BJSM Online First, published on May 25, 2016 as 10.1136/bjsports-2016-096278

2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern

Clare L Ardern,[1,2,3] Philip Glasgow,[4,5] Anthony Schneiders,[6] Erik Witvrouw,[1,7] Benjamin Clarsen,[8,9] Ann Cools,[7] Boris Gojanovic,[10,11] Steffan Griffin,[12] Karim M Khan,[13] Håvard Moksnes,[8,9] Stephen A Mutch,[14,15] Nicola Phillips,[16] Gustaaf Reurink,[17] Robin Sadler,[18] Karin Grävare Silbernagel,[19] Kristian Thorborg,[20,21] Arnlaug Wangensteen,[1,8] Kevin E Wilk,[22] Mario Bizzini[23]

For numbered affiliations see end of article.

Correspondence to
Dr Clare Ardern, Aspetar Orthopaedic & Sports Medicine Hospital, P.O. Box 29222, Doha, Qatar; c.ardern@latrobe.edu.au

Accepted 1 May 2016

To cite: Ardern CL, Glasgow P, Schneiders A, *et al. Br J Sports Med* Published Online First: [*please include* Day Month Year] doi:10.1136/bjsports-2016-096278

ABSTRACT
Deciding when to return to sport after injury is complex and multifactorial—an exercise in risk management. Return to sport decisions are made every day by clinicians, athletes and coaches, ideally in a collaborative way. The purpose of this consensus statement was to present and synthesise current evidence to make recommendations for return to sport decision-making, clinical practice and future research directions related to returning athletes to sport. A half day meeting was held in Bern, Switzerland, after the First World Congress in Sports Physical Therapy. 17 expert clinicians participated. 4 main sections were initially agreed upon, then participants elected to join 1 of the 4 groups—each group focused on 1 section of the consensus statement. Participants in each group discussed and summarised the key issues for their section before the 17-member group met again for discussion to reach consensus on the content of the 4 sections. Return to sport is not a decision taken in isolation at the end of the recovery and rehabilitation process. Instead, return to sport should be viewed as a continuum, paralleled with recovery and rehabilitation. Biopsychosocial models may help the clinician make sense of individual factors that may influence the athlete's return to sport, and the Strategic Assessment of Risk and Risk Tolerance framework may help decision-makers synthesise information to make an optimal return to sport decision. Research evidence to support return to sport decisions in clinical practice is scarce. Future research should focus on a standardised approach to defining, measuring and reporting return to sport outcomes, and identifying valuable prognostic factors for returning to sport.

BACKGROUND
After a sports injury, the first question asked by most athletes (and coaches) is: 'When will I (the athlete) be able to compete again?' The answer to this question is rarely straightforward and is influenced by many factors. However, in most cases the goals of the injured athlete and the treating clinician (plus other stakeholders in the decision-making team, such as coaches, parents and managers) are the same—to facilitate a timely and safe return to sport (RTS).

The *Swiss Sport Physiotherapy Association* along with the *International Federation of Sports Physical Therapy* and the *BJSM* hosted the first international RTS congress in Bern, Switzerland (20–21 November 2015). The aim of the congress was to present current evidence and guidelines in areas where sports medicine clinicians (particularly physiotherapists and physicians) play a major role in helping athletes to RTS after injury or surgery. The congress also acknowledged the important role of practitioners including orthopaedic surgeons, physiologists, coaches, and strength and conditioning professionals in helping athletes RTS.

Consensus process
A half day consensus meeting was held following the congress (22 November), and 17 members of the consensus group participated. Prior to the congress, members of the consensus group were invited to write a narrative review on their topic area. Authors were asked to focus on summarising what is currently known and what are the future advances needed to advance knowledge in RTS. This information was disseminated to the group and used as a basis for the first round-table discussion, facilitated by two researchers (CLA and KMK), where the four sections of this statement were initially agreed on. Participants then elected to join one of the four groups, and each group focused on a different section of the statement. A section leader was nominated by the members of each group, and participants in each group discussed and summarised the key issues for their section. Each of the groups then presented their summary, and the 17-member group discussed the key issues to refine each section.

Objective
This consensus builds on important formative work published over a decade ago, regarding the team physician's role in the athlete's RTS. In 2002, an expert panel representing the most prominent American orthopaedic, sports and family medicine member societies placed the team physician prominently as the gatekeeper of the RTS decision.[1] The field of sport and exercise medicine has progressed considerably since then.[2] Now, more than ever, decision-making models and ways of practising that are athlete-centred are advocated, placing the athlete in the position of an active decision-maker

along with other relevant stakeholders.[3–5] Our consensus reflects this athlete-centred approach.

Terminology and structure

In recent years, the issues relating to the resumption of sports participation following injury have often been discussed using the term 'return to play' (RTP). Although RTP is common in sports medicine vernacular, the word 'play' is most applicable to the team sport athlete. This consensus statement is intended to be relevant to, and inclusive of, all sports and all athletes. Therefore, we use the term 'return to sport'.

This consensus statement is divided into four main sections:

1. Definitions related to RTS and the sports participation context
2. Models to help understand and guide the RTS process
3. Evidence to inform RTS decision-making
4. Priorities for future research

SECTION 1: DEFINING RTS

To make an informed RTS decision, the definition of each RTS process should, at a minimum, be according to the sport (eg, ice hockey, squash, 100 m sprint) and the level of participation (eg, NCAA Division I, English Premier League, local recreational football league) that the athlete aims to return to.

RTS success

Success means different things to different people and is context-dependent and outcome-dependent. To the athlete, success might be defined by return to sustained participation in sport in the shortest possible time (goal focus). To the coach (and many athletes), success might be defined relative to the athlete's performance on RTS (performance focus). To the clinician, success might be defined by the prevention of new (or recurring) associated injuries (outcome focus). The decision-making team must collaboratively decide on how success will be defined, as soon as possible after the injury.

Contextual considerations

Contextual factors influence the expectations and risk tolerance for RTS. These include the type of injury or illness (eg, acute vs chronic), the athlete's age (or stage of career), type of sport played (eg, individual or team, contact or non-contact), physical demands of the sport (eg, cutting, pivoting, landing), level of participation (eg, amateur professional), significance of upcoming participation opportunities (eg, championship match, Olympic final, preseason practice) and social and financial costs.

Progression and documentation

RTS can be viewed as a continuum paralleled with recovery and rehabilitation—not simply a decision taken in isolation at the end of the recovery and rehabilitation process. As injury is an inevitable part of sports participation, optimal contingency planning for RTS might even happen before an injury occurs (or at least as soon as the injury occurs).

Documentation should incorporate (but not be limited to): definition of sport, relevant contextual factors, RTS goals and performance on relevant clinical and functional tests to give evidence that could be used to guide RTS decision-making. It will also often be helpful to define and document the roles, responsibilities and actions of each member of the RTS decision-making team.

In a RTS continuum we define three elements (figure 1), emphasising a graded, criterion-based progression, that is applicable for any sport and aligned with RTS goals.

Figure 1 The three elements of the return to sport (RTS) continuum.

1. Return to participation. The athlete may be participating in rehabilitation, training (modified or unrestricted), or in sport, but at a level lower than his or her RTS goal. The athlete is physically active, but not yet 'ready' (medically, physically and/or psychologically) to RTS. It is possible to train to perform, but this does not automatically mean RTS.
2. Return to sport (RTS). The athlete has returned to his or her defined sport, but is not performing at his or her desired performance level. Some athletes may be satisfied with reaching this stage, and this can represent successful RTS for that individual.
3. Return to performance. This extends the RTS element. The athlete has gradually returned to his or her defined sport and is performing at or above his or her preinjury level. For some athletes this stage may be characterised by personal best performance or expected personal growth as it relates to performance.

RTS versus removal from sport: introducing a new way of thinking about RTS

In certain situations, the RTS decision may be reversed to a removal from sport decision. In injuries where symptoms gradually increase over time, the shared decision-making process may relate to reducing loading (ie, modifying training or competition), or when the athlete should cease participation altogether. In some acute injuries, the clinician must also recognise when immediate removal from sport is necessary to protect the health of the athlete (eg, removal from sport is vital to protect the health of the concussed athlete).[6]

Removal from sport does not necessarily mean that the athlete ceases all participation. Rather, the shared decision may be to modify the training and/or match load. For example, the athlete may not complete every training session, or the athlete's court time might be reduced and partly substituted with rehabilitation focused training. Decisions about reducing load, removal from sport and the subsequent RTS require the athlete, coach(es) and clinician(s) to work closely together. However, in some jurisdictions, clinicians are legally required to act on their own initiative if it is necessary to protect the health of the athlete.

RTS: whose decision is it anyway?

In contemporary clinical practice, the RTS decision should be a decision shared[4] between all stakeholders. This requires well-defined roles,[7] and a dispute resolution system to protect the athlete from coercion when there are competing risk tolerances across stakeholders.[5]

Summary

The key points regarding definitions of RTS and the RTS continuum are presented in box 1.

