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Developing consensus for upper limb rehabilitation, physical preparation and return to climbing in adults: protocol for an international e-Delphi study

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ABSTRACT

Climbing has grown into a grassroots participation sport and Olympic discipline. The high loads expressed through the upper limb may increase the risk of injury in this population. This may also affect rehabilitation and return to sport (RTS) considerations after injury. Treatment, management, rehabilitation and RTS parameters after injury are poorly documented. The aim of this study is to reach international expert consensus on the postinjury and surgical rehabilitation, physical preparation and RTS strategies in a range of climbers. This will provide a framework for the safe RTS of climbers. The study will be reported in accordance with guidance on conducting and reporting Delphi Studies guidelines. Panel members will be recruited with expertise in either the delivery of healthcare and/or physical preparation of climbers. The electronic Delphi is anticipated to consist of three irritative rounds. Round 1 will consist of open and closed questions to generate a broad range of statements on the rehabilitation, RTS and outcome measures used after climbing injury. In round 2, all participants will be provided with a summary of the current literature of the rehabilitation and RTS strategies for upper limb sports injuries. Rounds 2 and 3 will consist of a summary of the results from the previous round including any dissonance. Participants will be asked to anonymously rate responses on a 5-point Likert scale. The study steering group and patient public involvement representatives will be involved from conceptualisation until final dissemination.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ There is an absence of literature documenting rehabilitation, physical preparation and return to climbing parameters after musculoskeletal injury in climbers. This is in large part because climbing is still a minority sport with a limited research base.

WHAT THIS STUDY ADDS

⇒ This study will provide international expert consensus on the postinjury and surgical rehabilitation, physical preparation and return to sport after musculoskeletal climbing injuries. It will provide a framework for the safe return to participation, sport and performance in a range of climbers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The results obtained in this study will be important for developing future pilot and feasibility studies for rehabilitation and return to performance strategies in climbers after injury.

INTRODUCTION

Climbing in the past two decades has grown into both a dynamic grassroots participation sport and Olympic discipline.[1] In 2021 for the first time, the sport of climbing was included in the Olympic Games featuring the main three competition disciplines (lead climbing, speed climbing and bouldering). Climbing has also seen rapid growth in participation in both outdoor rock climbing and indoor climbing on artificial climbing walls.[2] Climbing indoors on artificial holds or outdoors on natural rock formations is underscored by participants reaching the end of a predetermined route without falling.[3] The sport is made up of different categories of climbing each with its own unique style, rules and physiological characteristics which define participation. The different types of climbing include traditional climbing, bouldering, speed climbing, ice climbing and sport or lead climbing.[4]

Traditional climbing is the oldest type of climbing and is undertaken outdoors on natural rock formations. The climber is attached to a rope and is belayed by a second climber. The climber ascends the route and places protective equipment into the rock and connects the rope. Sport climbing can be undertaken both outdoors and indoors and again the climber is attached to a rope while belayed by a second climber. In contrast to traditional climbing, the rope is attached by

the climber ascending to prefixed anchor points for their protection in the event of a fall.[5]

Bouldering is a separate discipline which involves the ascent or traverse along a predetermined route. This type of climbing is short in duration, typically 10–40 s utilising several powerful gymnastic-style movements to reach the end of the route. The height of these routes is low in comparison to traditional and sport climbing. The climber is not attached to a rope and in the event of a fall is managed by spotters and safety mats to reduce the risk of injury.[2]

Speed climbing is a separate Olympic sport at present. The aim is to ascend a predefined route while racing against another climber. The climber who reaches the end of the route first is the winner.[6] The time taken to ascend the route is quantified by an electronic timing plate at the start and end of the route.[7] All climbing disciplines are accessible to climbers with disabilities and are termed Para climbing.[8] This diversity of climbing activities contributes to a variety of injury types and biomechanical and physiological demands.

