soccer players. Functional outcomes, patient-reported outcomes, sport-specific outcomes, or any measure of return to play were defined as outcomes. Lower-extremity injuries were selected because they are most common injury in soccer [20, 29]. Elite status was defined as participation in National Collegiate Athletic Association (NCAA), other college level soccer, or professional soccer. Finally, a minimum level IV evidence was required, and reviews and case reports were excluded. The PRISMA (Preferred Reporting Items for Systematic

Reviews and Meta-Analyses) flowchart depicts this study's search selection algorithm which is shown in Fig. 1.

Data extraction

Standard data for all studies were extracted, including author names, date of publication, level of evidence, study design, and country of study. Patient demographics (sex, age, body mass index, soccer league) were extracted from each of the articles. Articles were further assessed for number of primary injuries, injury type, any concomitant injuries, and treatment options. Additionally, the definition, method, and length until return to play were evaluated as well. We extracted all reported patient-reported outcomes, functional outcomes, and sport-specific outcomes at both pre-operative and post-operative time points. Sport-specific outcomes were assessed for specific match statistics. Other follow-up information related to complication rates, recurrence, and career survival was also evaluated.

Quality assessment and statistical analysis

Study evidence was assessed by the Oxford Centre for Evidence-Based Medicine's 2011 levels of evidence [46]. The methodological index for nonrandomized studies was used for methodological quality assessment [39]. Due to the descriptive nature of this investigation, comparative statistical analysis was not conducted. However, descriptive statistics, such as mean, median, and standard deviation, were pooled and reported for player demographics and follow-up lengths using Microsoft Excel (Microsoft Office, Redmond, Washington).

Results

Literature selection

The initial literature search yielded 4086 articles after duplicate removal. Careful evaluation of the title and abstract yielded 22 articles for full-text review, including two articles selected by review of the reference lists. As one article only presented epidemiological data without any outcome scores, 21 articles reporting outcomes after lower-extremity surgery were included in the final systematic review (Fig. 1).

Methodological quality

Of the 21 selected studies, nine studies (43%) were level 3 evidence and the remaining 12 studies (57%) were level 4 evidence. All studies were non-comparative studies. The mean MINORS score was 10 ± 0.4 out of 16 (range 7–14).

Demographic analysis

All studies were published between 1995 and 2016, reporting a total of 1574 lower-extremity injuries that incurred from 1986 to May 2015. Four studies were conducted in the United States, while the remaining 18 focused on European professional soccer leagues. Of the studies that reported demographic data, the 15 (68%) studies that reported subject age had an average age of 24.5 ± 2.1 years and the 15 (68%) studies that reported sex had an average of 76% (SD 37.2) males. The most commonly reported injury location was the anterior cruciate ligament (ACL) [11, 15, 16, 35–37, 43, 44, 47], followed by the foot/ankle [6, 13, 32, 40], knee meniscus [21, 28, 33] and knee articular cartilage [21, 28, 33], hamstring [8], and medial collateral ligament (MCL) (Table 1) [22].

Objective and clinical outcomes

A total of 8 (38%) studies reported objective outcomes or PROs with 3.1 ± 0.8 outcomes reported per study [1, 15, 21, 27, 33, 37, 40, 47]. Six (29%) studies reported objective outcomes [15, 21, 27, 33, 37, 47]. Of the six studies, only four studies explicitly reported the time at last follow-up (mean 33.2 ± 28.6 months, range 12–72.6 months). Of all the objective measures, the use of a KT-1000/2000 arthrometer to measure side-to-side laxity difference was the most common [15, 37, 47], followed by the International Knee Documentation Committee (IKDC) Objective Score used by two studies [15, 27]. While six (29%) studies utilized patient-reported outcomes for baseline and post-operative timepoints, five studies reported the last follow-up used to gather the scores (mean 43.3 ± 27.8 months, range 12–72.6 months) [1, 15, 27, 40, 47]. The Lysholm score, Tegner score, and Visual Analog Scale (VAS) were the most commonly reported scores (Table 2). Of the six studies reporting objective outcomes, four of those studies also utilized patient-reported outcomes [15, 27, 33, 47].

