**Consensus Statement with a management guideline for Low Back Pain in Rowers**

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**ABSTRACT**

Purpose: To synthesise evidence on low back pain (LBP) in rowers to create a consensus statement to inform practice through a practical management guideline.

Methods: There were five key steps to develop the consensus statement. In step one, seven expert clinicians and researchers examined current evidence, and identified five sections that comprised the scope of the consensus statement: epidemiology; biomechanics; management; the athlete’s voice and clinical expertise. In step two, we established working groups for each section of the consensus statement to discuss and summarise key issues relevant to each section. In step three, we synthesised the evidence from each group to create the overall consensus statement. In step four, we used modified Delphi processes to create summaries and recommendations. In step five, we combined information from the consensus statement and that from a survey of clinical experts to produce a practical management guideline.

Results: Management of LBP in rowers should include education on risk factors, rowing biomechanics and training load. If treatment is needed, we recommend non-invasive management, including early unloading from aggravating activities, effective pain control and exercise therapy. Fitness should be maintained with load management and progression to full training and competition. The role of surgery is unclear. Management should be athlete focused and a culture of openness within the team encouraged.

Conclusion: Recommendations are based on moderate quality evidence and consensus, and align with international LBP guidelines in non-athletic populations. We recommend that research in relation to aspects of management of LBP in rowers be intensified.

**INTRODUCTION**

Low back pain (LBP) is the most frequently reported musculoskeletal disorder, and can result in long term pain and disability.1 2 Rowing is a sport associated with large volumes of training and high cumulative loading of the lumbar spine. The most frequently reported site of pain for rowers, as a result of rowing, is the low back.3 4 Recent research has focused on epidemiology and biomechanical analyses to understand mechanisms that contribute to LBP onset. There has been a limited focus on management or prevention strategies.

There are currently no guidelines for managing LBP in rowers (hereby defined as ‘rowing-related LBP’) or in athletes who participate in other sports. There are guidelines for managing LBP in the general population. While some principles of management are transferable, there is a need to consider issues that are particular to rowers.

The aim of this consensus statement was to (1) synthesise and present the current evidence on LBP in rowers and (2) develop a practical management guideline to facilitate the translation of evidence into practice

**METHODS**

The AGREE II reporting checklist5 (www.agreetrust.org) guided development and reporting of this consensus statement.

**Target populations**

The target user population is health care providers who are managing rowing-related LBP at elite and sub-elite levels. The plain language summary provides information for rowers, coaches and support staff. The accompanying management guideline was created to inform clinical decisions and standards of care. We intend the management guideline to provide education regarding how best to prevent rowing-related LBP and how to reduce the impact of LBP when it does occur, including how best to avoid the recurrence of pain or persistent pain.

The consensus statement applies to rowers with and without LBP, so that rowers and clinicians working with rowers may consider the recommendations in the context of primary and secondary LBP prevention.

The target patient population is adult male and female rowers of all boat and weight classes in all rowing settings from club and college to international standard. When applying the information in the consensus statement to Masters rowers, the clinician should consider aspects of normal ageing and age-related disease. The information in the consensus statement may not apply to youth (junior) level rowers who are under 18 years, or para rowers.

**Expected outcomes**

The consensus statement provides a framework to inform best care based on current evidence and clinical expertise. It includes stakeholder involvement by including the ‘rower’s voice’ from qualitative research and the rowers’ and coaches’ input into a plain language summary. This document reflects the current state of knowledge and should be read in conjunction with the systematic reviews and other associated papers,6-10 which provide context. The companion papers provide accompanying methodologies and report the scope of published research, including search strategies and references.

The primary goal is to improve the standard of care for rowers with LBP via the following outcomes: (i) characterising rowing-related LBP, (ii) creating triage guidelines for early diagnosis and management, and (iii) accounting for the lived experience of rowers with LBP.

We aimed to highlight evidence gaps and create a call for action, updating this consensus statement as evidence emerges. The ultimate goal is to reduce the long-term effects of LBP on rowers, and to influence outcomes by reducing personal burden and health care costs.

**Working groups and processes**

A core expert group comprising seven individuals (FW, JT, KW, AV, AMcG, CG, CN) who had published research in rowing-related LBP and who had broad experience of managing rowers with LBP, convened in British Rowing Headquarters, Hammersmith, London, in February 2018. This group defined the objectives of the consensus statement and outlined the personnel required. Two methods experts (JH and CA) were invited and consulted throughout the process of developing the guideline and recommendations. The Medical Commission of the international rowing body Fédération Internationale des Sociétés d'Aviron (FISA) oversaw and supported the process.

