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# Return-to-play criteria for hamstring injuries in elite European football: a survey of current practice

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**ABSTRACT**

The study aimed to describe which criteria are used by medical and performance practitioners in elite European football to progress players through different stages of rehabilitation following a hamstring strain injury. Practitioners from European football clubs from five first-division leagues (Bundesliga, La Liga, Ligue 1, Premier League, Serie A) were invited to participate in an online survey developed in English using the online software QuestionPro. The survey was divided into two parts: part one (six questions) aimed to analyse demographic and job roles; part two (six questions) presented two clinical cases. In total, 25 surveys were completed. The participants were asked to rate on a Likert scale from "Not important" to "Very important" the following criteria for the Return-to-high-speed-running, Return-to-training and Return-to-performance phases: Time since injury, Absence of pain, Hamstring flexibility, Askling H-Test, Negative Magnetic Resonance Imaging (MRI) (injury fully healed), Psychological readiness, Isometric strength, Eccentric strength (Nordics test), Isokinetic test, Single leg bridge (maximal number of repetitions), Jump tests, Completion of progressive on-field exposure (internal and external training load), Ability to run at maximal speed, Repeated sprint ability test, Global Position System (GPS) metrics equivalent to match requirements. We found that practitioners used a variety of criteria across the different stages. This heterogeneity highlights the need for a multidisciplinary approach to return-to-play (RTP) decision-making across all the phases, especially when rehabilitating an intramuscular hamstring tendon injury. Overall, the practitioners felt the need for a greater number and higher specificity of tests during the rehabilitation progression for the intramuscular tendon than the myotendinous junction injury.

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**HIGHLIGHTS**

- Hamstring injuries are not all the same and can affect different muscles, areas, and biological tissues.
- Readiness to RTP needs to be assessed with a more significant number and higher specificity of tests during the rehabilitation of an intramuscular tendon than a myotendinous junction hamstring injury.
- The variety and heterogeneity of the available RTP criteria highlight the need for a multidisciplinary approach to RTP decision-making across all the rehabilitation phases.

## Introduction

Hamstring strain injuries (HSIs) represent the most prevalent injury in professional football. Despite the efforts of researchers and practitioners, the number of HSIs has increased from 12% to 24% over the last twenty-one years (Ekstrand et al., 2023). Injuries have been reported to have a negative impact on football clubs' performance (Hägglund et al., 2013) and this is associated with an estimated loss of approximately 45 million pounds per season due to injury-related decrements in performance (Eliakim et al., 2020). Ekstrand et al. (2023) reported that 18% of the total number of recorded HSIs in European football were re-injuries. Pollock et al. (2016) reported a variable number of re-injury rates up to 63% in sports.

The return-to-play (RTP) involves a complex procedure of preparing an injured athlete for competition again, ensuring that the likelihood of further injury is as low as possible (Shrier et al., 2014). RTP is not an isolated final decision at the end of the rehabilitation process but a continuum where criteria are used throughout to inform stage progression up to the return to performance (Ardern et al., 2016). In a survey on RTP following a HSI in professional football, 95% of the Premier League teams interviewed reported basing their practice on an RTP continuum model (Dunlop et al., 2020). However, the lack of guidelines and high-quality studies to determine the most appropriate RTP criteria following a hamstring injury in professional football (Pecci et al., 2026; Pernaet al., 2024) has pushed researchers to ask medical and performance practitioners about their opinions and daily practice. Delvaux et al. (2013) administered a questionnaire to thirty-seven sports medicine physicians to rate the importance of fourteen RTP criteria. Dunlop et al. (2020) utilized an online survey to ask medical and performance practitioners worldwide to rate RTP criteria in each stage of the RTP continuum. van der Horst et al. (2017) conducted a Delphi study with fifty-eight clinical and academic experts in the field of HSI management in football to reach a consensus on the RTP criteria to include and exclude. Zambaldi et al. (2017) interviewed clinicians from the medical departments of twenty English professional football clubs – the experts reached a consensus on twelve RTP criteria.

