Development of a rugby shoulder function (RSF) questionnaire: An online Delphi study

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Highlights

- The RSF questionnaire may be used to monitor periodic shoulder health.
- The RSF questionnaire may help detect those athletes with variable shoulder function.
- The RSF questionnaire provides information in four areas of perceived shoulder function.
- The RSF may be used to facilitate time sensitive interventions.

Abstract

Objective: Develop a questionnaire to monitor symptoms of player perceived shoulder function/dysfunction.

Design: 3-Stage Online Delphi Study.

Methods: Participants: surgeons, sports and exercise medics, academic researchers, strength and conditioning coaches, therapists and athletes split by level of expertise/experience. Stage-1: experts (n = 12) rated constructs/items from the steering group and made changes/proposed additional constructs/items. Stage-2: experts rated/amended new constructs/items from stage-1. Stage-3: experienced professionals (n = 25) rated/ranked constructs/items from stage 2. Consensus thresholds were defined per stage (≥50% agreement/4–5 rating on 1–5 Likert scale (stages 1–2), ≥68% agreement, and items ranked for perceived importance (stage-3)).

Results: Stage-1, all four constructs (a. Activities of daily living, b. Range of motion, c. Strength and conditioning, d. Sports specific training and competition) and 26/42 original items achieved consensus. Twelve items were combined into five items. Four new items were also proposed. Stage-2, the combined items and three of the four new items achieved consensus. Stage-3 the four constructs and 22 items all achieved consensus.

Conclusions: Following a 3-stage online Delphi process, involving expert and experienced clinicians, practitioners and athletes, a new four construct, 22 item RSF questionnaire has been

developed which can be used with rugby players, to monitor perceived shoulder performance and symptoms.

Keywords: Epidemiology; Sports medicine; Athletic injury; Shoulder; Contact sport; Rugby

1. Introduction

Understanding the prevalence of injuries in sport, forms the cornerstone of preventative medicine (van Mechelen, Hlobil, & Kemper, 1992). This longstanding concept becomes complex when reviewing the potential recursive nature of the injury process (Meeuwisse, Tyreman, Hagel, & Emery, 2007). Musculoskeletal dysfunctions/complaints do not always result in the inability to train or play (e.g., a time-loss injury) (Clarsen et al., 2020) and athletes may not present for treatment or assessment (e.g., a medical attention injury), thus the true number of injuries and sub-clinical dysfunctions may be underestimated (Bahr, 2009). Comprehensive periodic health evaluation of an athlete may assist in detecting developing pathology (all complaints evaluation) but this is reliant on having a single or battery of tests that will give a true predictive assessment of the propensity for injury (Hughes, Sergeant, van der Windt, Riley, & Callaghan, 2018).

Athletes with sub-clinical lower limb complaints have been shown to have a greater propensity to result in a time loss injury (Whalan, Lovell, & Sampson, 2020). The point at which these complaints start to impact perceived performance is when athletes refer to themselves as injured (Bolling, Delfino Barboza, van Mechelen, & Pasman, 2019). Performance monitoring and early recognition of sub clinical complaints is therefore key to understanding functional changes in the early stages of time loss injuries and non-time loss complaints.

The incidence of shoulder time loss injury in different rugby competitions (4.5–12.7/1000 h) (Fitzpatrick, Naylor, Myler, & Robertson, 2018; Kemp et al., 2021; Stokes, Mckay, & Roberts, 2019; Usman, McIntosh, Quarrie, & Targett, 2015) and resultant burden (33–136 days) (Fitzpatrick et al., 2018; Usman et al., 2015) are consistently ranked within the top four most frequent body regions or specific injuries recorded in a range of different epidemiology studies (Fitzpatrick et al., 2018; Kemp et al., 2021; Stokes, Mckay, & Roberts, 2019; Usman et al., 2015). These statistics warrant further research to help understand the relationship between sub clinical shoulder complaints and time loss injuries. The shoulder complex includes a series of joints that are used through the largest range of motion, under considerable load from rotation, translational, compressive and distraction forces during contact sports (Cools et al., 2020-a). The shoulder needs to have a high degree of function on return to play and tolerate the forces exerted during high frequency events such as tackling (Burger et al., 2016). Structural integrity and dynamic coordination are therefore key for sports performance (Cools et al., 2020-a; Schwank et al., 2022).

