

Prevention and Training Rehabilitation Measures for Lower Back Injuries in Adolescent Rowers

Haoxuan Ye *

Montverde Academy Shanghai, Shanghai, China

* Corresponding author Email: marcus090302@gmail.com

Abstract: This paper investigates the current status, causes, and preventive rehabilitation measures for lower back injuries in adolescent rowers. Through a survey of 15 athletes from the Shanghai Adolescent Rowing DeYingLe Club and UC Rowing Club, combined with literature analysis, it was found that chronic strain injuries are the main type of lower back injuries in adolescent rowers, with lumbar muscle strain accounting for the highest proportion (66.7%), followed by lumbar disc herniation (20%) and lumbar joint disorder (13.3%). Injuries mostly occur during specialized strength training (53.3%) and aerobic endurance training (33.3%), with the main causes being improper technical movements (40%), chronic strain accumulation (26.7%), and insufficient warm-up (20%). The study also found that nearly half of the athletes tend to risk increasing training intensity in pursuit of performance, and more than half of the athletes have a history of lower back injuries. In response to these issues, this paper proposes preventive and rehabilitation measures including core stability training and sports biomechanics correction, and recommends establishing a scientific training management system and a collaborative rehabilitation management model of 'coach-rehabilitation therapist' to reduce the incidence of lower back injuries in adolescent rowers and ensure the healthy development of their sports careers.

Keywords: Adolescent Rowing; Lower Back Injury; Rehabilitation; Prevention.

1. Preface

Rowing originated in the UK, where one or more rowers sit in a boat, facing away from the direction of movement, using the strength of their lower limbs and core muscles, and simply propelling the boat forward by leveraging the oars and oarlocks. The power in rowing is centered on the explosive force of the legs, driving the torso to lean back, and finally connecting with the arms to pull the oar, forming a bottom-up power chain, emphasizing fast, coherent, and efficient power transmission. With rowing becoming an Olympic event, more and more adolescents are beginning to understand and participate in rowing. As a result, the competition in this event has become increasingly fierce, for example, the Shanghai Adolescent Rowing Championship has been held annually since 2021. However, due to the late start of adolescent rowing in China, many adolescents have irregular and unstable technical movements during rowing training, leading to a high risk of sports injuries, especially in the lower back, knees, and ankles. This not only negatively affects the athletes' performance but may also cause psychological trauma. Therefore, it is important to analyze the lower back injuries in adolescent rowers and explore the root causes behind the athletes' sports injuries. Only by identifying the causes of the problems can we minimize the physical injuries adolescents suffer in rowing.

2. Research Object and Method

2.1. Research Object

The research object of this paper is the current status of lower back injuries in adolescent rowers.

2.2. Research Method

2.2.1. Literature Review Method

By reviewing literature related to the keywords 'lumbar

injury', 'rehabilitation training', 'youth rowing', and 'prevention' on CNKI, we gained insights into the research on lumbar and back injuries caused by youth rowing and the conclusions drawn. Some of these research findings were used as references for this paper, laying the foundation for subsequent writing. [1-4]

2.2.2. Mathematical Statistics Method

A detailed investigation was conducted on the Shanghai Youth Rowing De Ying Le Club and the UC Rowing Club. Fifteen youth rowers were selected to investigate the types of sports injuries, the extent and impact of lumbar injuries, and the results were statistically analyzed. Used to present the current status of lumbar injuries in youth rowing, serving as the data foundation for sports injury analysis.

3. Research Results and Cause Analysis

3.1. Literature Reference on the Current Status of Injuries and Lumbar Injury Analysis in Youth Rowers.

3.1.1. Types of Sports Injuries

Common injuries among youth rowers include muscle strains (100%), muscle fatigue (85%), and joint sprains (55%). [5] Specific classifications are as follows:

Acute injuries: such as acute lumbar sprains and wrist ligament sprains.

Chronic injuries: such as lumbar muscle fatigue, lumbar disc herniation, and patellar chondritis. [4]

Special injuries: fatigue fractures of the lower ribs (caused by excessive load or technical deformation during ergometer training). [8]

3.1.2. Impact of Lumbar Injuries

Training and competition: 70% of athletes were banned from competition due to lumbar injuries, and 80% had to

suspend training. [5]

Long-term consequences: Chronic lower back pain may lead to degenerative lumbar diseases, even prematurely ending sports careers. [6]

3.1.3. Types of Lumbar Injuries

Lumbar muscle fatigue (most common): caused by repetitive rowing motions leading to excessive load on the core muscles. [10]

Lumbar disc herniation: the spine undergoes repeated flexion and extension stresses during rowing, exceeding the physiological range of motion. [7]

-Lumbar joint disorder: compensatory excessive lumbar activity when pelvic rotation is insufficient. [6]

3.1.4. Mechanism of Lumbar Injury Occurrence

Biomechanical factors

Lumbar-pelvic coordination imbalance: Ideal technique requires pelvis-driven rotation (hip joint movement), but adolescent athletes often compensate with lumbar flexion and extension, increasing pressure on the L4/L5 intervertebral disc. [7]

Risk of ergometer training: During land-based ergometer training, the lumbar flexion angle increases by 11.3% compared to on-water training, making it more prone to strain. [6]

Training Factors

Excessive load: The incidence of low back pain is highest (39%) during the winter heavy training period due to frequent use of ergometers. [6]

Technical errors: Novice athletes rely more on lumbar flexion and extension rather than pelvic rotation, leading to muscle strength imbalance. [4]

Decline in muscle function

Asymmetry of core muscles: Asymmetric force exertion in the abdominal and thigh muscles (e.g., fatigue difference between left and right erector spinae) is a significant cause of low back pain. [7]

Insufficient flexibility: Tight hip flexors and hamstrings limit pelvic rotation, forcing lumbar compensation. [8]

3.1.5. Lack of Personal Training Experience

Frequent lumbar injuries among adolescent rowers are largely due to their lack of understanding and knowledge of rowing. Inexperienced athletes often cannot accurately judge their training load capacity, leading to excessive increases in training volume (weekly increase > 10%) or insufficient recovery. Such load management errors hinder the adaptive repair of lumbar muscles and connective tissues. Secondly, adolescent athletes lacking professional guidance are prone to developing incorrect technical movement patterns, such as over-reliance on lumbar rotation for power during rowing rather than hip drive, or failure to maintain a neutral spine during the recovery phase. These incorrect movements can subject the lumbar spine to abnormal shear forces, with studies showing that such biomechanical compensation can exceed the safe threshold of 500N at the L4-L5 segment. [3] Additionally, some adolescent athletes lack experience in sports injury treatment and rehabilitation. After sustaining a lumbar injury, they may feel recovered and return to competition or training prematurely without heeding the advice of coaches and doctors, leading to recurrent injuries that eventually become chronic. Thus, lack of personal training experience is a significant factor in lumbar injuries among adolescent rowers. Some athletes, inexperienced in rowing training and not heeding the advice of doctors,

coaches, and other athletes, fail to truly value the injuries caused by sports, thereby exacerbating the impact of injuries and prolonging recovery and treatment time.

