Return to sport decisions after an acute lateral ankle sprain injury : introducing the PAASS framework - an international multidisciplinary consensus

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Abstract

Background: Despite being the most commonly incurred sports injury with a high recurrence rate, there are no guidelines to inform return to sport (RTS) decisions following acute lateral ankle sprain. We aimed to develop a list of assessment items that addresses this gap.

Methods: We used a 3-round Delphi survey approach to develop consensus of opinion among 155 globally diverse health professionals working in elite field or court sports. This involved surveys that were structured in question format with both closed- and open-response options. We asked panelists to indicate their agreement about whether or not assessment items should support the RTS decision after an acute lateral ankle sprain injury. The second and third round surveys included quantitative and qualitative feedback from the previous round. We defined a-priori consensus being reached at >70% agree or disagree responses.

Results: Sixteen assessment items reached consensus to be included in the RTS decision after an acute lateral ankle sprain injury. They were mapped to five domains with 98% panelist agreement – **PAASS**: **P**ain (during sport participation and over the last 24 hours), **A**nkle impairments (range of motion; muscle strength; endurance and power), **A**thlete perception (perceived ankle confidence/reassurance and stability; psychological readiness), **S**ensorimotor control (proprioception and dynamic postural control/balance), **S**port/functional performance (hopping, jumping, agility and sport-specific drills; ability to complete a full training session).

Conclusion: Expert opinion indicated that pain severity, ankle impairments, sensorimotor control, athlete perception/readiness, and sport/functional performance should be assessed to inform the RTS decision following an acute lateral ankle sprain injury.

Keywords (MeSH): return to sport, ankle injuries, consensus.

Study/trial identifier: ACTRN12619000522112 (retrospectively registered).

Introduction

Lateral ankle sprains are one of the most common injuries sustained during sport, but they are often perceived to be minor injuries that heal expediently with minimal need for therapeutic intervention[1-3]. More than half of individuals who sustain a lateral ankle sprain injury do not seek formal medical treatment[1-3] and many return to sport (RTS) before injury associated impairments are resolved[4]. In fact, 71% to 75% of US high school athletes were sanctioned to RTS within 3 days of incurring an acute lateral ankle sprain, with 95% sanctioned to RTS within 10 days of injury[5].

There are currently no criteria-based guidelines to inform RTS decisions following an acute lateral ankle sprain injury. A recent systematic review did not identify any studies that have prospectively evaluated RTS criteria for individuals who have incurred an acute lateral ankle sprain injury[6]. Further, a review of expert opinion identified little consensus on domains, specific assessments or cut-off thresholds to inform RTS decisions following acute lateral ankle sprain injury[7]. Lack of RTS guidelines and appropriate health care[2 8], may contribute to premature RTS after a lateral ankle sprain injury[5]. We propose that premature RTS may be one factor that contributes to the high prevalence of recurrent ankle problems [9-11]. To inform the development of criteria to guide the RTS decision in individuals who have sustained an acute lateral ankle sprain injury and provide the basis for prospective cohort studies to test the utility of the criteria, we aimed to collate expert opinion using a Delphi survey process - a process that has been previously used to develop other RTS criteria (e.g., following hamstring injury[12 13]).

We aimed to develop consensus for assessment items that should inform RTS decisions for individuals who have sustained an acute lateral ankle sprain injury. This is the first step for developing RTS criteria for acute lateral ankle sprain injuries.

Methods

We used a 3-round Delphi approach to establish consensus of opinion from a panel of experts on

assessment items that should be included to inform the RTS decision after an acute lateral ankle sprain injury. Items that did not achieve consensus after the third survey round were left undecided. Each Delphi survey round involved: data collection via an online survey platform, analysis of responses, and provision of feedback to panelists. We registered the study at the Australian New Zealand Clinical Trials Registry (Registry # ACTRN12619000522112). Trial information was submitted prior to the start of data collection, but it was not approved until data collection had commenced. Our study was approved by The University of Queensland Human Research Ethics Committee (#2018001434) and panelists provided electronic informed consent prior to participation.