Modifications to the Oslo sport trauma research centre questionnaire using expert consensus (Clarsen et al., 2020) have sought to provide a greater focus on overuse injuries under four self-reported 4-point Likert domains, but as a non-sports specific tool, this lacks specificity compared to tools designed for a particular sport. The Rugby Shoulder Score (RSS) (Roberts & Funk, 2013) is a single self-reported construct, specific to rugby, using 20, 7-point Likert questions. Whilst useful, it requires further validation to be used with ‘uninjured athletes’ who may have sub clinical complaints but continue to play, due to the original study being validated on athletes with chronic and or stable time loss shoulder injuries (Partner, Jones, Tee, & Francis, 2022). Minimal clinically important difference (MCID) and minimal detectable change (MDC) in RSS scores are also required to allow medical teams to relate changes in RSS score. Long established shoulder specific (Xu, Chen, Lie, Hao, & Lie, 2020) or upper limb outcome measures (Franchignoni et al., 2014; Smith, Calfee, Baumgarten, Brophy, & Wright, 2012; Tsuruike, Ellenbecker, & Hirose, 2018) have the benefit of established MCID and or MDC data, but often developed from the general not sporting population. These existing tools and questionnaires (Clarsen et al., 2020; Franchignoni et al., 2014; Roberts & Funk, 2013; Smith et al., 2012; Tsuruike et al., 2018; Xu et al., 2020) were designed to be used with injured or non-sporting populations. The items and constructs used in these tools were chosen for suitability for the injured or non-sporting population. Further validation of these tools with the uninjured population of rugby players would remain a limitation in design. A categorised self-reported questionnaire, which captures perceived shoulder function in both the time loss injured and uninjured athletes, is therefore required to assist in the serial monitoring of self-reported athletic shoulder function (Asker, Waldén, Källberg, Holm, & Skillgate, 2020; Fitzpatrick et al., 2018; Partner et al., 2022).

The aim of this study was to use expert consensus groups (Delphi study) to develop a new rugby shoulder function questionnaire (RSF) to monitor reported signs and symptoms of shoulder function in athletes involved in rugby.

2. Methods and materials

2.1. Study design

This study followed recommended guidance for undertaking Delphi studies (Beiderbeck, Frevel, von der Gracht, Schmidt, & Schweitzer, 2021; Blazey et al., 2022; Boulkedid, Abdoul, Loustau, Sibony, & Alberti, 2011). An anonymous online Delphi study was conducted under three stages with two groups of participants and a steering group (Table 1), using an online survey tool (Qualtrics^{XM} 2020). Two different participant groups (Robertson, Kremer, Aisbett, Tan, & Cerin, 2017) were defined using a range of metrics (Table 1) to delineate the highest level of expertise (Expert Group), who would add items and constructs in the early stages of the study, and those with defined expertise (Experienced Group) to increase the face validity of the tool for the end user. Given the breadth of professions included in the groups (Boulkedid et al., 2011), two different thresholds levels of consensus were utilised (Robertson et al., 2017). During Stage 1 and 2 a ≥50% consensus was used to allow more items/constructs to be retained for Stage 3 where a higher threshold was used (≥68%) with a larger group size. Questions during Stage 1 and 2 were a mixture of binary (agree/disagree) and Likert 1–5. Likert responses of 4 or 5 were classed as agreement.

The aim of the study was to achieve consensus opinion (≥68%) (Boulkedid et al., 2011; Robertson et al., 2017) of constructs and items which were initially proposed by a steering group, to create the RSF questionnaire. The steering group proposed four constructs, and 42 items between all constructs to monitor changes in performance and lifestyle. In Stage 1, the *expert* group (Table 1) were provided with constructs and asked to agree, disagree, add or amend. The *expert* group were also provided with items and asked to rate (1–5 Likert scale, add or amend) to determine which constructs and items achieved consensus (≥50%; agree/4–5 rating). In Stage 2, the *expert* group reviewed any new constructs and items (1–5 Likert scale) and approved any modification to constructs and items (≥50%; agree or disagree). Constructs and items which achieved consensus in Stage 1 or 2, were then reviewed by an *experienced* group of participants (Stage 3) to establish face validity. The *experienced* group of participants (Table 1) agreed or disagreed the constructs and items to an enhanced threshold (≥68%

agreement) and ranked the items within the constructs based on their importance for negatively impacting perceived performance and lifestyle (Fig. 1). Constructs and items which achieved consensus through Stages 1–3 are presented in rank order, as the RSF questionnaire (Fig. 2). Ethics approval was obtained through Leeds Beckett University.