Re-injury rate and the time to RTP are likely associated with the type of HSI (Brukner & Connell, 2016; Entwisle et al., 2017; Lempainen et al., 2018). Muscle injuries that extend into the tendon have shown a higher recurrence rate and a longer time to RTS in elite track and field athletes (Pollock et al., 2016), professional Australian rules football players (Comin et al., 2013), and professional players in English football (Shamji et al., 2021; Tears

**Table 1.** Practitioners' league, current role, and years of experience.

| League | n | % | Current role | n | % | Experience | n | % |
|---|---|---|---|---|---|---|---|---|
| Bundesliga (Germany) | 1 | 4.00% | Medical doctor | 2 | 6.67% | <1 year | 0 | 0.00% |
| La Liga (Spain) | 6 | 24.00% | Osteopath | 2 | 6.67% | 1 to 5 years | 6 | 24.00% |
| Ligue 1 (France) | 0 | 0.00% | Physiotherapist | 13 | 43.33% | 6 to 10 years | 7 | 28.00% |
| Premier League (England) | 9 | 36.00% | Sports scientist | 2 | 6.67% | >10 years | 12 | 48.00% |
| Serie A (Italy) | 9 | 36.00% | Sports therapist | 7 | 23.33% | | | |
| | | | Strength and conditioning coach | 3 | 10.00% | | | |
| | | | Other | 1 | 3.33% | | | |

et al., 2022). In a recent narrative review on the implications of an intramuscular tendon injury of the hamstring muscles, Kerin et al. (2023) concluded that the evidence is still conflicting when looking at time to RTP and re-injury rate. Similarly, in a systematic review on RTP following a muscle injury with intramuscular tendon involvement, the authors concluded that there is no strong evidence that this injury would lead to a longer time to RTP. Still, the percentage of the cross-sectional area of tendon disruption, presence of waviness and loss of tendon tension on magnetic resonance imaging (MRI) showed moderate evidence for a longer time to RTP (Beattie et al., 2023).

One of the reasons for the high variability in re-injury rate and time to RTP (called return to sport in some other context) might be the type of HSI and the different anatomical structures involved (Brukner & Connell, 2016; Entwisle et al., 2017; Lempainen et al., 2018). Despite the relevance and the challenges of this topic in professional football, there is little evidence of the best criteria to clear players to progress through phases of rehabilitation and return to performance and how the type of HSI can alter the decision-making process. Therefore, the aims of this paper are, firstly, to describe which criteria are used by medical and performance practitioners in elite European football to progress players through different stages of rehabilitation following an HSI and, secondly, to understand the difference in RTP criteria selection between myotendinous HSI and HSI that involve the intramuscular tendon.

## Methods

### *Participants*

Practitioners from European football clubs from five first-division leagues (Bundesliga, La Liga, Ligue 1, Premier League, Serie A) were invited to participate. Between 12 December 2023 and 29 February 2024, the participants were recruited via email, personal contact, messaging (i.e., Whatsapp), and social media (i.e., Linkedin, Instagram, Facebook, and X). The survey was completed by members of the Sports Science and Medicine departments who have worked with the first team of the included clubs over the last five years. A total of 25 practitioners decided to take part. League, job role, and years of experience are summarized in Table 1.

## Study design

The study was designed as a cross-sectional web-based survey. The purpose and objective were to understand what criteria practitioners working at the elite level of European

**Table 2.** Criteria definition for return to play.

| Phase | Definition |
|---|---|
| Return-to-high-speed running | The progression from a gym-based phase of the rehabilitation to running on-field up to high speed. |
| Return-to-train | The progression from individual on-field rehabilitation sessions to unrestricted team training. |
| Return-to-performance | The progression from unrestricted team training to return to playing competitive matches. |

football use to decide on rehabilitation progression and clear players to return to performance. The survey was developed in English using the online software QuestionPro (https://www.questionpro.com/). The study authors designed the survey questions with the support of football peers and experts in the field. Four researchers and football practitioners pilot-tested the survey before its official release and provided feedback. The study adhered to the Declaration of Helsinki and received approval from the Human Research Ethics Committee (University of Suffolk), protocol number RETH(S) 23/030. Before the start of the survey, the participants received written information about the objectives, the content, and the data storage of the study. Participants gave informed consent for data analysis and publication. Participation was anonymous and voluntary. Responses with insufficient information were excluded.