SECTION 2: MODELS TO HELP UNDERSTAND AND GUIDE THE RTS PROCESS

Theoretical models can help clinicians make sense of the myriad factors that influence RTS outcomes, as well as encourage consistency and transparency in RTS decision-making. In this

Box 1 Key take home messages regarding definitions for return to sport (RTS)

- The minimum information required to define RTS is: the sport and the level of participation the athlete aims to return to.
- RTS is a continuum comprising three elements: return to participation, return to sport and return to performance.
- In certain situations the RTS decision may be reversed to a removal from sport decision.
- The RTS decision should be shared among all stakeholders (except in the case of health risk to the athlete).

section, we describe the three models that may help the athlete and clinician with RTS planning, decision-making and transition.

The Strategic Assessment of Risk and Risk Tolerance (StARRT) framework—guiding the RTS decision

The Strategic Assessment of Risk and Risk Tolerance (StARRT) model[8] is a three-step model that helps estimate the risks of different short-term and long-term outcomes associated with RTS, and factors that may affect what should be considered an acceptable risk within a particular context (figure 2).

Step 1 (tissue health) of the StARRT framework synthesises information relevant to the load (stress) the tissue can absorb before injury. Step 2 (tissue stresses) synthesises information relevant to the expected cumulative load (stress) on the tissue. Step 3 (risk tolerance modifiers) synthesises information relevant to the contextual factors that influence the RTS decision-maker's tolerance for risk.

Biopsychosocial model—addressing the best interests of the athlete

Biopsychosocial approaches are common in health settings.[9–12] In the athletic injury context, they provide all RTS stakeholders with a framework for considering the biological, psychological and social factors that might influence treatment and outcome after athletic injury, and might be important to consider for RTS (figure 3).

Optimal loading—'the Goldilocks approach'

Load progression is a key part of rehabilitation and RTS decision-making. Achieving and maintaining optimal loading[13] are important clinical considerations. Monitoring the training load during the current training week (acute) against the average of preceding four training weeks (chronic) provides an acute:chronic workload ratio.[14] This ratio might also be a useful tool in planning load progressions in RTS,[14] especially when the athlete is transitioning from return to participation to RTS, and from RTS to return to performance in the RTS continuum. Still further research is needed to evaluate whether

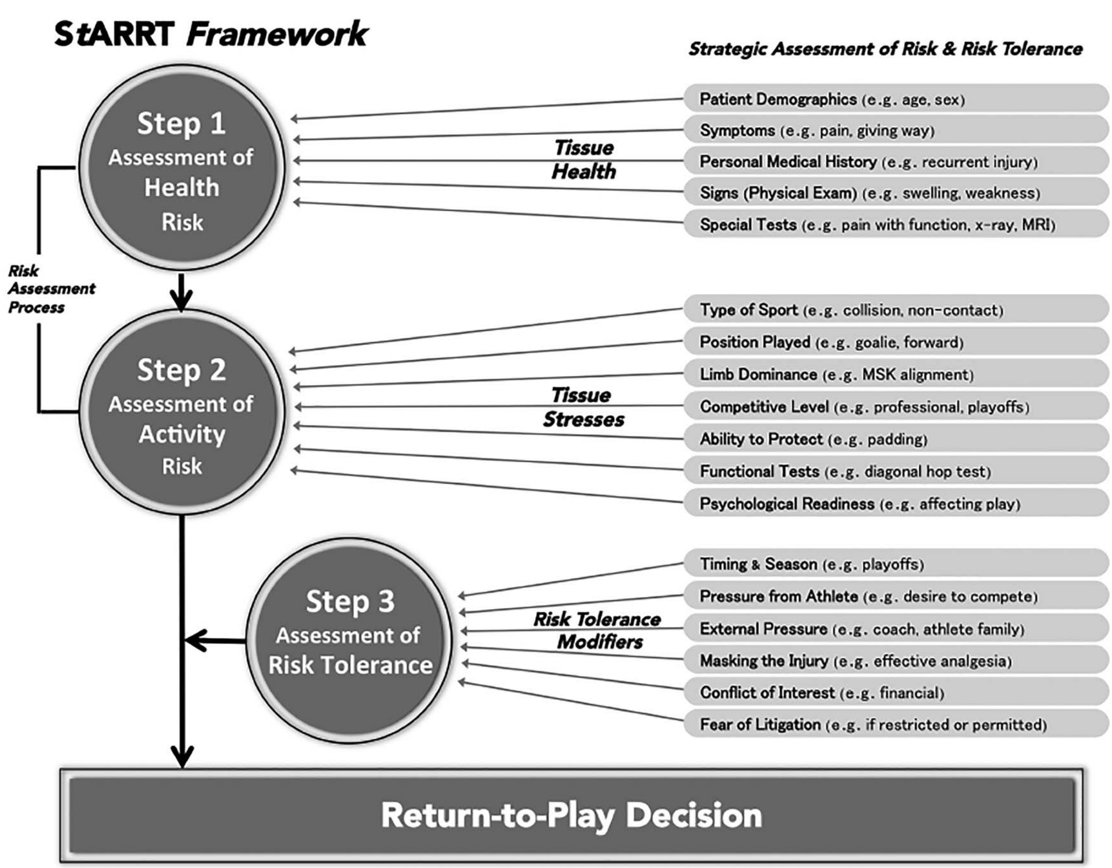

Figure 2 Strategic Assessment of Risk and Risk Tolerance (StARRT) framework for return to play decisions. Athletes should be cleared to RTS when the risk assessment (steps 1 and 2) is below the acceptable risk tolerance threshold (step 3), and not cleared to RTS if the risk assessment is above the risk tolerance threshold (reproduced with permission).

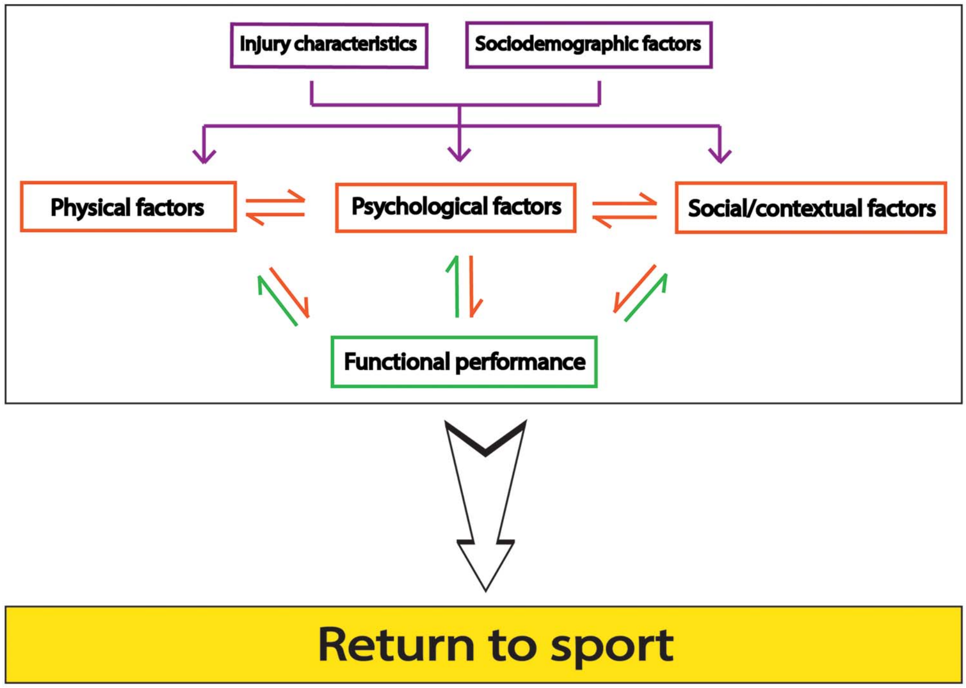

Figure 3 Biopsychosocial model of RTS after injury.[151] Examples of physical, psychological and social factors that may influence RTS are listed (reproduced with permission).

the acute:chronic workload ratio applies in a rehabilitation setting.

Summary

The key points regarding how RTS models can help guide the RTS decision and transition are presented in box 2.

SECTION 3: WHAT EVIDENCE DO WE HAVE TO INFORM THE CLINICIAN'S CONTRIBUTION TO THE SHARED RTS DECISION?

In this section, we summarise the evidence regarding RTS in commonly injured body regions. Using an appropriate combination of research evidence, athlete preference and clinical expertise,[3] high-quality, intensive rehabilitation[15] and a highly motivated athlete[16] are important for optimal RTS. Functional and sport-specific conditioning tests play an important role in RTS decision-making,[17 18] and many of the factors deemed important in RTS decision-making are based on prospective studies defining the risk factors for injury.

Box 2 Key take home messages regarding models that can guide return to sport (RTS)

- Considering the biological, psychological and social factors influencing the RTS decision and transition can assist the clinician to optimally contribute to the shared RTS decision (figure 4).
- The composition of, and roles within the decision-making team should be determined as early as possible.
- Members of the RTS decision-making team should be prepared to regularly share information among all relevant stakeholders.
- Regular assessments and review of goals should be scheduled.