Participants

Eligibility criteria for participants (panelists) were: (1) health and exercise professional (e.g., physiotherapist, athletic trainer/therapist, sports medicine physician); (2) working with athletes competing in nationally selected representative teams or teams in Tier/Division 1 national competitions (e.g. English Premier League, NCAA Division 1, Suncorp Super Netball); (3) working in field or court sports in which acute lateral ankle sprain injuries are among the most prevalent injuries; (4) involved in making RTS decisions for athletes with an acute lateral ankle sprain injury; and (5) proficiency in the English language. The sports targeted for this study included: basketball[14], volleyball[15], netball[16], handball[17], korfball[18], soccer[19], rugby[20], American/Canadian football[21], Australian rules football[16], Gaelic football[16], lacrosse[22], field hockey[16], hurling[16], camogie[16], tennis[23], badminton[23] and squash[16 23]. Health professionals working with Paralympic, Invictus Games or other groups of disabled athletes, or athletes from selective populations (e.g., military or World Maccabiah Games) were not eligible to partake in the panel. Authors in different geographical locations were responsible for recruiting participants from their region.

While there do not appear to be clear recommendations for the ideal number of panelists in a Delphi survey process[24], it has been suggested that having more participants is associated with

greater reliability and judgement of data[25]. It is recommended that panels be heterogeneous with individuals of different personalities, perspectives and backgrounds, and include those with clinical and scientific expertise in the area of study[26]. To ensure a heterogeneous panel recruitment, we targeted individuals from different geographical locations, health professions, research and clinical degrees, and types of sports. Authors identified potential panelists (based on eligibility criteria) from their geographic region and sent invitations to eligible individuals between December 2018 and March 2019. Individuals were given two weeks to accept or decline the invitation to participate and were reminded via email after one week.

Online Surveys

Data collection consisted of online surveys (Appendices 1-3) which included closed and open-response questions[27] informed by a review of the literature[6] and international expert consensus research on lateral ankle sprain assessment[28 29]. Panelists were asked to indicate *"Yes"*, *"No"* or *"Unsure/I do not know"* to a statement such as; *"Do you feel the assessment of ankle range of motion should be a criterion to support the RTS decision after an acute lateral ankle sprain?"*[12]. RTS was defined as *"sanctioned for unrestricted training and cleared/available for match play/competition selection"* and was based on definitions of time loss injury from Fuller et al[30] and RTS from Ardern et al[31].

A panelist's opinion to include a RTS assessment item was defined as selection of the *"Yes"* answer option, and an opinion to exclude a RTS assessment item was defined as selection of the *"No"* option. Panelists were asked to provide reasons for their responses in the form of free text. To increase richness of data[25], surveys included open-response questions (e.g.*"Is there anything else you feel should be a criterion to support the RTS decision after an acute lateral ankle sprain?"*). Based on Delphi guidelines, we made an a-priori decision that consensus was reached when >70% of respondents either included or excluded a RTS assessment item[27]. Assessments items that reached consensus were removed from the following survey.

Prior to sending the first-round survey to panelists, it was piloted on sports physiotherapists involved in making RTS decisions for individuals recovering from an acute lateral ankle sprain injury. This step was undertaken to improve clarity of questions and identify any ambiguities[32]. No changes were required to the survey after pilot testing.

Procedures

For each of the three Delphi survey round, panelists were sent an email invitation with a link to the online survey. They were given approximately four weeks to complete the survey, with reminders sent after one and three weeks. Percentage agreement was calculated and reported to panelists for items that reached consensus after each survey round. For items that did not reach consensus, the percentage of panelists who selected the *"Yes"*, *"No"* and *"Unsure/I do not know"* responses and the key reasons for responses, determined by thematic analysis of free-text responses[12], were reported to panelists in the subsequent round. Reasons for responses were also used to rephrase the original question in the final survey round[12]. New RTS assessment items suggested by panelists in the first survey were checked against previously included items and developed into questions for the second survey.

After the second survey, RTS assessment items that had reached consensus were mapped to domains representing separate aspects of RTS. This was provisionally undertaken in a meeting of three authors (MDS, BV, ED) and then presented to the authorship team for consideration and agreement. The domains and mapped RTS assessment items were presented to panelists as part of the third Delphi round. Panelists were asked to indicate if they agreed or did not agree with each of the domains and mapped assessment items.