## Survey content

The survey was divided into two parts: part one (six questions) aimed to analyse demographic and job roles; part two (six questions) presented two clinical cases of hamstring injuries. These cases (Case 1 and Case 2) were used to understand practitioners' decision-making across the rehabilitation phases in specific HSI scenarios. Case 1 described a 21-year-old professional football player who suffered a biceps femoris injury at the myotendinous junction graded "2b" on MRI according to the British Athletics Muscle Injury Classification (BAMIC). Case 2 described a 21-year-old professional football player who suffered a biceps femoris intramuscular tendon injury graded "3c" on MRI, according to the BAMIC. For each case, participants were asked to rate the importance of the proposed criteria with a 5-point Likert scale (from "not important" to "very important") throughout the following three phases: Return-to-high-speed running, which indicates the progression from a gym-based phase of the rehabilitation to running on-field up to high-speed, Return-to-train which indicates the progression from individual on-field rehabilitation sessions to unrestricted team training, and Return-to-performance which indicates the progression from unrestricted team training to playing competitive matches (Dunlop et al., 2020). Definitions are reported in Table 2. The survey content is available in the supplementary material.

## Statistical analysis

A descriptive analysis of the results was completed and reported following the checklist for reporting results of Web surveys (CHERRIES). All responses from QuestionPro were exported into a customized Excel spreadsheet (Microsoft Corp, Redmond, WA, USA) for analysis. Descriptive statistics for demographic

characteristics were presented. Data were analysed using a range of descriptive statistics (calculation of the mean, standard deviation, absolute and relative frequencies). Frequencies were determined for each Likert-type scale or close-ended question response. All participants were included in each analysis. A criterion was deemed relevant for the specific rehabilitation phase if more than 70% of the participants selected either the option "important" or "very important" for the specific criterion in that phase.

## Results

In total, surveys ($n = 25$) were completed. The participants worked in the Bundesliga ($n = 1$, 4%), La Liga ($n = 6$, 24%), Premier League ($n = 9$, 36%), and Serie A ($n = 9$, 36%). From these participants, 2 (7%) were medical doctors, 2 osteopaths (7%), 13 physiotherapists (43%), 2 sports scientists (7%), 7 sports therapists (23%), 3 strength and conditioning coaches (10%), and 1 other (3%). The majority of practitioners listed their experience as >10 years ($n = 12$, 48%), followed by 6 to 10 years ($n = 7$, 28%) and 1 to 5 years ($n = 6$, 24%). None of the participants had less than one-year experience. The information is summarized in Table 1. Other demographic information (gender and highest academic degree) can be found in the supplementary material.

### *Return to high-speed-running*

In case study 1, more than 70% of the participants rated the following tests as either "important" or "very important" criteria for the return to high-speed-running: Absence of pain (88%), Hamstring flexibility (78%), Psychological readiness (84%), Eccentric strength (Nordics) (84%), and Completion of progressive on-field exposure (internal and external training load) (92%). Similarly, in case study 2, the participants rated: Absence of pain (96%), Hamstring flexibility (84%), Psychological readiness (84%), Eccentric strength (Nordics) (80%), and Completion of progressive on-field exposure (internal and external training load) (76%), but the following tests were also considered important: Time since injury (92%), Askling H-test (76%), and Isometric strength (88%). The criteria reaching agreement for case study 1 and 2 are summarized in Tables 3 and 4.