The upper limb is an important anatomical region to understand in relation to training, injury and return to performance. The primary interface between the wall or natural rock is the hand and upper limb. The magnitude of forces expressed through the musculoskeletal system is influenced by biomechanical moment arms both at the whole body, body segment and local joint muscle interface.[9] The upper limb and especially the hand have a smaller surface area of bone, connective tissue and muscles in comparison to the lower body.[10] The smaller surface area for the absorption, transfer and the generation forces imposes mechanical penalties on these tissues. This applied force and surface area are directly related to the degree of mechanical stress imposed on biological tissues.[9] The relatively high loads expressed through the interface of the hand, wrist, elbow and shoulder regions may increase the risk of injury in this population.[11] It may also affect the rehabilitation, physical preparation and return to sport (RTS) considerations for the climber and clinicians.[12]

The injury burden associated with climbing has been well documented in the disciplines (sport and bouldering) with the highest participation levels.[3 4] Across a spectrum of performance levels the prevalence of injury has been reported to vary between 10 and 81% regardless of the cause.[13 14] This can be broken down into acute and chronic injuries and impact and non-impact injuries. Injuries associated with impact typically involve a fall from height and impact with the ground or climbing surface.[13 14]

The upper limb is most commonly associated with these injuries often affecting the fingers, wrist, elbow and shoulder regions.[11] Chronic overuse injuries account for between 33% and 44% of injuries in climbers, the result of repetitive and forceful exertions of tissues over a protracted timeframe.[15 16] The upper limb is the anatomical region subjected to the most chronic overuse injury at the site of the fingers, wrist, elbow and shoulder.[17] Upper limb injuries are common in elite climbers[18] and recreational climbers.[19] The hand is the most frequently reported anatomical location accounting for around 22.9% of injuries in a cohort of 436 elite climbers.[18] The prevalence of upper limb injuries was 77.1% and 17.7% in the lower limb and 5.2% associated with other regions. However, while the burden of injury is well documented and the surgical procedures[20] frequently reported in the literature, rehabilitation parameters after injury is sparce.[21]

The treatment, management, rehabilitation and RTS parameters after injury are poorly documented with only limited literature detailing approaches and principles of management. In situations in which physiotherapy and rehabilitation have been reported, it is as part of surgical treatment algorithms,[22] case studies[23 24] and clinical commentaries.[25 26] In these reports, rehabilitation is not reported in adequate detail and no guidance on return to climbing and subsequent return to performance is included. This level of detail is incompatible with the delivery of evidence-based rehabilitation and RTS guidance, which can direct care for the healthcare and physical preparation professional.

Aim

To reach international expert consensus among a panel of climbing experts on the postinjury and surgical rehabilitation, physical preparation and return to climbing strategies in a range of adult climbers. This will provide a framework for the safe return to participation, sport and performance in a range of climbers in a real-world applied setting.

Objectives

1. To determine expert consensus on important quantitative and qualitative outcome measures for early, middle and late-stage rehabilitation, RTS and return to performance.
2. To determine expert consensus on the components of early, middle and late-stage rehabilitation phases.
3. To determine expert consensus on the components of RTS and return to performance phases of a climber's recovery.

METHODS AND ANALYSIS

Study design

This study will be reported in accordance with guidance on conducting and reporting Delphi studies guidelines recommended by Enhancing the Quality and Transparency of Health Research.[27]

The purpose of the Delphi technique is the formation of consensus or exploration of a field beyond the existing knowledge or when there is a lack of published guidance. The aim is to build systematic consensus to resolve uncertainty about a clinical question or concept of care.[28] An electronic Delphi study allows input from a wide spectrum of experts across a range of disciplines related to

medicine, rehabilitation and performance from several countries.[29] It also allows anonymity preventing dominant behaviours or peer pressure influencing the responses of its participants.[30] The Delphi approach also allows irritation and controlled feedback to all participants of the group opinion. Participants during this process are able to refine, comment and amend their view in anonymity working towards consensus.[31]

Sample size and expert eligibility

Panel members will be selected because of their expertise in either the delivery of healthcare (such as athletic trainers, physiotherapists, doctors, osteopaths or other allied healthcare or medical professionals) and/or physical preparation and/or strength and conditioning (climbing coaches, physical preparation and S&C coaches and sports scientists) of climbers with a special interest in elite, subelite or recreational climbers in either bouldering, speed climbing, traditional climbing or sport/lead climbing. A sample of at least 20 healthcare professionals and 20 applied practitioners with expertise in the physical preparation and/or strength and conditioning of climbers will be recruited from two populations[32]:

1. Healthcare professionals or applied practitioner academics with ≥2 publications or conference proceedings as the first author in peer-reviewed scientific journals or textbooks on related subjects to injury management and/or rehabilitation in climbing or presented at sports medicine or rehabilitation conferences on related topics in the last 10 years.
2. Healthcare professionals and applied practitioner experts who can demonstrate a case load of ≥20% climbing-related injuries and/or training and/or consultancy on return to performance.