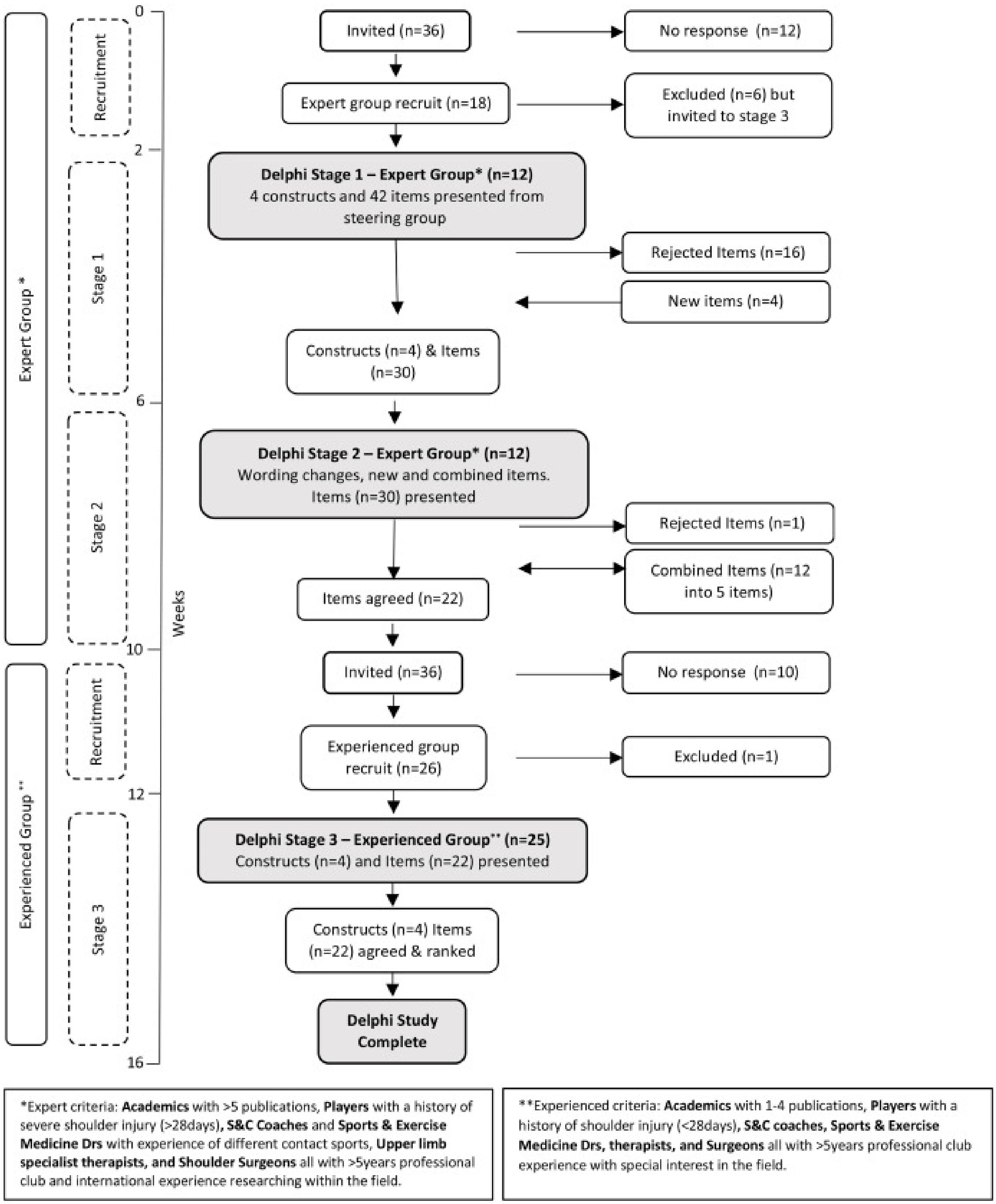
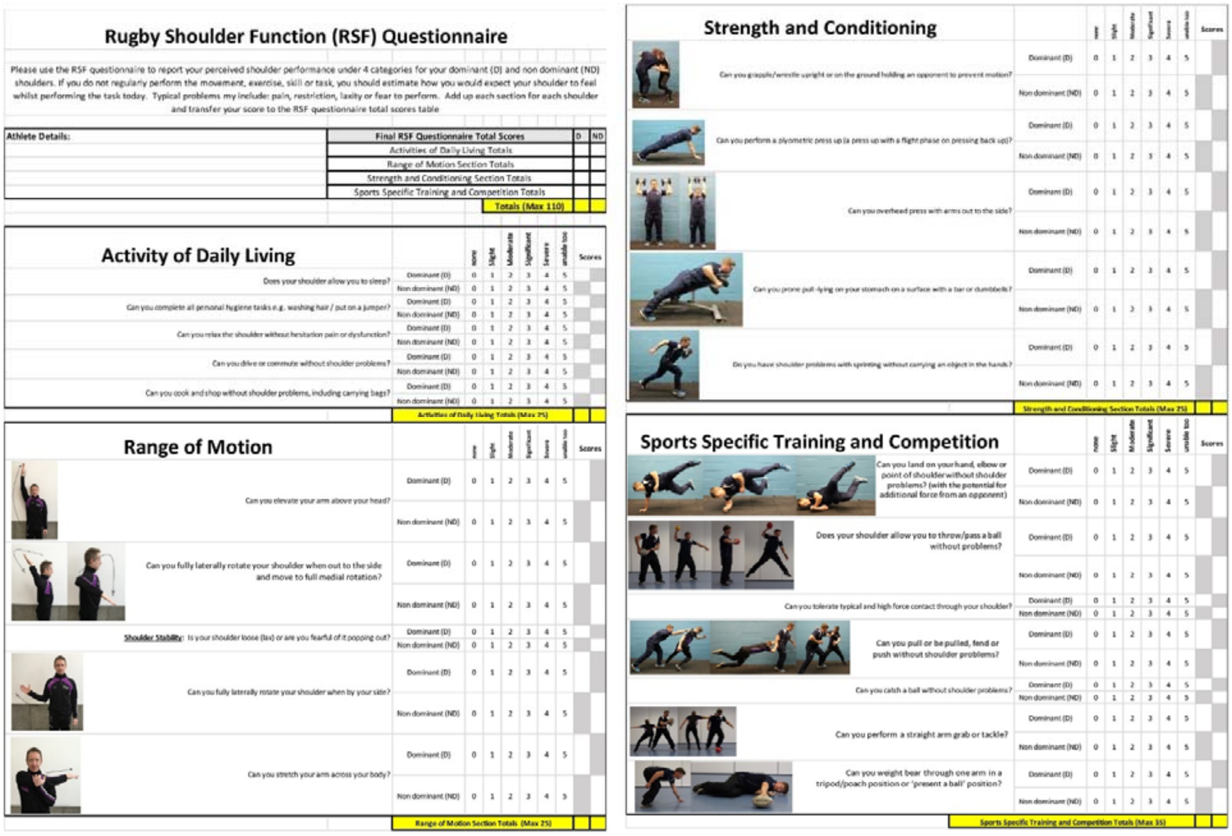