Data analysis

Survey data were exported from SurveyMonkey for calculation of achievement of consensus. Level

(%) of agreement was calculated for each item. For items that did not reach consensus after the final Delphi survey round, the percentage of panelists who selected each answer option (*"Yes"*, *"No"* or *"Unsure/I do not know")* is reported. Content analysis was used to identify themes from open-response questions[33]. Responses were initially read for familiarisation and then re-read for identification of themes. Once themes were identified, data were categorised. Themes and categorisation of data into themes were discussed between three researchers (MDS, ED, BV - one female and two male physiotherapists with 18-41 years of experience) to ensure agreement. This culminated in a thematic summary of explanation of responses and a list of new RTS assessment items which were included in subsequent surveys.

Results

The three rounds of this Delphi survey occurred from December 2018 to February 2020.

Participants

Invitations to participate in this study were sent to 250 individuals. Of these invitees, 198 (79.2%) accepted the invitation and were sent the link to the first Delphi survey (**Figure 1**). A total of 155 panelists (78.3 %) completed round 1 of the survey, defined as completing the questions on RTS assessment items. Round 2 and round 3 of the survey were completed by 137 and 119 panelists, respectively (88.4% and 76.8% of panelists who completed Survey 1). Demographics of panellists who completed survey 1 are presented in Table 1. There were minimal differences in age (<2 years), sex (≤1%), profession (≤5%) and sports (≤6%) between panelists who completed the three surveys (Appendix 4) – implying a similarity in these participant features across all surveys.

Consensus on assessment items to support the RTS decision

After the three Delphi survey rounds, 16 of the 35 assessment items presented to panelists reached consensus (>70% agreement) to be included in the RTS decision making process after an acute lateral ankle sprain injury (**Table 2**), and 17 assessment item reached consensus to not be included

(**Table 3**). Two assessment items, intra-articular swelling and static postural control/balance did not reach consensus after the third and final round of the Delphi survey process (**Table 4**).

Consensus on RTS domains and mapping of assessment items

Based on the agreed-upon RTS assessment items, five domains were created and proposed to the panelists. They were: **P**ain, **A**nkle impairments, **A**thlete perception, **S**ensorimotor control, and **S**port/functional performance (**PAASS**); 99.2% of panelists agreed with these domains. The mapping of assessment items to domains was agreed upon by 98.3% of panelist, with 2 panelists (1.7%) not in full agreement (**Figure 2**).

Discussion

Our international multi-disciplinary Delphi survey study developed consensus for assessment items that should and should not be included in the RTS decision making process for individuals who have sustained an acute lateral ankle sprain injury. Tables 2 – 4 show list the items.

The PAASS framework for RTS decisions

Expert opinion indicated 16 items that should be used to assess pain severity, ankle impairments, sensorimotor control, athlete perception/readiness, and sport/functional performance to inform the RTS decision. Assessment items were organised into the **PAASS** framework (**Figure 2**) based on agreed-upon domains. Overall, assessment items included were those that expert panelists felt directly influenced sport-specific function and/or contributed to risk of injury recurrence. Along with physical tests of sport/functional performance, sensorimotor control and ankle function, the importance of considering the athlete's perception of their ankle (e.g. perceived confidence/reassurance and stability) and readiness to RTS were recognised as an essential part of the RTS decision making process. This confirms the importance of obtaining input from the athlete and shared decision-making in determining RTS ability[12 13].

