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Assessment of return to play after an acute shoulder injury: protocol for an explorative prospective observational German multicentre study

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ABSTRACT

Introduction To date, there is no valid single test or battery of tests for informing return-to-play (RTP) decisions following an acute shoulder injury. The purpose of this exploratory study is to evaluate a diagnostic test battery based on a Delphi consensus at the time of unrestricted return to team training after acute shoulder injury.

Methods and analysis Data for this prospective multicentre cohort study are collected at two measurement time points: when the respective physician clears the patient for RTP (t1) and 12 months after RTP (t2). The study participants are 18–35 years old athletes participating at a professional level in the following team sports: handball, basketball, ice hockey, soccer, volleyball and American football. Maximum comparability will be ensured via uninjured matched pair teammates. To assess the subjective assessment of shoulder functioning and the athlete's readiness to RTP, patient-reported outcome measures (Western Ontario Shoulder Instability Index, Quick-Disabilities of the Arm, Shoulder and Hand, Psychological Readiness of Injured Athlete to Return to Sport and Shoulder Instability-Return to Sport after Injury) will be completed. After a medical check-up with a range of motion and anthropometric measurements as well as clinical tests, the participants will perform a structured warm-up protocol. The functional tests comprise handgrip strength, upper quarter Y-balance test, isometric strength, closed kinetic chain upper extremity stability test, wall hop test, functional throwing performance index and the unilateral seated shot put test and isokinetic tests.

Ethics and dissemination The results of this study will be disseminated through peer-reviewed publications and scientific presentations at national and international conferences. Ethical approval was obtained through the Institutional Review Board of Martin-Luther-University Halle-Wittenberg (reference number: 2022–016).

Trial registration number DRKS00028265.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Maximum comparability is ensured via uninjured matched pair controls from the respective team.
⇒ The assessment comprises subjective measurements in combination with a broad range of different functional capability tests.
⇒ Players from different team sports at professional level are assessed.
⇒ Information about individual rehabilitation programmes will not be assessed.

INTRODUCTION

Acute shoulder injuries in professional team sports are associated with long time-loss and high rehabilitation costs.[1–6] Acute injury of the athlete's shoulder often necessitates lengthy rehabilitation processes and may result in decreased sports performance after return to sports or even end the athlete's career. Because of their high risk of re-injury, shoulder injuries represent a severe threat to sports careers. Identifying risk factors for shoulder injuries is, therefore, an important step towards reduction of injury risk.[7]

To date, there is no valid single test or battery of tests for informing return-to-competition decisions following an acute shoulder injury. Most knowledge about risk factors for injuries and re-injuries of acute shoulder injuries consists of isolated factors and lacks multidisciplinary biological and psychosocial perspectives.[8] Athlete-specific and sport-specific factors for the shared-decision progress of returning to the individual sports are necessary to improve rehabilitation and to reduce re-injury risk.[9]

Staff involved in medical rehabilitation need a reliable, valid method of assessing postoperative shoulder function for high-level athletes, that is, cost-effective, safe and simple to implement in a clinical setting. This exploratory study aims to evaluate a diagnostic test battery based on a new Delphi consensus.[10] Specifically, the study has the following objectives:

1. Measure and comparatively analyse the subjective and functional shoulder

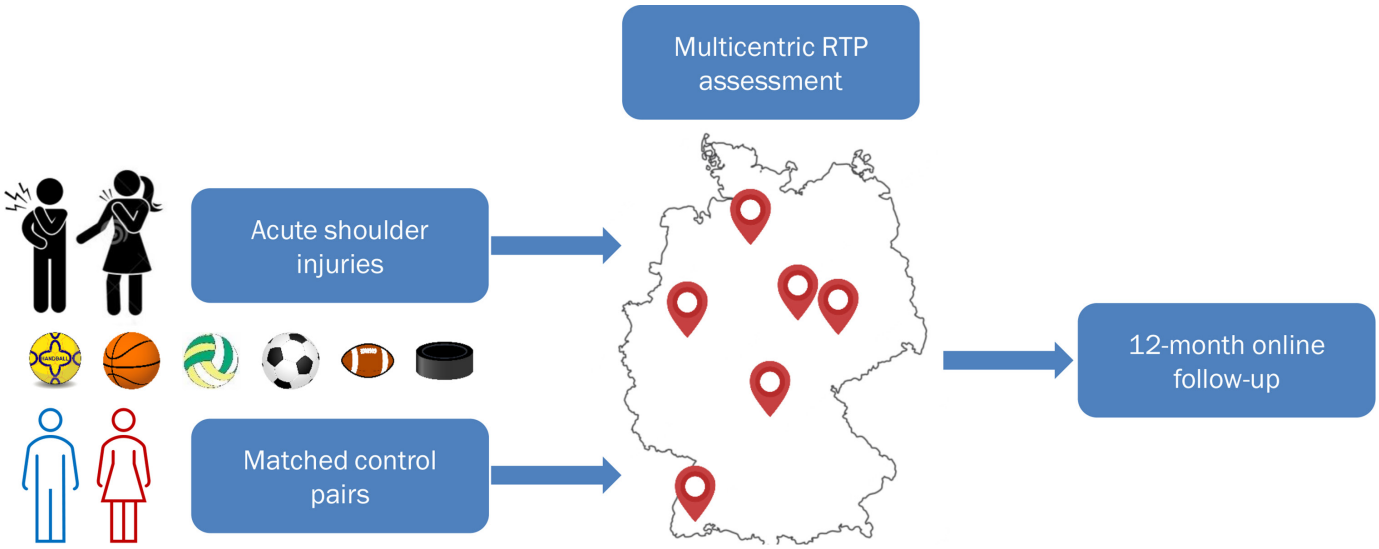

Figure 1 The study flow diagram. RTP, return-to-play.

performance of uninjured and injured athletes at the time of return to unrestricted team training.
2. Identify symptomatic deficits of the patients at the time of unrestricted return to team training by examining and comparing the uninjured and injured sides of an injured athlete.
3. Analyse the relationship between physical performance and patient-reported outcome measures by determining the correlation pattern of these two types of measures.
4. Evaluate the predictive value of the subjective and functional performance measures regarding return-to-play (RTP) decision and potential risk of re-injury or subsequent injury.
5. Provide reference data for (each test item for) uninjured and injured athletes.

METHODS AND ANALYSIS

Study design

The present study is a prospective multicentre cohort study, with measurements at the point in time when the respective physician clears the patient for RTP and follow-up questionnaires provided online 12 months after RTP (figure 1). The study was registered with the German Clinical Trials Register. The Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines were used for this trial protocol.[11] The baseline data collection started in May 2022. The planned end of the study is December 2023 followed by a 12-month follow-up.

Study participants

The study participants are 18–35 years old athletes participating at a professional level in the following team sports: handball, basketball, ice hockey, soccer, volleyball and American football. Patients are injured athletes that will undergo rehabilitation programmes at different physiotherapy clinics with comparable interventions and protocols applied by staff that have been previously agreed on with each other. Patients meeting the inclusion criteria listed in table 1 will be included consecutively in the study. Controls will be recruited following a matching approach[12]: for this, patients are requested to bring a matching partner of (approximately) the same age and sex from the same team to their test date. If this is the substitute player, the criterion of the same playing position is usually fulfilled.

For representative sampling, the study collective is monitored with regard to the proportion of female athletes included, the matching of patients and controls and other parameters that may need to be balanced in monthly meetings of the participating study centres.

Assessment procedures

After a brief standard explanation of the aim of the study and the assessments that will be used, participants will be asked to sign the informed consent. Thereafter, each participant will complete the following questionnaires in the same order: Western Ontario Shoulder Instability Index (WOSI), Quick-Disabilities of the Arm, Shoulder and Hand (QuickDASH) questionnaire, Psychological Readiness of Injured Athlete to Return to Sport (PRIA-RS) and Shoulder Instability-Return to Sport after Injury (SIRSI). After the medical check-up, which includes a range of motion and anthropometric measurements as well as clinical examinations, participants will perform/

Table 1 Inclusion and exclusion criteria for the patients

Inclusion criteria	Exclusion criteria
▶ Age: 18–35 years. ▶ Participation in team sports (handball, basketball, ice hockey, soccer, volleyball and American football) at professional level. ▶ Acute shoulder injury with at least 8 days of unavailability for team training or match selection.	▶ Recurrence of shoulder injury (last 2 months). ▶ Chronic shoulder pathology. ▶ Bilateral shoulder pathologies.