Fig. 1. Schematic representation of the Delphi study



Rugby Shoulder Function (RSF) Questionnaire

Please use the RSF questionnaire to report your perceived shoulder performance under 4 categories for your dominant (D) and non dominant (ND) shoulders. If you do not regularly perform the movement, exercise, skill or task, you should estimate how you would expect your shoulder to feel whilst performing the task today. Typical problems my include: pain, restriction, laxity or fear to perform. Add up each section for each shoulder and transfer your score to the RSF questionnaire total scores table

Athlete Details:	Final RSF Questionnaire Total Scores	D	ND
	Activities of Daily Living Totals		
	Range of Motion Section Totals		
	Strength and Conditioning Section Totals		
	Sports Specific Training and Competition Totals		
	Totals (Max 110)		

Activity of Daily Living		none	Slight	Moderate	Significant	Severe	unable too	Scores
Does your shoulder allow you to sleep?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you complete all personal hygiene tasks e.g. washing hair / put on a jumper?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you relax the shoulder without hesitation pain or dysfunction?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you drive or commute without shoulder problems?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you cook and shop without shoulder problems, including carrying bags?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
	Activities of Daily Living Totals (Max 25)							

Range of Motion		none	Slight	Moderate	Significant	Severe	unable too	Scores
Can you elevate your arm above your head?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you fully laterally rotate your shoulder when out to the side and move to full medial rotation?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Shoulder Stability: Is your shoulder loose (lax) or are you fearful of it popping out?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you fully laterally rotate your shoulder when by your side?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you stretch your arm across your body?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
	Range of Motion Section Totals (Max 25)							