3.1.6. Weak Protective Awareness

The occurrence of sports injuries among adolescent rowers is due to weak protective awareness among rowing clubs, coaching staff, and the athletes themselves. It is precisely due to the weak protective awareness of the aforementioned parties and their underestimation of sports injuries that the severity and frequency of sports injuries are increased. Especially as competitions approach, athletes may adopt incorrect training methods due to insufficient training time in pursuit of certain training effects and results. From the club's perspective, many teenagers in rowing clubs significantly increase training intensity and duration in pursuit of better rankings and honors in the short term. However, increasing training intensity in the short term can exceed the normal load-bearing capacity of an athlete's waist during regular training, thereby greatly increasing the probability of waist injuries. When the training volume of pre-adolescent athletes increases by more than 7-8%, the risk of bone stress injuries increases by 3-5 times. [1] From the coaching staff's perspective, the coaching staff and the club share the same attitude, both hoping to cultivate athletes to achieve results in the short term. Additionally, some coaches have biases against athletes with less than ideal performance, which also increases training intensity and thus the risk of injury. From the perspective of teenage rowing athletes, due to insufficient knowledge and understanding of rowing, as well as short participation time, they lack self-protection awareness during training and competitions.

3.1.7. Irregular Training Procedures

When teenage rowing athletes suffer waist injuries, the coaching staff also has the obligation to take responsibility for this. Coaches often hope that teenage athletes can achieve excellent results in the short term, thus blindly increasing training intensity, which leads to insufficient time for adequate training, stretching, massage, and other measures. As a result, the power-generating parts of the teenager's body (waist, back, knee joints, ankles, hips, shoulders) are in a state of muscle fatigue for a long time, greatly increasing the probability of sports injuries. At the same time, some coaching staff lack professional training literacy. Even if they have never been involved in rowing, due to a lack of prevention and insufficient attention to sports injuries, they fail to set scientific training rules, leading to waist injuries in athletes. When athletes suffer sports injuries, some coaches lack professional sports medical knowledge, which can easily lead to serious misjudgments of the severity of certain injuries. Moreover, some coaches set specialized training that does not match the athletes' own conditions when conducting specialized training. For example, in rowing strength training, coaches pay more attention to hip strength training, thus neglecting core stability and waist, back, and leg training, leading to sports injuries caused by improper force during competitions, and in severe cases, even sports disabilities. Athletes who fail the core endurance test (side bridge < 90 seconds) have a 4.7 times higher risk of waist injuries during the season. [2] It can be seen that irregular training procedures can cause serious harm to teenage rowing athletes. The coaching staff's training arrangements, cycles, and intensity are all unreasonable and unscientific. What's more, due to the lack of relevant medical knowledge, coaches fail to form a correct understanding of waist and back injuries, leading to

secondary injuries in athletes and causing more serious impacts.

3.1.8. Waist Rehabilitation Training Measures

(1) Core Stability Training (Key Rehabilitation Method)

Goal: Enhance lumbar-pelvic stability, reduce excessive spinal flexion and extension, and improve the mechanical load in rowing techniques.

Specific Methods:

Five-Point Support Method (Suitable for Initial Rehabilitation)

Action: Lie on your back with knees bent, lift your hips using your head, elbows, and feet as support points until your body forms a straight line, hold for 5-10 seconds, repeat 10-15 times.

Effect: Activates deep lumbar muscles (multifidus, transversus abdominis), reduces pressure on lumbar intervertebral discs. [9]

Flying Swallow Pose (Advanced Training)

Action: Lie prone, extend arms backward, lift head, chest, and legs simultaneously, only abdomen touches the ground, hold for 5 seconds, repeat 8-12 times.

Effect: Strengthens erector spinae and gluteus maximus, improves lumbar extension control.

Precautions: Avoid during acute low back pain, perform within pain-free range. [4]

Suspension Training (S-E-T)

Method: Use suspension straps for unstable training (e.g., plank variations, side bridge), focus on activating core small muscles.

Effect: Improves lumbar dynamic stability, reduces compensatory movements during rowing. [9]

(2) Traditional Chinese Medicine Therapy (Pain Relief and Recovery Promotion)

Applicable Stage: Acute pain relief or chronic strain rehabilitation.

Specific Methods:

Acupuncture Treatment

Acupoints: Yaoyangguan, Shenshu, Weizhong (promotes local blood circulation, relieves muscle spasms).

Course: 3 times a week for 2-4 consecutive weeks. [8]

Heat Therapy and Cupping

Method: Infrared irradiation or herbal hot compress (e.g., moxibustion) on the lower back for 20 minutes, combined with cupping (moving cupping to release fascial adhesions).

Evidence: Indicates that heat therapy can reduce muscle tension and improve chronic low back pain. [6]

Manual Reduction

Applicable Situation: Acute low back pain caused by lumbar facet joint disorder.

Operation: Performed by a professional therapist using joint mobilization or chiropractic techniques (avoid self-operation).

(3) Sports Biomechanics Correction (Preventing Recurrence)

Key Point: Reduce excessive lumbar flexion during rowing (common technical error).

Training Methods:

Pelvic Control Training

Action: Sit on a Swiss ball and simulate a rowing motion, emphasizing pelvic tilt (rather than lumbar flexion and extension).

