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Injury surveillance, on-field rehabilitation and return-to-play criteria: A survey of current practices in male professional football

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ABSTRACT

Injuries in professional football present complex challenges to multiple stakeholders. Subsequent rehabilitation processes are guided by epidemiological research and rehabilitation frameworks providing objective criteria informing decision-making. Processes must constantly evolve to provide support and minimise subsequent injury risk. The aims of this exploratory study were to investigate current practices in injury surveillance, on-field rehabilitation (OFR) and return-to-play (RTP) criteria in male professional football. In total, 81 practitioners responded to an online survey consisting of 34 questions divided into four sections: 1) practitioner demographics, 2) injury data collection and monitoring, 3) OFR and RTP criteria, and 4) decision-making process for return-to-training and RTP. Results indicate that for injury data collection, variability exists in rehabilitation end-date classification, post-rehabilitation timeframes, and a potential disparity between subsequent injury classification and reporting. A range of external running load metrics and objective targets are used to monitor and progress OFR, indicating lack of consensus and availability of validated objective criteria. A multidisciplinary, shared decision-making approach is adopted, including input from players; however, communication was highlighted as a key area to improve. Findings of this study may be beneficial for practitioners developing internal rehabilitation procedures and for identifying future research gaps that could result in positive rehabilitation outcomes.

ARTICLE HISTORY

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KEYWORDS

Injury; decision-making;
multidisciplinary;
frameworks; soccer

Introduction

Injuries in male professional football significantly impact multiple stakeholders, affecting team performance and often with substantial financial implications (Eirale et al., 2013; Eliakim et al., 2020; Hägglund et al., 2013; McCall et al., 2017; Oliveira-Júnior et al., 2024). On average a player sustains two injuries per season, and, at any point in-season, teams can expect 12–14% of their squad to be unavailable due to injury, putting significant pressure on medical and coaching departments (Bengtsson et al., 2021; Ekstrand et al., 2011; Mitchell & Gimpel, 2024). Rehabilitation is a constant learning process, refined by experience and reflection (McCall et al., 2017), informed by epidemiological classification systems (Aiello, McCall et al., 2023; Hägglund et al., 2005) and guided by rehabilitation frameworks providing objective criteria aiding decision-making (Buckthorpe et al., 2019a, 2019b; Dixon et al., 2025; Mitchell & Gimpel, 2024; Taberner et al., 2025a, 2025b; Taberner, Allen, et al., 2019).

Injury surveillance (i.e., injury data collection and monitoring procedures) plays a vital role in

understanding injury patterns and identifying priority injury problems (Bitchell et al., 2020; Ekstrand et al., 2011). In male professional football, lower extremity injuries have the highest incidence rates (6.8 injuries/1000 hours) and account for up to 87% of injuries (Ekstrand et al., 2011; López-Valenciano et al., 2020). Research demonstrates associations between previous lower limb muscle, joint or ligament injury, back injury and concussion with an increased risk of subsequent injury (Finch et al., 2017; McPherson et al., 2019; Nordström et al., 2014; Tabben, Chamari, et al., 2025; Toohey et al., 2017). Subsequent injury categorisation (SIC) models have been developed (Finch & Cook, 2014; Toohey et al., 2018) to classify these injuries, however, few studies have utilised SIC models (Bitchell et al., 2020) and subsequent injuries are poorly investigated and reported (Pucciarelli et al., 2023). To better inform injury mitigation programming this information is crucial (Pucciarelli et al., 2023) and a sport-specific systematic analysis of inter-injury relationships recommended

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(Finch et al., 2017; Moore et al., 2018). Little information exists on investigating injury monitoring systems used by practitioners (Tabben, Hassanmirzaei, et al., 2025) or on the awareness and use of SIC models (Pucciarelli et al., 2023). Insights into current practices may improve understanding of injury surveillance, thereby informing future epidemiological research.

Player monitoring, using subjective (e.g., wellness) and objective methods (e.g., external running load measures), throughout the rehabilitation process is common, and use of objective data during rehabilitation is recommended (Mitchell & Gimpel, 2024). Evidence demonstrates reduced reinjury rates when individuals pass objective criteria before return-to-sport (Draovitch et al., 2022) and absence of valid objective criteria may risk inadequate rehabilitation (Bisciotti et al., 2019; Mitchell & Gimpel, 2024; Zambaldi et al., 2017). Aetiological models of sports injury (Bittencourt et al., 2016; McIntosh, 2005; Windt & Gabbett, 2017) and rehabilitation frameworks (Buckthorpe et al., 2019b; Mitchell & Gimpel, 2024; Taberner, Allen, et al., 2019) highlight the importance of load management; however, there is scarce evidence for specific metrics and thresholds used to inform return-to-training (RTT), return-to-play (RTP) (Armitage et al., 2024; Dunlop et al., 2020) and post-rehabilitation phase (Armitage et al., 2024; Dixon et al., 2025; Dunlop et al., 2020). Use of global navigation satellite systems (GNSS) is prominent to quantify external running loads and is highly influential on decision-making during on-field rehabilitation (OFR) (Armitage et al., 2024). However, external load progressions using GNSS for RTT and RTP decision-making are based on anecdotal evidence (Buckthorpe et al., 2019b; Taberner, Allen, et al., 2019) and case reports (Estévez Rodríguez et al., 2024; Taberner & Cohen, 2018; Taberner et al., 2022; Taberner, van Dyk, et al., 2019). Few insights exist into targets set by practitioners, during rehabilitation, to inform decision-making and allow a perceived safe RTP (Armitage et al., 2024; Dunlop et al., 2020). Gathering this information is crucial to improve practice, formulate research questions and inform future research directions (Armitage et al., 2024; Dunlop et al., 2020; Fanchini et al., 2020; Impellizzeri et al., 2020).

Given the continual evolution of rehabilitation processes, growth of multidisciplinary teams (MDT), and need for cross-departmental working (e.g., medical team and technical coaches), it is important to acknowledge the range of skillsets required and complexity of decision-making within the professional football environment (Dixon et al., 2026a; King, McHugh, et al., 2024; King, Yiannaki, et al., 2024). Evidence suggests an association between internal communication quality and injury rates, with poor communication reducing player

availability by 6–7% (Ekstrand et al., 2018, 2019, 2025; Mitchell & Gimpel, 2024). Despite this, specific involvement of staff during RTP decision-making is not clear (Dunlop et al., 2020). Furthermore, a holistic player-centred approach may positively impact rehabilitation (J. King et al., 2019; Tranaeus et al., 2024); however, to the authors' knowledge, there are no insights into practitioners' perceptions of player involvement in the rehabilitation process and RTP decision.

It is important to understand the translational gap between research and application, with inconsistencies in practices a potential risk to rehabilitation outcomes. Whilst previous survey studies have explored OFR monitoring (Akenhead & Nassis, 2016; Armitage et al., 2024) and injury-specific RTP procedures (Dunlop et al., 2020; Perna et al., 2026) there is little research investigating current practices for subsequent injury and inter-injury relationship tracking, specific GNSS metrics used, OFR targets set, and practitioners' perceptions of player involvement in the rehabilitation process. To better inform practices and improve RTP outcomes, further research is required to aid consistency in injury surveillance and the integration of objective data into rehabilitation programming. Therefore, the aims of this study were to investigate injury surveillance, OFR practices, and RTP criteria in male professional football, including the perceived influential factors involved in RTT and RTP decision-making.

Methods

Sample size justification

As an exploratory study, sample size could not be determined using an *a priori* power analysis (Ditroilo et al., 2025) and, due to the specialist population targeted, was constrained by domain knowledge. This study had a larger sample compared to similar surveys (Armitage et al., 2024; Weldon et al., 2021) likely due to broader inclusion criteria. Qualitative data reached the point of saturation where no new themes were generated, and this was agreed by all authors.

