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The prevention of the most common shoulder injuries in competitive swimming

A narrative literature review

DEGREE PROGRAMME IN PHYSIOTHERAPY
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ABSTRACT

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The purposes of this thesis was to explore the prevalence and types of shoulder injuries common in competitive swimming and to identify effective preventive exercises for minimizing injury risk. A narrative literature review was conducted, analyzing 10 studies focused on competitive swimmer's shoulder health. The findings revealed that shoulder pain and dysfunction, often referred to as swimmer's shoulder, are prevalent due to the repetitive overhead movements and the imbalances between shoulder internal and external rotators. Additionally, key risk factors include limited shoulder mobility, muscle strength imbalances, and high training workloads.

Preventive exercises programs emerged as crucial for enhancing shoulder stability, strength, and range of motion, therefore reducing injury occurrence. Based on the review, the guidebook was created. The guidebook is targeting exercises for the swimmers, that focus on shoulder strength and stability. Evidence suggest that incorporating targeted dry-land training and pre-swim warm-ups can reduce shoulder strain and enhance muscular endurance, particularly through exercises like resistance band rotations, TRX-based shoulder stabilization, and core-balancing routines.

The findings inform an exercise guide developed for the swimmers and coached on Porin Uimaseura, with recommendations to balance muscle conditioning and minimize injury risk. This guidebook offers a structured, evidence-based approach to strengthening exercises, aiming to promote injury prevention and sustainable performance improvement for competitive swimmers.

Keywords: Competitive swimming, injury prevention, shoulder injuries in swimming, preventive exercises for shoulder injuries

CONTENTS

1 INTRODUCTION

The shoulder injuries are considered to be the most common injury in competitive swimming (Wanivenhaus F, Fox AJ, Chaudhury S, Rodeo SA. 2012.). The distinctive characteristics of various swimming strokes and the extensive repetition required during training expose swimmers to a notable risk of shoulder injuries. The term "swimmer's shoulder" encapsulates a spectrum of pathologies, ranging from impingement syndrome to rotator cuff tendinitis, labral injuries, instability, neuropathy, and anatomical variations. (Matzkin E, Suslavich K, Wes D. 2016.)

It's important that the swimmers and coaches know about the proper techniques of swimming and preventing factors for shoulder injuries. In this thesis I am going give information about the shoulder injury prevention and overall shoulder health, that aims to give the tools to the athletic community, sports medicine practitioners, and coaches through up-to-date research and studies.

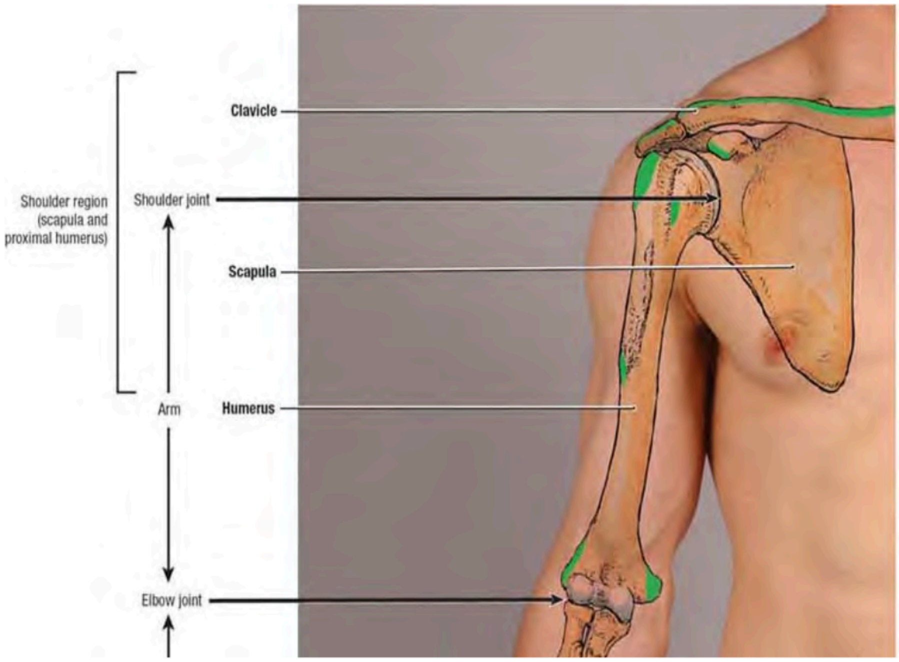
As a part of my thesis, I am going to do a guidebook for the swimmers and coaches of Porin uimaseura who are commissioning my thesis.