**Table 3.** Criteria for reaching an agreement for case study 1 and the percentage of agreement. GPS: global positioning system.

| Return-to-high-speed running | Return-to-train | Return-to-performance |
|---|---|---|
| Absence of pain (88%) | Absence of pain (100%) | Absence of pain (96%) |
| Hamstring flexibility (78%) | Psychological readiness (92%) | Psychological readiness (92%) |
| Psychological readiness (84%) | Nordics (92%) | Nordics (84%) |
| Nordics (84%) | Completion of progressive on-field exposure (internal and external training load) (100%) | Completion of progressive on-field exposure (internal and external training load) (100%) |
| Completion of progressive on-field exposure (internal and external training load) (92%) | Ability to run at maximal speed (100%) | Ability to run at maximal speed (100%) |
| | Repeated sprint ability test (72%) | Repeated sprint ability test (88%) |
| | | GPS metrics equivalent to match requirements (100%) |

**Table 4.** Criteria for reaching an agreement for case study 2 and the percentage of agreement. GPS: global positioning system; MRI: magnetic resonance imaging.

| Return-to-high-speed running | Return-to-train | Return-to-performance |
|---|---|---|
| Absence of pain (96%)<br>Time since injury (92%)<br>Hamstring flexibility (84%)<br>Askling H-Test (76%)<br>Psychological readiness (84%)<br>Isometric strength (88%)<br>Nordics (80%)<br>Completion of progressive on-field exposure (internal and external training load) (76%) | Absence of pain (96%)<br>Time since injury (88%)<br>Hamstring flexibility (77%)<br>Askling H-Test (76%)<br>Psychological readiness (96%)<br>Isometric strength (80%)<br>Nordics (88%)<br>Completion of progressive on-field exposure (internal and external training load) (100%)<br>Ability to run at maximal speed (100%)<br>Repeated sprint ability test (84%)<br>GPS metrics equivalent to match requirements (84%) | Absence of pain (96%)<br>Time since injury (72%)<br>Hamstring flexibility (72%)<br>Negative MRI (injury fully healed) (80%)<br>Psychological readiness (100%)<br>Isometric strength (72%)<br>Nordics (88%)<br>Completion of progressive on-field exposure (internal and external training load) (100%)<br>Ability to run at maximal speed (100%)<br>Repeated sprint ability test (84%)<br>GPS metrics equivalent to match requirements (100%) |

### *Return-to-train*

In case study 1, Absence of pain (100%), Psychological readiness (92%), Isometric strength (72%), Eccentric strength (Nordics) (92%), Completion of progressive on-field exposure (internal and external training load) (100%), Ability to run at maximal speed (100%), and Repeated sprint ability test (72%) were considered important criteria for the return-to-train phase . In case study 2, the following criteria were considered important: Time since injury (88%), Absence of pain (96%), Hamstring flexibility (77%), Askling H-Test (76%), Psychological readiness (96%), Isometric strength (80%), eccentric strength (Nordics) (88%), Completion of progressive on-field exposure (internal and external training load) (100%), Ability to run at maximal speed (100%), Repeated sprint ability test (84%), and GPS metrics equivalent to match requirement (84%).

### *Return-to-performance*

In case study 1, Absence of pain (96%), Psychological readiness (92%), Eccentric strength (Nordics) (84%), Completion of progressive on-field exposure (internal and external training load) (100%), Ability to run at maximal speed (100%), Repeated sprint ability test (88%), and GPS metrics equivalent to match requirements (100%) were rated as the most important criteria for the RTP phase. In case study 2, Time since injury (72%), Absence of pain (96%), Hamstring flexibility (72%), Negative MRI (Injury fully healed) (80%), Psychological readiness (100%), Isometric strength (72%), Eccentric strength (Nordics) (88%), Completion of progressive on-field exposure (internal and external training load) (100%), Ability to run at maximal speed (100%), Repeated sprint ability test (84%), and GPS metrics equivalent to match requirements (100%) were considered the most important criteria for the RTP.