Participants

To be eligible for inclusion practitioners had to be aged 18 and over, currently working full-time in male professional football in a medical or physical performance role with players aged 18 or over in one of the top two leagues, or a national team, of a listed country and have experience in the areas of injury monitoring, OFR, GNSS metrics and RTT/RTP decision-making. Following an introductory section explaining the purpose and objectives, all participants provided informed consent

prior to completing the survey. Ethical approval for the study was granted by the University of Lancashire HEALTH ethics review panel (Ref: HEALTH 01241).

Survey design and data collection

The study was designed as a cross-sectional, explorative study into the contemporary practices and rehabilitation procedures in male professional football. An online survey software (QualtricsTX, Utah, USA) was used to create the questionnaire (Electronic Supplementary Material (ESM) 1) and collect answers anonymously. Platform-level controls were set to prevent multiple submissions. The survey (in English) consisted of 34 questions (27 closed and 7 open) and was divided into four sections: 1) practitioner demographics, 2) injury data collection and monitoring, 3) OFR and RTP criteria, and 4) decision-making process for RTT and RTP. A section was included at the start of the survey on injury definitions, rehabilitation phases and terminology. Before distribution, three practitioners with significant experience in medical, performance and sports science across professional football and academia, reviewed the survey for content validity and provided feedback. Following piloting, the answer options for two questions were adapted. Data was collected between May-September 2025. Participants were recruited using a digital invitation via the research team's network and online platforms (i.e., LinkedIn). Chain sampling was used to maximize the sample size, whereby practitioners were requested to share the survey with their network (Asimakidis et al., 2024; Weldon et al., 2021). Reporting of study results was guided by the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) checklist (ESM 2) (Sharma et al., 2021).

Data analysis

Raw data were exported to Microsoft Excel (Microsoft Corp, Redmond, WA, USA) for analysis. To analyse the data a mixed-methods approach was used, with frequency, rate and rank analysis performed on closed questions and inductive qualitative content analysis (Armitage et al., 2024; Elo & Kyngäs, 2008; Field et al., 2021) for open question responses. Rating questions used 7-point and 5-point Likert scale response anchors. Similar to previous studies (Armitage et al., 2024; McCall et al., 2014, 2016; Querido et al., 2022), points were attributed for each rating, with the highest rating awarded the most points and the lowest rating awarded one point. The total points were summed and ranked from highest to lowest. Inductive content analysis of open questions first involved data familiarisation, then coding and refining into similar meaning units and higher-order concepts. Themes were generated and reflected upon by the research team until consensus

was reached (Armitage et al., 2024; Field et al., 2021). Code themes with frequency counts and occurrence statistics are presented in ESM 3.

Results

Participants

In total, 81 practitioners completed the survey. Practitioner job titles included 'Head of' ($n = 34$, 42%), 'First Team' ($n = 15$, 19%), and 'Director of' ($n = 5$, 6%). The most reported leagues worked in were English Championship ($n = 21$, 26%), English Premier League ($n = 13$, 16%), United States of America – Major League Soccer ($n = 9$, 11%). Respondent demographics are presented in Table 1.

Injury surveillance

Figure 1 illustrates the frequency of responses regarding the roles responsible for injury surveillance. For data collection systems, 43% ($n = 35$) reported developing their own 'using other software' with six different software named (Microsoft Excel, Google Sheets, Microsoft

Table 1. Respondent demographics.

		Responses (%)
Years Experience	<5	15 (19%)
	6–10	27 (33%)
	11–15	27 (33%)
	16–20	9 (11%)
	>20	3 (4%)
Highest Academic Qualification	Bachelor's	10 (13%)
	Master's	56 (70%)
	Master's Candidate	1 (1%)
	PhD	9 (11%)
	Sports Medicine MD	1 (1%)
	Professional Doctorate	1 (1%)
	Doctor of Physical Therapy (DPT)	2 (2%)
Country of Work	Missing Data	1 (1%)
	Australia	1 (1%)
	Belgium	4 (5%)
	Brazil	1 (1%)
	China	1 (1%)
	Cyprus	1 (1%)
	Denmark	1 (1%)
	England	37 (46%)
	France	4 (5%)
	Germany	1 (1%)
	Greece	4 (5%)
	Hungary	1 (1%)
	Japan	1 (1%)
	Netherlands	2 (2%)
	Norway	3 (4%)
	Poland	1 (1%)
	Portugal	1 (1%)
	Saudi Arabia	2 (2%)
	Scotland	1 (1%)
	Spain	1 (1%)
	Sweden	1 (1%)
	Switzerland	2 (2%)
	Turkey	1 (1%)
	United States of America	9 (11%)

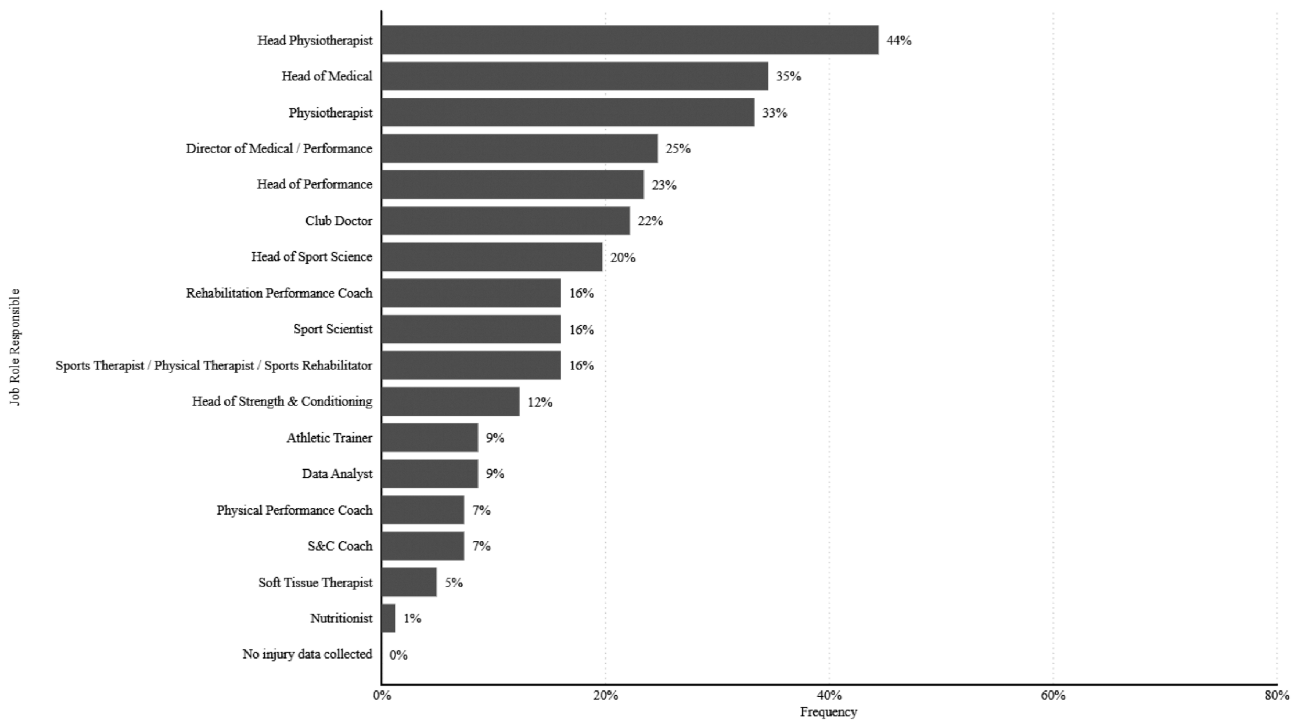


Figure 1. Role(s) responsible for injury data collection.