2 UNDERSTANDING THE SHOULDER GIRLDE ANATOMY

Because the shoulder is one of the most movable parts of the body, it is a very complex in both structurally and functionally. It includes the shoulder girdle, that links up the upper limp to the axial skeleton through the sternoclavicular joint. This extensive range of motion, however, compromises the joint stability, making the shoulder susceptible to dislocations and injuries. (Miniato, Anand, Varacallo, 2023)

2.1 Bones of the shoulder girdle

As seen from picture 1, the shoulder girdle is constructed by the scapula and clavicula which attach with the proximal humerus (Miniato, Anand, Varacallo, 2023).



Picture 1: upper limb (Agur, Anne M.R.; Dalley, Arthur F, 2008, p. 478)

2.1.1 Scapula

The scapula is a triangular bone that is sturdy and flat. It’s a bone that connects the clavicula to the humerus and forms the posterior of the shoulder girdle. The scapula is very important for the function of the shoulder joint. It plays a part in six types of motions, that makes upper extremity movement fully functional. The movements include retractions, protraction, depression, elevation, downward rotation, and upward rotation. (Cowan, Mudreac, Varacallo, 2023)

2.1.2 Clavicle

The clavicle, a sigmoid-shaped long bone, connects the axial skeleton to the appendicular skeleton alongside the scapula, forming the pectoral girdle. It is essential for upper limb movement, providing a range of motion and protecting the underlying neurovascular structures. Each part of the clavicle has specific attachment points that contribute to shoulder stability and function.

Medially, the clavicle forms the SC joint with the sternum, supported by a fibrous capsule, an intra-articular disc, and the interclavicular ligament. Laterally, it connects with the acromion to form the AC joint, stabilized by the AC, coracoclavicular, and coracoacromial ligaments.

The shaft of the clavicle is divided into a medial two thirds and a lateral third. The medial two thirds provide attachments for muscles like the sternocleidomastoid, subclavius, and pectoralis major. The lateral third is where the deltoid and trapezius muscles attach. The clavicle is also very prone to fractures, caused by direct impact or falls. (Hyland, Charlick, Varacallo, 2023)

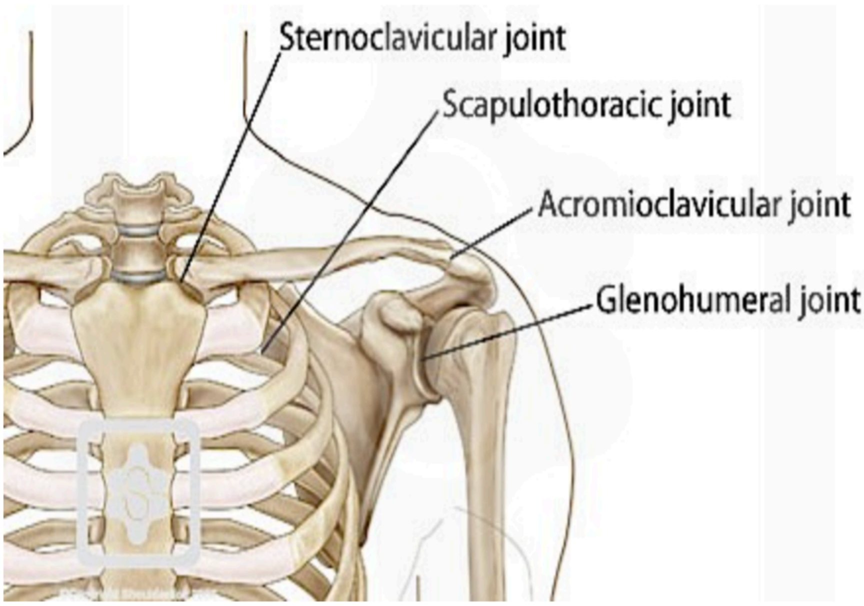
2.1.3 Humerus

The humerus is the biggest bone in the upper extremity, forming the arm. It connects to the glenoid at the glenohumeral joint proximally and to the radius and ulna at the elbow joint distally.