Sport-specific outcomes

While only two studies reported sport-specific outcomes, both studies compared them with baseline statistics. Erickson et al. reported these outcomes for 62 subjects with ACL tears [11], while Mithoefer et al. reported the outcomes for 21 subjects undergoing microfracture for knee articular cartilage defects [28]. The most commonly reported soccer statistic was games played per season, which was followed for 5 years in one study [11] and five seasons in the other [28]. Mithoefer et al. only reported these statistics at a non-specified last follow-up, while Erickson et al. reported

Table 1 Study design and demographics

Lead author	Year	Injury location	Reported treatment	League/association	Total injuries
Alvarez-Diaz [1]	2016	Meniscus	Meniscal repair	RFEF	29
Calder [6]	2010	Foot/ankle	Ankle arthroscopy	EPL/EFL	27
Ekstrand [8]	2016	Hamstring	Repair	UEFA	255
Erickson [11]	2013	ACL	Reconstruction	MLS	62
Gajhede-Knudsen [13]	2013	Achilles tendon	Non-operative/operative	UEFA	203
Guzzini [15]	2016	ACL	Reconstruction	FIGC	16
Howard [16]	2016	ACL	Reconstruction	NCAA	79
Levy [21]	1996	Knee cartilage	Debridement	Division 1/ Professional	23
Lundblad [22]	2013	MCL	Unspecified	UEFA	346
Marcacci [27]	2014	Meniscus	Meniscus allograft transplantation	Professional	12
Mithoefer [28]	2012	Knee cartilage	Microfracture	Professional	21
Nawabi [30]	2014	Meniscus	Meniscectomy	Professional	90
Oztekin [32]	2009	Foot/ankle	Ankle arthroscopy	TFF	66
Panics [33]	2012	Knee cartilage	Mosaicplasty	Professional	61
Roi [35]	2006	ACL	Reconstruction	Serie A	38
Roos [36]	1995	ACL	Reconstruction	Professional	24
Seijas [37]	2014	ACL	Arthroscopy with platelet-rich plasma	Professional	19
Staresinic [40]	2013	Foot/ankle	Peroneal retinaculoplasty	Professional	3
Walden [43]	2011	ACL	Reconstruction	UEFA/SvFF	78
Walden [44]	2016	ACL	None/reconstruction	UEFA	157
Zaffagnini [47]	2014	ACL	Reconstruction	Serie A	21

ACL anterior cruciate ligament, *MCL* medial collateral ligament, *RFEF* Real Federacion Espanola de Futbol, *EPL* English premier league, *EFL* English football league, *UEFA* Union of European Football Associations, *MLS* major league soccer, *FIGC* Federazione Italiana Giuoco Calcio, *NCAA* National Collegiate Athletic Association, *TFF* Turkish Football Federation, *SvFF* Swedish Football Association

several soccer-specifics statistics, such as assists per season or shots per season, at 1 year intervals until final follow-up 5 years post-operatively (Table 2) [11, 28].

Return to play

Studies were investigated for the modality in which return to play was recorded. Eighteen (86%) studies reported at least one measure of return to play (Table 3). Thirteen studies reported the time to play first competitive match [6, 11, 16, 21, 27, 30, 32, 33, 35, 37, 43, 44, 47], and six of the studies reported time to resume full team training [6, 16, 27, 43, 44, 47]. Only one study explicitly reported time to return to pre-injury or higher levels of competition, while another reported time to return to full sports activity [1, 40]. Three studies, all from the Union of European Football Association (UEFA) Champions League, also reported lay-off time [8, 13, 22]. Lay-off time was described as the number of days until the patient resumed full team training in one study [8], but unclearly defined in the other two studies [13, 22].

Duration of follow-up was variably reported in 19 studies. The majority of studies used either seasons and games [11, 22] or time period [1, 6, 15, 21, 27, 28, 32, 33, 35–37, 40, 43, 47], reporting an average of 4.0 ± 2.6 years (range 2 months–9.6 years) as the final follow-up. Other studies followed their patients until reported RTP [30, 44] or throughout collegiate eligibility [16].

Complications/long-term impact

Several studies commented on post-surgical complication rates and injury recurrence. 76% of the studies reported post-surgical complications, re-injury rate, and revision surgery rate after the primary surgery (Table 3). The majority of studies reported player activity level in terms of % active players, % players playing at the same level, % players playing at a lower level, or % players whose careers were ended by injury at the time of final follow-up (Table 3).