Effect: Cultivate a 'hip-dominant force generation' pattern to reduce lumbar load. [6]

Ergometer Technique Adjustment

Correction Plan:

Shorten the duration of each ergometer training session (≤ 30 minutes);

Increase the height of the seat cushion to reduce the angle of lumbar flexion. [4]

3.2. Questionnaire Survey Results and Analysis

3.2.1. Statistics on the Frequency of Rowing Training per Week for Young Rowers

According to the statistics from Wenjuanxing, among 15 young rowers, 66.67% (i.e., 10 athletes) train 1-2 times per week. This may indicate that these athletes have adopted a more conservative training strategy to avoid overtraining and potential injury risks. This training frequency may help athletes maintain physical fitness while allowing sufficient recovery time, thereby reducing the likelihood of injury. Secondly, 33.33% (i.e., 5 athletes) train 3 or more times per week. This group of athletes may face a higher risk of injury due to greater training intensity and physical stress. High-frequency trainers may require more recovery time and appropriate nutritional supplementation to reduce injury risks.

Table 1. Statistics on the Frequency of Rowing Training per Week for Young Rowers (Graph)

Options:	Total	Proportion
0 times	0	0%
1-2 times	10	66.67%
3 times or more	5	33.33%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.2. Statistics on the Duration of Each Rowing Training Session for Young Rowers

According to the statistics from Wenjuanxing, among 15 young rowers, 73.33% (i.e., 11 athletes) train for 2 hours per session, which is the most common duration. Additionally, 13.33% (i.e., 2 athletes) train for 1 hour per session, which may reflect lower training intensity. Similarly, 13.33% (i.e., 2 athletes) train for more than 2 hours per session, which may indicate that these athletes are undergoing higher intensity or more specialized training.

Table 2. Statistics on the Duration of Each Rowing Training Session for Young Rowers (Graph)

Options:	Total	Proportion
1 hour	2	13.33%
2 hours	11	73.33%
2 hours and above	2	13.33%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.3. Statistics on the Causes of Back and Lumbar Injuries in Young Rowers

According to the statistics from Wenjuanxing, among 15 young rowers, incorrect technique is the primary cause of injury, accounting for 40% (i.e., 6 athletes). This highlights the importance of ensuring that athletes master correct techniques during training to prevent injuries. Secondly, the accumulation of chronic strain is also an important factor, with (26.67%, i.e., 4) athletes. This emphasizes the importance of adequate rest and recovery during training to avoid injuries caused by long-term repetitive movements. Insufficient warm-up was reported by (20%, i.e., 3) athletes. This indicates that a thorough warm-up is equally important for preventing sports injuries, as insufficient preparation may

increase the risk of injury. Insufficient basic physical fitness and training or competing while injured were each reported by (6.67%, i.e., 1) athletes. This suggests the need to strengthen basic physical training and avoid continuing to train or compete while injured. No athletes reported errors in training plan arrangements or coaching guidance, which may indicate that these factors were not major issues in this survey, or that the existing training plans and coaching guidance were relatively reasonable.

Table 3. Statistics on the Causes of Back and Lumbar Injuries in Young Rowers (Graph)

Options:	Total	Proportion
Insufficient preparation activities	3	20%
Technical action error	6	40%
Insufficient basic physical quality	1	6.67%
Training plan arrangement	0	0%
Training or competition with injury	1	6.67%
Coach's guidance error	0	0%
Chronic strain accumulation	4	26.67%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.4. Statistics on the Stages of Lumbar Injuries in Young Rowers

According to the statistical results from the questionnaire, among the 15 young rowers, the period of specialized strength training (including exercises such as bench pulls, bench presses, and squats) was the most injury-prone phase, with (53.33%, i.e., 8) athletes. The proportion of injuries during aerobic endurance training was the next highest, with (33.33%, i.e., 5) athletes. In contrast, the incidence of lumbar injuries during competitions and general technical training was lower, with (6.67%, i.e., 1) athlete each. No injury reports were found during short-distance fast rowing (such as starts and high-stroke-rate sprints) or other situations. This distribution pattern may be related to the load characteristics of different training phases: specialized strength training involves heavy loads and complex movements, which can easily exert significant pressure on the lumbar region; the prolonged repetitive movements of aerobic endurance training may also lead to cumulative injuries. Although the intensity of competitions and technical training is high, the duration is shorter or the movements are closer to natural force patterns, resulting in relatively lower injury risks. These data suggest that in young rowers' training, special attention should be paid to lumbar protection measures during strength training and aerobic endurance training.

Table 4. Statistics on the stages of lumbar injuries in young rowers (Graph)

Options:	Total	Proportion
During the competition	1	6.67%
During special strength training [lying pull, bench press, squat]	8	53.33%
During aerobic endurance training	5	33.33%
During the training of general technical movements	1	6.67%
During short-distance fast rowing [set sail, end sprint with high paddle frequency]	0	0%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.5. Statistics on the Impact of Lumbar Injuries on Young Rowers

According to the statistical results from the questionnaire, among the 15 young rowers, (73.33%, i.e., 11) athletes had to suspend training due to lumbar injuries, reflecting that lumbar injuries significantly disrupted their daily training plans. Another (6.67%, i.e., 1) athlete was prohibited from competing due to severe injuries, while (20%, i.e., 3) athletes reported that the injuries did not significantly affect their training or competitions. Notably, no cases of sports career termination due to lumbar injuries were found in this survey. Combined with the statistical data on the stages of injury occurrence (53.33% during specialized strength training and 33.33% during aerobic endurance training), the analysis found: First, moderate injuries (manifested as training suspension) dominated during strength training, which may be related to the heavy loads the lumbar region bears during strength training; second, the severity of injuries is somewhat correlated with the type of training, as injuries caused by strength training often require longer recovery periods; finally, all injury cases were recoverable, with no irreversible sports career terminations. This phenomenon may be related to the strong physical recovery ability of adolescent athletes.

Table 5. Statistics on the impact of lumbar injuries on young rowers (Graph)

Options:	Total	Proportion
No influence	3	20%
Ban the game	1	6.67%
End a sports career	0	0%
Pause training	11	73.33%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.6. Statistics on the Types of Lumbar Injuries among Adolescent Rowers

According to the statistical results from the questionnaire, among the 15 adolescent rowers, lumbar muscle strain occupies an absolute dominant position, with (66.67%, i.e., 10) athletes, making it the most common type of injury; followed by lumbar disc herniation (20%, i.e., 3) and lumbar joint disorder (13.33%, i.e., 2). Based on the statistics of the previous injury occurrence stage (special strength training accounted for 53.33%) and the impact degree (73.33% needed to suspend training), an in-depth analysis can be found: First, the high incidence of lumbar muscle strain is closely related to the repetitive load in special strength training, especially the overuse of lumbar muscle groups in compound movements such as bench press and squat; Second, although the incidence of lumbar disc herniation is relatively low (20%), as a structural injury, it may bring more serious long-term consequences; Third, there is a significant correlation between the type of injury and the recovery cycle, muscle strain usually requires 2-4 weeks to recover, while structural injuries often require a longer rehabilitation time.