Strength and Conditioning		none	Slight	Moderate	Significant	Severe	unable too	Scores
Can you grapple/wrestle upright or on the ground holding an opponent to prevent motion?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you perform a plyometric press up (a press up with a flight phase on pressing back up)?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you overhead press with arms out to the side?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you prone pull -lying on your stomach on a surface with a bar or dumbbells?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Do you have shoulder problems with sprinting without carrying an object in the hands?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
	Strength and Conditioning Section Totals (Max 25)							

Sports Specific Training and Competition		none	Slight	Moderate	Significant	Severe	unable too	Scores
Can you land on your hand, elbow or point of shoulder without shoulder problems? (with the potential for additional force from an opponent)	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Does your shoulder allow you to throw/pass a ball without problems?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you tolerate typical and high force contact through your shoulder?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you pull or be pulled, fend or push without shoulder problems?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you catch a ball without shoulder problems?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you perform a straight arm grab or tackle?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
Can you weight bear through one arm in a tripod/poach position or 'present a ball' position?	Dominant (D)	0	1	2	3	4	5	
	Non dominant (ND)	0	1	2	3	4	5	
	Sports Specific Training and Competition Totals (Max 35)							

Fig. 2. RSF questionnaire.

2.2. Steering group

The steering group consisted of three United Kingdom based academic researchers (Table 1), with expertise in the field of elite rugby and other contact sports, led by the chair (RP). The steering group, based on their professional and research experience, proposed four constructs which identified a perceived negative change in performance and lifestyle, due to shoulder dysfunction. Items were then proposed within each construct (n = 42), from previous similar questionnaires (Clarsen et al., 2020; Franchignoni et al., 2014; Roberts & Funk, 2013; Smith et al., 2012; Tsuruike et al., 2018; Xu et al., 2020) or based on their professional and research experience. The analysis and feedback at each stage was conducted by the chair.

2.3. Participants

Thirty-six *expert* professionals and athletes from the United Kingdom, Ireland and mainland Europe, were invited via email and direct messaging, to participate as the *expert* group in Stages 1 and 2. Eighteen participants did not respond and a further six were excluded due to not meeting the *expert* criteria, creating a group of twelve *experts*. Thirty-six *experienced* professionals from the United Kingdom, Ireland and mainland Europe, were invited via email and direct messaging (including six participants excluded from the *expert* group), to participate in Stage 3. Ten participants did not respond, and one was excluded due to not meeting the *experienced* criteria, creating a group of 25 *experienced* professionals. The *expert* and *experienced* groups were purposefully recruited based on their professional experience within elite rugby and other contact sports or relevant scientific publications, to include the following professions: orthopaedic surgeons, sports and exercise medicine (SEM) doctors, therapists (physiotherapists, physical therapists, athletic trainers, sport rehabilitators or sports therapists) strength and conditioning coaches, academic researchers and professional athletes. Snowball sampling of potential participants was permitted, within the defined expert or experience criteria (Table1). The *expert* group (n = 12) participated in Stages 1 and 2 based on their level of expertise in the field, to establish the initial structure of the Delphi to ensure content validity at ≥50% threshold of consensus (Yaddanapudi & Yaddanapudi, 2019). The larger *experienced* group (n = 25) participated in Stage 3, and reviewed the constructs and items to ensure face validity, using an enhanced consensus threshold (≥68%) (Yaddanapudi & Yaddanapudi, 2019). The response rate of the *expert* and *experienced* group meeting the inclusion criteria in all stages of the study was 100% (Fig. 1).

2.4. Constructs and items

The four constructs included a) activities of daily living, b) range of motion, c) athlete conditioning, and d) match play and skills training. Items within the activities of daily living (ADL) construct, included typical personal, social and non-sporting activities. Items within the range of motion construct, included active movements performed by the athlete in typical single or combined planes of motion. Items within the athlete conditioning construct, included familiar body weight, free weights and combat tasks that were not replicating a specific tactical skills session. Items within the match play and skills training constructs, included common upper limb specific contact statements with opponents and the ground as well as throwing and passing related skills that could be in a training or competition environment.