## Discussion

This paper aimed to describe which criteria are used by medical and performance practitioners in elite male European football to progress players through different stages of rehabilitation following HSIs and to understand the difference in RTP criteria selection

between a myotendinous and intratendinous HSI. We found that practitioners used a variety of criteria across the different stages according to the expected level of the players. For example, field-based criteria were more commonly used during the late stages of rehabilitation, while clinical and gym-based testing were more prevalent in the initial return to running phase. This survey study presented two clinical scenarios of professional footballers with different hamstring injuries graded on MRI with the BAMIC classification. Overall, the practitioners felt that more tests were needed to decide on rehabilitation progression for the intramuscular tendon injury than for the myotendinous junction injury. This idea that a more complex injury with a higher re-injury rate and a more extended period of modification in training requires a higher number of criteria and testing was previously described in track and field athletes (Macdonald et al., 2019). Also, a recent commentary has highlighted that the injury location, the anatomy of the injury, and the mechanism of injury should be considered when determining RTP criteria (Perna et al., 2025).

Among the most commonly used clinical criteria, we found time since injury, absence of pain, and restoring hamstring flexibility. The practitioners in our study did not find "time since injury" an important RTP criterion during the rehabilitation of a "2b" hamstring injury, while they considered this criterion important to progress through all three different phases of the rehabilitation continuum of a hamstring injury with intramuscular tendon involvement. Studies from different sports have highlighted how injuries graded "c" on MRI have a longer time to RTP: athletics (McAleer et al., 2022; Pollock et al., 2016), rugby (Kerin et al., 2024), Australian football (Eggleston et al., 2020), and football (Cohen et al., 2011; McAuley et al., 2022; Shamji et al., 2021; Tears et al., 2022). A recent systematic review has shown the high risk of bias in the studies on this topic and the need for future research on the time to RTP in intramuscular tendon injuries (Beattie et al., 2023). Regarding absence of pain, the participants considered this criterion as important in the proposed clinical scenarios in all three RTP phases (return-to-high-speed running, return-to-train, and return to performance). Previous research in professional football have described similar results, for instance, in the Delvaux et al. (2013) study, the interviewed physicians from professional football clubs ranked "complete pain relief" as the first and most important criterion for RTP (Delvaux et al., 2013). Similarly, van der Horst et al. (2017) reported that the practitioners of their Delphi study considered important the absence of pain "on palpation of the hamstrings, during strength and flexibility testing, and during or after functional performance" (van der Horst et al., 2017). A systematic review of RTP criteria in sports also highlighted that rehabilitation progression and RTP decisions are largely based on players' perception of pain (Hickey et al., 2017). A recent scoping review on the criteria to return to high-speed running described the absence of pain as common practice to clear players to returning to run at those speeds (Perna et al., 2026). Although the practitioners felt that it was important to be pain-free across all phases, it is clear that pain should not be present when high speeds are introduced during on-field rehabilitation. Therefore, this clinical marker should be cleared earlier than return-to-performance before exposing the hamstring muscles to actions that will increase their activation. While restoring hamstring flexibility was considered an important criterion in all three phases of intramuscular tendon injury, it was only important in the return-to-high-speed-running phase in the first clinical scenario. Restoration of hamstring flexibility has often been described in the literature as an important criterion for RTP following a hamstring injury

(Delvaux et al., 2013; Hickey et al., 2017; van der Horst et al., 2017; Zambaldi et al., 2017). However, the experts of a recent consensus statement on hamstring injuries failed to agree on using hamstring flexibility as a Return-to-Sports criterion (Paton et al., 2023).