Assessment items not included in the RTS decision

Expert panelists agreed that 17 of the assessment items presented should not be included in the RTS decision after an acute lateral ankle sprain injury. First, items were excluded if they were not considered to influence RTS ability. Assessment of structural integrity of ligaments on imaging, ligamentous laxity and pain severity on palpation, which may be important for injury diagnosis[29], were excluded from the RTS decision making process as they were thought to resolve in parallel with functional gains and not to be linked to sport-specific function. Similarly, panelists felt that foot mechanics and lower limb/trunk kinematics would not influence the RTS decision making process. Second, experts felt that general measures of patient-reported foot and ankle function (e.g., health-related quality of life, Foot and Ankle Ability Measure[34] or Foot and Ankle Outcome Score[35]) were not sufficiently sensitive to assess RTS requirements. Thus, it was felt that the athletes' opinion on their ability to RTS was captured through the assessment of perceived ankle stability, ankle reassurance/confidence and psychological readiness. Third, the perceived relatively quick RTS[5], progression of ability and resolution of impairments after an acute lateral ankle sprain led to the exclusion of items that were assessed over longer timeframes (e.g., pain severity over the last week) and those with deficits associated with time away from sport and exercise (e.g., aerobic and anaerobic fitness). While evidence suggests loss of fitness occurs after two weeks of detraining[36], panelists indicated that subtle deficits in aerobic or anaerobic fitness or a sub-optimal acute:chronic workload would not stop clearance of an athlete for RTS after an acute lateral ankle sprain. Fourth, items were excluded if it was thought that limitations would be captured with other assessment items included in the **PAASS** framework. Experts felt that meaningful deficits in ankle muscle length and ankle joint arthrokinematics would be identified when assessing ankle range of motion, and similarly hip and knee muscle strength/endurance deficits would be identified during hopping, jumping and sport specific tests. They felt that straight-line running would be included within the assessment of sport-specific tasks (when required by the sport). Panelists also indicated that it is was not required, or possible, to clinically assess ankle muscle reaction time separately from dynamic balance and agility.

Assessment items that did not reach consensus

Of the 35 items presented to panelists in this study, only two items did not reach inclusion or exclusion consensus: intra-articular swelling and static postural control/balance. Key reasons provided by panelists for the inclusion of intra-articular swelling were that swelling can impair muscle, joint, proprioceptive and sport-specific function, and intra-articular swelling is an indication of joint/cartilage damage that may affect long-term joint health. Panelists who indicated that intra-articular swelling should not be included felt that intra-articular swelling is not related to pain or dysfunction, and it is not reasonable to delay RTS based on the presence of swelling, as long as function is restored and impairments have resolved. Close to equal numbers of panelists voted for the inclusion and exclusion of static postural control/balance in the RTS decision. Panelists who thought static postural control/balance should be included felt that it was an important part of understanding function and ability. The following reasons were provided by panelists who indicated that static postural control/balance should not be included in the RTS decision making process: it is superseded by dynamic postural control/balance when determining ability to RTS and assessing dynamic postural control/balance provides the necessary information to determine RTS.

RTS compared to initial assessment items

There are some commonalities between assessment items in the **PAASS** RTS assessment framework and impairments suggested to be important to include in the initial assessment of acute lateral ankle sprain injuries[29]. Assessment of pain, ankle joint range of motion, ankle muscle strength and dynamic balance were identified as important to include in both the RTS decision making process and initial injury assessment. Swelling, ankle joint arthrokinematics, static postural balance, gait, physical activity level and patient-reported foot and ankle function were recommended to be assessed after an acute lateral ankle sprain but did not reach consensus for inclusion in the RTS decision making process. The lack of inclusion of these items in the RTS decision making process was due to the progressive resolution of deficits and changing focus of

management through the rehabilitation continuum, and the specificity of determining RTS ability rather than daily function.

Study strengths and limitations

Our study included diverse geographical, sporting and professional representation. The 155 panelists were from 19 countries, 6 professions and 15 sports, and have a wealth and diversity of clinical experience. This enhances the generalisability of the data obtained and facilitates the utility of the PAASS RTS assessment framework globally. The number of panellists and geographical representation exceeds that of recent consensus statements[12 13 29 37 38]. Similar to other consensus papers on RTS criteria[13] and management of musculoskeletal/sporting injuries[37 38], the majority of panelists were physiotherapists. The inclusion of panelists working in a range of different sports provides a list of assessment items that can be used generically across different sports. However, there may be items specific to individual sports that were not identified in this study. The panelists in this study were all health and exercise professionals, and we did not include athletes to gain their perspective. This is an important consideration for future research.