2.5. Delphi process

Participants were sent an online survey for Stages 1–3 using the Qualtrics^{XM} (2020) system with replies anonymous. Each stage lasted four weeks and automatic reminders were sent at two weeks and 48-h prior to the four-week deadline for participants who had not completed the survey (Fig. 1). At Stage 1 and 2, 28/42 statements were supplemented with images to assist interpretation. Each construct was presented with a binary agree disagree question and each item was presented on a 5-point Likert scale with the descriptors ‘not important’ (1 point) to ‘extremely important’ (5 points). *Experts* were given the option to abstain from answering a question if the statement fell outside of their scope of expertise, but this did not happen. During Stage 1 participants could suggest new constructs, items or alterations to any wording from the initial list presented by the steering group, to increase breadth of knowledge and experience used in the early stages of the Delphi study. Any changes were presented verbatim to the expert group in Stage 2 to establish consensus agreement (≥50%). *Experienced* group participants in Stage 3 were asked to agree/disagree with proposed constructs and items from Stage 2, and rank items in order of perceived importance of their impact to negatively impact performance and shoulder function.

In the absence of agreed consensus thresholds in Delphi studies (Hasson, Keeney, & McKenna, 2000), consensus threshold is recommended to be tailored to the sample demographics and the number of stages/rounds (Boulkedid et al., 2011). Number of rounds of surveys is determined by the point at which no further changes are required (Boulkedid et al., 2011). Consensus agreement was set at ≥50% for Stages 1 and 2 to acknowledge the high level yet diverse expertise of the expert group during these stages. With the larger group of *Experienced* professionals during Stage 3 a ≥68% threshold for consensus was applied, based on the process already undertaken in Stages 1 and 2 (Boulkedid et al., 2011; Hasson et al., 2000; Robertson et al., 2017). In Stages 1 and 2, constructs were evaluated using binary ratings, which required ≥6 experts (≥50%) to agree to reach consensus. In Stages 1 and 2, items were evaluated using a 5-point Likert scale, requiring ≥6 experts (≥50%) to rate items as 4 or 5 to reach consensus. In Stage 3, only binary ratings were used, with ≥17 *experienced* professionals having to agree (≥68%) to reach consensus.

2.6. Data analysis

Percentage agreements were calculated for each construct and items at each Stage of the Delphi study using SPSS® version 28 (IBM®). Rank order of items in Stage 3 was calculated by adding up the scores allocated to each item by the *experienced* group, where a score of 1 represented the most important item in the construct. The lowest mean score represented the highest importance placed on the item.

3. Results

3.1. Constructs

Consensus was achieved for the four constructs (≥68%–100% actual agreement) (Table 2). The four agreed constructs after Stage 2 were: a) activities of daily living, b) range of motion, c) strength and conditioning (modified from 'athlete conditioning' originally proposed by the steering group), d) sports specific training and competition (modified from proposed 'match play and skills training' originally proposed by the steering group). Constructs also achieved consensus during Stage 3 (≥68%–100% actual agreement).

3.2. Items

During Stage 1, there were 26 of the original 42 items that achieved consensus (Table 2). Twelve of the 26 items were suggested to be combined. In the sports specific training and competition construct, items 1 and 2 were combined to create a general throwing item. Item 3–5 were combined to create a general landing on the upper limb item. Items 6–8 were combined to create a pulling, pushing, traction force item and item 10 and 11 combined to create a shoulder contact item. In the range of motion construct, items 2 and 3 were combined to create an overhead rotation item. Four additional items were proposed, two in the sport specific training and competition construct: 1. Weight bearing through one arm in a tripod/poach/present a ball position (item 12), 2. Grab/straight arm tackle (item 13). The other two additional items were in the ADL construct: 3. Pain in the shoulder when relaxing (Item 8), 4. Ability to carry or play with children (item 9).

During Stage 2, three of the new items ($n = 4$) achieved consensus with only 'ability to carry or play with children' (item 9) failing to achieve consensus. In total, 22 items achieved consensus and were presented in Stage 3.

During Stage 3, all 22 items achieved 100% consensus, creating the RSF questionnaire (Fig. 2).

4. Discussion

The aim of this study was to develop a new questionnaire for monitoring and evaluating perceived shoulder function/dysfunction in contact sport athletes. This Delphi study involved 12 experts, 25 experienced professionals and a three-person steering group, based on consensus agreement achieved through the study. A four construct 22 item RSF questionnaire was developed which can be used by athletes to independently monitor perceived shoulder function or form part of existing periodic shoulder health screening.