PowerBI, Orreco, Askamon and SAP), 31% ($n = 25$) reported developing their own club-specific system and 25% ($n = 20$) selected 'other AMS' (athlete

management system) with thirteen different AMS disclosed (Kitman Labs, Benchmark54, Smartabase, XPS, Apollo, TeamWorks, TrainMyAthlete, Action Apps,

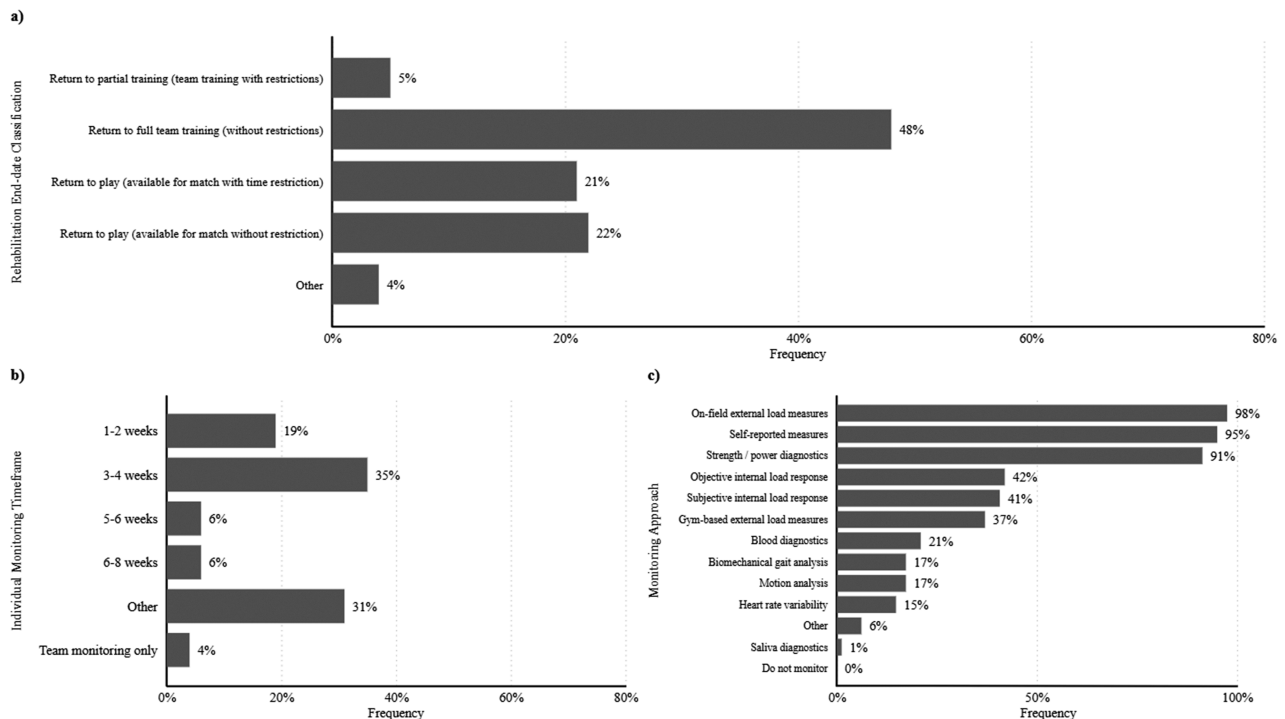


Figure 2. A) rehabilitation end-date classification, b) on-field individual load monitoring timeframe post-rehabilitation, c) monitoring approaches for injury risk.

Athlete Record Management System, Opteamal, Openfield, TalentX and Edge10).

The timepoint practitioners classify as the end-date of rehabilitation is shown in Figure 2a. When 'other' was selected ($n = 3, 4\%$) practitioners provided further classifications such as 'returned to play 90 mins multiple times' and '4–6 weeks of secondary injury prevention'. Following full RTT 95% ($n = 77$) of practitioners monitor the on-field training load individually, with timeframes used shown in Figure 2b. Content analysis of the 31% ($n = 25$) selecting 'other', highlight the timeframe being based upon injury severity and player factors (e.g., age, injury history) (ESM 3). Additional individual, injury-specific monitoring is reportedly completed by 81% ($n = 66$) of practitioners following RTT with open answer responses indicating injury site strength, injury-specific external load metrics (e.g., sprint distance for hamstring injuries) and subjective feedback being important (ESM 3) in the post-rehabilitation phase. Monitoring approaches used are shown in Figure 2c with 'player conversations' highlighted as a further approach from additional content analysis (ESM 3).

Practitioner awareness and use of SIC models is indicated in Figures 3a and 3b along with the perceived importance of inter-injury relationships (Figure 3c). Most practitioners ($n = 70, 87\%$) report tracking inter-injury relationships (Figure 3d).

On-field rehabilitation and return-to-play criteria

The most common method of monitoring on-field external load was GNSS, with 99% ($n = 80$) using this method. Inertial measurement units (IMU) ($n = 4, 5\%$), light detection and ranging systems ($n = 3, 4\%$) and optical tracking systems ($n = 2, 3\%$) the next most common. Table 2 shows the external running load metrics reportedly used during OFR, categorised into volume/frequency, intensity and density categories (Dixon et al., 2026b). Derived from open answer questions specific external running load RTT and RTP targets are provided in Table 3. The use of relative percentage thresholds, i.e., using individual or positional benchmarks from training or match data, was the most coded theme for RTT and RTP external load targets (ESM 3). Table 4 shows the ranked perceived importance of rehabilitation components at different timepoints.

Decision-making process

Table 5 shows the roles responsible when making the RTT and RTP decision, with most practitioners reporting use of a shared decision-making approach. Despite this, communication was identified as a key theme for development to positively impact rehabilitation procedures