Some tests can be used as criteria for progressing players from one phase to another, for instance, Askling H-Test, isometric strength test, eccentric strength, isokinetic test, single leg bridge and jump test. The Askling H-Test is a validated test to measure hamstring active flexibility and apprehension following an HSI (Askling et al., 2010). This criterion reached the importance threshold (70%) only in the return to high-speed running and return-to-train of the intramuscular tendon injury scenario and was not considered important in all three phases of the myotendinous injury scenario. The Askling H-test has shown promising results as a criterion for RTP to minimize the risk of hamstring re-injury in football (0.8%) (Askling et al., 2013) and athletics (3%) (Askling et al., 2014). A recent narrative review has highlighted the higher recurrence rate in intramuscular tendon injuries than in other HSI, with reported re-injury rates of 17–20% (Kerin et al., 2023; Van Der Made, Almusa, Reurink, et al., 2018; Van der Made, Almusa, Whiteley, et al., 2018). The combination of the higher re-injury rates in intramuscular tendon injuries and the positive results of the Askling H-Test as a RTP criterion to prevent an injury recurrence might explain the importance given to this test only for the intramuscular tendon case. Another commonly used criterion is the isometric strength test, which was considered important for the return-to-train in the first scenario and all the phases of the second scenario. Practitioners commonly use isometric training during sports injury rehabilitation, especially in the first phase when forces can be produced within pain-free joint angles. It has also gained popularity thanks to specific characteristics such as the analgesic effect, the positive transfer to performance and injury prevention, and the changes in tendon stiffness and health (Oranchuk et al., 2019). The positive impact on tendon health and strength makes isometric training an effective component of tendon injury rehabilitation (Macdonald et al., 2019). Therefore, this may be the reason why the majority of the practitioners found it more important to use isometric strength criteria during the intramuscular tendon injury case than the myotendinous case. Isometric strength measures have been described as common criteria for returning to high-speed running in football (Perna et al., 2026). The results from this survey confirm what is currently present in the literature. Eccentric strength assessed with the Nordics test was considered important for all the phases in both scenarios. The Nordics test is a valid measure of eccentric strength (Bishop et al., 2022) and is commonly used by practitioners in professional sports. The broad use of this test is based on extensive research on the use of the Nordic hamstring exercise (NHE) to prevent hamstring injuries (Ekstrand et al., 2022) and eccentric strength in rehabilitation (Perna, De Keijzer, et al., 2024). Therefore, it is unsurprising that practitioners felt it was important to evaluate eccentric strength throughout the rehabilitation and use this information to inform progression to the next phase. Despite the importance given to isokinetic and Nordics strength measures, the Isokinetic test did not reach the importance threshold for any of the phases in both scenarios. Although the isokinetic test is widely used in football as an RTP criterion, especially after anterior cruciate ligament reconstruction (ACLR) (Van Der Horst & Denderen, 2022), the evidence as an RTP criterion following a hamstring injury in professional football is still controversial with the normalization of eccentric strength not being correlated to successful RTP and low re-injury rates (Tol et al., 2014).

The final two tests included in this survey are, the single leg bridge (maximal number of repetitions) and the countermovement jump (CMJ). In this survey, the single-leg bridge test did not reach the importance threshold for any of the phases in both scenarios. These results disagree with the opinion of the Delphi study by van der Horst et al. (2017) on RTP criteria after hamstring injuries in football (van der Horst et al., 2017). Moreover, the jump tests did not reach the importance threshold for any of the phases in both scenarios. The CMJs are used in professional sports and football as a performance (Anicic et al., 2023; Quagliarella et al., 2011) and neuromuscular fatigue indicator (Beattie et al., 2021; Nedelec et al., 2014). Therefore, players are often required to perform this test during a football season for different purposes. There is no evidence of the use of jump testing as an RTP criterion in professional football, but there is evidence that a previous injury can negatively impact CMJ performance (Hart et al., 2019).

The need for a negative MRI (injury fully healed) was considered important only as a return-to-performance criterion in the intramuscular tendon scenario. The use of MRI is increasing in professional sports, and medical practitioners are requesting more imaging to diagnose and predict lay-off time following a HSI (Reurink et al., 2015). The MRI's important role in muscle injury diagnosis is widely accepted in elite athletes (Isern-Kebschull et al., 2022), while the prognostic and RTP criterion roles have limited and conflicting evidence. Several studies have reported using MRI to inform the decision on RTP (Baldock et al., 2021; Isern-Kebschull et al., 2022; Kerin et al., 2023; Taberner et al., 2022). The presence of the following signs on MRI at the moment of RTP following an intramuscular tendon injury might increase re-injury risk: transversal and/or mixed connective tissue gap, loss of tendon tension, intermuscular oedema, callus gap, interstitial feather oedema pattern, ongoing high signal, and discontinuity within the injured tendon (Baldock et al., 2021; Isern-Kebschull et al., 2022). Although there is emerging evidence supporting the use of MRI in the late stages of intramuscular tendon hamstring injury rehabilitation to help the RTP decision-making process in alignment with the participants' responses in this study, this criterion remains controversial as other studies showed that resolution of intramuscular tendon injuries is not necessary for a successful RTP (Vermeulen et al., 2021).