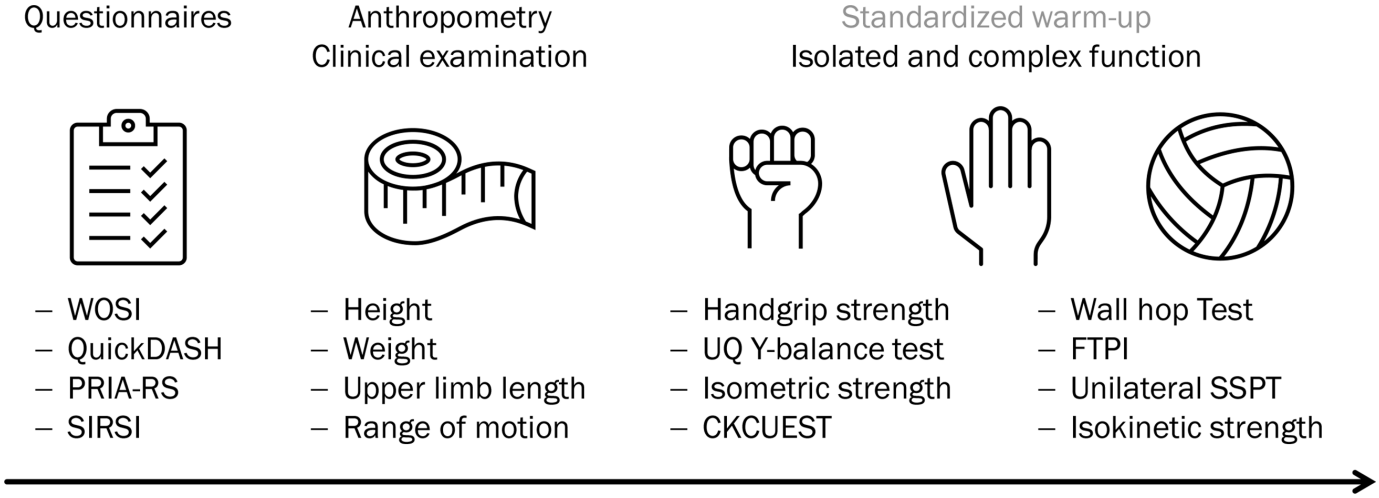

Figure 2 Overview of the assessment procedures. CKCUEST, closed kinetic chain upper extremity stability test; DASH, Disabilities of the Arm, Shoulder and Hand; FTPI, functional throwing performance index; PRIA-RS, Psychological Readiness of Injured Athlete to Return to Sport; SIRSI, Shoulder Instability-Return to Sport after Injury; SSPT, seated shot put test; UQ, upper quarter; WOSI, Western Ontario Shoulder Instability Index.

complete a structured warm-up protocol. Functional tests comprise handgrip strength, upper quarter Y-balance test (UQYBT), isometric strength, closed kinetic chain upper extremity stability test (CKCUEST), wall hop test (WHT), functional throwing performance index (FTPI) and the unilateral seated shot put test (SSPT). To avoid tiredness affecting the results of the other tests, isokinetic tests are performed at the end. For an overview of the assessment procedures used in the study, please refer to figure 2. The outcome categories with the exploratory variables are listed in table 2.

Evaluation of patient-reported outcome measures

Since a multifactorial RTP decision should consider the subjective assessment of shoulder functioning and the athlete's willingness to RTP, those aspects will be measured using these patient-reported outcome measures:

- WOSI.
- QuickDASH questionnaire.
- PRIA-RS.
- SIRSI.

Participants will have the possibility to choose whether to answer the validated German or English language versions of the questionnaires.

The WOSI addresses individuals with shoulder instability.[13] It consists of four subscales with a total of 21 items (10 items for physical symptoms, 4 items for sports/recreation/work, 4 items for lifestyle habits and 3 items for emotions) addressing patients with shoulder instability.[13] The German version has shown high internal consistency and high to excellent test–retest reliability.[14] Each question in this version is scaled on a Numerical Rating Scale from 0 (best) to 10 (worst), with the WOSI score ranging from 0 (highest shoulder-related quality of life) to 210 (worst shoulder-related quality of life).[15] Multiplied by 10, the score of the German version is equal to the score of the original version. For better comparisons across respondents, a modified score (100 – (original score/21)) proposed by Otley *et al*[16] with values greater than 95 suggesting a clearance criterion for RTP[17] will be applied/used. The QuickDASH is a more efficient version of the DASH outcome measure with strong correlations between the two scores.[18] The QuickDASH comprises 11 questions scored on a 5-point Likert scale. It captures symptoms and functional limitations in individuals with upper extremity injuries resulting in a score between 0 (no functional limitations) and 100 (highest level of functional limitations). The QuickDASH has two additional optional modules (work and sports/performing arts) of four questions each, which have not changed from the original DASH.[19]