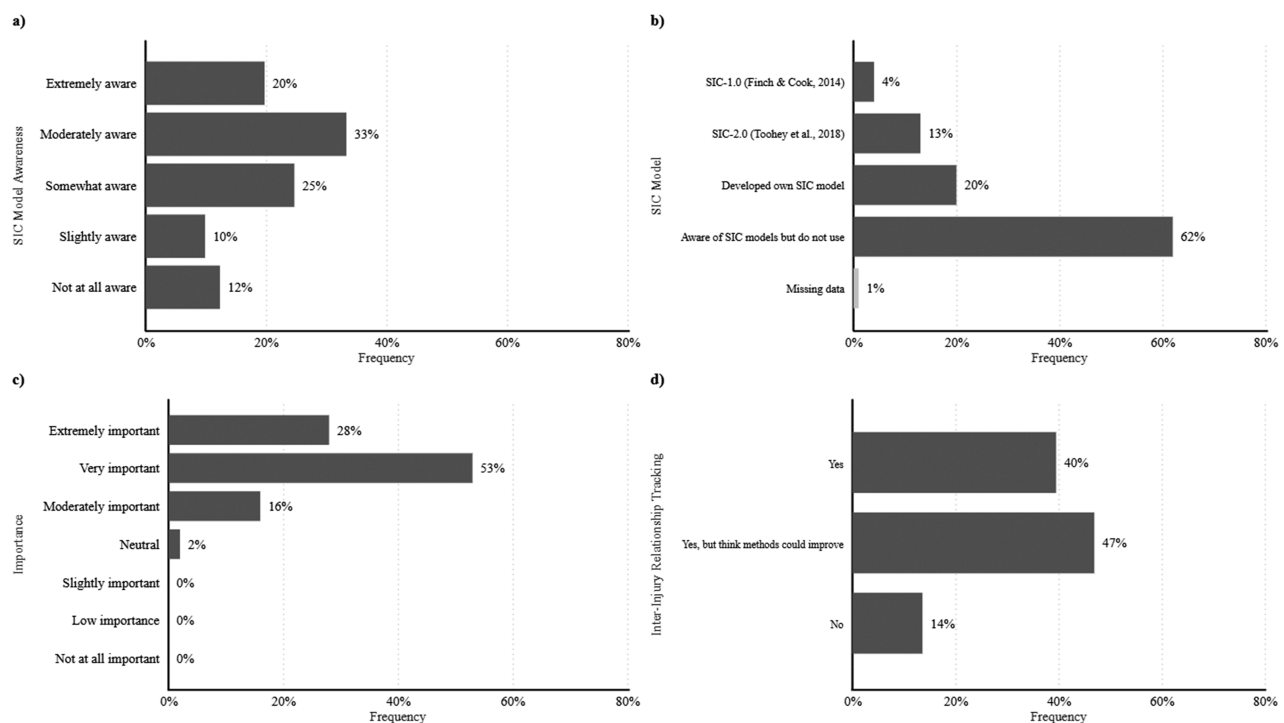


Figure 3. Awareness (a) and use (b) of subsequent injury classification models and inter-injury relationship perceived importance (c) and tracking (d). Note: $n = 71$ for b), respondents ($n = 10$) were excluded from b) if 'not at all aware' was selected for a). Abbreviations: SIC, subsequent injury classification.

Table 2. External running load metrics used for on-field rehabilitation.

Volume / frequency metrics		Intensity metrics		Density metrics	
Metric	Count (%)	Metric	Count (%)	Metric	Count (%)
Total distance	79 (98%)	Total number of Hi accelerations	69 (85%)	Total distance per min.	67 (83%)
Total number of accelerations	78 (96%)	Total number of Hi decelerations	69 (85%)	Absolute HSR per min.	38 (47%)
Total number of decelerations	78 (96%)	Absolute sprint distance	66 (81%)	Absolute sprint distance per min.	33 (41%)
Total number of sprint efforts	68 (84%)	Absolute HSR distance	64 (79%)	Accelerations per min.	33 (41%)
Total number of HSR efforts	60 (74%)	Absolute max. velocity	63 (78%)	Decelerations per min.	33 (41%)
Total number of RHIE	41 (51%)	Relative max. velocity	61 (75%)	Relative HSR per min.	22 (27%)
Player Load	23 (28%)	Relative sprint distance	40 (49%)	Relative sprint distance per min.	18 (22%)
Total number of HMP efforts	14 (17%)	Relative HSR distance	37 (46%)	Explosive distance per min.	18 (22%)
Equivalent distance	10 (12%)	Explosive distance	33 (41%)	Hi accelerations per min.	17 (21%)
Custom Player Load metric	1 (1%)	Hi acceleration distance	27 (33%)	Hi decelerations per min.	17 (21%)
TPI	1 (1%)	Hi deceleration distance	27 (33%)	Player Load per min.	12 (15%)
Acceleration distance	1 (1%)	HMLD	24 (30%)	HMLD per min.	11 (14%)
Deceleration distance	1 (1%)	Absolute max. acceleration magnitude	24 (30%)	Hi deceleration distance per min.	10 (12%)
Acceleration load	1 (1%)	Absolute max. deceleration magnitude	24 (30%)	Hi acceleration distance per min.	9 (11%)
		Relative max. acceleration magnitude	18 (22%)	None	1 (1%)
		Relative max. deceleration magnitude	18 (22%)	TRIMP per min.	1 (1%)
		Total number of moderate/Hi COD	1 (1%)	Hi efforts per 0–30 s rest	1 (1%)
		Mechanical power	1 (1%)	Acceleration load per min.	1 (1%)
		Kilojoules (w/kg)	1 (1%)	Missing data / did not answer	6 (7%)

Abbreviations: HSR, high speed running; RHIE, repeated high intensity efforts; HMP, high metabolic power; TPI, external load metric provided by a specific GPS company; Hi, high intensity; max., maximum; HMLD, high metabolic load distance; COD, change of direction; w/kg, watts per kilogram; min., minute; TRIMP, training impulse; s, seconds.

(ESM 3). The ranked perceived importance of different influential components of the RTT and RTP decision-making process is illustrated in Table 6.

When exploring inclusion of the player as a key stakeholder, most practitioners report discussing the OFR programme with the player, agree with the player having input and tend to include the player in decision-making (Figure 4). Key reasons given were ensuring awareness and understanding of rehabilitation planning and to increase player engagement or 'buy-in'. Further inductive content analysis of practitioners' rationale for OFR programme discussion can be found in ESM 3.

Discussion

The current study provides novel insights into the injury surveillance, OFR practices and RTP criteria used in male professional football, including influential factors involved in RTT and RTP decision-making. Key findings of the investigation demonstrate variability in classification of the rehabilitation end-date, post-rehabilitation timeframes and, despite a perceived importance of inter-injury relationships, potential disparity between subsequent injury classifications and reporting. For OFR, the range of specific metrics used during rehabilitation and variability in objective targets set to inform RTT and RTP decisions is highlighted, demonstrating potential lack of consensus and availability of validated objective criteria. Most practitioners report using a shared decision-making approach, including input from the player throughout rehabilitation, however, improving interdepartmental communication is a key area to continue to

evolve processes. The findings of the current study may be beneficial for practitioners when evaluating and developing internal rehabilitation procedures that could result in the enhanced delivery of rehabilitation processes, and positive outcomes for RTT and RTP.

Injury surveillance

Senior medical roles are predominantly designated as responsible for injury data collection demonstrating the perceived importance of injury surveillance (Figure 1). Furthermore, 70% ($n = 57$) of respondents selected more than one role being responsible indicating a multidisciplinary approach. These findings demonstrate that injury surveillance appears to be led by senior medical practitioners, although it is no longer solely the responsibility of medical staff, with integration of performance and medical disciplines. Such an approach promotes collaboration between departments; however, an identified challenge within multidisciplinary sport departments is inconsistent information sharing (King, Yiannaki, et al., 2024). Therefore, caution is advised to ensure alignment in definitions and injury classifications to minimise possible bias and variability to enhance quality of care with clear roles and consistent communication.

Across clubs, the results of the study show a range of different AMS and software being used to collect data with variability in classification of the end-date of rehabilitation and individual monitoring timeframes used post-rehabilitation (Figure 2). These findings highlight a possible lack of standardised criteria being available and support the notion that rehabilitation does not have

Table 3. Current practices of specific external running load and training targets used during return-to-training (RTT) and return-to-play (RTP) decision-making.