While consensus was obtained on assessment items that should be used to inform the RTS decision, we did not investigate specific tests for the agreed upon assessment items. For example, we did not ask experts to nominate the test(s) they would use to assess an athlete's dynamic postural control/balance or pain severity. Thus, while this study provides clinicians with items to assess, it does not specify how clinicians should assess these items. Further, there is no data on cut-off points for measures that indicate an athlete should or should not RTS. For example, we do not know what deficit in perceived stability is acceptable to sanction an athlete as being ready to RTS. These are important future research directions[7] and we encourage researchers to hypothesise and test thresholds for assessment items in the **PAASS** RTS assessment framework. We aimed to obtain consensus on assessment items to inform an athlete's ability to RTS, defined as *"sanctioned for unrestricted training and cleared/available for match play/competition selection"* but not return to

performance[31]. Panelists may include different outcomes to assess whether or not an athlete is performing at or above their pre-injury level[31].

Clinical application of findings

The **PAASS** framework proposed in this study provides clinicians and researchers with expert-recommended assessment items that can be used to inform RTS decisions after an acute lateral ankle sprain injury. Clinicians can use this framework to enhance clinical decision-making when identifying impairments and determining an athlete's ability to RTS. There are a range of clinical tests that can be used to assess each item, such as a numerical rating scale to measure pain severity, ankle stability and ankle confidence/reassurance[39], or the T-test[40], 505 Test[41] or V Reactive Agility Test[41] to measure agility. We appreciate that RTS decision-making is multi-factorial and context specific. Researchers and clinicians should respect the complexity and temporal nature of the assessment items within the **PAASS** framework. As outlined in the StARRT (Strategic Assessment of Risk and Risk Tolerance) framework, the **PAASS** items must be considered in context with the other elements of tissue health (e.g., age and injury recurrence) and tissue stresses (e.g., type of sport and ability to protect the tissues), and risk tolerance modifiers (e.g., timing in season)[42].

Conclusion

This international inter-professional Delphi survey study recommends that health professionals should assess pain severity, ankle impairments, athlete perception, sensorimotor control and sport/functional performance to determine an athlete's ability to RTS after an acute lateral ankle sprain injury.

What are the new findings?

- Five domains covering 16 assessment items constitutes the **PAASS** framework developed by international experts from a wide range of sports that have a high prevalence of ankle

sprains.

- The PAASS framework is: **P**ain (during sports participation and over the last 24 hours), **A**nkle impairments (range of motion; muscle strength; endurance and power), **A**thlete perception (perceived ankle confidence/reassurance and stability; psychological readiness), **S**ensorimotor control (proprioception and dynamic postural control/balance), **S**port/functional performance (hopping, jumping, agility and sport-specific tasks; ability to complete a full training session).

How might it impact on clinical practice in the future?

- The **PAASS** framework provides clear clinician consensus-driven direction of what is important and what is not important when making decisions for RTS after an acute lateral ankle sprain injury.
- Pain, Ankle impairments, Athlete perceptions, Sensorimotor function, and Sport/functional performance (PAASS) are domains that are advised to be assessed in deciding RTS after an acute lateral ankle sprain.

Contributors: MDS, BV and ED were responsible for the conception of the study, drafting of the surveys for data collection and qualitative analysis of free-text data. All authors were responsible for recruitment and communication with participants (i.e. panelists), reviewing surveys and qualitative analysis, and contributing to mapping of RTS outcomes to domains. Data analysis was undertaken by MDS, BV and ED and presented to the authorship team for feedback. All authors contributed to the interpretation of findings approved the final version of the manuscript.

Competing interests: Kristian Thorborg, Thomas Bandholm, Oluwatoyosi Owoeye, Eamonn Delahunt and Evert Verhagen are on the BJSM Editorial Board.

Patient and public involvement: Patients and the public were not involved in the design or conduct of the study. Health professionals were involved in piloting and providing feedback on the initial survey.

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Table 1. Demographics of panelists who completed survey 1 (n=155).