Table 6. Statistics on the types of lumbar injuries among adolescent rowers (Graph)

Options:	Total	Proportion
Lumbar muscle strain [most common]	10	66.67%
Lumbar joint disorder	2	13.33%
Lumbar intervertebral protrusion	3	20%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.7. Statistics on Whether Adolescent Rowers have Previous Records of Lumbar Sports Injuries

According to the statistical results from the questionnaire, among the 15 adolescent rowers, the previous incidence of lumbar sports injuries is at a high level. Specific data shows that among the 15 athletes surveyed, (53.33%, i.e., 8) athletes reported having a clear record of lumbar sports injuries, this proportion exceeds half; while (46.67%, i.e., 7) athletes said they had never experienced lumbar sports injuries.

Table 7. Statistics on whether adolescent rowers have previous records of lumbar sports injuries (Graph)

Options:	Total	Proportion
Yes	8	53.33%
No	7	46.67%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.8. Statistics on Whether Adolescent Rowers Continue to Increase Training Intensity at The Risk of Lumbar Injuries for Better Performance

According to the statistical results from the questionnaire, among the 15 adolescent rowers, (46.67%, i.e., 7) athletes admitted that they would choose to continue to increase training intensity in pursuit of better sports performance, even if they realized that this might increase the risk of lumbar injuries; at the same time, (53.33%, i.e., 8) athletes said they would not take such risks. No other situations requiring special explanation were received in the survey. This survey result reflects several important characteristics: First, in the competitive sports environment, a considerable proportion of adolescent athletes (nearly half) will prioritize performance improvement and choose to bear higher injury risks, this tendency needs special attention in the competitive sports training system. Second, there are obvious differences in the cognition and acceptance of training risks within the athlete group, about half of the athletes show a more cautious attitude. This divergence may stem from personal experience, coaching methods, or different levels of awareness of the consequences of sports injuries.

Table 8. Statistics on whether adolescent rowers continue to increase training intensity at the risk of lumbar injuries for better performance (Graph)

Options:	Total	Proportion
Yes	7	46.67%
No	8	53.33%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.9. Statistics on Whether Adolescent Rowers Actively Listen to The Training and Rehabilitation Advice of Coaches and Doctors After Lumbar Injuries

According to the statistical results from the questionnaire, adolescent rowers show a high degree of consistency in their rehabilitation attitude after lumbar injuries. The data shows that all 15 athletes surveyed (100%) said they would actively follow the training and rehabilitation advice of coaches and doctors, and there were no cases of non-cooperation or special explanation. This result reflects three significant characteristics of this group: First, it shows a complete trust and cooperation attitude towards professional guidance; Second, it reflects good medical compliance and rehabilitation awareness; Third, it indicates that the existing sports injury management system may have established an

effective communication mechanism.

Table 9. Statistics on whether adolescent rowers actively listen to the training and rehabilitation advice of coaches and doctors after lumbar injuries (Graph)

Options:	Total	Proportion
Yes	15	100%
No	0	0%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.10. Statistics on the Number of Previous Lumbar Injuries Among Adolescent Rowers

According to the statistical results from the questionnaire, among the 15 adolescent rowers, (46.67%, i.e., 7) athletes reported that they had experienced 1 to 2 lumbar injuries, while (26.67%, i.e., 4) athletes said they had experienced 0 injuries. In addition, (26.67%, i.e., 4) athletes said they had experienced 3 or more lumbar injuries. These data indicate that more than half of the athletes have experienced at least one lumbar injury, highlighting the prevalence of lumbar injuries in rowing.

Table 10. Statistics on the number of previous lumbar injuries among adolescent rowers (Graph)

Options:	Total	Proportion
0 times	4	26.67%
1-2 times	7	46.67%
3 times or more	4	26.67%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.11. Do Rowing Coaches Provide Incorrect Technical Guidance to Young Rowers?

According to the statistical results from Questionnaire Star, among 15 young rowers, 86.67% (13 athletes) reported that they had not experienced incorrect guidance from coaches. Only 13.33% (2 athletes) reported that they had encountered incorrect technical guidance from coaches. This result suggests that coaches are generally accurate in their technical guidance, and incorrect guidance is relatively rare. This data may indicate that coaches provide relatively correct technical guidance during training, helping athletes avoid injuries caused by technical errors. Although the proportion of incorrect guidance is low, it is still necessary to pay attention to individual cases to ensure that all athletes receive accurate and professional guidance.

Table 11. Statistics on whether rowing coaches provide incorrect technical guidance to young rowers (Graph)

Options:	Total	Proportion
Yes	2	13.33%
No	13	86.67%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.2.12. Duration of Persistent Lumbar Pain in Young Rowers After Sports Injuries

According to the statistical results from Questionnaire Star, among 15 young rowers, 40% (6 athletes) experienced acute lumbar injuries, with pain relieved within 6 weeks; 20% (3 athletes) suffered subacute lumbar injuries, with pain lasting from 6 weeks to 3 months; and 40% (6 athletes) experienced chronic lumbar injuries, with pain lasting more than 3 months. These data indicate that both acute and chronic lumbar

injuries are relatively common among the respondents, each accounting for 40%, while the proportion of subacute lumbar injuries is relatively low, at 20%. These detailed distributions help understand the recovery time of different types of lumbar injuries, providing important references for developing appropriate rehabilitation plans and preventive measures. By identifying injury types and predicting recovery times, coaches and medical professionals can better manage athletes' training loads, optimize training plans, reduce the risk of future injuries, and promote athletes' rapid recovery.