	Acute / In-session	
	RTT Targets	RTP Targets
Training Relative	• '2 × 90% MaxV exposure' • '80% of an average of a performance day (MD-3 - with highest HSR and Accel/Decel volume)' • '95%+ max v, 95%+max acc/decel' • 'At least 85% of his explosive metrics pre-injury' • 'A max. training session for all metrics' • '90% + Max Velocity' • '<3 weeks... 75% of a typical "hard" training session. 4–8 weeks... minimum exposure of 100% of a typical "hard" session' • 'The equivalent of his personal or positional average for the historical hardest training session of the week' • 'Utilizing worst case scenarios and sessions focused more on densities that match a match or hardest training drills' • '>90–95% MV+ repeated exposures across week' • 'General range based on training day/progression: TD (m): 3000–5000 HSR (m): 0–300 Sprint (m): 0–50 at ~80% top speed Accel/Decel (#): 10–35' • 'x2 Main sessions aiming for 90% of total team load and 100% total team load metrics' • '>90% Max Velocity' • 'High Acc/decel actions of peak Training Sessions' • 'TD, HSR dist, Sprint dist, Acc#, Dec#... (60% in one session)' • '60% of match load for total distance, high speed running, sprint distance, explosive distance' • 'Over 85% of absolute max acceleration and deceleration magnitude' • 'A percentage of match load equivalent to 60 mins of match play' • '70% of match day high-speed running load' • '100% match load in one session (TD 70–80%)' • 'Most > 85% match load' • '70% relative match load for all metrics' • 'At least 60% of a Match Load in all metrics' • '4–8 weeks ... >75% exposure to a player's "average match load". >12 weeks ... targets fit with a more traditional "WCS" model' • 'Within 10% of relative training and match load metrics' • '5 min worst case scenario' • '>60% TD/HSR/Z6/HIA/HID Match sim format' • '>80% peak match values' • '55–60%+ MD Total distance 70–90%+ MD High Speed Running 95%+ Max Velocity 70–90%+ of MD Sprint Distance 50–60%+ of MD Explosive Distance 70–90%+. High Acc/decel actions of MD Acc/Dec magnitude > 90%'	• 'Try to reproduce the same targets for RTT but get them from training sessions not just rehab sessions' • 'TD (m): 5000–7000 HSR (m): 300–600 Sprint (m): 50–100 at +90% top speed Accel/Decel (#): 40–60' • 'Need to arrive to 100% of max performance metrics prior to injury in a structure of a microcycle' • '>80% PMV'
Match Relative	• 'Match play data hit at 60 mins or greater' • 'Absolute metrics compared to positional avg. relative metrics compared to premorbid match day metrics' • 'A minimum of 60 minutes of match play in targeted metrics' • '80% of average of full game load' • '% of max match load's worth of minutes that they will be required to play' • 'Must hit session equivalent to 60 min match volume and density. Also, must hit position specific peak periods for HSR/Acc+Dec' • '>90% match loads' • 'Previous game targets should be reached in training' • 'Rolling average match data relevant to minute prescription' • 'To achieve, at minimum, the equivalent external load/intensities of 45 minutes' worth of match play' • 'Match load and worst-case scenario intensity' • 'Rough guide (again dependent on length of time out) Acute: >80% game load covered across HSR/Z6/HIA/HID'	

(Continued)

Table 3. (Continued).

Chronic		
	RTT Targets	RTP Targets
Training Relative	• '120% of average weekly load across the week' • '110% max weekly load' • 'A lower bound week for the weekly load' • 'Approx 80% volume of training week. 100% HSR' • 'Accumulate total distance metrics up to 90% on 2 weeks' • '110% of their preinjury weekly training load' • '>80% of weekly average load (TD/HSR/Z6/HIA/HID)' • 'TD, HSR dist, Sprint dist, Acc#, Dec# regular weekly load (60% in one session)'	• 'Same as RTT but also completing 3–4 team training sessions. However, depends on match importance, player readiness and season phase' • 'Training time with squad – length determined by length of time loss from injury' • 'Returned to previous weekly training load metrics' • 'Percentage of weekly loads' • 'Weekly volume and individual runs should be 10–15% above preinjury data. Intensity and explosive metrics should be above 90% preinjury data' • 'GPS profiling for normal weekly loading (team training) + normal match day loading' • 'The club have the rule one week of full team training before being able to be selected' • 'Complete 1–2 full Team microcycles' • 'Depends on time-loss, shorter injury, average week training load completed with session highs as previous. Longer time loss, higher bound of weekly training load' • 'Complete at least a full week of training with the team with normal individual metrics' • 'For moderate term injuries involved in full, un-modified team training for 1–2 weeks where possible. For longer term injuries (ACLs etc.) involved in full, un-modified team training for 4 weeks' • 'Achieve a full week of his personal or positional training load' • 'Typically, 2 weeks full training unrestricted. Completed intensive & extensive days especially 11v11' • 'Chronic: 80–100% average training week (TD/HSR/Z6/HIA/HID) Max velocity/accel > 95%' • 'Match previous training loads. Exposure to worst case scenarios' • '1.5–2x game load' • 'Overload match and match week metrics'
Match Relative	• 'Typically, 2.5–3 x match values' • '250% of match day total distance across a week' • 'Average training week & between 2–3 game loads based on the individual' • '200% of match day metrics across a week' • '230–250% of MD Total distance 150–170%+ of MD High-Speed Running 140–160%+ of MD Sprint Distance 210–230%+ of MD Explosive Distance 90–110%+ High Acc/decel actions of Weekly Load 90–110%+ High Acc/decel actions of Peak MD'	

Abbreviations: MaxV, maximum velocity; MD, match day; HSR, high speed running; accel or acc, accelerations; decel or dec, decelerations; TD, total distance; dist, distance; HIA, high intensity actions; HID, high intensity distance; PMV, peak maximal velocity.

a definitive endpoint (Dixon et al., 2025). Consensus is required to provide clear definitions, classification and monitoring of key dates throughout the rehabilitation process of different injuries (e.g., return-to-run, modified RTT, full RTT, restricted RTP, full RTP). Consensus may improve consistency in injury data collection and give deeper insights into rehabilitation phases specific to differing pathologies and progressive, injury-specific loading strategies required to optimise outcomes. Standardised criteria are crucial for reliable epidemiological research (Waldén et al., 2023) and the variation in post-rehabilitation monitoring timeframes may not accurately capture the risk of subsequent injury or identify longer-term deficits.

For monitoring approaches to understand injury risk, a multidimensional approach is recommended (Buchheit & Hader, 2025). The results of the current study demonstrate a possible discrepancy between the use of external and internal load monitoring (Figure 2). Of the respondents, 98% ($n = 79$) reported using on-field external load measures (e.g., GNSS); conversely, 42% ($n = 34$) and 41% ($n = 33$) reported using objective (e.g., heart rate) and subjective (e.g., sRPE) internal load response measures. External load measures provide insights into the volume and intensity of physical movement outputs, whereas internal load is vital for understanding the biological stresses that drive adaptations and inform recovery status (Buchheit & Hader, 2025). Practitioners reported using monitoring tools to understand short- and long-term responses to applied load through self-reported measures (e.g., wellness, soreness) (95%, $n = 77$) and strength/power diagnostics for neuromuscular response and adaptation (e.g., isometric testing) (91%, $n = 74$). Although outside the scope of this study, reduced use of internal load monitoring may be due to constraints practitioners are working within (e.g., financial, player engagement); however, excluding internal load measures may undermine the value of other

load/response measures (Buchheit & Hader, 2025). Further investigation is warranted into constraints and contexts that impact internal load data collection to inform possible solutions aiming to reduce the burden on players and practitioners, whilst improving integration of internal load measures, through technological advancements.

The current study illustrates the reported awareness and use of SIC models by practitioners in male professional football (Figure 3). Despite a lack of use of SIC models, practitioners perceive inter-injury relationships (i.e., how an index injury modifies the likelihood, mechanism, severity or location of a subsequent injury) to be of high importance (Figure 3c). For respondents demonstrating awareness of SIC models, despite 87% ($n = 70/71$) reporting the tracking of inter-injury relationships (Figure 3d), Figure 3b shows 62% ($n = 44/71$) do not use SIC models and 20% ($n = 14/71$) report developing their own. These results demonstrate a translational gap between research and practices, suggesting informal awareness and use of specified classification in subsequent injury tracking do not coincide, indicating that practitioners are developing systems that fit internal workflow rather than using standardised and validated frameworks. Such findings demonstrate disparity between research and applied practices, indicating a need to develop a validated, football-specific, SIC model building upon current recommendations (Waldén et al., 2023). In male professional football in Qatar, 34% of injuries followed a subsequent injury logic with a particularly high rate in lower limb muscles (Tabben, Chamari, et al., 2025). Although subsequent logic does not necessarily imply a causal link, better understanding of subsequent injuries is required (Bitchell et al., 2020; Finch et al., 2017) particularly in the post-rehabilitation phase when there is a heightened risk of subsequent non-contact injury (Dixon et al., 2025). Future studies investigating the

Table 4. Ranking of perceived importance of rehabilitation components pre-return-to-training (RTT) and during the post-rehabilitation phase.