The PRIA-RS questionnaire enables a screening of psychological readiness to RTP based on the confidence, the individual perception, insecurity and fear of re-injury reported by the athlete at the end of the rehabilitation process.[20] It comprises 10 questions, each rated on a 5-point Likert scale (50 total points), with a higher score representing a more positive psychological response. A score of 40 or less indicates a higher risk of re-injury.[20]

The SIRSI is a valid and reliable scale developed to assess the athletes' psychological readiness for RTP following traumatic shoulder dislocation.[21] It was shown to map four constructs: performance confidence, fear of re-injury and re-injury risk, emotions and rehabilitation and surgery.[22] The SIRSI includes 12 questions with an 11-point Likert scale (0–10). The total score is the sum of the values of the 12 answers divided by 100 to obtain a percentage. Higher scores correspond to a more positive psychological response. As reported by the authors, the mean SIRSI score was significantly higher in patients who successfully RTP compared with players who did not.[21]

Table 2 Outcome categories with exploratory variables

Outcome categories	Explanatory variables	Unit or range
Patient-reported outcome measures	WOSI	0–2100
	QuickDASH	0–100
	PRIA-RS	10–50
	SIRSI	%
Shoulder range of motion	IR	Degree (°)
	ER	Degree (°)
	TROM	Degree (°)
Handgrip strength	Absolute strength	kg
	Relative strength	kg/kg
Isometric shoulder strength	Peak force 90° ABD, 90° ER	N/kg
	Peak force 90° ABD, 0° ER	N/kg
	Peak force 90° ABD, 90° IR	N/kg
	Peak force 90° ABD, 0° IR	N/kg
	Peak force 90° ABD, ECC	N/kg
	Peak force 30° ABD	N/kg
	ER:IR ratio	%
	ECC:IR ratio	%
	ER:ABD ratio	%
Isokinetic shoulder strength	IR–ER (50–70°), 60°/s, CON	Nm/kg
	IR–ER (50–70°), 240°/s, CON	Nm/kg
	IR–ER (50–70°), 60°/s, ECC	Nm/kg
	ABD–ADD (150–0°), 60°/s, CON	Nm/kg
	ER:IR ratio, 60°/s, CON	%
	ER:IR ratio, 240°/s, CON	%
	ER 60°/s ECC:IR 240°/s CON ratio	%
Dynamic shoulder control	UQYBT medial reach	cm, % ULL
	UQYBT inferolateral reach	cm, % ULL
	UQYBT superolateral reach	cm, % ULL
	UQYBT composite score	%
	CKCUEST valid repetitions	Quantity
	CKCUEST power score	%
	Wall hop valid contacts	Quantity
Throwing	Accuracy, FTPI	%
	Unilateral seated shot put	cm

.ABD, abduction; ADD, adduction; CKCUEST, closed kinetic chain upper extremity stability test; CON, concentric; DASH, Disabilities of the Arm, Shoulder and Hand; ECC, eccentric; ER, external rotation; FTPI, Functional Throwing Performance Index; IR, internal rotation; PRIA-RS, Psychological Readiness of Injured Athlete to Return to Sport; SIRSI, Shoulder Instability-Return to Sport after Injury; TROM, total range of motion; ULL, upper limb length; UQYBT, upper quarter Y-balance test; WOSI, Western Ontario Shoulder Instability Index.

Medical check-up

The examiner will fill out the demographic information (patient ID, sex, age, height, weight, handedness, throwing arm, type of sports, playing position, performance level), medical history (date and type of previous shoulder injuries) and history of the injury (date and type of current shoulder injury, ICD (International Classification of Diseases) diagnosis, injury cause and mechanism, days of absence) in a standardised observation sheet. The clinical examination will include shoulder range of motion and injury-specific shoulder tests such as the Jobe relocation test, the Lift off test, the O'Brien's active compression test, the Apprehension test as well as tests identifying scapular dysfunction. In addition, a physician will assess patient-reported current shoulder pain. A self-reported pain score of >3 on a Numerical Rating Scale (0–10) will lead to exclusion from the study. Finally, the physician will provide medical clearance for further functional testing.