Following the February 2018 meeting, additional experts were identified for each sub-section based on relevant expertise. Experts were required to have (i) been engaged in managing rowing related LBP, and (ii) conducted research in the area, which they had disseminated. The expert group included physiotherapists, physicians (sports medicine and endocrinology), surgeons (orthopaedics), coaches, sport scientists (e.g. strength and conditioning experts) and athlete representatives. The group represented all key stakeholders, and reflected the composition of the appropriate FISA Commissions and the range of key characteristics of the user populations.

Expert group members represented Europe, North America and Australasia, which comprise the greatest number of rowing nations. All rowing nations had the opportunity to contribute to the consensus statement via (i) a clinician survey distributed to every nation registered with FISA, and (ii) at an interim presentation of the protocol and preliminary results at the World Rowing Sports Medicine, Science and Coaches Conference in Berlin, November 2018.

**Setting the task and defining questions**

The first task of the February 2018 meeting was to define the questions that would underpin the consensus statement. A round-table format was adopted for open discussion. The keynote presentation from the 2015 World Rowing Championships (WRC) Medical Meeting was used as the reference document.11 This presentation had synthesised and summarised the evidence on rowing-related LBP, and was later posted on the World Rowing website in 201611 to inform and invite discussion by the world rowing community. The content of the community feedback on the website, input from the FISA Sports Medicine Commission members and informal feedback (audience questions and debate) from the WRC meeting were considered and used to inform discussion at the February 2018 meeting. Questions were proposed and debated by the core expert group and were refined and decided on by discussion and informal consensus. Three definitive key questions were raised at the February 2018 meeting:

1. What is the extent (prevalence) of rowing-related LBP; how does this compare to other sports and LBP in the general population?

2. Can rowing-related LBP be managed, and how?

3. Can rowing-related LBP be prevented?

We aimed to answer Questions #1 and #2 by exploring epidemiology and management strategies. To understand management, we evaluated the evidence for non-pharmacological management (including surgery) of LBP in athletes. We also conducted an extensive survey of expert and experienced clinicians to investigate current best clinical assessment and management of an acute episode of LBP in rowers. Qualitative research investigated the athlete’s lived experience. We agreed that the focus of #3 would be to explore risk factors reported in epidemiology and to examine the influence of biomechanics as a modifiable and influencing factor in rowing related LBP. Initial discussions and informal scoping of rowing-related LBP studies identified a considerable research focus on biomechanics and we agreed to create a subgroup to explore this. As part of the clinician survey, we also asked their opinions on modifiable risk factors.

**Consensus objectives**

The core expert group defined study objectives by discussing the key questions; reflecting on how established research could answer these and where new research was required. The following set of objectives were agreed by discussion and informal consensus (Table 1).

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| Objectives |
| To perform systematic reviews of epidemiology, biomechanics and management of low back pain |
| To seek information from end users o Rowing athletes to examine their experiences of low back paino Clinicians to investigate their opinions, experiences and recommendations regarding rowing-related low back pain management |
| To provide a definition of rowing-related low back pain |
| To create a management framework for rowing-related low back pain with recommendations regarding recognition, triage, and management in the acute, sub-acute and chronic phases, in addition to rehabilitation recommendations and prevention advice |

Table 1: Objectives of inaugural meeting, February 2018

To accomplish our objectives, we established five working groups. Two groups were charged with conducting original research; these were for the qualitative study of the rowers’ lived experience of LBP and the other was a Delphi survey of opinions and recommendations in rowing clinicians. One group had collected data prior to the February 2018 meeting (the qualitative study) so were reconvened for the consensus statement project. Three groups were established to conduct systematic reviews. A systematic review of literature on epidemiology of LBP in athletes was initiated with a subgroup analysis of studies that examined rowing-related LBP. Another group examined the biomechanics related to rowing-related LBP, and another reviewed the treatment of LBP in athletes with studies examining rowing-related LBP synthesised where possible. The group that conducted the review of epidemiology was also charged with creating a definition of rowing-related LBP.

The full methodologies and outputs from each work group are presented in companion papers to this consensus statement.6-10 The study proposal, interim findings and key questions (from the February 2018 meeting) were then presented at the World Rowing Sports Medicine, Science and Coaches Conference in Berlin, November 2018. Debate and comments were invited.

**Modified Delphi process**

For each of the outputs from the working groups and upon completion and analysis of findings, a series of summary statements and recommendations (where possible) were created to reflect the study or review findings. We used a modified two-to-four round Delphi process.