No exclusion criteria will be applied with regard to geographical location, biological sex, gender or cultural background. A balance will attempt to be made between experience, biological sex, gender, ethnicity, nationality and professional representation.

Recruitment

Participants will be recruited through professional networks and social media via a purposeful snowballing sampling approach,[33] including the International Climbing Research Association and International Federation of Sport Climbing. This sampling method is applied when it is difficult to access participants with specific target characteristics. In this method, existing participants will be asked to recruit and recommend other suitably qualified participants from their network. A long list of potential participants will be constructed and once consolidated potential participants will be contacted and invited to participate because of their experience and knowledge in this area.

Sample size

Sample sizes and sampling methods are not well defined in the Delphi technique, however, if the groups are representative and knowledgeable in the area of study, then content validity can be assumed.[34] The purpose of the Delphi technique is the formation of consensus and exploration of a field beyond the existing knowledge when there is a lack of published guidance. The aim is to build systematic consensus to resolve uncertainty about a clinical question or concept of care.[28] Expert practitioners that mange the care of climbers is very small internationally. For example, in the United Kingdom, there are approximately five practitioners with a special interest in climbing injuries. In clinical rehabilitation fields, evaluating interventions consensus has been achieved with 14–27 experts previously.[35 36] Therefore, to achieve consensus, it is estimated that a minimum of 27 experts will be required. In these studies, the response rate is typically about 70%, therefore a minimum of 40 experts will be recruited because of the anticipated levels of dropout.[37] Furthermore, there is no data on the number of practitioners internationally involved in the management of climbing injuries. Therefore, the sample size will account for the likely range of experts internationally with a special interest in the rehabilitation and physical preparation of climbers.

Procedure

The study will consist of three rounds. Figure 1 presents a summary of the e-Delphi rounds. A pilot study will be conducted by the principal investigator to evaluate the questionnaire. This will be to refine the readability and meaning of open and closed questions in round 1. This feedback will be analysed and necessary changes made before distribution to participants in each round. This data will be separated from the Delphi survey and used only for the development and piloting of questionnaires. The questionnaire will be piloted by a small group of healthcare professionals with expertise in climbing research and clinical practice. To increase feasibility and readability, the survey in all three rounds will be piloted. The survey will be compiled and distributed using the Joint Information Systems Committee (Jisc UK) V.3 Online Surveys.

Round 1

Aim

The aim of round 1 is to generate a broad range of statements on the rehabilitation, RTS, performance strategies and techniques used after climbing injury. It will also aim to understand which outcome measures experts believe are important in each phase.

Procedure

After the pilot testing and prior to e-Delphi survey distribution, a discussion among the study steering group and patient public involvement representative will be undertaken.

Round 1 will include demographic questions about the participants' percentage of climbing injury practice and the nature of their clinical or academic work and