Range of motion

Glenohumeral internal (IR) and external rotation (ER) will be measured in supine position using a goniometer. The assessed shoulder will be placed at 90° of abduction in the scapular plane (10–15° anterior to the coronal plane) with the elbow flexed at 90°. A towel roll will be used to ensure that the humerus remains in the desired position during the measurement.[23] For further analysis, the total range of motion (TROM) concept will be used.[24] Full, non-painful range of motion (ROM) is required as a clearance criterion for RTP. For the overhead athlete shoulder, TROM should be within 5° of the non-throwing shoulder.[17]

Standardised warm-up programme

Before performing the functional tests, the participants will perform a standardised 15-min warm-up programme to ensure readiness for the requirements of the assessment. The warm-up programme consists of a 5-min run on a treadmill at 10 km/hour, mobilisation exercises of wrists, cervical and thoracic spine and shoulders, core stabilisation and functional exercises (eg, one-arm plank exercise, plank rotations, (wall-ups) push-ups, bird dog exercise) and shoulder exercises with resistance band (eg, abduction, ER and IR).

Handgrip strength measurements

Handgrip strength will be measured during upright standing using a handheld dynamometer (SH5001, Saehan Corporation, Masan, South Korea). The first position is with the shoulder adducted and neutrally rotated, elbow flexed at 90° and forearm in neutral. To involve the shoulder joint, the second position is with the shoulder abducted at 90°and externally rotated at 90°, elbow flexed at 90° and forearm in neutral.[25] Patients will start with their unaffected controls with their right sides. In each position, two maximal attempts will be recorded after two submaximal familiarisation trials. For all participants, the second handle position will be used, as this is assumed/considered to be the most reliable and consistent position in adults.[26] The test–retest reliability of the handgrip strength testing in young adults during standing has been found to be excellent with intraclass correlation coefficient (ICC) values above 0.9.[27]

UQYBT

To conduct the UQYBT, the official test kit will be used. While controlling a 3-point plank position, participants are asked to move the pipes attached in the medial

(horizontal), inferolateral (135° to horizontal) and superolateral (135° to horizontal) reach directions with their fingertips as far as possible. Patients will start with their unaffected controls with their right sides. After two familiarisation trials, three measurements will be recorded for each direction. The maximum reach distances achieved will be normalised according to the participants upper limb length (distance from the C7 spinous process to the distal tip of the right middle finger). The test–retest reliability of the UQYBT administered with the official test device has been found to be good to excellent with ICC values ranging from 0.80 to 0.99.[28 29]

Isometric strength measurements

Isometric strength measurements will be performed while seated using a handheld dynamometer (microFET2, Hoggan Scientific, Salt Lake City, Utah, USA). Participants will complete two trials in each mode with the respective direction (concentric abduction, concentric IR, concentric ER, eccentric ER). Although performed seated, the test positions for rotator strength are comparable with those used to evaluate handgrip strength with involvement of the shoulder joint. The concentric abduction will be performed with the elbow joint extended in the scapular plane. Patients will start with their unaffected controls with their right sides. In each position, two maximal trials will be recorded after two submaximal familiarisation trials. Test–retest reliability measurements have revealed excellent ICC values (≥0.90) for external and internal shoulder rotators.[30]

CKCUEST

The distance for the CKCUEST will be marked with tape on the floor and normalised according to the participants' half arm span (=upper limb length, ULL, used to normalise the UQYBT).[31] Participants start with middle fingers at the centre of the tapes and their feet shoulder width apart. They will perform three 15 s trials interspersed with 45 s pauses,[32] with the maximum number of alternate touches of the back of the contralateral hand counted. The test–retest reliability of the CKCUEST has been found to be excellent (ICC=0.92).[32]

WHT

The aim of the single-arm WHT is to examine the plyometric function of the upper extremity. It is inspired by the one-arm hop test of the upper extremity[33] and the 30 s side hop test of the lower extremity.[34] Thus, compared with the one-arm hop test, patients are exposed to a reduced plyometric intensity but are exposed to multiple contacts.[35] The distance from the wall corresponds to one-arm length and two feet length of the participant. Leaning forward and supported by one arm at the wall, the participants are asked to hop with their hand back and forth over a minimum distance of 30 cm and achieve as much contacts as possible within the test duration of 30 s. After a 10 s familiarisation trial, patients will start with their unaffected controls with their right sides.