Ahead of round one, we used content analysis to summarise key results using Microsoft Excel (Microsoft Corporation, USA) and uploaded to Google Docs (www.docs.google.com) for online sharing with each work group. Members of the work groups anonymously rated their level of agreement on a 10-point Likert type scale where 1=Disagree Strongly and 10=Agree strongly. Respondents could add statements, or suggest modification of the original statements. Agreement was established when the mean reached a score of seven or above as a representation of combined group opinion.

For round two, the agreed statements, and those that were added in round one, were shared with each study’s authors and the core expert group (if they were not already a member of that work group) established at the February 2018 meeting, along with a completed copy of the study findings. Voting was again conducted anonymously in the Google Doc as described, and the group was invited to add or modify the statements. These invited comments and modifications were also voted on at this stage. In round three, participants re-rated their level of agreement for each statement after viewing scoring distribution of group opinion from round two. Consensus for a statement was established when the round three mean score reached seven or above and the standard deviation was two or less. If necessary, a fourth round was conducted. For example, if any authors added modifications of any of the agreed statements at round three.

A separate voting process was conducted by the epidemiology group for the definition of LBP where experts who had published in athlete LBP were also invited to vote in an initial three-round process. A fourth-round vote was conducted and the final statement that was chosen was the one with the highest mean score.

The clinician survey was conducted from the outset as a Delphi process and methods are detailed in the accompanying paper.10

The final summaries and recommendations were based on assessing the quality of evidence, patient values and preferences as well as the experience and understanding in the work groups.

**Plain language summary**

On completion of the consensus statement, three athletes (GO’D, FS, KB) and two coaches (MH, PT) independently provided feedback on content and language. A plain language summary was constructed using their feedback and was guided by methods outlined by the Cochrane Collaboration.12 A modified version of a table (Table 1A, online supplementary material) and figure (Figure 1A, online supplementary material) were created to reflect content in language that was clear to this user group.

**Updating, applicability and dissemination**

It is intended that this consensus statement will be formally reviewed and updated at five-year intervals. The first review is due before 31st December 2025. Barriers to application of this guideline may be resource availability in some settings, including access to a healthcare provider with adequate experience. The plain language guideline provides information that may be helpful for athletes without access to such healthcare. Tools that will be used to promote access to this guideline will be open access publishing in the host journal and on the worldrowing.com website. An infographic will promote key messages. Following publication and after a defined period of time, rowing nations will be surveyed to explore their use of the guideline. To measure guideline dissemination, the core expert group recommended using download metrics of this paper, and the number of engagements on social media when the guidelines are disseminated through the channels described above.

**RESULTS**

**SECTION ONE: Findings of systematic reviews and summary statements.**

**Epidemiology of low back pain in rowers**

A systematic review examined the prevalence of and risk factors for LBP in the general sports population to provide context for rowing.6 The following question regarding rowing- related LBP was raised:

*“What is the current epidemiological evidence for prevalence of LBP in rowers and what are the associated risk factors?”*

In 86 studies in all sports, the mean LBP point prevalence was 33%; lifetime prevalence was 63%; 12-month prevalence was 51%. Comparison across sports was limited by participant numbers, study quality and methodologies, and varying LBP definitions. Risk factors for LBP included history of a previous episode, and statistically significant associations were reported for high training volume, periods of load increase, and years of exposure to the sport. There were 11 studies, with a total of 1695 participants identified, that specifically examined LBP in rowers. Six of these (667 participants) were identified as high quality.13-23 The most common prevalence estimate for rowing studies was 12 months. The mean 12-month prevalence of LBP for rowers was 48% (range 32% - 95%). When only high-quality studies were pooled, the 12-month prevalence was **61%** (95% CI: 42-78%, I2 95%). Data are summarised in Table 2 (online supplementary material).

Summary statements from the Delphi process are in Table 3

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| Summary statements & recommendations: Epidemiology of low back pain in athletes with a rowing subgroup analysis |
| Prevalence varies widely among studies as a result of different methodologies and definitions of LBP. More research is needed, using gold standard prospective data collection, to estimate more precisely the prevalence of LBP in athletes. |
| Exercise caution when comparing results of studies with different definitions of LBP. A standardised definition of athlete LBP is needed.  |
| Risk factors for LBP in athletes are: history of LBP; rapid increase in training or competition load; higher volume and intensity of training/competition; Increased years of exposure to the sport (career length) |
| Rowing-specific risk factors are: all of above + ergometer training greater than 30 minutes/session. |
| Radiological abnormalities should be considered in relation to symptom presentation and not in isolation. The significance of radiological abnormalities in the absence of symptoms is unclear. |
| Pre-season screening does not predict within season onset of LBP in athletes. |
| Technical issues/biomechanics are likely to be a risk factor for LBP in some sports, but there is insufficient evidence to identify those and more research is needed to confirm this. |

Table 3: Summary statements and recommendations from epidemiology of LBP in athletes review.