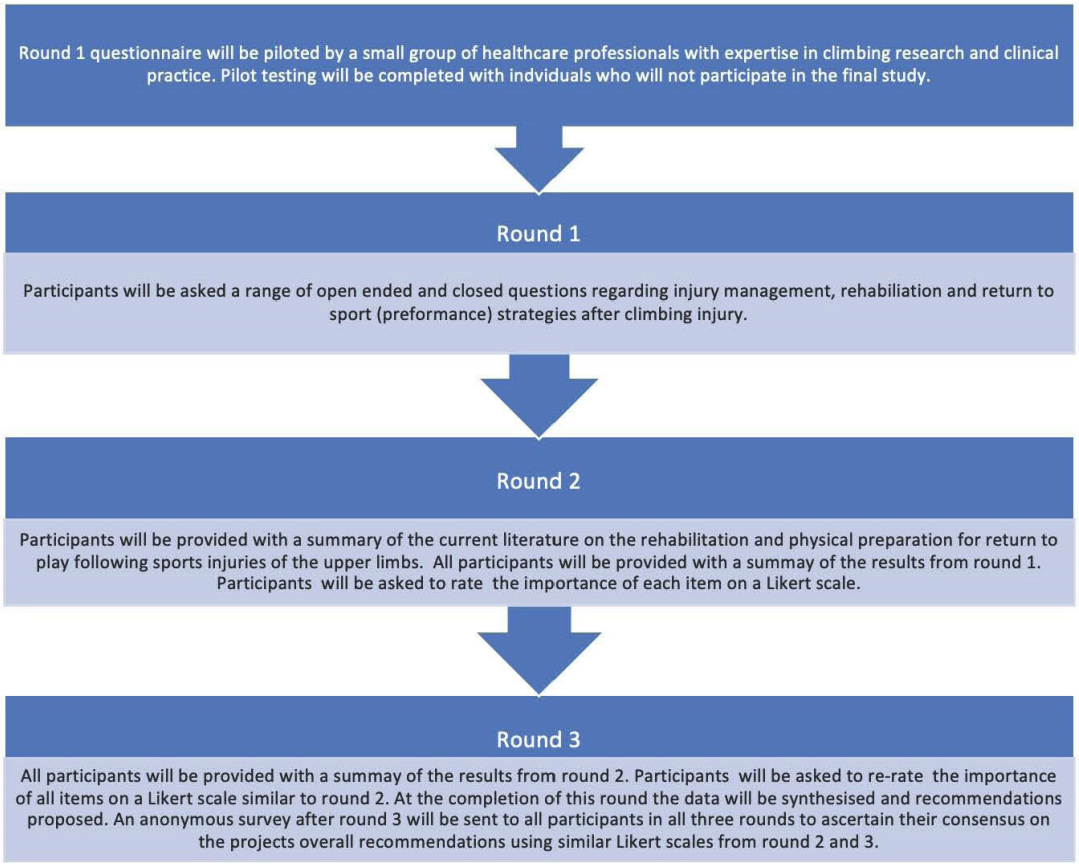

Figure 1 Stages of the Delphi procedure.

geographical location. The survey will then follow the following category format: at least 5–10 open-ended and closed questions about rehabilitation and injury management strategies after climbing injury. Then, 5–10 open-ended and closed questions about physical preparation strategies in the middle to late stage of rehabilitation (eg, strength training, load management periodisation, power and rate of force development (RFD), sports-specific skills, energy system development and kinetic chain development). Then, 5–10 open-ended and closed questions about return to climbing performance considerations will be sought (eg, physical and psychological). Finally, two open-ended questions about diagnostic testing for progression through the different stages of rehabilitation and RTS in an applied setting (eg, early, middle and late stage/RTS).

Data analysis

The data will be analysed using inductive content analysis for open questions to identify themes, patterns and concepts[38] using NVivo V.14 (Lumivero Denver, USA). The results will be reviewed by a second researcher to ensure consistency.[39] Closed questions will be analysed descriptively for measures of central tendency and converted to Likert numerical data (mode and percentage agreement)[40] using SPSS V.29.020(20) (IBMY). Areas of disagreement among the group will be determined and highlighted in round 2 to attempt to move the entire group towards consensus. Data on participant demographics and characteristics will also be tabulated to aid analysis of the results and to illustrate potential confounders or mediators in the results.

Definition of consensus

During round 1, consensus will be defined as agreement >2. Therefore, only responses where there is agreement between two or more participants will be redistributed.[41]

Round 2

Aim

The aim of round 2 is to move the groups towards consensus. This will be achieved by allowing participants to revise, review and anonymously rate the statements.

Procedure

All participants will be invited to round 2 including those that consented to round 1 but did not complete round 1. This will be to reduce the risk of false consensus.[41] The statements generated during round 1 will be distributed to participants in round 2. Any disagreement or dissonance between professional groups (eg, physiotherapists, doctors and performance/conditioning coaches) during round 1 will be summarised and redistributed for further consideration and feedback. During round 2, participants will be requested to reconsider all responses where there is agreement between two or more participants.