Assessing readiness to RTS

Most functional test procedures are based on closed skill tasks (eg, single or triple hop, T drill, figure 8 runs), but sport requires open skills in addition to closed skills. Open skills have a reactive element to execute the motor task, usually in addition to decision-making, often in a fatigued state. Therefore, relying on closed skill tasks alone in determining readiness to RTS is not optimal. Gradual and sequential introduction of sport-specific training can be used as functional tests that include an element of protected reactive decision-making (ideally context specific).[19–21] Any battery of tests assessing the athlete's readiness to RTS should consider both open and closed skills, although in some clinical contexts this may be difficult because of factors including time, space and resources. If this is the case, assessment of closed skills in conjunction with other impairment-based and functional parameters gives the clinician and the athlete a minimum level of information for RTS decision-making.

Physical testing has historically received most attention in RTS decisions, but psychological readiness is also an important element for optimal RTS. Emotions including fear of reinjury and cognitive factors including self-efficacy and motivation influence RTS.[22–25] The ACL-Return to Sport after Injury scale[26] and the Injury Psychological Readiness to Return to Sport scale[27] are evidence-based scales that may assist the clinician assess the athlete's psychological readiness to RTS after injury.

Specific sports injuries and RTS considerations

Acute knee injuries

Prevalence

ACL injuries are reported to occur with an annual incidence of 85/100 000 people.[28] The majority occur as non-contact injuries,[29] and adolescent girls are at the highest risk.[30] Medial

 Ardern CL, et al. Br J Sports Med 2016;0:1–12. doi:10.1136/bjsports-2016-096278

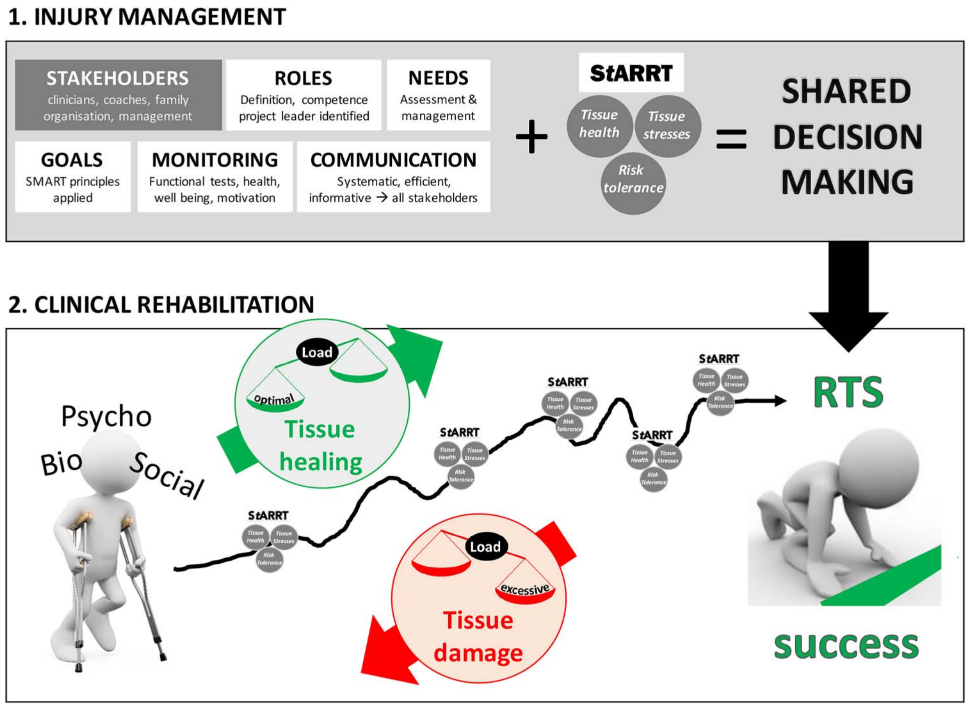

Figure 4 Integrating RTS information to make an optimal decision. The top part (1) describes the management aspects that need to be addressed to lead the rehabilitation project. The bottom part (2) shows the progression of rehabilitation on a timeline, where load is progressively increased to promote tissue healing, but can be excessive and require adaptation to avoid damage. These adaptations go thorough iterations where the StARRT model is applied at different time points until eventual full RTS. Final decisions are reached by applying a shared decision-making process.

collateral ligament (MCL) injuries are the second most common serious injury in football (behind the ACL), with 70% occurring as a result of contact.[31] Medial and lateral meniscus injuries and articular cartilage injuries frequently occur in combination with knee ligament injuries.[32]

RTS rate and time to RTS

About half of athletes return to competitive sport after primary ACL reconstruction, while 65% return to their preinjury sport.[33] Around 60% of non-professional athletes RTS after non-operative treatment,[34] although this has not been extensively investigated and the available studies are variable. Regardless of treatment, the RTS rate is affected by factors including specific sport demands and regional differences.[15 35] RTS rates are lower after revision ACL reconstruction than after primary surgery.[36 37] The length of time taken to RTS after ACL injury is variable, although only a minority of athletes have returned to their preinjury level 1 year after surgical reconstruction.[38] In men's professional football, almost all players RTS after ACL reconstruction.[39]

The mean lay-off time in professional football for all MCL injuries is 23±23 days.[40] Most MCL injuries can be managed conservatively, although grade III MCL injuries, or involvement of the deep MCL and/or the posterior oblique ligament are associated with longer recovery time.[41 42]

Athletes who require lateral meniscus treatment have longer recovery times and lower RTS rates than athletes who require medial meniscus treatment.[43 44]

Factors associated with returning or not returning to sport

Younger age, absence of concomitant full thickness cartilage injury, being a professional athlete, psychological readiness and symmetrical knee function are important for RTS.[15 33 45–47] Additionally, close follow-up and high-quality sports physiotherapy interventions increase the likelihood of RTS.[16]

Factors associated with increased risk of ACL graft rupture are young age (<20 years), continued participation in pivoting sports and the use of allografts.[15 32 48–50] Athletes who have had an ACL injury retire at a younger age than athletes without previous ACL injury,[51] although the reasons for this are yet to be fully elucidated.

RTS criteria (based on published literature)

Supporting optimal physical and psychological function with respect to RTS is an important clinical consideration to promote sustained sports participation. Therefore, we recommend the incorporation of assessments of direction changes and reactive agility tests into standard RTS criteria, and the assessment of psychological readiness to RTS using an instrument such as the ACL-Return to Sport after Injury scale.[26]

Acute hamstring injuries

Prevalence

Acute hamstring injury is the most frequent non-contact muscle injury in sports involving high-speed running;[31 52–54] with a consistently high incidence,[31 55] and high reinjury risk.[55–58]

RTS rate and time to RTS

Time to RTS after acute hamstring injuries varies substantially between studies, from an average of 11.3 days[59] to 50 weeks.[60] Among professional football players, the mean lay-off time was 18±19[61] and 19±17[62] days. Following surgical repair after total proximal hamstring ruptures, RTP is generally allowed after 6–9 months.[63 64]

Factors associated with returning to sport or not returning to sport
Although multiple studies have assessed the possible predictors for time to RTS,[65–69] there is currently no strong evidence that MRI can predict time to RTS.[65] The individual variation in time to RTS and different RTS definitions[70] as well as low methodological quality and the considerable risk of bias in the current literature[65] might be an explanation for this. Clinical findings are more valuable for prediction of time to RTS than MRI measures, but predicting time to RTS is inaccurate for the individual athlete.[67 71] Except for (the relatively uncommon) total hamstring rupture, not returning to sport is not a major issue in acute hamstring injuries—close to 100% of athletes RTS after a hamstring injury.

RTS criteria (based on published literature)
In the absence of validated objective RTS criteria, a number of different criteria have been suggested: pain-free clinical evaluation,[72–74] minimal range of motion and/or strength deficits,[59 72 75 76] symmetrical hopping performance,[72] successful completion of a progressive rehabilitation programme and sport-specific functional field testing,[77–80] attained preinjury sprinting speed,[60] no apprehensions during full effort sport-specific movements[73] or full-speed sprints,[74] ballistic hamstring test (eg, Askling H-test).[81]

Groin injury
RTS rates and time to RTS
In general, RTS rates are high (>85% returned to some form of sport) after hip and groin injury and surgery, but these are based on poor quality evidence.[82 83] After groin injury, most athletes RTS within 4 weeks, but this must be considered against a high recurrence rate (15–25%).[84 85] When reinjury occurs, or if adductor and abdominal injury coexist, a longer absence from sport can be expected.[84–86] RTS times after surgery for long-standing groin pain are similar to RTS times after non-surgical procedures,[87] but for full adductor ruptures a faster RTS is seen with a non-surgical approach compared with surgery.[88]

Factors associated with returning or not returning to sport
Reduced hip adduction strength is associated with adductor injury, and is a strong risk factor for groin injuries in football and ice hockey.[89–92]

RTS criteria (based on published literature)
Given the association between reduced strength and adductor injury, we suggest hip adduction strength should be measured to inform RTS decision-making.