Table 12. Statistics on the duration of persistent lumbar pain in young rowers after sports injuries (Graph)

Options:	Total	Proportion
< 6 weeks [acute waist injury]	6	40%
6 weeks to 3 months [subacute waist injury]	3	20%
> 3 months [chronic waist injury]	6	40%
Other [details]	0	0%
The number of people who fill in this question effectively	15	

3.3. Lumbar Training and Rehabilitation Measures for Young Rowers

3.3.1. Preventive Measures (Innovative Training Methods)

(1). Breathing-core linkage training

Supine paper blowing exercise: Lie supine with knees bent, hold a small piece of paper in hand and perpendicular to the lower lip, blow the paper up through diaphragmatic breathing, hold for 5 seconds (3 sets × 10 times)

Rowing breathing rhythm: Coordinate each stroke with a complete breathing cycle (exhale during the pull, inhale during the recovery)

(2). Unstable plane core strengthening

Foam roller rowing simulation: Sit on a foam roller and complete rowing movements (3 sets × 20 times)

(3). Reverse movement correction training

Inverted rowing machine training: Place the front part of the ergometer at a high position and complete the rowing motion in an unbalanced state before and after the ergometer (3 times a week × 15 minutes)

(4). Tactile cue "technical correction

Waist taping training: Apply sports tape to the lumbar spine, and the tape will produce a pulling sensation when the movement is deformed

3.3.2. Phased Rehabilitation Measures

(1). Acute phase (0-2 weeks)

Ice application: 3-4 times a day, 15 minutes each time (within 48 hours after injury)

Supine abdominal breathing: 20 times × 4 sets/day

Pelvic tilt exercise: Lie on your back with knees bent, gently tighten your abdomen

(2). Recovery phase (2-4 weeks)

Four-point kneeling balance: Alternate lifting hands/feet, hold for 30 seconds

Elastic band rowing: Seated, low-resistance elastic band exercise

(3). Strengthening phase (after 4 weeks)

Single-leg deadlift: No weight, pay attention to waist posture

Water adaptation training: Start with 500 meters of low intensity

3.4. Practice of Waist Training and Rehabilitation Measures for Young Rowers

3.4.1. Preventive Measures (Innovative Training Methods)

(1) Breathing-core linkage training

Supine paper blowing exercise: Lie supine with knees bent, hold a small piece of paper in hand and perpendicular to the lower lip, blow the paper up through diaphragmatic breathing, hold for 5 seconds (3 sets × 10 times)



Figure 1. Holding the piece of paper above the mouth



Figure 2. Blow air into the piece of paper with your mouth

Preparation Posture:

Lie on your back on a yoga mat or flat ground

Bend your knees so that your heels are close to your hips, and place your feet flat on the ground

Place your hands on both sides of your body, palms down

Pick Up the Paper:

Pick up a small piece of paper

Hold the paper in your hand, making it perpendicular to your lower lip

Start Training:

Blow the paper up using diaphragmatic breathing. The key to diaphragmatic breathing is to use the abdominal muscles to control breathing, not the chest



Figure 3. Lean forward, bend the knees, and perform the water-catch motion like in rowing

While blowing up the paper, ensure that the abdominal muscles are tense to keep the paper in the air
 Keep the paper in the air for 5 seconds
 Repetition Count:
 Perform 10 blows and holds per set
 Complete 3 Sets
 Rowing breathing rhythm: Coordinate each stroke with a complete breathing cycle (exhale during the pull, inhale during the recovery)



Figure 4. Lean the body backward and use the strength of the knees to perform the rowing stroke movement for the boat

Preparation Posture:
 Sit on the rowing machine with your feet fixed on the foot pedals
 Hold the handle with both hands, keep your back straight, and tighten your core muscles
Start paddling:
 Exhale while pulling the oar. During the process of pulling the oar, use the abdominal muscles to control exhalation, which helps strengthen the core muscles
 Inhale while returning the oar. During the process of returning the oar, inhale naturally through the nose or mouth, maintaining steady and rhythmic breathing
Breathing cycle:
 Each stroke should be accompanied by a complete breathing cycle. This means exhaling while pulling the oar and inhaling while returning the oar
 Maintain even and rhythmic breathing, avoiding breath-holding or rapid breathing
Repetition Count:
 Set the number of strokes and sets per group based on personal fitness and training goals
 For example, you can set 20 strokes per group and complete 3 groups
 (2) Unstable Plane "Core Strengthening"
 Foam Roller Rowing Simulation: Sit on the foam roller and complete rowing movements on the ergometer (3 sets × 20 times)



Figure 5. Place the foam roller on the seat of the rowing machine



Figure 6. Perform the rowing stroke and continue to maintain the breathing rhythm



Figure 7. Lean forward and perform the complete rowing motion

Preparation Posture:
 Place the foam roller on the seat of the rowing machine
 Sit on the foam roller with your feet secured on the foot pedals
 Hold the handles with both hands, keep your back straight, and tighten your core muscles
Start paddling:
 Perform rowing movements on the foam roller, which increases instability, thereby challenging and strengthening the core muscles
 Exhale while pulling the oar. During the process of pulling the oar, use the abdominal muscles to control exhalation, which helps strengthen the core muscles
 Inhale while returning the oar. During the process of returning the oar, inhale naturally through the nose or mouth, maintaining steady and rhythmic breathing
Breathing cycle:
 Each stroke should be accompanied by a complete breathing cycle. This means exhaling while pulling the oar and inhaling while returning the oar
 Maintain even and rhythmic breathing, avoiding breath-holding or rapid breathing
Repetition Count:
 Perform 20 rowing movements per set
 Complete 3 Sets



Figure 8. Perform the rowing stroke and continue to maintain the breathing rhythm

(3) Reverse movement "corrective training"

Inverted rowing machine training: Place the front part of the ergometer at a high position and complete the rowing motion in an unbalanced state before and after the ergometer (3 times a week × 15 minutes)



Figure 9. Lean forward and perform the complete rowing motion

Preparation Posture:

Place the front part of the rowing machine on a high platform, placing the ergometer in an inverted state

Sit on the rowing machine with your feet secured on the foot pedals

Hold the handles with both hands, keep your back straight, and tighten your core muscles

Start paddling:

Perform rowing movements on the inverted ergometer, which increases instability, thereby challenging and strengthening the core muscles

Exhale while pulling the oar During the process of pulling the oar, use the abdominal muscles to control exhalation, which helps strengthen the core muscles

Inhale while returning the oar During the process of returning the oar, inhale naturally through the nose or mouth, maintaining steady and rhythmic breathing

Breathing cycle:

Each stroke should be accompanied by a complete breathing cycle. This means exhaling while pulling the oar and inhaling while returning the oar

Maintain even and rhythmic breathing, avoiding breath-holding or rapid breathing

Repetition Count:

Train 3 times a week, each session lasting 15 minutes

(4) Tactile cues "technical correction"

Waist taping training: Apply sports tape to the lumbar spine, and the tape will produce a pulling sensation when the movement is deformed

(The picture of the tape is for reference only, athletes can adjust the length of the tape and the position on the waist by themselves)

Warm-up:

Before training, perform appropriate warm-up activities such as jogging, stretching, etc., to prevent sports injuries

Apply tape:

Clean and dry the skin of the waist, ensuring there is no oil or sweat



Figure 10. Apply sports tape to the lumbar spine

Apply sports tape to the lumbar spine The tape should be applied along the direction of the spine, covering the main muscle groups of the waist

Ensure the tape is firmly applied but not too tight, so as not to affect blood circulation

Start Training:

Perform daily training or specific waist stability exercises with the tape applied

Pay attention to the pulling sensation of the tape during the movement, which helps remind you to maintain the correct lumbar posture

Feedback when the movement is deformed:

When your lumbar posture begins to deform, the tape will produce a pulling sensation, providing immediate tactile feedback

Use this feedback to adjust your posture and return to the correct lumbar position

Training content:

You can perform various exercises that require good lumbar posture, such as yoga, Pilates, core training, etc.

The focus is on using the tactile cues of the tape to correct and maintain the correct lumbar posture

3.4.2. Phased Rehabilitation Measures

(1) Acute phase (0-2 weeks)

Ice application: 3-4 times a day, 15 minutes each time (within 48 hours after injury)



Figure 11. Place the ice pack on any injured area of the waist (view from side)



Figure 12. Place the ice pack on any injured area of the waist (view from above)

(The tape in the picture is for reference only, athletes can adjust the ice pack position according to the injured area of the waist)

Prepare ice pack:

Place the ice pack or ice pack in the freezer until it is completely frozen

Prepare a towel or cloth cover to wrap the ice pack to prevent direct contact with the skin

Ice application area:

Determine the area that needs to be iced. According to the picture, the area to be iced is located in the injured area of the waist

Start icing:

Wrap the ice pack with a towel or cloth cover, then place it on the area that needs to be iced

Ensure that the ice pack covers the entire injured area

Icing duration:

Each ice application lasts for 15 minutes

Perform ice application 3-4 times a day

Icing cycle:

Start ice application within 48 hours after the injury and continue

Supine abdominal breathing: 20 times $\times$ 4 sets/day



Figure 13. Lie on the yoga mat with your hands placed on your abdomen



Figure 14. Take a deep breath and feel the bulge of your abdomen when you inhale

Preparation Posture:

Lie on your back on a yoga mat or flat ground

Bend your knees, place your feet flat on the ground, shoulder-width apart

Place your hands on your abdomen to feel the rise and fall of your abdomen during breathing

Start breathing:

Inhale slowly through the nose, allowing the air to reach deep into the abdomen. Feel the abdomen rise as you inhale

Keep the chest as still as possible, mainly using the abdomen for breathing

Exhale:

Exhale slowly through the mouth or nose, allowing the abdomen to fall as you exhale

Ensure the exhalation time is slightly longer than the inhalation time to fully expel air from the lungs

Repetition Count:

Perform 20 abdominal breaths per set

Complete 4 sets daily

Pelvic tilt exercise: Lie on your back with knees bent, gently tighten your abdomen



Figure 15. By contracting the abdominal muscles, the pelvis is tilted upward



Figure 16. Relax the abdomen and press the lower part of the waist down against the ground

Preparation Posture:

Lie on your back on a yoga mat or flat ground

Bend the knees, place the feet flat on the ground, hip-width apart

Place your hands on both sides of your body, palms down

Start practice:

Gently tighten the abdominal muscles, but do not overexert

Slowly tilt the pelvis upward while keeping the lower back pressed against the ground

At the highest point of the movement, tighten the abdominal muscles and hold this position for a few seconds

Restore:

Slowly lower the pelvis back to the starting position while relaxing the abdominal muscles

Ensure the lower back remains pressed against the ground throughout the entire process

Repetition Count:

Set the number of repetitions and sets per group based on personal fitness and training goals

For example, you can set 10-15 repetitions per set and complete 2-3 sets

(2) Recovery period (2-4 weeks)

Four-point kneeling balance: Alternate lifting hands/feet, hold for 30 seconds



Figure 17. Tighten your core muscles and slowly raise and straighten one arm while simultaneously lifting and straightening the other leg backward



Figure 18. Change the sequence of the left and right legs and arms

Preparation Posture:

Assume a four-point kneeling position on the yoga mat, with both hands and knees on the ground

Hands shoulder-width apart, knees hip-width apart

Keep the back straight, do not arch or hunch

Start practice:

Keep the core muscles tight, slowly lift one arm forward and extend it, while lifting the opposite leg backward and extending it

Both arms and legs should be parallel to the ground, maintaining body balance

Maintain balance:

Hold this position for 30 seconds, ensuring body stability and avoiding shaking

Focus on keeping the core muscles tense to maintain balance

Alternate arm/leg raise:

Lower the raised arm and leg, and repeat the action on the other side

Alternate sides, holding each side for 30 seconds

Repetition Count:

Set the number of repetitions and sets per group based on personal fitness and training goals

For example, you can set 5 repetitions per side, holding for 30 seconds each, completing 2 sets in total

Elastic band rowing: Seated, low-resistance elastic band exercise

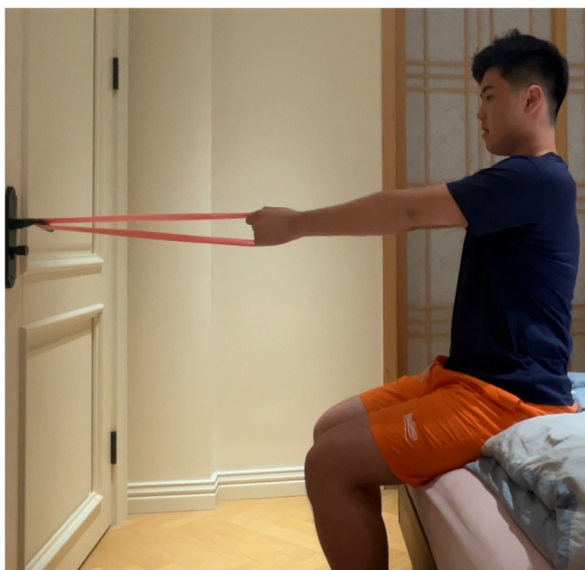


Figure 19. Keep your arms straight to simulate the motion of a row

Preparation Posture:

Sit on a stable chair or bench with your back straight

Place both feet flat on the ground, shoulder-width apart

Secure the resistance band to a door handle or other stable fixed point

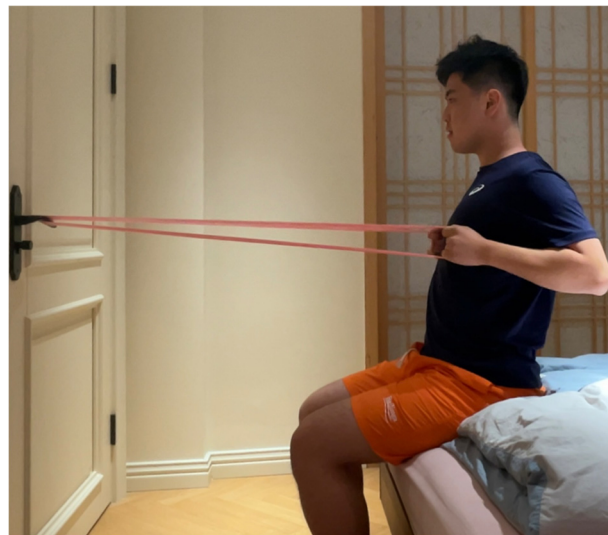


Figure 20. Pull the resistance band backward to simulate the rowing motion

Start practice:

Hold both ends of the resistance band with your hands, arms straight and at shoulder height

Keep your arms straight and slowly pull the resistance band towards your sides, simulating a rowing motion

Rowing motion:

While pulling the resistance band, keep your back straight and your core muscles engaged

Bend your elbows towards your sides until you feel a slight stretch in your back muscles

Restore motion:

Slowly return the resistance band to the starting position, maintaining control and avoiding sudden relaxation

Throughout the process, maintain even and rhythmic breathing

Repetition Count:

1 Set the number of repetitions and sets per group based on personal fitness and training goals

For example, you can set 30-35 repetitions per set, completing 2-3 sets in total

(3) Strengthening Phase (after 4 weeks)

Single-leg deadlift: No weight, pay attention to waist posture



Figure 21. Place one leg as the supporting leg and lift the other leg backward

Preparation Posture:

Stand on a yoga mat with your feet together

Choose one leg as the supporting leg and lift the other leg

backward, keeping the foot about 10-20 cm off the ground

Start deadlift:

Keep the supporting leg straight and slowly bend your body forward while keeping your back flat

The knee of the supporting leg can be slightly bent, but maintain the correct waist posture to avoid excessive bending or twisting of the waist.

Lower and restore:

While keeping the back straight, lower the body as much as possible until you feel a stretch in the hamstring of the supporting leg.

Then slowly return the body to the starting position.

Alternate practice:

After completing a set of exercises for the supporting leg, repeat the above actions with the other leg.

Alternate and perform the same number of repetitions on each side.

Repetition Count:

Set the number of repetitions and sets per group based on personal fitness and training goals

For example, you can set 10-15 repetitions per side, completing 2-3 sets in total.

Water adaptation training: Start with 500 meters of low intensity



Figure 22. Rowing training on the water

Warm-up:

Before engaging in water training, perform appropriate warm-up activities such as jogging and stretching to prevent sports injuries.

Check the rowing equipment and safety gear to ensure everything is ready.

Start Training:

Start with a 500-meter low-intensity row. Maintain a steady rhythm and avoid excessive force.

Pay attention to rowing techniques, maintaining smooth and efficient movements.

Gradually increase the intensity:

After adapting to low-intensity rowing, gradually increase the rowing distance and intensity.

For example, you can gradually increase to 1000 meters, 2000 meters, etc., while appropriately increasing the rowing speed.

Maintain breathing rhythm:

During rowing, maintain even and rhythmic breathing, avoiding holding your breath or breathing rapidly.

You can try synchronizing your breathing with the rowing motion, such as exhaling with each stroke and inhaling with each recovery.

Rest and recovery:

Set appropriate rest times based on personal fitness and training goals.

After high-intensity training, perform appropriate relaxation activities such as stretching and massage to promote recovery.

3.5. Summary of Training Outcomes for Teenage Rowers

Feedback from two teenage rowers after completing a 4-week core strengthening program:

Improved lumbar stability: "The lower back no longer shakes during the stroke, and the entry into the water is more stable."

Enhanced core endurance: "At the end of the leg pull, I can hold the position for an additional 3-4 seconds without collapsing the lower back."

Activation of key muscle groups: After inverted rowing machine training, the surface electromyography amplitude of the transverse abdominis and multifidus muscles increased by an average of 20%.

Overall health improvement: The next day after training, there was a significant reduction in lower back and lumbar pain, and daily sitting posture became more upright.

Single-leg deadlift: No weight, pay attention to waist posture



Figure 23. Tighten your core muscles and slowly raise and straighten one arm while simultaneously lifting and straightening the other leg backward



Figure 24. Change the sequence of the left and right legs and arms

Inverted rowing machine training: Place the front part of the ergometer at a high position and complete the rowing motion in an unbalanced state before and after the ergometer (3 times a week $\times$ 15 minutes)

Supine paper blowing exercise: Lie supine with knees bent, hold a small piece of paper in hand and perpendicular to the lower lip, blow the paper up through diaphragmatic breathing, hold for 5 seconds (3 sets $\times$ 10 times)



Figure 25. Perform the rowing stroke and continue to maintain the breathing rhythm



Figure 26. Lean forward and perform the complete rowing motion



Figure 27. Lean forward and perform the complete rowing motion



Figure 28. Holding the piece of paper above the mouth and blow air into the piece of paper with your mouth

4. Conclusion and Recommendations

4.1. Conclusion

4.1.1. Analysis of Injury Epidemiology Characteristics Shows

Distribution of injury types: Chronic strain injuries are predominant (66.7%), with lumbar muscle strain accounting for the highest proportion (66.7%), followed by lumbar disc herniation (20%) and lumbar joint disorder (13.3%).

Injury occurrence scenarios: Specialized strength training

sessions (53.3%) and aerobic endurance training sessions (33.3%) constitute high-risk periods for injuries.