**Definition of rowing-related low back pain**

Fourteen experts (FW, KW, JT, KA, CG, JH, LT, AV, SJM, JPC, AMcG, MW, JAH, JS) rated nine initial statements proposed by the experts from standard, widely used LBP definitions and from those contained in the athlete LBP epidemiology studies. A decision was made following a four-round Delphi process. The consensus definition is described in **Box 1** in the following Results section 2 (The Guideline):

**Relationship between biomechanics and rowing-related low back pain**

A systematic review examined the relationship between rowing-related LBP and rowing biomechanics.7 The following question regarding rowing-related LBP was raised:

*“What are the spine, pelvis and hip biomechanics of rowing and how do they influence the risk of low back pain in rowers?”*

Thirteen studies investigated spinal kinematics during rowing and nine studies investigated muscle activity. One study compared the ergometer to rowing in a boat and all other studies were conducted on an ergometer. Rowing activity resulted in an increased sagittal flexion range in the lumbar spine over time (spinal creep), which increased as rowers fatigued.

Studies that specifically examined LBP reported conflicting results regarding the influence of LBP on kinematics; some demonstrated that rowers with LBP history move more through their lumbar spine than their hips and other studies found no difference between groups.

Muscle activity during rowing is dominated by the extensor group of the trunk with trunk flexor activity focused on the transition from the drive to recovery phase. One study compared fixed and dynamic ergometers and found no difference in trunk muscle activity. One recently published cross sectional, injury surveillance study (not included in the biomechanics review) reported a reduction in LBP prevalence when fixed ergometers were replaced by dynamic ergometers but no biomechanical factors were explored.24 No studies examined trunk muscle function in a boat. Fatigue altered muscle recruitment. Rowers with LBP history had less efficient erector spinae recruitment compared to those without a history of LBP.

Summary statements from the Delphi process are in Table 4.

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| Summary statements & recommendations: Relationship of biomechanics to rowing-related LBP |
| There is insufficient evidence to recommend one ergometer type (fixed vs dynamic) over the other to avoid LBP |
| Rowing requires a relatively vertical pelvic position at the catch. If limitations in hip flexion do not allow for this and increased lumbar flexion results, this may increase the risk of LBP |
| Trunk asymmetries do not appear to be associated with LBP |
| The muscle activity of the trunk is dominated by the extensor group when rowing and the flexor group is relatively silent. The trunk flexors (abdominals) act as a braking force (eccentrically) at the end of the drive and at the change in direction of the trunk to the recovery. |
| There is insufficient evidence to confidently define what trunk and hip biomechanics increase risk of LBP in rowers. Future studies should evaluate rower biomechanics as part of a longitudinal LBP risk assessment programme |

Table 4: Summary statements and recommendations from relationship of biomechanics to rowing-related LBP

**Managing low back pain in athletes**

A systematic review examined the management strategies for LBP in athletes and aimed to examine rowing specifically (where possible).8 The following question was raised:

 “*What is the evidence for commonly used treatments for managing LBP in athletes?*”

Thirteen randomised controlled trials with 505 participants examined exercise, biomechanical and activity modifications, and manual therapy. These were included in the review. Studies examining surgery and injection therapies were observational in design and were not included. There was a reduction in pain and disability after any treatment. Exercise was the most frequently investigated treatment, although no return to sport (RTS) data were reported for any exercise intervention. Different treatments for LBP in athletes improved pain, function, and RTS, but it was unclear what the most effective treatments were. All exercise approaches reduced pain and improved function in athletes with LBP. There was insufficient evidence to support activity or biomechanical modifications or manual therapy as stand-alone therapies. No studies that specifically examined management strategies in rowers were found.

Summary statements and recommendations from the Delphi process are shown in Table 5.