Achilles tendon injuries (*Achilles tendinopathy* and *Achilles tendon rupture*)
Prevalence
The Achilles tendon is one of the most injured tendons in athletes involved in running and jumping activities.[93] The cumulative incidence (before 45 years) in male athletes is 18.2% for *Achilles tendinopathy* and 5.4% for *Achilles tendon rupture*.[94]

RTS rate and time to RTS
Between 10 and 86% of athletes (athletes of various activity levels likely explain much of the variation in RTS rates) RTS after 12 weeks of treatment for *Achilles tendinopathy*.[95 96] After 1 year, 55–90% RTS.[97 98] However, up to 44% of people have a recurrence of *Achilles tendinopathy* after RTS.[99 100] After *Achilles tendon rupture*, 29–87% of athletes return to their preinjury level.[101–105]

Factors associated with returning or not returning to sport
Athletes with *Achilles tendinopathy* who follow a standardised load progression have fewer incidences of recurrence compared with those who do not follow a progressive loading programme.[99 100] This highlights the role of the clinician in promoting gradual and progressive loading when treating patients with *Achilles tendinopathy*. The pain monitoring model and rating of perceived exertion may give the clinician important clinical cues when working with an injured athlete.[106]

After *Achilles tendon rupture*, permanent deficits in calf muscle strength and tendon elongation are common.[107–109] Fear of reinjury often affects the decision to RTS after *Achilles tendon rupture*, especially to the same sport in which the injury occurred.[101]

RTS criteria (based on published literature)
Athletes with *Achilles tendinopathy* should complete a full progressive loading programme prior to clearance to RTS. Pain should not be greater than 5/10 during activity, and pain should subside by the next morning. Pain and stiffness are not permitted to increase from week to week.[110]

There are no milestone-based criteria for RTS following *Achilles tendon rupture*. The time-based criteria are for non-contact sport resumption from 16 weeks following injury, and contact sports from 20 weeks after injury.

RTS after shoulder injury
Prevalence
The average prevalence of shoulder problems in overhead athletes is ∼30%, with a point prevalence of 20%. The prevalence of substantial shoulder problems, defined as those leading to moderate or severe reductions in sports participation or performance, or to time loss, is ∼10–15%.[111 112]

RTS to sport rate and time to RTS
Little evidence exists regarding RTS rates or time to RTS after shoulder injury.

Factors associated with returning or not returning to sport
Predictors of RTS after shoulder injury are unknown. Loss of glenohumeral rotation range of motion, scapular dyskinesis and external rotator weakness may be risk factors for shoulder injury in athletes.[113–115]

RTS criteria (based on published literature)
The specific goals for rehabilitation may depend on the sport,[113 116] underscoring the importance of the clinician's knowledge of the sport, and working closely with coaches. Broadly, aim for a 10% increased rotator cuff strength on the dominant throwing side compared with the non-dominant side,[117] with external/internal rotation ratios from 65% (isokinetic) to 100% (isometric).[118]

Scapular asymmetry is normal in overhead athletes.[119] However, scapular upward rotation and scapular stabiliser muscle strength are hypothesised to be key factors in optimal sports performance.[120 121] Functional performance tests for the shoulder are gaining interest. However, these tests are not yet fully explored in clinical practice,[122–125] and lack normative data and cut-off values for injury prevention and RTS.

Important clinical considerations are when the athlete with shoulder pain may be permitted to throw, and how to manage optimal loading in the overhead athlete. Graded progression of load is critical, and must be specific to the demands of the sport.[126 127] Emerging technologies (eg, load cells) permit accurate quantification of load during overhead activities and may help the clinician more precisely quantify upper limb loading during activity.[128]

Summary

RTS criteria for many common sports injuries are not based on solid scientific evidence, and lack consensus. It is unknown whether this contributes to the relative high incidence of reinjuries or relatively low percentage of athletes who return to their preinjury level. It is also unclear whether fulfilling common RTS clinical criteria predicts progression through the RTS continuum (return to participation, RTS and return to performance). However, absence of research evidence should not mean immediate cause for despair that current practice is inadequate—there are cases where high-quality clinical practice is associated with excellent clinical outcomes.[129] The key points regarding evidence for RTS are presented in box 3.

SECTION 4: RTS RESEARCH: PRIORITIES AND FUTURE DIRECTIONS

Priority: providing clear definitions

Future studies reporting RTS outcomes should include clear definitions of injuries sustained, adopting any relevant international consensus on the reporting, categorisation and diagnosis (eg, the 'Scapular Summit' consensus on scapular dyskinesis[130] or the Doha agreement on terminology and definitions in groin pain).[131] It is also important to provide clear definitions of what constitutes reinjury, ideally using published guidelines.[132]

A clear definition of RTS is important, and researchers should consider using the RTS continuum (figure 1) as a basis for their definition. In some research contexts it may be necessary to elaborate on some elements of the RTS continuum. For example, for return to participation, to report the number of athletes who return to a different sport than their preinjury or the number who return to the preinjury sport but at a lower level (eg, was playing national competition basketball, now playing in a regional competition). Researchers should also report the number of athletes who stop playing sport.

Box 3 Key take home messages regarding the evidence for return to sport (RTS)

- Time to RTS varies independent of the type and severity of injury, reflecting the challenge in accurately predicting injury prognosis and RTS timelines.
- RTS decisions should always use information gathered from a battery of tests mimicking the reactive elements and the decision-making steps athletes use in real sport situations.
- Workload may be linked to reinjury, so should be taken into consideration when making RTS decisions.
- Psychological factors should be taken into account during rehabilitation and at the time the athlete is making the transition back to sport.
- Consensus is needed regarding the RTS criteria for common athletic injuries.

Priority: quantifying RTS

Participation and performance

Many elite level sports regularly use metrics to quantify performance (eg, metres gained, goals/points scored, assists) that may be helpful in describing performance outcomes for team sports (eg, American football, baseball, soccer) and some individual sports (eg, cycling and triathlon times). Various aspects of load can be readily quantified by the Global Positioning Systems (GPS), gyroscopes and accelerometers, and offer an interesting opportunity to benchmark performance levels, quantify load and performance, and set sport-specific targets for RTS.[133 134] Challenges lie in determining the relevance of specific measures to RTS as well as the reliability and availability of these data. Nevertheless, it is a rapidly developing and exciting field. To complement these objective measures, it is also important to consider subjective measures of acute and chronic training loads.[135]

Follow-up duration

Long-term follow-up is needed to examine the impact of injury on long-term participation in sport. The length of follow-up needs to be relevant to the injury studied (eg, after Bankart repair, 1 year might be considered short-term follow-up, while after muscle injury, 1 year might be considered long-term follow-up), and defined in advance by the researcher. Given that a sizeable proportion of athletes cease participation in their preinjury sport by the medium-term following injury,[82 136] it is an important avenue for future research to establish whether these athletes retire from sport or whether they change sports.

Satisfaction and confidence in RTS

Reasons for participating or not participating in sport vary greatly between different populations and sporting activities.[27 137] Future studies should seek to establish why some athletes do not RTS and if non-return is related to reasons for playing sport initially, and explore whether athletes are satisfied with their postinjury participation.

(Re)Injury risk after RTS

Consistent reporting of impairment-based and activity-based measures, and patient (athlete)-reported outcome measures during recovery and rehabilitation may help identify subgroups at high, moderate and low risk of reinjury. Early identification of these subgroups may allow targeted interventions to address risk factors (eg, specific strengthening programmes to address subcomponents of strength or psychological input for at-risk groups), which may result in better long-term outcomes. Quantification of risk may help categorise athletes who are not ready to RTS, those who require supervision, and those who are ready to RTS.

Priority: Identify prognostic factors for RTS outcome

Table 1 summarises some of the key factors that may influence RTS outcome and highlights the multifactorial nature of RTS. Interrelationships between factors and the impact of these relationships on RTS remain unclear, and warrant further investigation.

Priority: Identify and validate tests to guide RTS decision-making

Tests may be performed prior to injury as a benchmark, then at four key time points: (1) immediately after injury (ie, diagnostic tests), (2) through the course of rehabilitation (to monitor progression), (3) at the time of clearance to RTS, (4) after RTS to

Table 1 Reporting of factors that influence RTS outcomes

Risk assessment	Contributing factors that should be reported
Health risk (injury-specific factors)	Demographic characteristics (including: age, sex) Information collected from patient history (including: injury history, nature and severity of initial injury, pain, medical history) Clinical examination and physical tests (including: signs and symptoms, strength (and relevant sub-qualities e.g. power, rate of force development, eccentric strength, strength endurance), range of motion) Diagnostic imaging (e.g. MRI, ultrasound)
Activity risk (performance/activity factors)	Preinjury level of participation Nature of sport (e.g. contact/non-contact; individual/team; open/closed skills, pivoting vs non-pivoting) Specific activities associated with that sport Sport-specific functional testing Psychological factors
Risk tolerance (contextual factors)	Social factors Professional vs recreational participation

RTS, return to sport.

measure performance and reinjury risk. Future studies to consider the prognostic validity of clinical tests for RTS and reinjury are underway.

Areas that warrant further investigation to establish the relationship to RTS outcomes and interrelationships between factors include strength, range of motion, neuromuscular control, psychosocial factors and skill execution.

Strength

The role of strength and its subqualities (eg, power, rate of force development, endurance) in RTS outcomes remains unclear for many injuries.[80 138] Future studies should consider the influence of rate of force development, eccentric strength and strength endurance on RTS outcomes.[139–141]

Range of motion (including flexibility and pain-provocation stretch tests)

Research investigating the influence of range of motion on RTS outcomes has been largely equivocal, although there is evidence in baseball players of a relationship between shoulder injury and glenohumeral internal and external rotation deficits.[113 142 143] Future studies should evaluate the role of sport-specific range of motion through multiplanar functional movements.