Composition of injury factors: Improper technical movements (40%), accumulation of chronic strain (26.7%), and insufficient warm-up activities (20%) are the main causes.

4.1.2. Research on Risk Behavior Characteristics Found

Nearly half of the athletes (46.7%) have a tendency to increase training intensity for performance gains.

More than half (53.3%) of the athletes have a history of lumbar injuries, indicating that the risk of recurrence needs special attention.

4.1.3. Current Status of Prevention System Construction

Existing preventive measures mainly focus on technical specifications (establishing hip-dominant force patterns), training cycle management (weekly training volume increase $\leq 8\%$), and core stability enhancement, but the implementation effectiveness needs improvement.

4.2. Recommendations

4.2.1. Suggestions for Research Method Improvement

Introduce sports biomechanics analysis to quantify the correlation between technical movement deviations and injury risk.

4.2.2. Optimization Directions for Research Design

Establish an injury grading standard system, refine the grading of lumbar muscle strain severity (mild/ moderate/severe), and improve spinal stability assessment indicators.

4.2.3. Practical Application Suggestions

Implement periodic athletic ability assessments (core muscle strength tests, joint mobility measurements, etc.) to build a dynamic injury prevention system.

4.2.4. Training Management Suggestions

Develop scientific training transition plans, strictly control the gradient of training intensity increase (recommended not to exceed 8% per week).

Strengthen standardized training of technical movements, focusing on correcting compensatory lumbar movement patterns.

Improve the training log system, and record training load and body response data in detail.

4.2.5. Rehabilitation System Construction

Establish a rehabilitation management model integrating 'coach-physiotherapist-rehabilitation therapist'.

Implement a phased rehabilitation plan, forming a complete closed loop from acute phase management to functional recovery.

References

- [1] Stracciolini, A., et al. (2020). Pediatric sports injuries: An age-based approach. *Current Sports Medicine Reports*, 19(10), 423–429. <https://doi.org/10.1249/JSR.0000000000001245>.
- [2] Vinther, A., et al. (2021). Lumbar spine injuries in elite rowers: The role of core endurance. *British Journal of Sports Medicine*. <https://doi.org/10.1136/bjsports-2020-103456>.
- [3] Wilson, F., Gissane, C., & Simms, C. (2022). Core stability in rowing: A kinematic and EMG analysis. *Journal of Sports Sciences*, 40(4), 456–465. <https://doi.org/10.1080/02640414.2021.1999876>.
- [4] Zhang, L. J. (2025). Analysis, prevention and rehabilitation research of sports injuries in rowing athletes. *Ice and Snow Sports Innovation Research*, 6(1), 156–158.

- [5] Xu, H. Y., Chen, J. Y., & Sun, J. (2023). Analysis of common sports injuries and preventive measures in adolescent rowing athletes. *Sports Vision*, (1), 101–103.
- [6] Liu, G. (2019). Analysis of the mechanism and predictive factors of low back pain in rowing athletes. *Contemporary Sports Technology*, 9(14), 61–63.
- [7] Zhang, S. S. (2015). Progress in the mechanism of low back pain in rowing athletes. *Sports Research*, 36(6), 93–96.
- [8] Qiao, G. L. (2018). Research on injuries and rehabilitation treatment methods for adolescent rowing athletes. *Western Sports Research*, 37(4), 1–5.
- [9] Zhi, T. Y. (2021). Analysis of low back injuries and rehabilitation training research in rowing athletes. *Ice and Snow Sports Innovation Research*, (8), 187–188.
- [10] Wang, M. Y. (2016). Strategies for scientific training of specialized strength in rowing athletes. *Contemporary Sports Technology*, 6(35), 68–70.

Appendices

Questionnaire on Low Back Injuries in Adolescent Rowing Sports

Hello! I am a summer intern at the School of Sports Rehabilitation of Beijing Sport University. Currently, under the guidance of my professor, I am conducting research on 'Prevention and Training Rehabilitation Measures for Lower Back Injuries in Young Rowers.' I would like to invite you to take a few minutes to fill out this questionnaire. This survey will gather information about your personal sports activities, rowing habits, and lower back injury status. This questionnaire is conducted anonymously and is solely for research purposes. The survey content will be kept confidential, so please feel free to fill it out. Thank you for your participation!

Name: Age: Gender: Date:

Contact information:

1. How many times do you engage in rowing training each week? 0 times ☐ 1-2 times ☐ 3 times or more ☐ Other: _____

2. How long is each of your rowing training sessions? 1 hour ☐ 2 hours ☐ More than 2 hours ☐ Other: _____

3. What do you think are the reasons for your lower back sports injuries? Inadequate warm-up ☐ Incorrect technical movements ☐ Insufficient basic physical fitness ☐ Training plan arrangement ☐ Training or competing with injuries ☐ Incorrect coaching guidance ☐ Accumulation of chronic strain ☐ Other: _____

4. During which stage did your lower back injury occur? During specialized strength training (e.g., deadlifts, bench presses, squats) ☐ During competition ☐ During aerobic endurance training ☐ During general technical training ☐ During short-distance fast rowing (e.g., start, final sprint) ☐ Other: _____

5. What impact did your lower back injury have on your rowing? No impact ☐ Prohibited from competing ☐ Suspended training ☐ Ended sports career ☐ Other: _____

6. What type of injury was your lower back diagnosed as? Lumbar muscle strain (most common) ☐ Lumbar disc herniation ☐ Lumbar joint disorder ☐ Other: _____

7. Do you have a previous record of lower back sports injuries? Yes ☐ No ☐ Other: _____

8. Have you continued to increase training intensity at the risk of lower back injury for the sake of achieving excellent results? Yes ☐ No ☐ Other: _____

9. Did you actively follow the training and rehabilitation advice from doctors and coaches after sustaining a lumbar injury? Yes ☐ No ☐ Other: _____

10. How many times have you previously injured your lower back during sports? 0 times ☐ 1-2 times ☐ 3 times or more ☐ Other: _____

11. Has your rowing coach previously provided incorrect technical guidance? Yes ☐ No ☐ Other: _____

12. How long did the pain in your lower back last after the sports injury? <6 weeks (acute lower back injury) ☐ 6 weeks~3 months (subacute lower back injury) ☐ >3 months (chronic lower back injury) ☐ Other: _____