4.1. Constructs

Shoulder function is multi-faceted whereby overall function can be impacted by changes in multiple sub constructs of the overall function. The four constructs relating to perceived shoulder function were unanimously agreed with only minor wording amendments and no additional constructs suggested by the expert group. Given the breadth of expertise recruited this provides a high level of content and face validity to the RSF questionnaire (Yaddanapudi & Yaddanapudi, 2019). The RSS (Roberts & Funk, 2013) is the most comparable questionnaire tool but has only one construct specific to rugby and developed for those with injury. The design of the RSF questionnaire, to include use with the uninjured population, means that items and constructs have been considered for inclusion that may not have been considered in the RSS and other tools during their design process. The RSF questionnaire has four constructs akin to other scoring systems (Clarsen et al., 2020; Smith et al., 2012) with the specificity to shoulder motion, strength and conditioning, rugby training/matches and ADL's. Some multi construct upper limb outcome measures report a composite score with overall MCID and MDC (Smith et al., 2012). The RSF questionnaire has the potential to be used with individual construct scores as well as composite score. Level of MCID and MDC will need to be calculated during further validation study of the psychometric properties of the RSF questionnaire.

4.2. Items

Item wording was evaluated at each stage, with minor adjustments made to provide greater clarity for the intended users. The multi-disciplinary nature of the *expert* and *experienced* groups, with the inclusion of athletes, enhances the usability of the final RSF questionnaire (Beiderbeck et al., 2021; Blazey et al., 2022; Boulkedid et al., 2011). The content validity for each item was evaluated using a Likert scale (Yaddanapudi & Yaddanapudi, 2019) and required ≥50% agreement from the *expert* group in Stages 1 and 2 and ≥ 68% agreement from the *experienced* group in Stage 3. Various agreement thresholds have been used in previous studies (Boulkedid et al., 2011; Robertson et al., 2017) and seek to achieve the fine balance of retaining enough items, which have an appropriate level of validity (Hair, Black, Babin, & Anderson, 2010; Yaddanapudi & Yaddanapudi, 2019). Retaining items with a high level of similarity can lead to overrepresentation from one problem. Experts identified during Stage 1, where similar items were proposed by the steering group in the sport specific skills and training construct. Different landing positions on an arm are reported to influence different types of injury patterns (Crichton, Jones, & Funk, 2012). These positions were replicated in the original item list (Item 3–5 Table 2) but were felt to be too similar, and therefore an overrepresentation from this type of dysfunction. This was also the same for throwing actions (items 1-2), pulling/pushing actions (items 6–8) and force/contact tolerance (items 10-11) in the same construct, which were subsequently merged. It is acknowledged that these merged skills and movements place different biomechanical stresses on the shoulder and are considered when trying to establish a pathology-based diagnosis by a clinician (Crichton et al., 2012). Experts also recommended during stage 1 to combine items 2 and 3 in the range of motion category to create an item replicating combined overhead rotation. Considering the notion of overrepresentation from similar items when completed by an athlete, combining these items, whilst retaining the original images would allow for greater clarity and interpretation for the end user (Fig. 2, Table 2).

During Stages 1 and 2, additional items were suggested relating to other epidemiological themes of shoulder injury mechanism, namely the poach position (Montgomery et al., 2019) and an identified weakness position, horizontal extension 'T' position (Ashworth, Hogben, Singh, Tulloch, & Cohen, 2018). These new items were given contextualised descriptions and images to help the end user. With the inclusion of new items, combination of similar items and removal of items failing to achieve consensus, the RSF questionnaire consisted of three constructs of five items and one construct with seven items.

The balance of the sports specific skills and training category had proportionally more items ($n = 7$) achieving consensus and carried forward from Stages 1 and 2 to Stage 3. This is in comparison to the other three constructs, which had five items achieving consensus and carried forward from Stages 1 and 2 to Stage 3. The expert and experienced participants unanimously agreed (≥68%–100% actual agreement) to maintain all 7 items in this construct rather than using rank order to create uniform construct balance in the final questionnaire, as it reflects the importance placed on shoulder function/dysfunction during sport specific skills and training activities. In practice, each item in the final RSF questionnaire is completed on a Likert scale for dominant and non-dominant upper limbs, reported as a construct and composite score, but the utility of these scores will require further validation (Fig. 2).