Neuromuscular control

Some evidence exists on the role of neuromuscular control in reinjury.[140 144 145] However, tests that are commonly used to determine whether the athlete is ready to RTS (eg, single-leg hop test and the Y balance test) lack sensitivity,[146] are predictable, and controlled by the athlete. Future studies should examine the role of more challenging tests associated with sport-specific skills, and consider the sensitivity of dynamic functional tests and reactive agility (ie, unexpected/unpredictable challenges) in predicting RTS outcomes.[147]

Psychological factors

Most of the research examining the impact of psychological factors on RTS has been of cross-sectional design. Future studies should use prognostic designs to consider the temporal relationship between key psychological factors and RTS. Another important question to consider is whether interventions that target psychological factors can change RTS outcomes.

Performance and skill execution

Future studies should assess performance measures associated with the athlete's sport. Ideally, this research should include objective (eg, GPS, game statistics) and subjective measures of loading and performance (eg, session rate of perceived exertion, satisfaction).

Methodological considerations

Using consistent tests and descriptions will improve the ability to make comparisons between studies. It might then be possible to perform meta-analyses and compare across a variety of sports and subgroups.

Future studies should identify, a priori, the appropriate size of the cohort and the duration of follow-up. Blinded designs are encouraged, especially when using subjective outcome measures. Studies should also seek to articulate the statistical and clinical significance of results. Researchers are encouraged to follow reporting guidelines for different study types such as PRISMA[148] for systematic reviews and meta-analyses, CONSORT[149] for randomised trials and STROBE[150] for observational studies. For more details on research reporting guidelines visit http://www.equator-network.org

Future directions: key research priorities

There are many avenues to be pursued in future research. In box 4 we provide some recommendations on priorities for future RTS research.

Box 4 Priorities for future return to sport (RTS) research

- Standardised approach to injury definition including the nature of the injury, severity and whether it is a primary or recurrent injury.
- Standardised approach to reporting preinjury sporting activity to include the level of sport played, volume and intensity.
- Standardised reporting of RTS outcomes (eg, performance, (re)injury risk, satisfaction) and follow-up.
- Identification of positive and negative predictive (or prognostic) factors for RTS outcomes
- Design and validation of tools to accurately measure RTS.
- Identification of specific sub-groups within injury types that have different RTS outcomes.

CONCLUSIONS

Combining information from a biological, psychological and social standpoint, while considering the risks can help all RTS decision-makers—whether they be clinicians, athletes, coaches or other stakeholders—make optimal decisions. Integrating clinical expertise, research evidence and athlete preferences is important for RTS decision-making and for longer-term RTS success. RTS criteria for many common injuries are not based on solid scientific evidence. Future research should focus on a standardised approach to defining, measuring and reporting of RTS outcomes, and on identifying the prognostic factors for RTS.

Author affiliations
[1]Aspetar Orthopaedic & Sports Medicine Hospital, Doha, Qatar
[2]Division of Physiotherapy, Linköping University, Linköping, Sweden
[3]School of Allied Health, La Trobe University, Melbourne, Australia

[4]Sport Northern Ireland Sports Institute, Newtownabbey, UK
[5]School of Sport, Ulster University, Newtownabbey, UK
[6]School of Human, Health & Social Sciences, Central Queensland University, Branyan, Queensland, Australia
[7]Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium
[8]Oslo Sports Trauma Research Center, Norwegian School of Sports Sciences, Oslo, Norway
[9]The Olympic Elite Sports Program (Olympiatoppen), Oslo, Norway
[10]Hôpital de La Tour, Swiss Olympic Medical Center, Meyrin, Switzerland
[11]Sports Medicine, Department for Human Locomotion, Lausanne University and Hospital, Lausanne, Switzerland
[12]College of Medical and Dental Sciences, University of Birmingham, Birmingham, UK
[13]Center for Hip Health and Mobility, University of British Columbia, Vancouver, British Columbia, Canada
[14]SPACE Clinics, Edinburgh, UK
[15]Scottish Rugby, Murrayfield Stadium, UK
[16]School of Healthcare Sciences, Cardiff University, Cardiff, UK
[17]The Sports Physicians Group, Amsterdam, The Netherlands
[18]Manchester City Football Club, Manchester, UK
[19]Department of Physical Therapy, University of Delaware, Newark, Delaware, USA
[20]Department of Orthopedic Surgery, Sports Orthopedic Research Center—Copenhagen (SORC-C), Amager-Hvidovre Hospital, Copenhagen University, Copenhagen, Denmark
[21]Department of Orthopedic Surgery and Physical Therapy, Physical Medicine Rehabilitation Research—Copenhagen, Amager-Hvidovre Hospital, Copenhagen University, Copenhagen, Denmark
[22]Champion Sports Medicine, Birmingham, Alabama, USA
[23]FIFA—Medical Assessment & Research Centre (F-MARC), Schulthess Clinic, Zürich, Switzerland

Author note All presentations from the First World Congress in Sports Physical Therapy are available free online at the congress Youtube channel: https://www.youtube.com/playlist?list=PL5-fLYMmHt3CYMu3aU5i_E9E2jYDhZiRK

Twitter Follow Clare Ardern at @clare_ardern, Philip Glasgow at @philglasgow, Benjamin Clarsen at @benclarsen, Steffan Griffin at @lifestylemedic, Håvard Moksnes at @HMoksnes, Nicola Phillips at @NicolaPhillPT and Arnlaug Wangensteen at @arnlaugw

Acknowledgements The authors acknowledge and thank Dr. Ian Shrier for his contribution to the consensus discussion and his comments on the earlier versions of the manuscript.

Competing interests BJSM covered the cost of travel to the Bern congress for CLA and SG. KMK is the Editor-in-Chief of BJSM.

Provenance and peer review Commissioned; externally peer reviewed.