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| Summary statements & recommendations: Managing low back pain in athletes |
| Until robust evidence is produced for athlete populations, recommendations for LBP management in non-athletic populations should be used to guide management of LBP in athletes, considering the sport-specific circumstances surrounding the athlete while adopting a biopsychosocial approach. |
| Employ shared decision-making regarding individual treatment goals – consider the athlete's goals, expectations regarding pain, disability, quality of life and return to sport |
| EXERCISE |
| Exercise interventions improve pain and function in athletes with LBP. |
| The effect of exercise interventions on return to sport rates is unknown. |
| Targeted, dynamic (isotonic rather than isometric), functional (sport-specific) exercise appears to be the most beneficial for athletes with LBP, but there is insufficient evidence to recommend one exercise protocol over another. |
| BIOMECHANICAL OR ACTIVITY MODIFICATIONS |
| Biomechanical and activity modifications may result in a reduction of LBP, but there is insufficient evidence to recommend them as stand-alone treatments. |
| MASSAGE AND MANUAL THERAPY |
| Massage and manual therapy may improve pain and function in athletes with LBP, but there is insufficient evidence to recommend them as stand-alone treatments. |

Table 5: Summary statements and recommendations from managing LBP in athletes.

**Qualitative study: rowers’ lived experience of rowing-related low back pain**

Semi-structured interviews were conducted with 25 rowers in Ireland and Australia.9 Rowers revealed a culture of openness or concealment that influenced their experience. Rowers’ relationships with coaches and peers framed their overall experience, their willingness to reveal their pain, how early they revealed their pain, and the support that they received. The summary recommendations from the Delphi process are shown in Table 6.

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| Summary recommendations: Rowers’ lived experience of rowing-related low back pain |
| Rowers should be taught about the nature, presentation, and various factors that contribute to LBP. |
| Rowers should be encouraged to disclose their LBP at an early stage and be informed about the potential negative impacts of concealing their LBP. |
| Rapid referral pathways to best evidence-based management should be created where possible, so that rowers can access care for LBP. |
| Rowers should be supported by their coaches, management, and teammates when disclosing LBP. |
| Rowers feel socially isolated during LBP rehabilitation and supports should be put in place where possible, including peer support (teammates). |
| There should be a clinical alliance among medical staff to ensure that LBP management strategies and information given to rowers is consistent. |
| Education regarding best practices should be available to clinicians treating rowing-related LBP.  |
| Medical teams should adopt shared decision-making strategies with the rowers they are treating. |
| Communication among rowers, coaches and medical staff is important to ensure a uniform narrative with clear and consistent messages around rowing-related LBP. |

Table 6: Summary recommendations from the qualitative study of rowing-related LBP

**Clinician survey**

National rowing federation clinicians participated in an internet-based survey answering open ended questions about the initial triage, acute, sub-acute and rehabilitation phases of the assessment and management of an acute episode of rowing-related LBP. Expert clinicians from around the world then rated and re-rated statements derived from this survey. Further information regarding the study methodology can be accessed in the accompanying paper.10 All statements that reached consensus are summarised in Appendix 1 and form the basis of a management consensus (see below ‘The Management Guideline’). The findings of this study are a representation of current clinical expertise.

**RESULTS**

**SECTION TWO:**

**THE MANAGEMENT GUIDELINE**

This guideline has been created by synthesising information from the preceding sections with the focus of clinical practice (the assessment and management) from the survey of experienced and expert clinicians.

***What is rowing-related low back pain and how prevalent is it?***

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| ***Low back pain (LBP)*** *is a symptom that can result from several different known or unknown abnormalities or diseases. It is defined by the location of pain, typically between the lower rib margins and the buttock creases. In some cases, it may be accompanied by pain in one or both legs and some people with LBP have associated neurological symptoms in the lower limbs.* ***Rowing-related LBP*** *is pain that affects a rowing athlete, that is because of or exacerbated by rowing or rowing-related training, resulting in a need to modify or stop scheduled activities.*  |

Box 1: Definition of rowing-related LBP

An average of 61% of adult rowers will have experienced an episode of LBP in a 12-month period.6 This compares with a 12-month prevalence of 51% in athletes overall6 and 37% in the general population.1

***What causes rowing-related low back pain, and can it be prevented?***

Risk and other factors contributing to rowing-related LBP are listed in Table 7 (online supplementary material). Factors identified in high quality rowing-specific studies highlight a history of LBP, rapid increases in training/competition load and ergometer training, particularly sessions lasting longer than 30 minutes.

***How should rowing-related low back pain be managed?***

**General recommendations common to each phase**

Understanding the multidimensional nature of LBP is important. Physical and non-physical factors contribute to both the onset and persistence of pain. A culture of early recognition and management of LBP should be adopted in the training environment. Most episodes of rowing-related LBP are unlikely to be serious and will likely be self-limiting. Rowers often report a feeling of isolation when in LBP rehabilitation. Coaches and support teams should create an environment where rowers are educated about the nature and presentation of LBP and supported and encouraged to disclose their LBP early to improve outcomes. Clinicians should have a consistent message with a clinical alliance among each other and a therapeutic alliance with the rower. Provide education and reassurance on a continual basis as needed; it is important to include the rower in decision-making from initial triage to return to on-water training.