FTPI

Participants will stand 4.57 m from a 30.48×30.48 cm^2 target on a wall at a height of 1.22 m from the floor.[36] The objective of the test is to throw a handball (Molten H1×3200-RB2, 50–52 cm circumference), certified by the International Handball Federation, into the target as many times as possible over three 30 s trials. Before testing, participants will perform a familiarisation session of three graded submaximal warm-up throws at 25%, 50% and 75% of maximal volitional effort[37] and one maximal throw.[17] A 1-min rest period will be allowed between trials. Patients will start with their unaffected controls with their right sides. Video recordings will document all trials. To avoid any discrepancies in judgements, the same examiner will determine the accuracy of all throws by using video footage of the performance. The total number of throws and accurate throws landing within the target square will be counted. FTPI is determined by dividing the number of accurate throws by the total number of throws. The average percentage score from three trials will be used. The intrasession reliability of the FTPI has been found to be good with an ICC value of 0.86.[38]

SSPT

Female athletes will perform the unilateral SSPT[39] with 3 kg medicine balls, while male athletes will use 4 kg medicine balls. The participants will be asked to throw the ball as far as possible while seated with their back against a wall and their knees bent at a right angle.[40] Patients will start with their unaffected controls with their right sides. After two familiarisation trials, the distance of three attempts will be recorded. The test–retest reliability of the unilateral SSPT in young athletes has been found to be good with an ICC of 0.82.[41]

Isokinetic strength measurements

Isokinetic strength testing is considered the standard criterion in muscle strength assessment with high reproducibility and internal validity for different test positions, muscle contraction modes or angular testing velocities.[42] A concession to the multicentre design of this trial is the use of two different test devices to assess isokinetic shoulder strength. Torque production of shoulder muscles for IR–ER as well as abduction–adduction will be recorded with the HUMAC NORM (Computer Sports Medicine, Stoughton, Massachusetts, USA) or the IsoMed 2000 (D. & R. Ferstl, Hernau, Germany) dynamometers. Familiarisation will be performed at 60°/s for six repetitions, and test sets will be interspersed by 1 min of rest. Shoulder abduction–adduction movements will be measured in supine position with the HUMAC NORM and in seated position on the IsoMed 2000. All other tests will be performed in an upright seated position. IR–ER testing will be executed in 90° abducted shoulder and 90° flexed elbow joints to ensure specificity for overhead (throwing) athletes.[43] Athletes will sit at 85° backrest inclination and fixed with pelvis and shoulder straps to prevent compensatory movements. Abduction–adduction and IR–ER

Table 3 Isokinetic assessment design

Test direction (range of motion)	Repetitions and angular velocities	Contraction mode
Internal–external rotation (50–70°)	3×60°/s	Concentric
Internal–external rotation (50–70°)	5×240°/s	Concentric
Internal–external rotation (50–70°)	3×60°/s	Eccentric
Abduction–adduction (150–0°)	3×60°/s	Concentric

strength will be recorded at 60°/s angular velocity for both concentric and eccentric muscle contraction modes. In addition, 240°/s angular velocity will be used to test concentric IR–ER strength.[44 45] Mean and peak torque data as well as strength ratios (eg, concentric internal/eccentric external) will be reported. The ICC values of IR–ER testing in 90° abducted shoulder and 90° flexed elbow joints have been found to vary between 0.09 and 0.89.[46] Table 3 summarises the isokinetic test design and the assessment modalities.

Follow-up

Twelve months after RTP assessment, all study participants will be asked to fill out an online follow-up questionnaire. The form will include questions about their RTP experience and their ability to return to their pre-injury level. It also captures re-injuries and subsequent injuries within the last 12 months. Finally, subjects will be asked about their preventive behaviours and measurements after RTP (eg, external stabilisation, preventive exercises).

Outcome measures

This study aims to analyse the re-injury rate 12 months after initial testing. The main outcome is the number and percentage of re-injured athletes defined as any subsequent injury with at least another 8 days of unavailability for team training or match selection.

Power analysis and sample size considerations

This study addresses several research questions. Thus, we approximated the sample size using two different approaches: explorative and hypothetical.

