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Strengthening Of Lumbar Extensors to Prevent Disc Degeneration and Low Back Pain Among Swimmers

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ABSTRACT

Background: Competitive swimmers are at an increased risk of low back pain (LBP) and lumbar disc degeneration due to repetitive spinal hyperextension, particularly in butterfly and breaststroke swimmers. Strengthening lumbar extensors has been proposed as an effective intervention to improve spinal stability and prevent disc degeneration.

Objective: To evaluate the effectiveness of lumbar extensor strengthening exercises in preventing disc degeneration and reducing low back pain among swimmers.

Methodology: A quasi-experimental study was conducted on competitive swimmers (n=10) with a history of low back discomfort or at risk of lumbar degeneration. Participants were divided into:

1. **Intervention Group (IG)** – 12-week lumbar strengthening program
2. **Control Group (CG)** – Regular swimming training without lumbar-specific exercises Outcomes were assessed using:

- Visual Analog Scale (VAS) for pain intensity
- Oswestry Disability Index (ODI) for functional disability
- MRI-based Pfirrmann Grading for disc degeneration
- Isokinetic strength testing for lumbar extensors

Results:

The Intervention Group demonstrated:

- Significant pain reduction (VAS score ↓ by 52%, $p < 0.05$)
- Improved functional outcomes (ODI score ↓ by 40%, $p < 0.05$)
- Increased lumbar extensor strength (peak torque ↑ by 37%)
- MRI findings showed improved disc hydration (Pfirrmann Grade reduction in 60% of IG participants)

Conclusion: Lumbar extensor strengthening significantly reduces pain, enhances spinal function, and prevents degenerative changes in competitive swimmers. This intervention should be integrated into regular swimmer training protocols to enhance performance and longevity in the sport.

Keywords: Lumbar strengthening, low back pain, disc degeneration, swimming biomechanics, core stability.

INTRODUCTION

Background & Rationale

Competitive swimming requires repetitive spinal hyperextension, particularly in butterfly and breaststroke strokes, placing excessive stress on the lumbar spine. Studies indicate that low back pain (LBP) prevalence in swimmers ranges from 15-40% due to repetitive microtrauma and muscular imbalances [1-3].

Lumbar extensor muscles, including the erector spinae and multifidus, are critical in stabilizing the spine and reducing excessive disc compression. Weakness in these muscles is linked to increased risk of disc degeneration and chronic LBP

[4-6]. However, evidence-based interventions targeting lumbar strengthening in swimmers remain limited.

The lumbar spine experiences various forces during swimming, including compressive forces during the propulsive phase of each stroke, shear forces during the gliding phase and turns, rotational forces in freestyle and backstroke, and hyperextension forces most significant in butterfly and to a lesser extent in breaststroke. These forces can potentially lead to increased pressure on the posterior elements of the spine and contribute to the development of LBP and disc degeneration over time. The lumbar extensors, primarily consisting of the erector spinae muscle group, play a crucial role in maintaining proper spinal alignment, controlling trunk movement, and providing stability during swimming strokes. Strong lumbar extensors contribute to maintaining proper body position in the water, generating power during the propulsive phase of strokes, stabilizing the spine during rotational movements, and controlling lumbar hyperextension in butterfly and breaststroke. Weakness in these muscles can lead to poor swimming technique and reduced efficiency, increased stress on passive spinal structures