Psychological readiness was rated important for all the phases in both scenarios. This aspect of the RTP is widely considered an essential factor in achieving successful rehabilitation outcomes in sports rehabilitation (Aizawa et al., 2020; Ardern et al., 2016; Kaplan & Witvrouw, 2019) and in professional football (van der Horst et al., 2017; Zambaldi et al., 2017). Despite the agreement on the importance of psychological readiness when deciding on RTP, there is limited evidence and understanding of the instruments to assess it. There is a pressing need to validate tools to measure psychological readiness objectively and provide accessible information for practitioners involved in RTP decisions in professional football.

Completing progressive on-field exposure was considered important for all the phases in both scenarios. The importance of gradual and appropriate on-field rehabilitation in football is greatly supported in the literature (Armitage et al., 2022, 2024). In particular, there is a need to be specific in the progression following a hamstring injury to address all the GPS metrics and technical skills required (Jiménez-Rubio et al., 2019; Perna et al., 2026; Taberner & Cohen, 2018). The most reported metrics in the literature for a running progression following a hamstring injury are high-speed running, sprint

distance, acceleration, and deceleration. This survey's participants also believed that achieving GPS metrics equivalent to match requirements was important for return-to-performance in the first scenario and for return-to-train and return-to-performance in the second scenario.

The ability to run at maximal speed and use the "Repeated sprint ability test" were considered important for return-to-train and return-to-performance in both scenarios. Return to maximal speed running represents an important milestone in hamstring on-field rehabilitation. Many studies have described sprinting as the most prevalent mechanism for hamstring injuries (Aiello et al., 2023; Danielsson et al., 2020; Gronwald et al., 2022; Jokela et al., 2022; Kerin et al., 2022). During high-speed running, the hamstring muscles are required to produce great force (Kalkhoven et al., 2023; Schache et al., 2012). The gym-based rehabilitation can partially prepare the muscles for these forces because of the lower electromyographical activation of the hamstring muscles during common rehabilitation exercises (van den Tillaar et al., 2017). Preparing players to reach maximal speed and to be able to repeatedly perform sprints are key performance indicators and could be considered a "vaccine" against re-injury (Edouard et al., 2019).

## Limitations

We acknowledge that only experts' opinions have been provided. Therefore, new and emerging evidence should update the current opinions. Furthermore, we recognize the potential responder bias due to the responders' prior knowledge and beliefs and the authors' network, which might have influenced their responses. The idea of this study was to ask staff working in elite male senior European football about the RTP criteria they believed were the most important during different phases of the rehabilitation. The responses were individual and did not reflect a specific club view. Due to the high profile required to participate in the study and the survey length, a small number of participants were reached. This sample represents a small percentage of the practitioners working at the top level of European football in the medical and performance fields. Therefore, this study does not provide criteria selection guidelines, but highlights practices and ideas that could help practitioners in their daily practice.

## Conclusions

This study analyses RTP criteria following a hamstring injury in professional football across different rehabilitation phases and compares the results of two clinical scenarios. Hamstring injuries are not all the same and can affect different muscles, areas, and biological tissues. The respondents in our survey have highlighted the need to assess the players' readiness to RTP in more detail and with a greater number and higher specificity of tests during the rehabilitation of an intramuscular tendon compared to a myotendinous junction hamstring injury. The criteria proposed were a combination of clinical, psychological, functional, and performance, both gym-based and on-field. This variety and heterogeneity highlight the need for a multidisciplinary approach to RTP decision-making across all the phases, especially when rehabilitating an intramuscular tendon hamstring injury.

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## Author contributions

CRediT: **Paolo Perna:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing; **Fearghal Kerin:** Methodology, Supervision, Validation, Writing – review & editing; **Lasse Lempainen:** Methodology, Supervision, Validation, Writing – review & editing; **Marco Beato:** Conceptualization, Data curation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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