Psychological stressors such as poor sleep, performance pressure, fear avoidance behaviour, and life stressors signal consideration for psychological support. However, this is on an individual needs basis and is not always necessary. Other levels of appropriate support may be provided by coaching staff, medical staff, family, and friends. Encourage the rower to seek mental health support if there is a specific identified need. It is important to manage coaches’ and athletes’ expectations. In the elite environment, it is important to involve the coach from the outset (if the athlete consents) and allow the coach to provide their ideas about contributing factors to LBP. An athlete-centred approach should be adopted at all stages. Yellow flags should be reviewed to avoid fear avoidance behaviour and catastrophising. It is important for the rower to avoid developing a fear of specific movement patterns.

The following are assessment and management general principles from initial presentation to RTS. Recommendations for each phase with specific details are presented in Table 8 (online supplementary material).

At the time of initial presentation and during the acute phase of recovery, priorities include: i) Comprehensive assessment for early identification of red and yellow flags

ii) Effective pain control for activities of everyday life

iii) Keeping the rower active with cross training

iv) Regaining rower-specific movement patterns

v) Empowerment and education of the rower and coach.

During the sub-acute phase and through rehabilitation to full RTS, priorities include:

i) Progressive increase on-water training volume and intensity with concomitant reduction in cross-training

ii) Multidisciplinary involvement in the RTS plan

iii) Ensuring modifiable risk factors for rowing related LBP are addressed

Progression criteria to allow a rower to move from one phase to the next are shown in Figure 1.

 *Figure 1 here*

 **Outcome measures and adjunct clinical assessment tools**

*Clinically based outcome measures*

Useful outcome measures for assessment at triage and through progression by experienced clinicians are: Visual Analogue Scale (VAS); Patient Specific Functional Scale (PSFS); Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ); and simple, functionally-orientated questions, such as the influence of pain on ability to row.

*Biomechanics*

The clinical tools that are considered useful for monitoring rowing-appropriate biomechanics in this population are:electromagnetic motion measuring devices (e.g., Flock of Birds system)*;* two or three-dimensional motion analysis systems (e.g., video recording or 3-D motion capture system)*;* ROM devices (e.g., goniometer or inclinometer)*;* force measurement devices (e.g., load cell attached to the rowing ergometer handle or in the foot plate)*;* electromyography (EMG)*;* isokinetic or isometric tests (e.g., isokinetic dynamometer). The relationship of biomechanics to prevention and treatment of rowing-related LBP is unknown.

*Imaging*

There is no evidence to support routine imaging of the low back in rowers. Anatomical MRI changes are common in the lumbar spine of symptomatic25 and asymptomatic26 rowers. Just as in the general population the interpretation of MRI findings in a rower should be considered in the context of the clinical presentation. We recommend that imaging be limited to the investigation of trauma or significant neurology, or where the imaging findings would influence the rower’s management plan.

*Surgery*

Surgery may be indicated if there are progressive or distinct neurological signs and symptoms, and a clear surgical target. It is unclear whether return to rowing rates are different after surgical management versus after non-surgical management and we could not identify any randomised controlled trials. Thus, our findings support recent non-systematic reviews on athlete LBP. Reviews focused on surgical outcomes report that surgery is more effective than non-surgical treatment at reducing pain in the short- and medium-term, but these effects do not persist.

*Pharmacology*

There were no specific recommendations made for managing rowing-related LBP in any studies. Guidelines for pharmacological management of LBP in the general population and for athletes27 should be followed according to the World Anti-Doping Agency rules.

**Plain language version**

The plain language version of this document is included in the online supplement along with the plain language version of Table 8 (labelled as plain language Table 1A) and progression flow char (labelled as plain language Fig 1A).

**DISCUSSION**

In our original meeting at British Rowing HQ in February 2018, we raised a number of questions regarding rowing-related LBP. We wanted to explore the prevalence of rowing-related LBP and how this compared to other sports and LBP in the general population. While the quality and heterogeneity of published studies examining back pain in sports prevents us from making confident comparisons, our review indicates that rowers may be at considerable risk of experiencing LBP. The risk for LBP in rowers may be higher than the risk in the general population, and rowing appears to be a sport with a higher prevalence than many other sports.