	n (%)
Sex, male	122 (78.7)
Age, years [a]	41.3 (8.7)
Clinical experience, years [a]	16.1 (7.9)
Profession	
Physiotherapist	82 (52.9)
Athletic trainer	28 (18.1)
Sports medicine physician	27 (17.4)
Athletic therapist	7 (4.5)
Exercise physiologist/Sports scientist	5 (3.2)
Strength and conditioning coach	4 (2.6)
Other	2 (1.3)
Highest education level	
Post-graduate	124 (80.0)
Bachelor degree	19 (12.3)
Certificate/diploma	8 (5.2)
Not stated	4 (2.6)
Sport working in	
Soccer/football	54 (34.8)
Basketball	26 (16.8)
Rugby	25 (16.1)
Volleyball	12 (7.8)
American/Canadian football	10 (6.5)
Handball	6 (3.9)
Netball	5 (3.2)
Field hockey	4 (2.6)
Other	13 (8.4)
Country	
Australia	11 (7.1)
Belgium	14 (9.0)
Brazil	11 (7.1)
Canada	7 (4.5)
China	11 (7.1)
Denmark	7 (4.5)
France	6 (3.9)
Ireland	5 (3.2)
Italy	9 (5.8)
Japan	4 (2.6)
New Zealand	7 (4.5)
Nigeria	1 (0.6)
Norway	10 (6.5)
Qatar	2 (1.3)
South Korea	10 (6.5)
Switzerland	6 (3.9)
The Netherlands	8 (5.2)
The United Kingdom	10 (6.5)
The United States of America	16 (10.3)

Data is presented as number (n) and percentage (%) unless otherwise stated.

[a] Data are presented as mean (standard deviation).

Table 2. Consensus on assessment items that should be included in the return to sport decision after an acute lateral ankle sprain, indicating the round of inclusion and level of agreement.

Assessment item to be included	**Round (1-3)**	**Agreement (%)**
Sport specific tasks	1	98%
Pain severity during sport participation	1	93%
Ankle range of motion	1	90%
Ankle muscle strength	1	87%
Hopping	1	87%
Agility	1	87%
Completion of a full training session	3	87%
Jumping	1	84%
Pain severity over the last 24 hours	1	81%
Perceived ankle reassurance/confidence	1	81%
Proprioception	1	74%
Perceived ankle instability	1	74%
Psychological readiness	1	74%
Ankle muscle endurance	1	73%
Dynamic postural control/balance	1	73%
Ankle (and lower limb) muscle power [a]	2	72%

[a] Lower limb muscle power and ankle muscle power were initially presented to panelists as separate items, but 95.7% of panelists agreed that these items would be assessed together.

Table 3. Consensus on assessment items that should not be included in the return to sport decision after an acute lateral ankle sprain, indicating the round of exclusion and level of agreement.

Assessment item not to be included	**Round (1-3)**	**Agreement (%)**
Structural integrity of the ligaments on imaging	2	89%
Pain severity over the last week	3	88%
Pain severity on palpation	3	88%
Health-related quality of life	2	85%
Hip and knee muscle endurance	3	85%
Ankle muscle length	3	85%
The Functional Movement Screen™	2	84%
Aerobic fitness	3	84%
Anaerobic fitness	3	82%
Ligamentous laxity	2	81%
Ankle joint arthrokinematics	3	78%
Ankle muscle reaction time	3	76%
Acute:chronic workload	3	76%
Lower limb and/or trunk kinematics	2	75%
Hip and knee muscle strength	3	74%
Foot biomechanics	2	74%
Straight-line running speed	3	72%
Patient-reported foot and ankle function (using questionnaires such as the Foot and Ankle Ability Measure[34] or Foot and Ankle Outcome Score[35])	3	70%

Table 4. Level (%) of agreement for assessment items that did not reach consensus after the third and final round of the Delphi survey process.

Assessment item that did not reach consensus	**Include**	**Not include**	**Unsure**
Intra-articular swelling	67%	26%	7%
Static postural control/balance	48%	48%	4%