Participants will be invited to rate their agreement with statements using a 5-point Likert scale (1=strongly disagree, 5=strongly agree). An open text box will also be provided for participants to offer their opinion on issues raised during round 1.

Information provided

At the start of round 2, all participants will be provided with a summary of the current literature on the rehabilitation and physical preparation for return to play following sports injuries of the upper limbs.[42] Research literature for managing acute and chronic upper limb injuries in athletes of all ages and participation levels will be reviewed using the following databases (PubMed, Cochrane Central Register of Controlled Trials, CINAHL, Medline, PEDRO, NICE, AMED and Gray literature searches in Google Scholar). Articles will be extracted and reviewed prioritising systematic reviews, clinical practice guidelines and original research and narrative reviews (in that order). The search terms used will be purposefully broad using patients with shoulder, arm, forearm, elbow, hand, upper limb injury, upper limb injury management AND *return to sport* OR return to play OR RTP OR physical preparation OR rehabilitation medicine OR athletic rehabilitation OR sports medicine. Articles which mention rehabilitation, or injury management of upper limb, elbow or hand or finger injuries will be included for review. Articles not mentioning shoulder, elbow or hand or finger injury management or rehabilitation in a sporting context or its focus is only on surgical management of injuries will be excluded. A deductive content analysis will be conducted to identify key themes from the literature search[39] to inform the first and second round of the Delphi. This will lead to the generation of specific open-ended and closed statements, which will be constructed into a questionnaire.

This literature review will be used in the following way:

1. It will lead to the generation of specific open-ended and closed statements, which will be used to construct the questionnaire used in round 1.
2. A summary of the literature review will be circulated to all participants at the start of round 2. This seeded approach of providing the participants with pre-existing information provides the panellists from different professional groups (doctors, physiotherapists and performance coaches) with an equitable starting point for upper limb rehabilitation, physical preparation and return to performance before the start of consensus development. Providing participants with pre-existing information from the general upper limb field is important because climbing specific rehabilitation and RTP is an under-researched area. However, this seeded approach will still allow expert panellists the opportunity to volunteer ideas that are not reported in the current literature.

Data analysis

Numerical data from round 2 will be analysed quantitatively using descriptive statistics to establish percentage agreement. Statements which are rated agree or strongly agree using the Likert scale will be used to calculate the percentage agreement. The median and mode will be used as a form of secondary analysis and the dispersion of each statement captured with IQR.[43] The median is not affected by extreme scores or outliers in the data and is the recommended measure of central tendency for ordinal data.[40]

Definition of consensus

Consensus will be determined when 70% of participants within the group agree with a statement.

During round 1, consensus will be defined as agreement >2. However, when a statement achieves consensus in round 2, it will proceed to round 3.[41]

Round 3

Aim

The aim of this round will be to determine consensus of any remaining statements which have not reached consensus.

Procedure

The results of round 2 will be sent to all participants including descriptive and inferential statistics outlining stability, disagreement and percentage agreement. Likert scales will be used in round 3 to ascertain the level of agreement. Participants will be asked to rate their agreement with statements that achieve 70% agreement during round 2 with the additional opportunity for open answer comments.

Information provided

Participants will be provided with a summary of the results from round 2 and areas of disagreement.

Definition of consensus

Consensus will be reached in each subdomain of study (eg, initial injury management, chronic injury management, intermediate stage, late stage and RTS, outcome measures and return to performance) when the Kendall's coefficient is ≥0.7.[41]

Data analysis

Numerical data from round 3 will be analysed quantitatively to establish percentage agreement from the remaining statements. Again, statements which are rated agree or strongly agree using the Likert scale will be used to calculate the percentage agreement. The median, mode and IQR will be computed. The assessment of stability is recommended in the final two rounds of Delphi studies to assess the degree of consensus.[40] The Wilcoxon Paired signed-ranks t-test with a significance level of $p<0.05$ will be used to compare differences in panellists' responses from rounds 2 to 3.[44] Kendall's coefficient of concordance will be used to evaluate overall agreement in each subdomain of the

study. Overall consensus will be determined with a value of 0 indicating weak association and 1 indicating strong association.[45] The data will then be tabulated and a visual summary of the results presented to participants. At the completion of this round, the data will be synthesised and recommendations proposed. An anonymous survey will be sent to all participants in all three rounds to ascertain their consensus on the project's overall recommendations using similar Likert scales from rounds 2 and 3.