REFERENCES

1 No authors listed]. The team physician and return-to-play issues: a consensus statement. *Med Sci Sports Exerc* 2002;34:1212–14.
2 Creighton DW, Shrier I, Schultz R, *et al*. Return-to-play in sport: a decision-based model. *Clin J Sports Med* 2010;20:379–85.
3 Ardern CL, Khan KM. The old knee in the young athlete: knowns and unknowns in the return-to-play conversation. *Br J Sports Med* 2016;50:505–6.
4 Elwyn G, Frosch D, Thomson R, *et al*. Shared decision making: a model for clinical practice. *J Gen Intern Med* 2012;27:1361–7.
5 Shrier I, Safai P, Charland L. Return-to-play following injury: whose decision should it be? *Br J Sports Med* 2014;48:394–401.
6 McCrory P, Meeuwisse WH, Aubry M, *et al*. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med* 2013;47:250–8.
7 Ardern CL, Bizzini M, Bahr R. It is time for consensus on return to play after injury: five key questions. *Br J Sports Med* 2016;50:506–8.
8 Shrier I. Strategic Assessment of Risk and Risk Tolerance (StARRT) framework for return-to-play decision-making. *Br J Sports Med* 2015;49:1311–15.
9 Atkins E, Colville G, John M. A 'biopsychosocial' model for recovery: a grounded theory study of families' journeys after a Paediatric Intensive Care admission. *Intensive Crit Care Nurs* 2012;28:133–40.
10 Ayers DC, Franklin PD, Ring DC. The role of emotional health in functional outcomes after orthopaedic surgery: extending the biopsychosocial model to orthopaedics. *J Bone Joint Surg Am* 2013;95:e165.
11 Pincus T, Kent P, Bronfort G, *et al*. Twenty-five years with the biopsychosocial model of low back pain—is it time to celebrate? A report from the Twelfth International Forum for Primary Care Research on Low Back Pain. *Spine* 2013;38:2118–23.
12 Wiese-Bjornstal DM, Smith AM, Shaffer SM, *et al*. An integrated model of response to sport injury: psychological and sociological dynamics. *J Appl Sport Psychol* 1998;10:46–69.
13 Gabbett TJ, Hulin BT, Blanch P, *et al*. High training workloads alone do not cause sports injuries: how you get there is the key issue. *Br J Sports Med* 2016;50:444–5.
14 Blanch P, Gabbett TJ. Has the athlete trained enough to return to play safely? The acute:chronic worload ratio permits clinicians to quantify a player's risk of subsequent injury. *Br J Sports Med* 2016;50:471–5.
15 Grindem H, Eitzen I, Engebretsen L, *et al*. Nonsurgical or surgical treatment of ACL injuries: knee function, sports participation, and knee reinjury: the Delaware-Oslo ACL Cohort Study. *J Bone Joint Surg Am* 2014;96:1233–41.
16 Grindem H, Risberg MA, Eitzen I. Two factors that may underpin outstanding outcomes after ACL reconstruction. *Br J Sports Med* 2015;49:1425.
17 Bizzini M, Hancock D, Impellizzeri F. Suggestions from the field for return to sports participation following anterior cruciate ligament reconstruction: soccer. *J Orthop Sports Phys Ther* 2012;42:304–12.
18 Bizzini M, Silvers HJ. Return to competitive football after major knee surgery: more questions than answers. *J Sports Sci* 2014;32:1209–16.
19 Gabbett TJ, Benton D. Reactive agility of rugby league players. *J Sci Med Sport* 2009;12:212–14.
20 Lockie RG, Jeffriess MD, McGann TS, *et al*. Planned and reactive agility performance in semiprofessional and amateur basketball players. *Int J Sports Physiol Perform* 2014;9:766–71.
21 Sheppard JM, Young WB, Doyle TLA, *et al*. An evaluation of a new test of reactive agility and its relationship to sprint speed and change of direction speed. *J Sci Med Sport* 2006;9:342–9.
22 Ardern CL. Anterior cruciate ligament reconstruction-not exactly a one-way ticket back to the preinjury level: a review of contextual factors affecting return to sport after surgery. *Sports Health* 2015;7:224–30.
23 Ardern CL, Taylor NF, Feller JA, *et al*. A systematic review of the psychological factors associated with returning to sport following injury. *Br J Sports Med* 2013;47:1120–6.
24 Czuppon S, Racette BA, Klein SE, *et al*. Variables associated with return to sport following anterior cruciate ligament reconstruction: a systematic review. *Br J Sports Med* 2014;48:356–64.
25 Tripp DA, Stanish W, Ebel-Lam A, *et al*. Fear of reinjury, negative affect, and catastrophizing predicting return to sport in recreational athletes with anterior cruciate ligament injuries at 1 year postsurgery. *Rehabil Psych* 2007;52:74–81.
26 Webster KE, Feller JA, Lambros C. Development and preliminary validation of a scale to measure the psychological impact of returning to sport following anterior cruciate ligament reconstruction surgery. *Phys Ther Sport* 2008;9:9–15.
27 Glazer DD. Development and preliminary validation of the Injury-Psychological Readiness to Return to Sport (I-PRRS) Scale. *J Athl Train* 2009;44:185–9.
28 Granan LP, Forssblad M, Lind M, *et al*. The Scandinavian ACL registries 2004–2007: baseline epidemiology. *Acta Orthop* 2009;80:563–7.
29 Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. *Am J Sports Med* 2006;34:299–311.
30 Waldén M, Hägglund M, Werner J, *et al*. The epidemiology of anterior cruciate ligament injury in football (soccer): a review of the literature from a gender-related perspective. *Knee Surg Sports Traumatol Arthrosc* 2011;19:3–10.
31 Ekstrand J, Hägglund M, Waldén M. Epidemiology of muscle injuries in professional football (soccer). *Am J Sports Med* 2011;39:1226–32.
32 Wright RW, Huston LJ, Spindler KP, *et al*., MOON Group. Descriptive epidemiology of the Multicenter ACL Revision Study (MARS) cohort. *Am J Sports Med* 2010;38:1979–86.
33 Ardern CL, Taylor NF, Feller JA, *et al*. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *Br J Sports Med* 2014;48:1543–52.
34 Grindem H, Eitzen I, Moksnes H, *et al*. A pair-matched comparison of return to pivoting sports at 1 year in anterior cruciate ligament-injured patients after a nonoperative versus an operative treatment course. *Am J Sports Med* 2012;40:2509–16.
35 Frobell RB, Roos HP, Roos EM, *et al*. Treatment for acute anterior cruciate ligament tear: five year outcome of randomised trial. *BMJ* 2013;346:f232.
36 Anand BS, Feller JA, Richmond AK, *et al*. Return-to-sport outcomes after revision anterior cruciate ligament reconstruction surgery. *Am J Sports Med* 2016;44:580–4.
37 Grassi A, Zaffagnini S, Marcheggiani Muccioli GM, *et al*. After revision anterior cruciate ligament reconstruction, who returns to sport? A systematic review and meta-analysis. *Br J Sports Med* 2015;49:1295–304.
38 Ardern CL, Webster KE, Taylor NF, *et al*. Return to the preinjury level of competitive sport after anterior cruciate ligament reconstruction surgery two-thirds of patients have not returned by 12 months after surgery. *Am J Sports Med* 2011;39:538–43.