Discussion

The most important finding of the present investigation is the distinct lack of consistency in outcome reporting following injury in elite soccer: 29% of the studies reported objective outcomes, 29% employed patient-reported outcomes, and 10% utilized sport-specific outcomes. Despite the variability found in objective, patient-reported, and sport-specific

Table 2 Follow-up time for reported functional outcomes, patient-reported outcomes, and performance-based outcomes

Descriptions	No. (%) of total studies reported	# Studies	Outcomes reported at pre- and post-operative timepoints							
			Pre	3 months	6 months	12 months	24 months	36 months	72 months	NS
Objective outcomes	6 (29%)									
Anterior drawer		1 [37]	×	–	–	–	–	–	–	×
Cartilage scoring [5]		1 [21]	–	–	–	×	–	–	–	–
ICRS grading		1 [33]	×	–	–	–	–	–	–	×
IKDC objective		2	× [15, 27]	–	–	× [27]	–	× [27]	× [15]	–
KT-1000/2000 arthrometer		3	× [15, 37, 47]	–	–	× [47]	–	–	× [15]	× [37]
Lachman		1 [15]	×	–	–	–	–	–	×	–
Pivot shift		1 [15]	×	–	–	–	–	–	×	–
Patient-reported outcomes	6 (29%)									
AOFAS		1 [40]	×	×	×	–	–	–	–	–
Cincinnati score		1 [33]	×	–	–	–	–	–	–	×
HSS score		1 [33]	×	–	–	–	–	–	–	×
IKDC subjective		2	× [15, 27]	–	–	× [27]	–	× [27]	× [15]	–
KOOS		1 [47]	×	×	×	×	–	–	–	–
Lysholm		3	× [15, 27, 33]	–	–	× [27]	-	× [27]	× [15]	× [33]
Tegner		3	× [1, 15, 27]	–	–	× [27]	–	× [27]	× [1, 15]	–
VAS		3	× [15, 27, 40]	–	–	× [27]	× [40]	× [27]	× [15]	–
WOMAC		1 [27]	×	–	–	×	–	×	–	–

Descriptions	No. (%) of total studies reported	# Studies	Outcomes reported at pre- and post-operative timepoints						
			Pre	12 months	24 months	36 months	48 months	60 months	NS
Sport-specific outcomes	2 (10%)								
Games played per season		2	× [11, 28]	× [11]	× [11]	× [11]	× [11]	× [11]	× [28]
Minutes per game		1 [11]	×	×	×	×	×	×	–
Goals per season		1 [11]	×	×	×	×	×	×	–
Total shots per season		1 [11]	×	×	×	×	×	×	–
Shots on goal per season		1 [11]	×	×	×	×	×	×	–
Assists per season		1 [11]	×	×	×	×	×	×	–
Yellow cards per season		1 [11]	×	×	×	×	×	×	–
Red cards per season		1 [11]	×	×	×	×	×	×	–
Fouls committed per season		1 [11]	×	×	×	×	×	×	–

NS post-operative timepoints not specified

Pre pre-operative, *PRO* patient-reported outcomes, *AOFAS* American Orthopedic Foot and Ankle Score, *ICRS* International Cartilage Repair Society, *IKDC* International Knee Documentation Committee, *HSS* Hospital for Special Surgery, *KOOS* Knee Injury and Osteoarthritis Outcome Score, *VAS* Visual Analog Scale, *WOMAC* Western Ontario and McMaster Universities Arthritis Index

Table 3 Return to play definition and follow-up data of knee injuries in elite football players

RTP reporting	No. (%) of total studies reporting	# Studies	Categories
What time to RTP did the studies report?	18 (86%)	1	Time to return to full sports activity [40]
		1	Time to return to pre-injury or higher level of competition [1]
		3	
		6	Lay-off time [8, 13, 22]
		13	Time to resume full team training [6, 16, 27, 43, 44, 47]
			Time to play first competitive match [6, 11, 16, 21, 27, 30, 32, 33, 35, 37, 43, 45, 47]
Follow-up	**No. (%) of total studies reporting**	**# Studies**	**Categories**
How was last follow-up measured?	19 (91%)	2	Until RTP [30, 45]
		2	Seasons/games [11, 22]
		1	Through collegiate eligibility [16]
		14	Time period [1, 6, 15, 21, 27, 28, 32, 33, 35–37, 40, 44, 47]
			(average 4.0 ± 2.6 years, range 2 months − 9.6 years)
Complications/ Recurrence	16 (76%)	9	Post-surgical complications [1, 6, 15, 27, 30, 35, 37, 40, 44]
		11	
		9	Re-injury rate [6, 8, 13, 15, 21, 22, 32, 37, 40, 44, 47]
			Revision surgery rate [1, 6, 8, 15, 21, 30, 40, 44, 47]
Player activity level at final follow-up	15 (71%)	14	% active players [1, 6, 11, 15, 16, 21, 27, 28, 33, 35, 37, 40, 44, 47]
		13	
		6	% playing at same level [1, 11, 15, 16, 21, 27, 33, 35–37, 40, 44, 47]
		6	
			% playing at lower level [15, 27, 36, 37, 44, 47]
			% ended career [1, 21, 27, 37, 44, 47]

RTP return to play, *ROM* range of motion

outcomes, 86% of the studies reported time to RTP, with most studies considering RTP as playing the first competitive match. Moreover, in this elite population, sport-specific outcomes were utilized the least often. This study has shown consistency in RTP reporting but a paucity in utilization of sports-specific outcomes for evaluating treatment efficacy in elite soccer players.