We explored the management of rowing-related LBP through a review of published research and by consulting experts. In general, there was an absence of good quality research examining interventions for LBP in athletes, and we could not find any specifically tailored to rowers. We synthesised available information from our review with recommendations from clinicians (gathered through a survey) to create a consensus statement which informed a management guideline. Some of these principles are supported by recommendations for managing LBP in the general population but are expanded with advice customised to the rowing context, particularly in progression through phases to allow RTS. We sought the opinion and feedback from rowers and coaches and used this feedback to create a plain language version that was meaningful to them.

We investigated if rowing-related LBP could be prevented. We were able to identify risk and other factors associated with an episode of rowing-related LBP but there was no research investigating effectiveness of interventions aimed to prevent LBP in rowers. This suggests that modifying exposures to risk factors where possible may currently be the best approach to preventing LBP in rowers.

The purpose of this project was to educate clinicians, rowers, and support staff on risk of developing rowing related LBP, and to develop a consensus statement which informed a practical management guideline for managing rowers. Synthesis of evidence from different sources allowed us to create a care pathway that was identified as user-friendly by rowers and coaches. It has highlighted the inadequate evidence on athlete LBP, and we call for more quality research in this area. The complexities of LBP were not addressed in athletes; no research has adequately explored the biopsychosocial interactions in rowing-related LBP.

A limitation of the consensus statement methods was that the Delphi process within each domain was completed by the authors of each review or study. Authors were blinded to responses where possible but there is a risk that this may have introduced some bias.

**Research priorities**

Prospective studies across diverse rowing populations (age groups, boat/rowing types, and ability levels including Para rowers) are required to establish incidence of and risk factors for rowing-related LBP. A standard definition of rowing-related LBP should be used in such research which we have introduced in this guideline. This definition should be used and refined as needed. High-quality randomised controlled trials are urgently needed to determine the effectiveness of individual interventions and management strategies (particularly surgery) from initial acute cate to a full return to training and competition. A care pathway should be created for Junior, Para and Masters rowers.

**CONCLUSIONS**

We present a consensus statement for best practice in rowing-related LBP. Our recommendations are based on research evidence or on consensus and align with recommendations from international guidelines for managing of LBP in the general population. Research efforts in relation to all aspects of managing rowing- and athlete-related LBP should be intensified. Combining information from the sections of the consensus statement, clinicians, athletes, coaches, and other stakeholders will help guide decisions regarding prevention and management of rowers with LBP. Integrating clinical expertise, research evidence, and athlete preferences is important for the overall management of athlete LBP. Future research should focus on a standardised approach to defining, assessing, and managing LBP in rowers. Research should be conducted to encompass the biopsychosocial influences on LBP.

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**Patient and public involvement**

Patients and public (athletes, coaches and the wider rowing community) were involved in the design, conduct, reporting, and dissemination plans of our research.

**Competing interests** None to report

**Contributions**

All authors have made substantial contributions to: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version submitted.

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REFERENCES

1. Hartvigsen J, Hancock MJ, Kongsted A, et al. What low back pain is and why we need to pay attention. *The Lancet* 2018;391(10137):2356-67.

2. Kongsted A, Kent P, Axen I, et al. What have we learned from ten years of trajectory research in low back pain? *BMC Musculoskeletal Disorders* 2016;17(1):220.

3. Wilson F, Gissane C, McGregor A. Ergometer training volume and previous injury predict back pain in rowing; strategies for injury prevention and rehabilitation. *British Journal of Sports Medicine* 2014;48(21):1534-7.

4. Mäestu J, Jürimäe J, Jürimäe T. Monitoring of performance and training in rowing. *Sports Medicine* 2005;35(7):597-617.

5. Brouwers MC, Kerkvliet K, Spithoff K, et al. The AGREE Reporting Checklist: a tool to improve reporting of clinical practice guidelines. *British Medical Journal* 2016;352:i1152.