39 Waldén M, Hägglund M, Magnusson H, *et al*. ACL injuries in men's professional football: a 15-year prospective study on time trends and return-to-play rates reveals only 65% of players still play at the top level 3 years after ACL rupture. *Br J Sports Med* Published Online First: 31 Mar 2016 doi:10.1136/bjsports-2015-095952
40 Lundblad M, Waldén M, Magnusson H, *et al*. The UEFA injury study: 11-year data concerning 346 MCL injuries and time to return to play. *Br J Sports Med* 2013;47:759–62.
41 Laprade RF, Surowiec RK, Sochanska AN, *et al*. Epidemiology, identification, treatment and return to play of musculoskeletal-based ice hockey injuries. *Br J Sports Med* 2014;48:4–10.
42 Laprade RF, Wijdicks CA. The management of injuries to the medial side of the knee. *J Orthop Sports Phys Ther* 2012;42:221–33.
43 Aune KT, Andrews JR, Dugas JR, *et al*. Return to play after partial lateral meniscectomy in National Football League athletes. *Am J Sports Med* 2014;42:1865–72.
44 Nawabi DH, Cro S, Hamid IP, *et al*. Return to play after lateral meniscectomy compared with medial meniscectomy in elite professional soccer players. *Am J Sports Med* 2014;42:2193–8.
45 Røtterud JH, Sivertsen EA, Forssblad M, *et al*. Effect of meniscal and focal cartilage lesions on patient-reported outcome after anterior cruciate ligament reconstruction: a nationwide cohort study from Norway and Sweden of 8476 patients with 2-year follow-up. *Am J Sports Med* 2013;41:535–43.
46 Zaffagnini S, Grassi A, Marcheggiani Muccioli GM, *et al*. Return to sport after anterior cruciate ligament reconstruction in professional soccer players. *Knee* 2014;21:731–5.
47 Ardern CL, Österberg A, Tagesson S, *et al*. The impact of psychological readiness to return to sport and recreational activities after anterior cruciate ligament reconstruction. *Br J Sports Med* 2014;48:1613–19.
48 Kvist J, Kartus J, Karlsson J, *et al*. Results from the Swedish National Anterior Cruciate Ligament Register. *Arthroscopy* 2014;30:803–10.
49 Maletis GB, Inacio MC, Funahashi TT. Risk factors associated with revision and contralateral anterior cruciate ligament reconstructions in the Kaiser Permanente ACLR Registry. *Am J Sports Med* 2015;43:641–7.
50 Webster KE, Feller JA, Leigh WB, *et al*. Younger patients are at increased risk for graft rupture and contralateral injury after anterior cruciate ligament reconstruction. *Am J Sports Med* 2014;42:641–7.
51 Myklebust G, Bahr R. Return to play guidelines after anterior cruciate ligament surgery. *Br J Sports Med* 2005;39:127–31.
52 Brooks JHM. Incidence, risk, and prevention of hamstring muscle injuries in professional rugby union. *Am J Sports Med* 2006;34:1297–306.
53 Orchard J, Seward H. Epidemiology of injuries in The Australian Football League, seasons 1997–2000. *Br J Sports Med* 2002;36:39–44.
54 Yeung SS, Suen AMY, Yeung EW. A prospective cohort study of hamstring injuries in competitive sprinters: preseason muscle imbalance as a possible risk factor. *Br J Sports Med* 2009;43:589–94.
55 Orchard JW, Seward H, Orchard JJ. Results of 2 decades of injury surveillance and public release of data in The Australian Football League. *Am J Sports Med* 2013;41:734–41.
56 de Visser HM, Reijman M, Heijboer MP, *et al*. Risk factors of recurrent hamstring injuries: a systematic review. *Br J Sports Med* 2012;46:124–30.
57 de Vos RJ, Reurink G, Goudswaard GJ, *et al*. Clinical findings just after return to play predict hamstring re-injury, but baseline MRI findings do not. *Br J Sports Med* 2014;48:1377–84.
58 Ekstrand J, Waldén M, Hägglund M. Hamstring injuries have increased by 4% annually in men's professional football, since 2001: a 13-year longitudinal analysis of the UEFA Elite Club injury study. *Br J Sports Med* Published Online First: 8 Jan 2016 doi:10.1136/bjsports-2015-095359
59 Kilcoyne KG, Dickens JF, Keblish D, *et al*. Outcome of grade I and II hamstring injuries in intercollegiate athletes: a novel rehabilitation protocol. *Sports Health* 2011;3:528–33.
60 Askling CM, Tengvar M, Saartok T, *et al*. Acute first-time hamstring strains during high-speed running: a longitudinal study including clinical and magnetic resonance imaging findings. *Am J Sports Med* 2007;35:197–206.
61 Hallén A, Ekstrand J. Return to play following muscle injuries in professional footballers. *J Sport Sci* 2014;32:1229–36.
62 Ekstrand J, Healy JC, Waldén M, *et al*. Hamstring muscle injuries in professional football: the correlation of MRI findings with return to play. *Br J Sports Med* 2012;46:112–17.
63 Birmingham P, Muller M, Wickiewicz T, *et al*. Functional outcome after repair of proximal hamstring avulsions. *J Bone Joint Surg Am* 2011;93:1819–26.
64 Cohen SB, Towers JD, Zoga A, *et al*. Hamstring injuries in professional football players: magnetic resonance imaging correlation with return to play. *Sports Health* 2011;3:423–30.
65 Reurink G, Brilman EG, de Vos RJ, *et al*. Magnetic resonance imaging in acute hamstring injury: can we provide a return to play prognosis? *Sports Med* 2015;45:133–46.
66 Fournier-Farley C, Lamontagne M, Gendron P, *et al*. Determinants of return to play after the nonoperative management of hamstring injuries in athletes: a systematic review. *Am J Sports Med* 2015; doi:10.1177/0363546515617472.
67 Wangensteen A, Almusa E, Boukarroum S, *et al*. MRI does not add value over and above patient history and clinical examination in predicting time to return to sport after acute hamstring injuries: a prospective cohort of 180 Male athletes. *Br J Sports Med* 2015;49:1579–87.
68 Jacobsen P, Witvrouw E, Muxart P, *et al*. A combination of initial and follow-up physiotherapist examination predicts physician-determined time to return to play after hamstring injury, with no added value of MRI. *Br J Sports Med* 2016;50:431–9.
69 Pollock N, Patel A, Chakraverty J, *et al*. Time to return to full training is delayed and recurrence rate is higher in intratendinous ('c') acute hamstring injury in elite track and field athletes: clinical implication of the British Athletics Muscle Injury Classification. *Br J Sports Med* 2016;50:305–10.
70 van der Horst N, van de Hoef S, Reurink G, *et al*. Return to play after hamstring injuries: a qualitative systematic review of definitions and criteria. *Sports Med* 2016; doi:10.1007/s40279-015-0468-7
71 Moen MH, Reurink G, Weir A, *et al*. Predicting return to play after hamstring injuries. *Br J Sports Med* 2014;48:1358–63.
72 Malliaropoulos N, Papacostas E, Kiritsi O, *et al*. Posterior thigh muscle injuries in elite track and field athletes. *Am J Sports Med* 2010;38:1813–19.
73 Sanfilippo JL, Silder A, Sherry MA, *et al*. Hamstring strength and morphology progression after return to sport from injury. *Med Sci Sports Exerc* 2013;45:448–54.
74 Silder A, Sherry MA, Sanfilippo J, *et al*. Clinical and morphological changes following 2 rehabilitation programs for acute hamstring strain injuries: a randomized clinical trial. *J Orthop Sports Phys Ther* 2013;43:284–99.
75 A Hamid MS, Mohamed Ali MR, Yusof A, *et al*. Platelet-rich plasma injections for the treatment of hamstring injuries: a randomized controlled trial. *Am J Sports Med* 2014;42:2410–18.
76 Timmins RG, Bourne MN, Shield AJ, *et al*. Short biceps femoris fasicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study. *Br J Sports Med* Published Online First: 16 Dec 2015 doi:10.1136/bjsports-2015-095362
77 Askling CM, Tengvar M, Tarassova O, *et al*. Acute hamstring injuries in Swedish elite sprinters and jumpers: a prospective randomised controlled clinical trial comparing two rehabilitation protocols. *Br J Sports Med* 2014;48:532–9.
78 Askling CM, Tengvar M, Thorstensson A. Acute hamstring injuries in Swedish elite football: a prospective randomised controlled clinical trial comparing two rehabilitation protocols. *Br J Sports Med* 2013;47:953–9.
79 Sherry MA, Best TM. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. *J Orthop Sports Phys Ther* 2004;34:116–25.
80 Tol JL, Hamilton B, Eirale C, *et al*. At return to play following hamstring injury the majority of professional football players have residual isokinetic deficits. *Br J Sports Med* 2014;48:1364–9.
81 Askling CM, Nilsson J, Thorstensson A. A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1798–803.
82 Casartelli NC, Leunig M, Maffiuletti NA, *et al*. Return to sport after hip surgery for femoroacetabular impingement: a systematic review. *Br J Sports Med* 2015;49:819–24.
83 Serner A, van Eijck CH, Beumer BR, *et al*. Study quality on groin injury management remains low: a systematic review on treatment of groin pain in athletes. *Br J Sports Med* 2015;49:813.
84 Emery CA, Meeuwisse WH, Powell JW. Groin and abdominal strain injuries in The National Hockey League. *Clin J Sport Med* 1999;9:151–6.
85 Werner J, Hägglund M, Walden M, *et al*. UEFA injury study: a prospective study of hip and groin injuries in professional football over seven consecutive seasons. *Br J Sports Med* 2009;43:1036–40.
86 Hölmich P, Thorborg K, Dehlendorff C, *et al*. Incidence and clinical presentation of groin injuries in sub-elite male soccer. *Br J Sports Med* 2014;48:1245–50.
87 King E, Ward J, Small L, *et al*. Athletic groin pain: a systematic review and meta-analysis of surgical versus physical therapy rehabilitation outcomes. *Br J Sports Med* 2015;49:1447–51.
88 Schlegel TF, Bushnell BD, Godfrey J, *et al*. Success of nonoperative management of adductor longus tendon ruptures in National Football League athletes. *Am J Sports Med* 2009;37:1394–9.
89 Thorborg K, Branci S, Nielsen M, *et al*. Eccentric and isometric hip adduction strength in male soccer players with and without adductor-related groin pain. An assessor-blinded comparison. *Orthop J Sports Med* 2014;2:2325967114521778.
90 Thorborg K, Hölmich P. Advancing hip and groin injury management: from eminence to evidence. *Br J Sports Med* 2013;47:602–5.
91 Tyler TF, Nicholas SJ, Campbell RJ, *et al*. The association of hip strength and flexibility with the incidence of adductor muscle strains in professional ice hockey players. *Am J Sports Med* 2001;29:124–8.