4.3. Monitoring perceived shoulder function/dysfunction

Criterion validity of shoulder function/dysfunction is difficult to ascertain in the absence of an agreed gold standard in rugby players with an absence of time loss injury. The RSS exists as a single construct designed to evaluate injured athletes in rugby (Partner et al., 2022; Roberts & Funk, 2013), and the Oslo sport trauma research centre questionnaire (Clarsen et al., 2020) collects similar information pertaining to overuse injuries without the specific contact focus. Psychological readiness to return to play (Rogowski et al., 2020) has been shown to be impacted in rugby players even in the presence of restoration of physical capabilities. This further emphasises the gaps in our ability to rely on functional testing alone to gain full understanding of the perceived level of function/dysfunction present in contact sport athletes with or without perceived injury. The RSF questionnaire can be used to monitor the ongoing shoulder health of rugby players, providing practitioners with early information, which would support early intervention, potentially enhancing the career longevity, and improving the overall long-term health of athletes.

4.4. Strengths, limitations and recommendations for future research

The aim of this study was to create a new RSF questionnaire by a Delphi study design with experts and experienced participants. Expertise is often limited to a single or ill-defined metrics in Delphi studies (Blazey et al., 2022; Boulkedid et al., 2011; Hasson et al., 2000). This study offers comprehensive detail about participant criteria bespoke to each profession. However, by not compromising on the design of the study to involve these different participant groups and multi-faceted inclusion criteria, the total participants per group may be smaller than some Delphi studies with homogenous expert groups (Robertson et al., 2017). The total number of participants in this study and number of experts is more comparable to those studies with heterogenous expert groups (Beiderbeck et al., 2021; Boulkedid et al., 2011; Clarsen et al., 2020). Differing thresholds of agreement at different stages of the study help when dealing with multiple professional opinions to retain more items, but this could also mean more items have been retained than needed per construct. Raw agreement data percentages have been reported (Table 2) to help the reader interpret the strength of consensus per item. Factor analysis would need to be employed to further evaluate the effectiveness of each item per construct in future studies.

Future research is also required to ascertain if the intended analysis by construct or composite score offers greater clinical utility than single construct tools (Roberts & Funk, 2013; Smith et al., 2012). The time point of completion of any monitoring tool may be impacted by a micro or macrocycle of sport participation (Meeuwisse et al., 2007). Standardising the day of data collection for longitudinal serial monitoring to take place on a 'reduced load day' (match day-1) (Partner et al., 2022), may represent good practice for this type of use. However future research may also consider the usefulness of the RSF questionnaire in evaluating the level of perceived function post high load training or matches to help guide micro cycle training load. The RSF questionnaire asks players to estimate how their performance and symptoms would be on the day of completion (Fig. 1). This immediate reporting of performance and symptoms reduces symptom recall issues but requires the athletes to estimate and anticipate for items which they have not performed that day. Recall of 7-days is often used, but it is recognised that athlete monitoring may need to be over shorter time periods to monitor change (Clarsen et al., 2020). Future research is therefore indicated to understand the stability of the RSF over short test-retest time periods. The RSF questionnaire will quantify levels of perceived function but to enhance the interpretation of results it should be compared to known specific or proxi measures of shoulder and upper limb function. Future research investigating the relationship between changes in RSF questionnaire scores and upper limb performance metrics (Ashworth et al., 2018; Fanning, Daniels, Cools, Miles, & Falvey, 2021) may help with period health evaluation of the rugby shoulder (Schwank et al., 2022).

Expert opinion is often used to create new tools in the absence of a gold standard (Boulkedid et al., 2011). The RSF questionnaire offers quantifiable data for perceived shoulder function for the first time in four constructs designed for injured and uninjured rugby players. Future research using the RSF questionnaire prospectively across a range of playing levels will help with further validation of its utility. The RSF questionnaire has not been evaluated for its predictive ability in relation to measurable performance markers and time loss injury events. Generating thresholds for MCID and MDC would also allow the RSF questionnaire to be used when evaluating therapeutic interventions and monitoring athletes over their career.

5. Conclusions

A Delphi study consisting of 37 participants from six professions evaluated new constructs and items, proposed to evaluate shoulder function/dysfunction in contact sport athletes. This Delphi study created the RSF questionnaire, consisting of 4 constructs with 5–7 items per construct, providing practitioners with a practical tool to monitor the shoulder function/dysfunction of rugby players. This can provide valuable information to help practitioners implement appropriate interventions to enhance athlete career longevity and the overall long-term health of athletes, in relation to shoulder health.

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Ethical statement

Ethical approval was gained through Leeds Beckett University April 2019 to carry out this research.

Declaration of competing interest

None.

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