Ranking	Pre-RTT		Post-Rehabilitation Phase	
	Component	Points	Component	Points
1	Clinical markers	503	Positional specific and game model replication	514
2	Player psychological readiness	484	Player psychological readiness	513
3	Strength/power development	469	High speed running/sprint metrics	510
4	Nutritional adherence	458	Explosive running metrics	509
5	Load response strength/power diagnostics	438	Clinical markers	502
6	Player metabolic fitness level	435	Running volume	485
7	High speed running/sprint metrics	426	Player metabolic fitness level	478
8	Explosive running metrics	408	Nutritional adherence	476
9	Running volume	408	Load response strength/power diagnostics	459
10	Visual cognitive and attentional challenges	377	Visual cognitive and attentional challenges	441
11	Positional specific and game model replication	357	Strength/power development	425
12	Other load response diagnostics	332	Other load response diagnostics	362

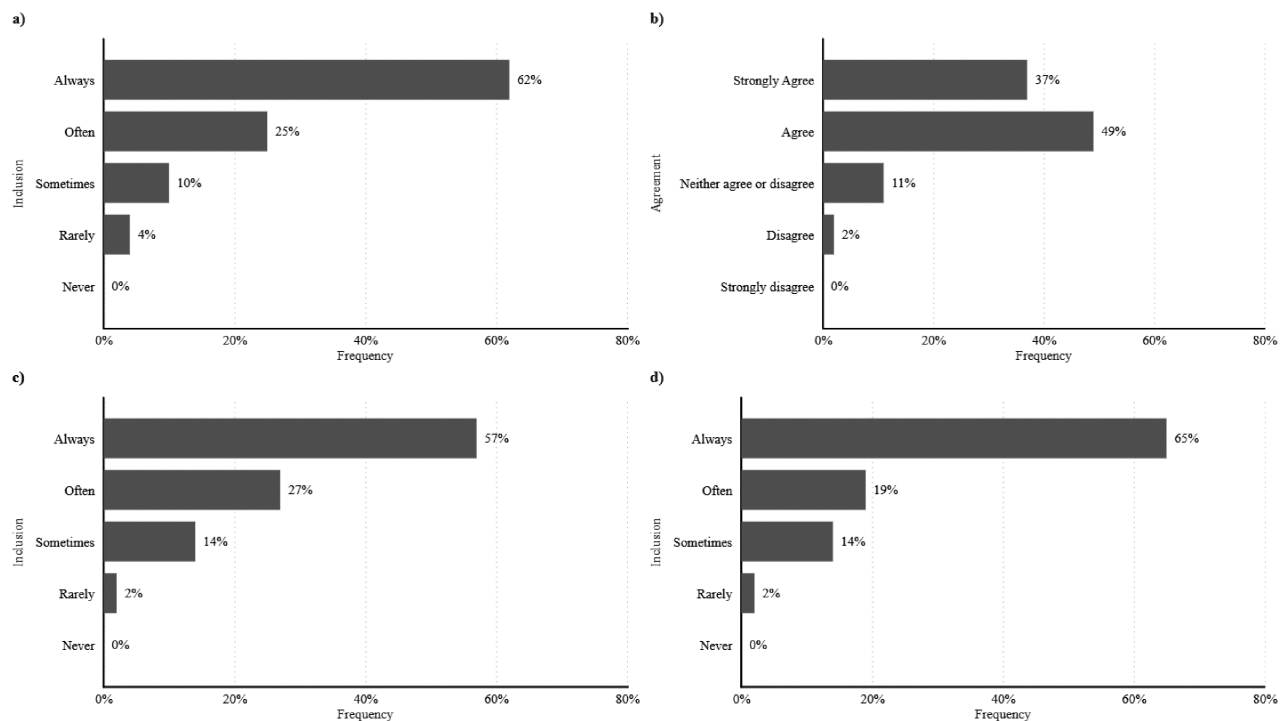
Table 5. Roles responsible for the final return-to-training (RTT) and return-to-play (RTP) decisions during rehabilitation.

RTT decision		RTP decision	
Role	Responses (%)	Role	Responses (%)
Shared decision	49 (60%)	Shared decision	53 (65%)
Head of Medical	10 (12%)	Head Coach/Manager	10 (12%)
Head of Performance	4 (5%)	Head of Medical	5 (6%)
Director of Medical/Performance	4 (5%)	Head of Performance	5 (6%)
Physiotherapist	4 (5%)	Player	2 (3%)
Head Coach/Manager	3 (4%)	Director of Medical/Performance	1 (1%)
Club Doctor	2 (3%)	Club Doctor	1 (1%)
Player	2 (3%)	Physical Performance Coach	1 (1%)
Physical Performance Coach	2 (3%)	Physiotherapist	1 (1%)
Head Physiotherapist	1 (1%)	Missing data / did not answer	2 (3%)

Table 6. Ranking of influential decision-making factors for return-to-training (RTT) and return-to-play (RTP).

RTT			RTP	
Ranking	Influential factor	Points	Influential factor	Points
1	Player injury history	344	Player subjective readiness	343
2	Achieving strength/power targets	324	Player physical fitness	337
3	Player physical fitness	324	Achieving GNSS/GPS running targets	335
4	Player subjective readiness	322	Player injury history	327
5	Achieving GNSS/GPS running targets	315	Achieving strength/power targets	319
6	Injury timeframe	291	Number of team training sessions completed	305
7	Specialist/surgeon opinion	282	Player importance to team	298
8	Player importance to team	275	Injury timeframe	295
9	–	–	Match importance	291
10	–	–	Specialist/surgeon opinion	261

Abbreviations: GNSS, global navigation satellite systems; GPS, global positioning system.

**Figure 4.** Player involvement in the rehabilitation process. a) on-field rehabilitation programme discussion, b) practitioner agreement with player inclusion in the planning, player inclusion in the c) RTT and d) RTP decision-making process. Abbreviations: OFR, on-field rehabilitation; RTT, return-to-training; RTP, return-to-play.

mechanisms, severity and type of subsequent injury and the influence of modifiable risk factors (e.g., match exposure) would be beneficial to further inform practices and understand potential vulnerability following RTP from specific injuries.

On-field rehabilitation and return-to-play criteria

External load metrics are an important objective criterion in OFR frameworks (Buckthorpe et al., 2019b; Mitchell & Gimpel, 2024; Taberner, Allen, et al., 2019), although suggested metrics lack evidence and are based on anecdotal experiences (Dixon et al., 2026a). The relationship between load and injury risk is likely associative and not causal (Impellizzeri et al., 2020), however, in the absence of empirical evidence, insights into clinical expertise are important to progress evidence-based practices (Armitage et al., 2024; Fanchini et al., 2020). The current study supports previous suggestions that wearable GNSS are the most frequently used method for monitoring OFR (Armitage et al., 2024). The current results highlight the range of specific metrics being used by practitioners during rehabilitation (Table 2) and the objective OFR targets set to inform RTT and RTP decisions (Table 3). As reported in a previous study, in uninjured players (Akenhead & Nassis, 2016), the large number of variables may be reflective of the emergence of multiple different metrics and a lack of empirical support for their validity, reliability and usefulness. There is little consensus on which variables are most appropriate for football training (Akenhead & Nassis, 2016) and an insufficient understanding of how to define physical and psychological thresholds for RTP (Eppinga et al., 2025). Differing injury pathologies and practitioners' adaptive expertise may account for a degree of variability in OFR criteria used, although it is clear a strong evidence base, to inform practices, is lacking. Despite widespread use of GNSS, there is a distinct lack of agreement on application, and the results of this study demonstrate this to be evident in the context of rehabilitation and in setting OFR targets to inform RTT and RTP.