Reviewing the objective and subjective outcomes in this study reveals inconsistencies. Eight of the included studies utilized a total of seven objective outcomes and nine different PROs with a mean of 3.1 ± 0.8 per study to measure treatment efficacy (Table 3). Specifically, studies evaluating treatment of knee injuries showed much heterogeneity in the utilized measures. A systematic review of outcome reporting after shoulder and elbow injuries in competitive baseball players revealed similar findings [26]. Makhni et al. demonstrated a high volume of different outcomes scored at a low frequency across the literature, with 49 included studies using twenty-seven validated and non-validated PRO measures. Our study similarly provides further emphasis on the need for standardized outcome reporting at elite levels and this study is the first to address this issue in elite soccer.

RTP is an important metric for outcome assessment in athletes, and as such, 86% of the studies in this review reported RTP. A previous systematic review on outcomes after ACL reconstruction in athletes found a similar rate of RTP reporting in the literature of 88% [45]. However, in addition to the variability in its reporting, as evident in this study, RTP alone may not be an accurate metric to assess an athlete's performance and thus treatment efficacy. Although Alvarez-Diaz et al. reported a 90% RTP to "pre-injury level," this measurement was defined as return to the same level of competition (recreational vs competitive) and not the level of performance [1]. These patients may have in fact returned to the same level of competition but with a decreased performance after the surgical intervention. To fully evaluate treatment efficacy in elite athletes, more sensitive measures are required. Furthermore, RTP can be provider dependent as there is no standard criteria for safe RTP, which affects comparisons among the literature [9].

While objective and subjective outcomes can provide insight on recovery, these outcomes do not have the sensitivity to differentiate between recreational and professional athletes [17, 23, 31]. Additionally, many PROs are only validated among the general population, but not in elite athletes. Performance-based statistics, however, can be used as a sports-specific outcome to evaluate an athlete's performance after treatment. Comparison to pre-injury performance is possible due to the availability of performance statistics at elite levels. With respect to these sport-specific outcomes, only two of the articles in this review used these measures to evaluate treatment. Erickson et al. investigated the impact

of ACL reconstruction on RTP and treatment efficacy in male Major League Soccer (MLS) players. When determining sport-specific outcomes, confounders such as personal health and motivation, order of lineup, player position, skill of the surrounding players, as well as team performance among other factors can potentially impact these statistics. In an effort to reduce confounders, the study utilized a control group that experienced an "index year", which was defined as the average length of time when ACL tear occurred in their injured counterparts. Pre-injury and post-injury soccer specific performance statistics were then compared between groups. In addition, Mithoefer et al. reported on games played per season prior to and after articular cartilage microfracture, but did not include a control group or additional performance-based statistics. 29% of studies (6 out of 21) reported on the ultimate effect the injury had on the player's career. This information is of important prognostic value in the elite athlete but is less specific regarding performance for those who continue to participate at the elite level of play.

Treatment efficacy in several other sports has been evaluated by performance-based outcomes. In particular, Erickson et al. reported a 97% return to sport rate for National Hockey League (NHL) players undergoing ACL reconstruction, while comparing in-game performance measures with a control group [10]. They concluded that NHL players who underwent ACL reconstruction performed better than the control group in several post-operative performance variables including goals, points scored, shots, and time on ice per season. While this phenomenon can be attributed to variety of external factors, it is reassuring that performance-based measures concretely demonstrate a return to the same or even higher level of function. A recent systematic review of outcome reporting in professional baseball found that 33% of selected studies utilized sport-specific performance-based outcomes [42]. However, as with RTP, much variability was found in outcome reporting for these performance-based outcomes. Instead of relying on subjective measurements that may lack sensitivity, sport-specific outcomes have the potential to objectively inform players and coaches on performance after treatment.