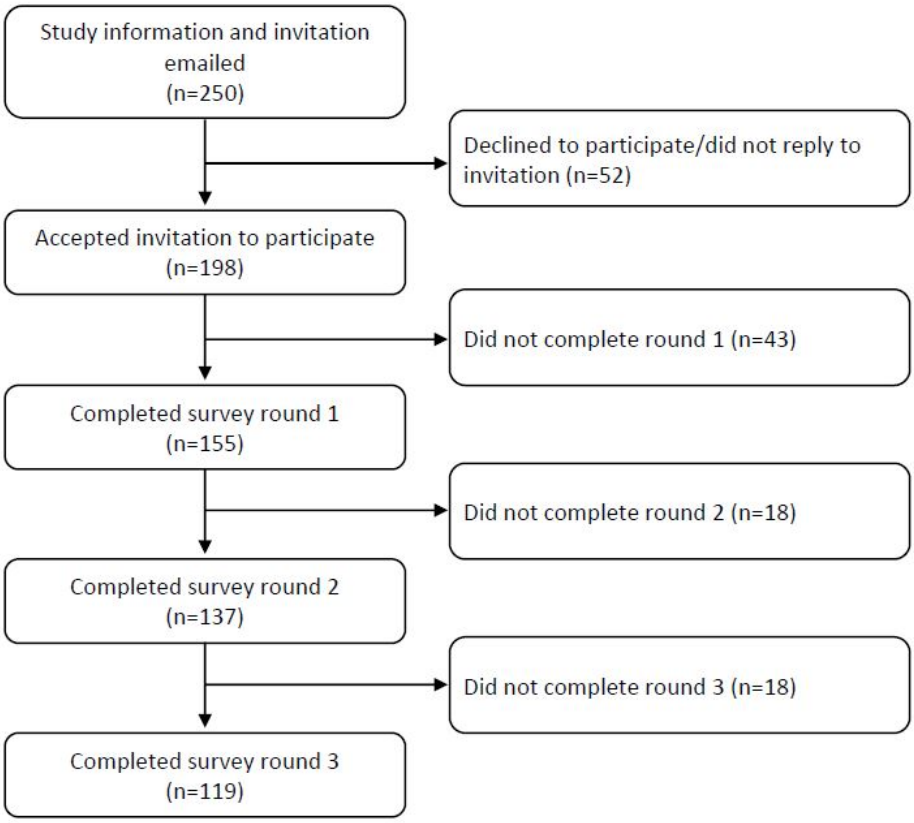

Figure 1. Participant flow through study.

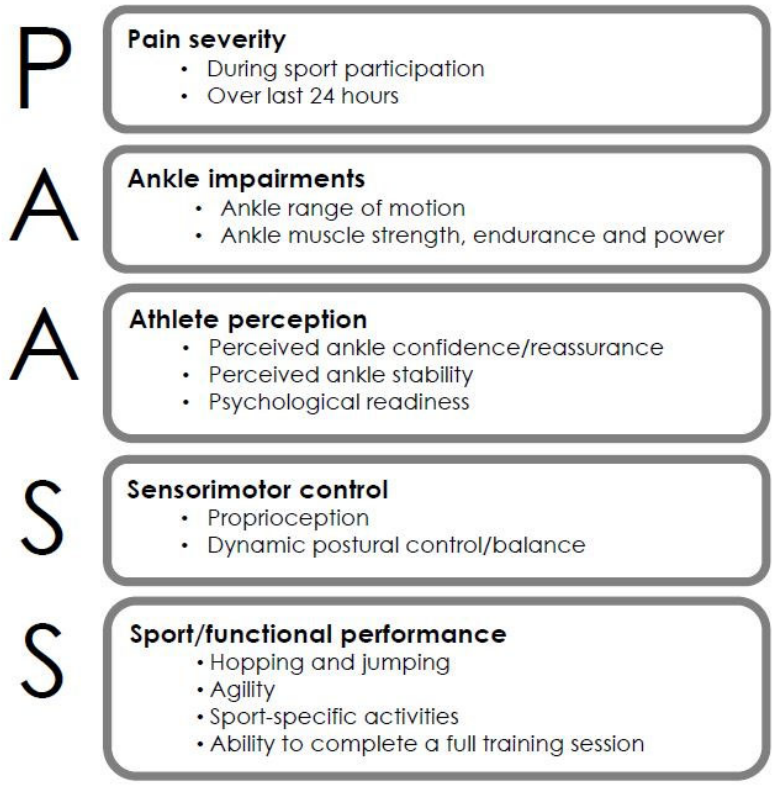

Figure 2. Return to sport domains (PAASS) and mapping of the agreed-upon return to sports items to domains (in nominal ordered list). PAASS = Pain severity, Ankle impairments, Athlete perception, Sensorimotor control, and Sport/functional performance. Note: Ability to complete a full training session reached consensus in Round 3 and was not presented to panelists for their agreement on mapping. This placement was agreed upon by the author group. Panelists agreed that ankle muscle strength would be assessed using tests of total lower limb muscle strength.