Within the survey external load metrics used for OFR were categorised into volume/frequency, intensity and density categories (Dixon et al., 2026b). Studies have indicated that total distance (TD), absolute speed outputs, absolute sprint distance (SD), accelerations and decelerations are perceived as important metrics during OFR (Akenhead & Nassis, 2016; Armitage et al., 2024) further supported by their reported use in the current study (Table 2). Less than half of respondents reported using relative SD ($n = 40$, 49%) and relative HSR ($n = 37$, 46%) despite there being a strong rationale for the

application and use of relative thresholds (Akenhead & Nassis, 2016; Pimenta et al., 2025). For measuring SD and HSR, relative intensities have been shown to have greater association with non-contact lower body injury (Aiello, DiClaudio, et al., 2023; O'Connor et al., 2020). For acceleration and deceleration magnitude 22% ($n = 18$) reported using relative approaches to capture the intensity of these efforts even though it is evident that global thresholds do not account for individual capacities and may provide an inaccurate representation of the relative intensity of these events (Abbott et al., 2018; Silva, Nakamura, Praça, et al., 2024; Silva, Nakamura, Serpiello, et al., 2024). Research is required concerning the application of absolute and relative thresholds for high-intensity actions to best inform training prescription and progressive overload throughout rehabilitation, particularly, as the intensity of professional football increases and these actions become increasingly important to monitor accurately (Allen et al., 2024; Harper et al., 2021).

For density metrics, only TD per minute was used by more than half the respondents ($n = 67$, 83%). The results appear to show reduced usage of density metrics, such that 25% ($n = 20$) reported using only one in rehabilitation, compared to the volume/frequency and intensity categories, in which all practitioners ($n = 81$, 100%) reported using multiple metrics. One respondent (1%) stated that density metrics were not used, and six participants (7%) were missing data or did not answer the question regarding density metric usage. This indicates that further research into the density of actions, and the application of these metrics, is required to inform practice. For example, a change of direction (COD) density metric has been proposed in youth players, indicating the COD demands of match-play with implications for rehabilitation progressions (Morgan et al., 2025). Evolving demands of professional football are evident, with moderate increases in density of high intensity running metrics (e.g., HSR per minute) reported (Allen et al., 2025) increasing the biomechanical demands of match-play. Differing densities of external load may impact the internal physiological and biomechanical load-response pathways. This is important during rehabilitation of different pathologies, as varying biomechanical demands induce different mechanobiological tissue responses (Khan & Scott, 2009; Stańczak et al., 2025). Therefore, the nature and velocity of load and magnitude of energy transfer are important factors to consider (Stańczak et al., 2025). There is a need to improve our understanding of biomechanical loads experienced and the impact this may have on rehabilitation processes. For example, the use of external density metrics, and the impact on internal biomechanical load

for different structures, has not yet been fully quantified and may help inform the integration of rehabilitation into modified team training drills and allow practitioners to accurately monitor and progressively overload specific injured structures as part of sport-specific, team training.

The results of the current study illustrate the lack of consensus and the range of external running load targets being used in practice to inform RTT and RTP decisions (Table 3). 'Training load' has been shown as one of the most frequently used criteria progressing a player through the final stages of rehabilitation, although little is currently known about the relationship between training load and RTP (Dunlop et al., 2020). Metrics of interest are emerging for specific injury pathologies, for example, acceleration and deceleration distance after anterior cruciate ligament (ACL) reconstruction (Picinini et al., 2025); however, acknowledged limitations are a lack of empirical evidence and an absence of pre-injury data and post-OFR information (Picinini et al., 2025). Further research is required to better inform external load targets prior to RTP, resulting in positive outcomes. Improved understanding of the use of pre-injury data, the influence of contextual factors (e.g., playing position, game model) and individualised post-RTT/RTP load exposure, and response to applied load, is vital to support practitioners. Table 4 shows a change in the ranking of the perceived importance of running metrics and positional specific and game model replication from pre-RTT to the post-rehabilitation phase, indicating an acceptance that exposure to sport-specific load is crucial as players near RTP. The number of team training sessions completed was not ranked highly as an influential factor in the RTP decision, despite evidence that this may decrease subsequent injury risk (Bengtsson et al., 2020). The need for further detail of the content of training sessions prior to RTP, from a physical, technical, biomechanical, physiological and cognitive load perspective, rather than the number of training sessions completed, may support the RTP decision. More detailed and representative information, through a performance-model lens reflecting the true requirements for RTP, alongside weighted injury-specific metrics, could aid practitioners' understanding of the protective effect of training load exposure, particularly when derived from sport-specific and mechanism of injury (MOI) tasks.

The benefit of pathology-specific rehabilitation frameworks and programming, considering severity, anatomical structure involved, injury location, healing response and MOI, has been highlighted (Pedret et al., 2025; Perna et al., 2025). To improve understanding of subsequent injury risk and potential inter-injury relationships it is important to investigate the effect injury site

and severity may have on altering muscle coordination patterns, tissue forces, muscle fatigue and biomechanics. Studies demonstrate altered muscle activation patterns post-injury (Einarsson et al., 2021) and the link between anatomical segments has the potential to influence biomechanics and mechanical strain (Bramah et al., 2024). Movement mechanics are a modifiable risk factor for injury, however, investigation is needed into the associations of specific kinematic parameters and injury susceptibility (Bramah et al., 2024). In the current study, for monitoring approaches used to understand potential injury risk, biomechanical gait analysis and motion analysis were only employed by 17% ($n = 14$) of respondents each. It is important to acknowledge possible practical barriers to implementation (e.g., equipment availability, expertise, time constraints) may partially explain low-uptake; however, longitudinal monitoring to understand whole-body movement strategies for key athletic skills, such as acceleration (Wild et al., 2022), sprinting (Bramah et al., 2025), cutting (Dos'Santos et al., 2019) and deceleration (DiPaolo et al., 2021; Wolfe et al., 2023), to detect possible changes in response to influencing factors (e.g., injury), may be beneficial. Injuries, and treatment strategies (e.g., ankle strappings) have been demonstrated to change biomechanics and resultant loading rate of ground reaction forces (Utku et al., 2024), potentially altering applied mechanical strain and injury risk. Deeper insights into injury-related biomechanical modification, altered muscle activation and subsequent tissue forces throughout rehabilitation are vital, alongside understanding applied load, treatment strategies used and individual responses in preparation for RTT. These insights may help guide applied practices, alongside practitioner experience, and help inform rehabilitation programming and the development of injury-specific RTT/RTP targets incorporated into pathology-specific rehabilitation frameworks.

Decision-making processes

Previous injury is perceived to be the most important intrinsic factor for injury risk (McCall et al., 2016) and, in the current study, player injury history was ranked most important when making the RTT decision, with achieving strength/power targets and physical fitness equal second (Table 6). For the RTP decision player injury history drops to the fourth most influential factor and achieving strength/power targets to fifth, with player subjective readiness, physical fitness and achieving running targets deemed most influential (Table 6). Similar to previous studies (Armitage et al., 2024; Dunlop et al., 2020), a shift in the perceived rehabilitation priorities is demonstrated through different phases, from injury-

based factors (i.e., restoring strength and function) to individual player psychological and physical readiness (i.e., subjective readiness, running targets). These results indicate, as rehabilitation progresses, practitioners interchange from a medical-based to a performance-based model, with rehabilitation frameworks (Mitchell & Gimpel, 2024) influencing practices.