6. Wilson F, Ardern CL, Hartvigsen J, et al. Prevalence and risk factors for back pain in sports: a systematic review with meta-analysis. *British Journal of Sports Medicine* 2020

7. Nugent F, Vinther A, McGregor A, et al. The relationship between rowing related low back pain and rowing biomechanics. A systematic review. *British Journal of Sports Medicine* 2020;In review

8. Thornton J, Caneiro J, Hartvigsen J, et al. Treating low back pain in athletes. A systematic review with meta-analysis. *British Journal of Sports Medicine* 2020;In review

9. Wilson F, Ng L, O'Sullivan K, et al. 'You’re the best liar in the world’: a grounded theory study of rowing athletes’ experience of low back pain. *British Journal of Sports Medicine* 2020

10. Wilkie K, Thornton J, Vinther A, et al. Clinical management of acute low back pain in elite and sub-elite rowers. A Delphi survey of experienced and expert clinicians. *British Journal of Sports Medicine* 2020;In review

11. Wilson F. Back pain in rowing - update on current understanding: Worldrowing; 2016 [cited 2016. Available from: [www.worldrowing.com/news/back-pain-rowing-update-current-understanding](file:///C%3A%5CUsers%5Camcgrego%5CAppData%5CLocal%5CMicrosoft%5CWindows%5CINetCache%5CContent.Outlook%5CCJHBL5RP%5Cwww.worldrowing.com%5Cnews%5Cback-pain-rowing-update-current-understanding).

12. Chandler J, Churchill R, Higgins J, et al. Methodological Expectations of Cochrane Intervention Reviews (MECIR) Standards for the reporting of Plain language summaries in new Cochrane Intervention Reviews. Booklet Version 1, 2013.

13. Bahr R, Andersen SO, Loken S, et al. Low back pain among endurance athletes with and without specific back loading--a cross-sectional survey of cross-country skiers, rowers, orienteerers, and nonathletic controls. *Spine* 2004;29(4):449-54.

14. Fett D, Trompeter K, Platen P. Back pain in elite sports: A cross-sectional study on 1114 athletes. *PLoS ONE* 2017;12(6) doi: 10.1371/journal.pone.0180130

15. Maselli F, Ciuro A, Mastrosimone R, et al. Low back pain among Italian rowers: A cross-sectional survey. *Journal of Back and Musculoskeletal Rehabilitation* 2015;28(2):365-76. doi: 10.3233/bmr-140529

16. Newlands C, Reid D, Parmar P. The prevalence, incidence and severity of low back pain among international-level rowers. *British Journal of Sports Medicine* 2015;49(14):951-56. doi: 10.1136/bjsports-2014-093889

17. Trompeter K, Fett D, Platen P. Prevalence of Back Pain in Sports: A Systematic Review of the Literature. *Sports Medicine* 2017;47(6):1183-207. doi: 10.1007/s40279-016-0645-3

18. Wilson F, Gissane C, Gormley J, et al. A 12-month prospective cohort study of injury in international rowers. *British Journal of Sports Medicine* 2010;44(3):207-14. doi: 10.1136/bjsm.2008.048561

19. Clay H, Mansell J, Tierney R. ASSOCIATION BETWEEN ROWING INJURIES AND THE FUNCTIONAL MOVEMENT SCREEN (TM) IN FEMALE COLLEGIATE DIVISION I ROWERS. *International Journal of Sports Physical Therapy* 2016;11(3):345-49.

20. Gonzalez SL, Diaz AM, Plummer HA, et al. Musculoskeletal screening to identify female collegiate rowers at risk for low back pain. *Journal of Athletic Training* 2018;53(12):1173-80. doi: 10.4085/1062-6050-50-17

21. Hickey GJ, Fricker PA, McDonald WA. Injuries to elite rowers over a 10-yr period. *Medicine & Science in Sports & Exercise* 1997;29(12):1567-72.

22. Schulz SS, Lenz K, Buettner-Janz K. Severe back pain in elite athletes: a cross-sectional study on 929 top athletes of Germany. *European Spine Journal* 2016;25(4):1204-10. doi: 10.1007/s00586-015-4210-9

23. Smoljanovic T, Bohacek I, Hannafin J, et al. Sport injuries in international masters rowers: a cross-sectional study. *Croatian Medical Journal* 2018;59(5):258-66. doi: 10.3325/cmj.2018.59.258

24. Trease L, Wilkie K, Lovell G, et al. Epidemiology of injury and illness in 153 Australian international-level rowers over eight international seasons. *British journal of sports medicine* 2020

25. Hosea T, Hannafin J, Bran J, et al. Aetiology of low back pain in young athletes: role of sport type. *British Journal of Sports Medicine* 2011;45(4):352-52.

26. Maurer M, Soder RB, Baldisserotto M. Spine abnormalities depicted by magnetic resonance imaging in adolescent rowers. *The American journal of sports medicine* 2011;39(2):392-97.

27. Hainline B, Turner JA, Caneiro J, et al. Pain in elite athletes—neurophysiological, biomechanical and psychosocial considerations: a narrative review. *British Journal of Sports Medicine* 2017;51(17):1259-64.