In addition to individual performance statistics, performance indices have potential for outcome reporting in elite athletes. Jack et al. assessed performance and RTP in the National Football League after hernia surgery [19]. A performance index was calculated for each player based on game actions specific to the position played. This single performance index was then compared to a control group based on position, age, years of experience, and performance data prior to surgery [19]. A similar methodology and performance index was utilized by Busfield et al in the National Basketball Association to evaluate performance after ACL reconstruction. Other than reporting games played per season, only one study has applied sport-specific outcomes in elite soccer;[11] however, no previous investigation utilized performance indices to evaluate treatment efficacy in soccer. Perhaps the reason for the paucity of sports-specific outcome reporting in soccer is the difficulty in defining performance statistics for the various positions during game play as each has a unique role. One possibility for further utilization of performance-based outcomes in soccer is incorporation of third party assessments. In 2016, a performance index was introduced to the MLS—the Audi Player Index [3]. This statistic is calculated for each player during every match. This single numeric assessment is a composite of nearly 90 components and up to 2000 player movements throughout the match. In addition, this index quantifies player impact on each play as a component of the final Audi Player Index for that specific match. The comprehensive assessment provided by this real-time analysis has potential to serve as a performance-based outcome measure in elite soccer, as it captures players' overall performance at each position in every match.

Despite the potential benefits, performance-based sport-specific outcomes have inherent limitations. Previous methodologies for treatment assessment have not been validated to date [42]. Although numerous studies have compared treatment groups to controls, an appropriate time interval before the injury and after treatment must be defined for standard reporting. A previous study has shown that different time intervals for outcome measurement before and after the treatment can lead to different conclusions [42]. Additionally, specific sports and positions played during game play may detract from the availability of performance statistics. Depending on the methodology for comparison, the impact and meaning of the statistic must be investigated. For example, a decrease in the average shots on goal may indicate a larger deficit in performance than fouls committed. The overall performance indices have an advantage in this regard. Finally, the performance indices themselves must be standardized in their calculation methodologies.

This study should be interpreted in the context of its potential weaknesses. Although the purpose was to evaluate current outcome reporting in elite soccer, few studies reported sports-specific performance-based outcomes. This prevented a thorough assessment of current methods of treatment. However, this depicted the current paucity of data in the literature and emphasized the need for performance-based outcomes. While sport-specific outcomes may provide a clearer understanding of treatment efficacy after RTP, there is much to consider moving forward. Primarily, since no study has validated these measures, this must be addressed before clinical application. Furthermore, a standard method of reporting performance-based outcomes in soccer must be established whether this includes individual performance measures or a single performance index. These future measures would be necessary to help providers and players better understand

how injuries and treatments affect soccer performance. Objective measures, such as anterior laxity, may be used to determine when players can return to sport; however, patient-reported outcome measures lack the sensitivity to detect changes in patient function and performance following return to play. As physicians are asked to evaluate outcomes in operative procedures, attention should be paid to standardize outcome reporting and interpret these findings on an individual basis, especially in the case of elite soccer players.

Conclusion

This systematic review establishes that while a majority of studies reported time to RTP, objective and subjective outcomes scores were inconsistent across the literature. Sport-specific outcomes measuring performance were only clearly established in two studies, revealing the paucity in the literature of performance-based outcomes in elite soccer and its impact on measuring treatment efficacy.

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Compliance with ethical standards

Conflict of interest Dr. Verma is a board member for American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Society, Arthroscopy Association of North America, and is on the editorail board for Arthroscopy, Journal of Knee Surgery, SLACK Incorporated. Dr. Verma receives research support from Arthrex Inc, Arthrosurface, DJ Orthopaedics, Ossur, Athletic, CONMED Linvatec, Miomed, Smith and Nephew, and Mitek. Dr. Verma has stock options in Cymedica, Minivasive, Omeros. Dr. Verma receives publishing royalties from Arthroscopy, and Vindico Medical Orthopaedics-Hyperguide. Dr. Cole receives research support from Aseculap, Arthrex Inc, Geistlich, National Institute of Health, Sanofi-Aventis, and Zimmer, Dr. Cole is on the editorial board for the American Journal of Orthopaedics, American Journal of Sports Medicine, Arthroscopy, Cartillage, Journal of Bone and Joint Surgery, Journal of Shoulder and Elbow Surgery, and Journal of the American Academy of Orthopaedic Surgeons. Dr. Cole has stock options in Aqua Boom, Biometrix, Gitelischope, Ossio, and Regintis, as well as receives material support from Tournier. Dr. Cole is a board member for Arthroscopy Association of North America, and International Cartilage Repair Society. Dr. Cole receives IP royalties from Elsevier and DJ Orthopaedics, and Dr. Cole is a paid consultant for Flexion, Regentis, and Smith and Nephew. Dr. Bach has received publishing royalties from SLACK Incorporated as well as research support from Arthrex Inc, CONMED Linvatech, DJ Orthopaedics, Ossur, Smith and Nephew and Tornier. Dr. Forsythe receives paid royalties from Elsevier, research support from Arthrex Inc, Stryker, fellowship support from Ossur and Smith and Nephew, and has stock options in Jace Medical.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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