Study steering group

Coauthors (SP, MB, VRS and GJ) are the study steering group and provide academic, methodological and clinical expertise in rehabilitation, strength and conditioning, performance and climbing. The group will meet to discuss results after each round and provide feedback and critical insights as the project progresses.

Patient and public involvement

Two patient and public involvement (PPI) representatives, a male and female climber, will be involved in the conceptualisation of the project until final dissemination. The PPI representatives will provide important insights and feedback on the methodology and results synthesis at all stages of the process. To promote transparency Guidance for Reporting Involvement of Patients and Public Short Form Checklist will be used.[46]

DISCUSSION

There is an absence of literature documenting rehabilitation, physical preparation and return to climbing parameters after musculoskeletal injury in climbers. This is large part because climbing is still a minority sport with a limited research base.[47] In situations in which rehabilitation is reported, it is typically as a part of surgical treatment algorithms,[22] case studies[23 24] or clinical commentaries.[21 26] In many situations, rehabilitation parameters are not reported in adequate detail and there is limited guidance about return to climbing and return to performance. This is incompatible with the delivery of evidence-based rehabilitation and RTS guidance for healthcare and physical preparation professionals. This gap in the knowledge may have wider reaching implications for patient care and reinjury. Recently, Gronhaug and Saeterbakken[48] have reported that climbers believe that healthcare professionals do not have adequate knowledge to treat climbing-related upper limb injuries. In this study, climbers report not seeking professional advice and instead trusting management advice from other climbers or using social media forums to manage injuries. This may underscore the need to develop evidence-based frameworks for rehabilitation and return to performance after climbing injury. This should include defining the principles of rehabilitation after climbing injuries and developing consensus in physical preparation and return to performance considerations with climbers, clinicians, coaches and physical development practitioners.

In the absence of primary research, the Delphi approach has been shown to be beneficial in gathering data from specific individuals, groups and populations across multiple sectors.[49] The Delphi approach is a descriptive explanatory approach for achieving expert consensus.[50] It is based on the assumption that expert group opinion is more valid than expert individual opinion using a rigorous methodology which is reproducible.[51] Importantly, a Delphi technique does not produce definitive answers, but instead valid expert opinion.[40] The anonymity of responses from its panel members provides the opportunity to express opinions to others without feeling pressurised by more influential members. This helps to promote honesty and reduces the risk of bias.[34] The controlled feedback in each round of the survey, its multiple irritations and the exploration of consensus enhance the validity and reliability of the end product.[42]

There is currently no example in the literature of using the Delphi technique in the rehabilitation, return to sport and return to performance of climbers after injury. However, there are many examples of its application in healthcare for developing clinical guidelines[52 53] and research priorities.[54 55] Consensus obtained in this study will be important for developing future pilot and feasibility testing for rehabilitation and return to performance strategies for climbers.

ETHICS AND DISSEMINATION

Full ethical approval is provided by St Marys University (Reference number SMU_ETHICS_2024–25_872). Dissemination will take place through peer-reviewed publications and conference proceedings.

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Contributors Conceptualised and proposed the consensus study. UE drafted the initial manuscript. VRS and GJ contributed to the development and piloting of the research questions. MB and SP contributed to the development of the study design, framework and subsequent revisions and approved the final manuscript. UE is the guarantor of the work accepting full responsibility for its content, data integrity and decision to publish. Mrs Beth Boddice at the Royal Orthopaedic Hospital Library Service assisted with literature searching. Miss Jo Neame and Mr Luke Smith were patient and public representatives and provided critical insights on aspects of the development of research questions.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval Ethics reference number is SMU_ETHICS_2024-25_872: St Marys University—Faculty of Sport, Technology and Health Sciences. Participants gave informed consent to participate in the study before taking part.

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