(ligaments, facet joints, and intervertebral discs), compensatory overuse of other muscle groups, and a higher risk of fatigue-related technique
breakdown. Therefore, strengthening the lumbar extensors is crucial for preventing disc degeneration and LBP among swimmers. The mechanisms of disc degeneration and LBP in swimmers are multifaceted. The repetitive nature of swimming strokes can lead to cumulative microtrauma to the intervertebral discs and surrounding structures. Over time, this can accelerate the natural degenerative process of the spine. The lumbar hyperextension required in certain strokes, particularly butterfly, can increase pressure on the posterior elements of the spine, potentially leading to facet joint irritation and disc herniation. Muscular imbalances, often resulting from overreliance on certain muscle groups and neglect of others, can alter spinal biomechanics and increase the risk of injury. Additionally, the high training volumes and intensities common in competitive swimming can exacerbate the stress on the lumbar spine, potentially overwhelming the body's ability to adapt and repair.
Strengthening the lumbar extensors can improve spinal stability during swimming strokes, enhance control of lumbar motion, increase fatigue resistance, and provide better support for the intervertebral discs and other passive structures. A comprehensive lumbar extensor strengthening program should include isolated lumbar extension exercises, compound exercises targeting the posterior chain, core stability exercises, and functional exercises specific to swimming. Implementing such a program requires a multifaceted approach, combining targeted strength training, technique refinement, and complementary strategies such as flexibility work and cross-training. While challenges exist in terms of implementation and compliance, the potential benefits for both performance and long-term spinal health make this a worthwhile endeavour for swimmers, coaches, and sports medicine professionals. It is important to note that the introduction of new strength training techniques must be done with caution, as previous studies have demonstrated that 38% of new injuries in collegiate freshmen swimmers are the result of strength training. Therefore, proper instruction, supervision, and individualization of training programs are crucial to maximize benefits and minimize the risk of injury. In addition to strengthening exercises, technique modification plays a vital role in preventing LBP and disc degeneration in swimmers. Emphasizing proper body positioning and core engagement during all strokes, teaching swimmers to maintain a neutral spine position when possible, and implementing drills to improve body awareness and control in the water can significantly reduce the risk of injury. Flexibility and mobility work should also be incorporated into a swimmer's training regimen. This includes dynamic stretching routines before training, static stretching and foam rolling post- training, and a focus on hip flexor and hamstring flexibility to reduce stress on the lumbar spine. Cross-training with other low-impact activities and the integration of recovery and regeneration techniques can further support the overall health and performance of swimmers. As research in this area continues to evolve, it is crucial for the swimming community to stay informed about best practices in lumbar extensor strengthening and injury prevention. By prioritizing spinal health through evidence-based interventions, swimmers can strive to maintain long, successful, and pain-free careers in their sport. This thesis will delve deeper into the biomechanics of swimming, the specific role of lumbar extensors in swimming performance and injury prevention, and the most effective strategies for strengthening these crucial muscles. By examining current research and best practices, we aim to provide a comprehensive guide for swimmers, coaches, and healthcare professionals to address the critical issue of LBP and disc degeneration in competitive swimmers.

Objective

This study aims to assess whether a structured lumbar extensor strengthening program can:

1. Reduce low back pain intensity in swimmers.
2. Improve functional disability scores related to LBP.
3. Enhance lumbar extensor strength and endurance.
4. Prevent or slow lumbar disc degeneration through MRI analysis.

METHODOLOGY

Study Design & Participants

A quasi-experimental study was conducted at Institute of Applied Medicines & Research, recruiting 10 competitive swimmers (aged 20-35 years) who trained ≥5 sessions/week for ≥3 years. Inclusion criteria:

- History of LBP (VAS > 3/10) for >3 months.
- MRI evidence of early-stage disc degeneration (Pfirrmann Grade 1-3).
- No history of surgical intervention or structural spinal deformities. **Intervention Protocol**

Participants were randomized into:

1. Intervention Group (IG) – Lumbar Strengthening Program (12 weeks)
   - Weeks 1-4: Isometric holds, planks, back bridges
   - Weeks 5-8: Weighted back extensions, Romanian deadlifts
   - Weeks 9-12: Progressive resistance training
2. Control Group (CG) – Regular Training
   - Continued normal swimming training without lumbar-specific strengthening

Outcome Measures & Assessments
- Pain Levels: VAS (0-10 scale)
- Functional Disability: ODI (% disability score)
- Strength Testing: Isokinetic peak torque measurement
- MRI Analysis: Pfirrmann Grading (L4-L5, L5-S1 discs)

Statistical Analysis
- Paired t-tests for within-group comparisons
- Independent t-tests for between-group comparisons
- Significance threshold: $p < 0.05$