92 Engebretsen AH, Myklebust G, Holme I, *et al*. Intrinsic risk factors for groin injuries among male soccer players: a prospctive cohort study. *Am J Sports Med* 2010;38:2051–7.
93 Houshian S, Tscherning T, Riegels-Nielsen P. The epidemiology of Achilles tendon rupture in a Danish county. *Injury* 1998;29:651–4.
94 Kujala UM, Sarna S, Kaprio J. Cumulative incidence of Achilles tendon rupture and tendinopathy in male former elite athletes. *Clin J Sports Med* 2005;15:133–5.
95 Mafi N, Lorentzon R, Alfredson H. Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis. *Knee Surg Sports Traumatol Arthrosc* 2001;9:42–7.
96 Roos EM, Engström M, Lagerquist A, *et al*. Clinical improvement after 6 weeks of eccentric exercise in patients with mid-portion Achilles tendinopathy – a randomized trial with 1-year follow-up. *Scand J Med Sci Sport* 2004;14:286–95.
97 Brown R, Orchard J, Kinchington M, *et al*. Aprotinin in the management of Achilles tendinopathy: a randomised controlled trial. *Br J Sports Med* 2006;40:275–9.
98 Silbernagel KG, Thomeé R, Thomeé P, *et al*. Eccentric overload training for patients with chronic Achilles tendon pain--a randomised controlled study with reliability testing of the evaluation methods. *Scand J Med Sci Sport* 2001;11:197–206.
99 Gajhede-Knudsen M, Ekstrand J, Magnusson H, *et al*. Recurrence of Achilles tendon injuries in elite male football players is more common after early return to play: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med* 2013;47:763–8.
100 Hägglund M, Waldén M, Ekstrand J. Lower reinjury rate with a coach-controlled rehabilitation program in amateur male soccer: a randomized controlled trial. *Am J Sports Med* 2007;35:1433–42.
101 Möller M, Movin T, Granhed H, *et al*. Acute rupture of tendon Achilles. A prospective randomised study of comparison between surgical and non-surgical treatment. *J Bone Joint Surg Br* 2001;83:843–8.
102 Nillson-Helander K, Silbernagel KG, Thomeé R, *et al*. Acute Achilles tendon rupture: a randomized, controlled study comparing surgical and nonsurgical treatments using validated outcome measures. *Am J Sports Med* 2010;38:2186–93.
103 Olsson N, Silbernagel KG, Eriksson BI, *et al*. Stable surgical repair with accelerated rehabilitation versus nonsurgical treatment for acute Achilles tendon ruptures: a randomized controlled study. *Am J Sports Med* 2013;41:2867–76.
104 Amin NH, Old AB, Tabb LP, *et al*. Performance outcomes after repair of complete Achilles tendon ruptures in national basketball association players. *Am J Sports Med* 2013;41:1864–8.
105 Parekh SG, Wray WH, Brimmo O, *et al*. Epidemiology and outcomes of Achilles tendon ruptures in The National Football League. *Foot Ankle Spec* 2009;2:283–6.
106 Silbernagel KG, Crossley KM. A proposed return to sport program for patients with midportion Achilles tendinopathy: rationale and implementation. *J Orthop Sports Phys Ther* 2015;21:1–42.
107 Don R, Ranavolo A, Cacchio A, *et al*. Relationship between recovery of calf-muscle biomechanical properties and gait pattern following surgery for Achilles tendon rupture. *Clin Biomech (Bristol. Avon)* 2007;22:211–20.
108 Mullaney MJ, McHugh MP, Tyler TF, *et al*. Weakness in end-range plantar flexion after Achilles tendon repair. *Am J Sports Med* 2006;34:1120–5.
109 Silbernagel KG, Steele R, Manal K. Deficits in heel-rise height and Achilles tendon elongation occur in patients recovering from an Achilles tendon rupture. *Am J Sports Med* 2012;40:1564–71.
110 Silbernagel KG, Thomeé R, Eriksson BI, *et al*. Continued sports activity, using a pain-monitoring model, during rehabilitation in athletes with Achilles tendinopathy: a randomized controlled study. *Am J Sports Med* 2007;35:897–906.
111 Caine DJ, Harmer PA, Schiff MA. *Epidemiology of injury in Olympic sports, volume XVI*. Oxford, UK: Wiley-Blackwell, 2009.
112 Clarsen B, Bahr R, Heymans MW, *et al*. The prevalence and impact of overuse injuries in five Norwegian sports: application of a new surveillance method. *Scand J Med Sci Sport* 2015;25:323–30.
113 Wilk KE, Macrina LC, Fleisig GS, *et al*. Deficits in glenohumeral passive range of motion increase risk of shoulder injury in professional baseball pitchers: a prospective study. *Am J Sports Med* 2015;43:2379–85.
114 Clarsen B, Bahr R, Andersson SH, *et al*. Reduced glenohumeral rotation, external rotation weakness and scapular dyskinesis are risk factors for shoulder injuries among elite male handball players: a prospective cohort study. *Br J Sports Med* 2014;48:1327–33.
115 Shitara H, Kobayashi T, Yamamoto A, *et al*. Prospective multifactorial analysis of preseason risk factors for shoulder and elbow injuries in high school baseball pitchers. *Knee Surg Sports Traumatol Arthrosc* 2015. doi: 10.1007/s00167-015-3731-4
116 Wilk KE, Macrina LC. Nonoperative and postoperative rehabilitation for glenohumeral instability. *Clin Sports Med* 2013;32:865–914.
117 Ellenbecker TS, Cools A. Rehabilitation of shoulder impingement syndrome and rotator cuff injuries: an evidence-based review. *Br J Sports Med* 2010;44:319–27.
118 Cools AM, Vanderstukken F, Vereecken F, *et al*. Eccentric and isometric shoulder rotator cuff strength testing using a hand-held dynamometer: reference values for overhead athletes. *Knee Surg Sports Traumatol Arthrosc* 2015. doi: 10.1007/s00167-015-3755-9
119 Ribeiro A, Pascoal AG. Resting scapular posture in healthy overhead throwing athletes. *Man Ther* 2013;18:547–50.
120 Cools AM, Johansson FR, Cambier DC, *et al*. Descriptive profile of scapulothoracic position, strength and flexibility variables in adolescent elite tennis players. *Br J Sports Med* 2010;44:678–84.
121 Laudner KG, Stanek JM, Meister K. Differences in scapular upward rotation between baseball pitchers and position players. *Am J Sports Med* 2007;35:2091–5.
122 Tucci HT, Martins J, Sposito Gde C, *et al*. Closed Kinetic Chain Upper Extremity Stability test (CKCUES test): a reliability study in persons with and without shoulder impingement syndrome. *BMC Musculoskelet Disord* 2014;15:1.
123 van den Tillaar R, Marques MC. Reliability of seated and standing throwing velocity using differently weighted medicine balls. *J Strength Cond Res* 2013;27:1234–8.
124 Westrick RB, Miller JM, Carow SD, *et al*. Exploration of the y-balance test for assessment of upper quarter closed kinetic chain performance. *Int J Sports Phys Ther* 2012;7:139–47.
125 Gorman PP, Butler RJ, Plisky PJ, *et al*. Upper Quarter Y Balance Test: reliability and performance comparison between genders in active adults. *J Strength Cond Res* 2012;26:3043–8.
126 McDonough A, Funk L. Critical reflection of the advanced rehabilitation of an elite rugby league player sustaining a posterior Bankart lesion. *Phys Ther Sport* 2013;14:60–7.
127 Moore SD, Uhl TL, Kibler WB. Improvements in shoulder endurance following a baseball-specific strengthening program in high school baseball players. *Sports Health* 2013;5:233–8.
128 Morouço PG, Marinho DA, Fernandes RJ, *et al*. Quantification of upper limb kinetic asymmetries in front crawl swimming. *Hum Mov Sci* 2015;40:185–92.
129 Weiler R. Unknown unknowns and lessons from non-operative rehabilitation and return to play of a complete anterior cruciate ligament injury in English Premier League football. *Br J Sports Med* 2016;50:261–2.
130 Kibler WB, Ludewig PM, McClure PW, *et al*. Clinical implications of scapular dyskinesis in shoulder injury: the 2013 consensus statement from the 'scapular summit'. *Br J Sports Med* 2013;47:877–85.
131 Weir A, Brukner P, Delahunt E, *et al*. Doha agreement meeting on terminology and definitions in groin pain in athletes. *Br J Sports Med* 2015;49:768–74.
132 Finch CF, Cook J. Categorising sports injuries in epidemiological studies: the subsequent injury categorisation (SIC) model to address multiple, recurrent and exacerbation of injuries. *Br J Sports Med* 2014;48:1276–80.
133 Hausler J, Halaki M, Orr R. Application of global positioning system and microsensor technology in competitive rugby league match play: a systematic review and meta-analysis. *Sports Med* 2016;46:559–88.
134 Mendiguchia J, Edouard P, Samozino P, *et al*. Field monitoring of sprinting power-force-velocity profile before, during and after hamstring injury: two case reports. *J Sports Sci* 2016;34:535–41.
135 Saw AE, Main LC, Gastin PB. Monitoring the athlete training response: subjective self-reported measures trump commonly used objective measures: a systematic review. *Br J Sports Med* 2016;50:281–91.
136 Ardern CL, Taylor NF, Feller JA, *et al*. Return-to-sport outcomes at 2 to 7 years after anterior cruciate ligament reconstruction surgery. *Am J Sports Med* 2012;40:41–8.
137 Allender S, Cowburn G, Foster C. Understanding participation in sport and physical activity among children and adults: a review of qualitative studies. *Health Educ Res* 2006;21:826–35.
138 Thomeé R, Kaplan Y, Myklebust G, *et al*. Muscle strength and hop performance criteria prior to return to sports after ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2011;19:1798–805.
139 Croisier JL, Ganteaume S, Binet J, *et al*. Strength imbalances and prevention of hamstring injury in professional soccer players a prospective study. *Am J Sports Med* 2008;36:1469–75.
140 Eitzen I, Moksnes H, Snyder-Mackler L, *et al*. Functional tests should be accentuated more in the decision for ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1517–25.
141 Ithurburn MP, Paterno MV, Ford KR, *et al*. Young athletes with quadriceps femoris strength asymmetry at return to sport after anterior cruciate ligament reconstruction demonstrate asymmetric single-leg drop-landing mechanics. *Am J Sports Med* 2015;43:2727–37.
142 Shanley E, Rauh MJ, Michener LA, *et al*. Shoulder range of motion measures as risk factors for shoulder and elbow injuries in high school softball and baseball players. *Am J Sports Med* 2011;39:1997–2006.
143 Wilk KE, Macrina LC, Fleisig GS, *et al*. Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball players. *Am J Sports Med* 2011;39:329–35.

144 Demeritt KM, Shultz SJ, Docherty CL, *et al*. Chronic ankle instability does not affect lower extremity functional performance. *J Athl Train* 2002;37:507–11.
145 Scheurmans J, van Tiggelen D, Danneels L, *et al*. Susceptibility to hamstring injuries in soccer. A prospective study using muscle functional magnetic resonance imaging. *Am J Sports Med* 2016;44:1276–85.
146 Logerstedt DS, Grindem H, Lynch A, *et al*. Single-legged hop tests as predictors of self-reported knee function after anterior cruciate ligament reconstruction: the Delaware-Oslo ACL cohort study. *Am J Sports Med* 2012;40:2348–56.
147 Mendiguchia J, Samozino P, Martinez-Ruiz E, *et al*. Progression of mechanical properties during on-field sprint running after returning to sports from a hamstring muscle injury in soccer players. *Int J Sports Med* 2014;35:690–5.
148 Moher D, Liberati A, Tetzlaff J, *et al*., The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *BMJ* 2009;339:b2535.
149 Schulz KF, Altman DG, Moher D, for the CONSORT Group. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *BMJ* 2010;340:c332.
150 von Elm E, Altman DG, Egger M, *et al*. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;370:1453–7.
151 Ardern CL, Kvist J, Webster KE. Psychological aspects of anterior cruciate ligament injuries. *Oper Tech Sports Med* 2015. doi:10.1053/j.otsm.2015.09.006

BJSM

2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern

Clare L Ardern, Philip Glasgow, Anthony Schneiders, Erik Witvrouw, Benjamin Clarsen, Ann Cools, Boris Gojanovic, Steffan Griffin, Karim M Khan, Håvard Moksnes, Stephen A Mutch, Nicola Phillips, Gustaaf Reurink, Robin Sadler, Karin Grävare Silbernagel, Kristian Thorborg, Arnlaug Wangensteen, Kevin E Wilk and Mario Bizzini

Br J Sports Med published online May 25, 2016