For the explorative approach, power analysis is based on testing differences between patients and controls. For an undirected (two-sided) mean comparison of two (independent) groups (t-test), with a test power (1-β) of 0.8, an α-error of 0.05 and an expected medium effect size of d=0.5, n=64 subjects per group will be needed. According to these considerations, a total sample of n=128 should be obtained to achieve valid test results. To be able to detect smaller effects of, for example, d=0.3 to d=0.4, 200–350 subjects are to be included in the study. Against this background and taking into account a dropout rate of a maximum of 20%, an initial sample of 200 participants (patients=100, controls=100) should be realised in order to reach the calculated sample size of 128 at the end of the study.

For the hypothetical approach, power analysis is based on testing differences between injured and uninjured sides in the patient group using a two-sided paired sample t-test. Previous results of the UQYBT superolateral reach distance of 65 uninjured throwing athletes were used (70.6±1.3% ULL).[47] Here we assume that the patients' uninjured side will achieve a comparable relative distance. Moreover, we suppose that the injured side can be comparable, better or worse than the uninjured side depending on individual characteristics and the non-dominance/dominance of the upper extremity, which is why we use a two-sided test. From a conservative point of view, clinically relevant changes for reach distances are above 10%.[28] Considering a 10% lower (63.5% ULL) or higher (77.7% ULL) average, respectively, an expected SD of 2.6%, a power of 0.95 and a medium effect size of d=0.5, 54 participants need to be examined (G*Power V.3.1.9.2).

Statistical analyses

The data collected will be used to answer various research questions. Hence different analyses will be conducted. First, data quality checking will be performed to ensure that discrepancies, errors or duplicates are excluded from further analyses and overall data consistency is given. Second, data will undergo exploratory data analysis. Finally, depending on the variables available, appropriate statistical tests (eg, linear regressions, t-tests, χ^2 tests) will be applied to uncover hints on relationships and differences associated with a successful and or unsuccessful return to sports after an acute shoulder injury. Statistical analyses will be performed using IBM SPSS V.28.0 (IBM, Armonk, New York, USA) software.

1. Subjective and functional upper extremity performance of uninjured and injured athletes will be compared using t-tests (interval scaled data, specifying means and SD), χ^2 test (categorical data, specifying frequencies in per cent) or Mann-Whitney U tests (ordinal data, specifying median) depending on the level of data.
2. The functional level of the uninjured and injured side of the injured athletes are first described by means of descriptive statistics (depending on the data level, indication of mean values, SD, minimum, maximum, frequencies, percentages) and compared with each other by means of t-tests for dependent samples, χ^2 independence tests or Mann-Whitney U tests.
3. The association of subjective and functional assessments will be tested by means of correlations. Depending on the data level, Spearman's or Pearson's correlation coefficients will be reported.
4. To investigate the risk of re-injury or subsequent injury following RTP, regression analyses will be conducted.
5. Reference data will be reported as statistical measures (eg, mean, SD, number and frequency, minimum, maximum, cut-off if applicable) separately for injured and uninjured athletes. If the number of cases is sufficiently large, reference data will be reported stratified for men and women, and by team sport.

Patient and public involvement statement

Patients are encouraged to recruit their own colleague as a matching partner. Moreover, players' experience with the tests will be asked in order to better judge the exhibited performance. The test battery was designed within a three-step Delphi survey incorporating experts from different professions. The results will be communicated by the German statutory insurance company Verwaltungs-Berufsgenossenschaft and implemented into their rehabilitation routines.

Ethics and dissemination

The present study has been approved by the Institutional Review Board of Martin-Luther-University Halle-Wittenberg (reference number: 2022–016). Prior to enrolment in the study, all participants will be asked to give their written informed consent. The participant can decide at any time to be released from the study, and they will be made aware of this in the information leaflet. Their data will then be deleted from the data collection file. Voluntary termination of study participation will have no disadvantages for participants.

Results

The research results from this study will be disseminated through peer-reviewed (open-access) publications and scientific presentations at national and international conferences.

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Contributors EK, HB, IB, DM, AP, SSe, SSt and LA designed the test battery and contributed to the development of the study protocol. EK, HB, IB and LA drafted the manuscript. EK submitted to the ethics committee. DM and AP assisted in drafting the manuscript. All authors read and approved the final version of the manuscript.

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Competing interests HB works for the sponsor of the study as an advisor in the prevention field of sport (prevention department) and IB as an advisor in the field of insurance and benefits (rehabilitation department). Both supervise research projects in their departments and accompany the project participants until successful completion of the study. This is usually defined as successful implementation and transfer of the study results into practice.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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