Development of rehabilitation frameworks is crucial to positively influence practices and decision-making. Current frameworks provide a stepwise approach (Buckthorpe et al., 2019b; Mitchell & Gimpel, 2024; Taberner, Allen, et al., 2019), however, a multicomponent, adaptable progression framework (Cranswick et al., 2025) has been proposed. In practice these types of approaches may act as a multicomponent continuum to support practitioners blending phases reflecting contemporary performance-rehabilitation processes (Dixon et al., 2025). Flexibility of frameworks is essential to incorporate various interacting factors across multiple disciplines (Dixon et al., 2026a; Forsdyke et al., 2025). For example, profiling psychosocial status, alongside physical status, may aid decision-making (Forsdyke et al., 2025). Therefore, flexible, interdisciplinary rehabilitation frameworks may be crucial to develop injury specific RTT and RTP criteria, inform decision-making and understand holistic player readiness.

Given the perceived importance of achieving strength/power targets prior to RTT (Tables 4 and 6), strength/power training integration into rehabilitation frameworks requires future investigation. The need for better understanding of strength development's impact on the healing process and effective concurrent training strategies (i.e., strength programming combined with OFR) may be vital. Strength, power and endurance contribute to the neural and mechanical characteristics required for muscle function and involve different contractile behaviours, force expression and motor activation patterns (Cranswick et al., 2025). Further investigation to inform the restoration and development of these qualities through different phases of rehabilitation, considering the sport-specific physical skills and capacities required (e.g., deceleration) (Sheth & Elis, 2025), and loading strategies used (e.g., early low jerk ramping isometrics) (Power et al., 2023) specific to injury pathology and potential healing impact, may aid decision-making.

Table 5 indicates use of shared decision-making; however, these results are lower than previous research (Dunlop et al., 2020) and inductive content analysis (ESM 3) illustrated communication as an emerging theme for perceived improvement within rehabilitation processes. Communication has been highlighted as a key extrinsic risk factor for injury (Ekstrand et al.,

2023; McCall et al., 2016) and the association between department processes, internal communication quality and injury burden is supported (Ekstrand et al., 2025; Odetoynbo & McKay, 2025). Given changing communication methods, expanding department sizes (Lewin & Lewin, 2018) and the emergence of artificial intelligence and data driven decision-making (Mateus et al., 2025), the number, and complexity, of communication lines is increasing. Establishing clear communication structures, decision pathways, shared terminology and individual skillset use, whilst emphasising exchange and integration across all departments to ensure collective understanding (McLean et al., 2025), is crucial to achieve shared situational awareness promoting effective communication. Research investigating MDT sizes, structures, internal communication pathways and the integration of effective communication strategies is required to positively impact rehabilitation processes.

The results of the current study indicate a player-centred approach is widely utilised (Figure 4). Communication between all stakeholders is important, and better relationships between head coaches, medical and performance departments and the player can facilitate the process (J. King et al., 2019) with player involvement vital to aid engagement and trust (J. King et al., 2019). Further research investigating player's perceptions of the process would provide an integral perspective to help understand if player and practitioner viewpoints conform. Given the multicultural composition of professional football squads, investigating and understanding cultural differences of player perceptions may help influence practices, delivery of rehabilitation programmes and potential cross-cultural training needs for practitioners.

For organisations to operationalise the study findings, the integration of injury surveillance, RTT and RTP criteria into decision-making processes is vital. Rehabilitation is complex and dynamic involving numerous stakeholders in a multi-criteria decision-making process. Decision science research suggests practitioners should consider weighting criteria to provide a transparent decision-making process (Kizielewicz et al., 2024) and is recommended in healthcare settings (Marsh et al., 2016). Implementation of structured, weighted criteria-based frameworks, informed by injury surveillance, to standardise the rehabilitation decision-making process could aid internal workflows and communication channels for all stakeholders involved. These standardised processes could complement individualised rehabilitation programming and RTP criteria, adapted depending on influential contextual factors and injury-specific pathology, including the use of weighted criteria and

probabilistic risk approaches (Shrier, 2015) to inform the decision process.

Limitations

As with previous survey studies (Armitage et al., 2024; Dunlop et al., 2020) level 5 evidence (expert opinion) has been provided, and results may change with emerging evidence and evolving paradigms. Due to the recruitment method, calculating a response rate was not possible. The voluntary nature of the survey increases the risk of selection bias, with potential for self-report bias common to survey methodologies and differences in practitioners' systems and data literacy possibly influencing how practices were reported. Inductive content analysis was performed and consensus reached for derived themes, however, formal intercoder reliability was not assessed. Authors' networks may have influenced respondents and, as the survey was conducted in English only; this may explain the lower number of respondents for non-English-speaking countries, limiting intergroup comparisons. Future research, using multiple languages, may provide further insights and allow for a deeper understanding between different cultures and education systems. The survey targeted current practices in male professional football, research is warranted to understand similarities and differences to rehabilitation practices of other sports and female professional football. An overview of missing data illustrating the number and percentage of missing values (Borg et al., 2022) has been made available (ESM 4). Interpretation of results may have been improved by limiting missing data points with open answer questions generating the highest percentage of missing data. Due to skip logic used in the survey design, certain open answer questions were conditionally displayed and, therefore, not considered as missing data. Open answer questions were qualitatively analysed without imputation with missingness transparently reported. For closed and rate questions, a missing rate of 5% or less is considered inconsequential (Dong & Peng, 2013). In the current study, only one question exceeded this level (7.4%) with all other closed questions demonstrating a missing rate of less than 3%. To minimise impact complete-case analysis was conducted, with missing data treated as missing not at random and thus only data given by responders were analysed.

Conclusion

The aims of the current study were to investigate injury surveillance, OFR practices and RTP criteria in male professional football including influential factors

involved in RTT and RTP decision-making. Key findings of the current study show variability in classification of rehabilitation end-date, post-rehabilitation timeframes, and potential disparity between subsequent injury classifications and reporting, despite perceived importance of inter-injury relationships. The use of multidisciplinary approaches within current practices is demonstrated, although the need for further consensus and clear definitions in terminology and injury surveillance methodology is evident. For OFR, the range of specific metrics used and variability in objective targets set to inform RTT and RTP decisions is highlighted, demonstrating lack of consensus and availability of validated objective criteria. Better understanding of the internal physiological and biomechanical load-response pathways across volume/frequency, intensity and density categories of external load, and inclusion of multiple monitoring techniques, may improve application during rehabilitation. A shared decision-making approach, including input from the player, is utilised however, improving interdepartmental communication is a key area to prioritise. It is important organizations integrate injury surveillance, weighted objective criteria and probabilistic risk approaches into internal decision-making processes to aid rehabilitation outcomes. Further research is recommended to develop pathology-specific guidance informing sport-specific, flexible rehabilitation frameworks accounting for subsequent injury risk, influential contextual factors, individualised training and match exposure, treatment modalities used, biomechanical modifications, psychological readiness and cultural differences. Development of frameworks, combined with practitioner experience and intuition, is vital for rehabilitation practices to continue to evolve.

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Author contributions

CRedit: **Ben Dixon:** Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft; **Jill Alexander:** Conceptualization, Methodology, Supervision, Writing – review & editing; **Damian Harper:** Conceptualization, Methodology, Supervision, Writing – review & editing.

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Consent to participate

Respondents provided informed consent prior to commencing the survey.

Data availability statement

Due to the sensitivity of data collected, all have been anonymised and presented collectively. Where direct quotations have been used, potentially identifiable information has been omitted. The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethics approval

Ethical approval for this research was obtained from University of Lancashire HEALTH ethics review panel (Ref: HEALTH 01241).

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