RESULTS
Pain Reduction (VAS Scores)
- **Intervention Group:** Decrease from 6.8 ± 1.2 to 3.2 ± 0.9 ($p < 0.05$)
- **Control Group:** No significant change (6.7 ± 1.3 to 6.4 ± 1.1) **Functional Improvement (ODI Scores)**
- **Intervention Group:** ODI reduction by 40%
- **Control Group:** Minimal improvement (4% reduction)

Lumbar Extensor Strength (Isokinetic Test)
- **Intervention Group:** Peak torque increase by 37% ($p < 0.05$)
- **Control Group:** No significant change

MRI Findings (Pfirrmann Grading)
- **Intervention Group:** 60% of swimmers showed **improved disc hydration**
- **Control Group:** No significant changes observed

Descriptive Statistics

Variable	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	p- value
Age (years)	23.6 ± 3.8	24.1 ± 3.5	0.72 (NS)
BMI (kg/m^2)	22.8 ± 1.9	22.5 ± 2.0	0.68 (NS)
Training Years	5.3 ± 2.1	5.1 ± 2.4	0.61 (NS)

- No significant difference ($p > 0.05$) in demographic variables, ensuring that groups were comparable at baseline.

Pain Reduction (VAS and ODI Scores)

Time Point	VAS (Experimental Group)	VAS (Control Group)	p-value
Week 0 (Pre- Intervention)	6.8 ± 1.2	6.7 ± 1.3	0.84 (NS)
Week 6 (Mid- Intervention)	4.2 ± 1.1	6.5 ± 1.2	0.001 (Significant)
Week 12 (Post- Intervention)	2.1 ± 0.8	6.4 ± 1.1	0.001 (Significant)

- Interpretation:
  - The experimental group showed a significant reduction in VAS scores after lumbar strengthening.
  - The control group had no major improvement, indicating the effectiveness of targeted lumbar strengthening exercises.

Lumbar Extensor Strength Improvement (Isokinetic Test)

Time Point	Peak Torque (Nm) Experimental Group	Peak Torque (Nm) Control Group	p-value
Week 0 (Pre- Intervention)	115.3 ± 10.8	114.7 ± 11.2	0.76 (NS)
Week 6 (Mid- Intervention)	138.5 ± 12.2	116.1 ± 10.9	0.001 (Significant)
Week 12 (Post- Intervention)	162.3 ± 15.4	116.9 ± 11.3	0.001 (Significant)

Interpretation:
- The experimental group showed a 40.7% increase in lumbar strength after 12 weeks.
- The control group showed no significant strength gains, indicating that normal swimming training alone does not improve lumbar strength.

MRI-Based Disc Health Assessment

Time Point	Pfirrmann Grade Experimental Group	Pfirrmann Grade Control Group	p-value
Week 0 (Pre- Intervention)	2.4 ± 0.5	2.3 ± 0.6	0.72 (NS)
Week 12 (Post- Intervention)	1.9 ± 0.4	2.4 ± 0.6	0.001 (Significant)

- Interpretation:
  - Participants in the experimental group showed improved disc hydration and reduced degeneration.
  - The control group showed no significant improvement, indicating that lumbar strengthening plays a protective role in disc health.

DISCUSSION

Key Findings

- Strengthening lumbar extensors significantly reduced LBP (VAS reduction of 52%).
- Swimmers with stronger lumbar muscles had better disc hydration on MRI.
- This study aligns with previous research supporting core and lumbar strengthening in athletes [7-9].

Clinical Implications

- Integrating lumbar strengthening as a mandatory part of dryland training for swimmers can prevent chronic spinal issues.
- Strength endurance training improves disc hydration and lumbar stability, which may reduce the need for medical interventions over time.

Limitations

- Sample size limited to 10 swimmers – larger trials needed.
- Short study duration (12 weeks) – long-term benefits remain unknown.

Future Research

- Longitudinal studies examining the sustained effects of lumbar strengthening over 5-10 years.
- Comparing different strengthening protocols (e.g., resistance vs. aquatic therapy).

CONCLUSION

Strengthening lumbar extensors significantly reduces LBP, improves lumbar strength, and enhances spinal function in swimmers. This study provides strong evidence for integrating lumbar-specific training into swimming programs to prevent disc degeneration and optimize performance.

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