The proximal end of the humerus features the head, forming a ball-and-socket joint with the glenoid cavity of the scapula. Below the head is the anatomical neck, which separates it from the greater and lesser tubercles, where muscles attach. The surgical neck, located below the tubercles, is a common fracture site. (Mostafa, Imonugo, Varacallo, 2023)

2.2 Joints of the shoulder girdle

There are four joints in the shoulder, see picture 2: The sternoclavicular joint, acromioclavicular joint, scapulothoracic joints, and glenohumeral joint.

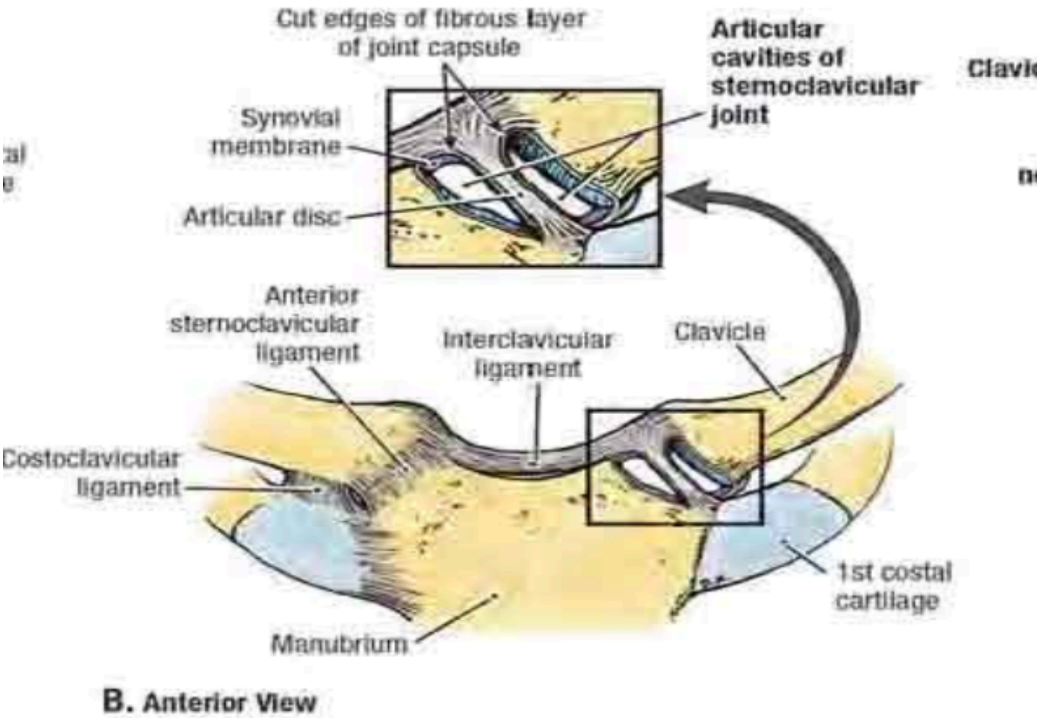


Picture 2: Bones and joints of the shoulder (shoulderdoc.co.uk)

2.2.1 The sternoclavicular joint

The sternoclavicular joint (SC) is characterized as a saddle shaped synovial joint. The sternoclavicular joint is the primary joint in the shoulder girdle that connects the axial skeleton to the upper limb. The sternoclavicular joints are one of the five key articulations necessary for the upper limb function. It has significant anatomical relationships with critical structures such as the brachiocephalic arterial trunk, common carotid artery, and internal jugular vein, as well as vagus and phrenic nerves, trachea, and esophagus.

Therefore, beyond its vital part in stabilizing and supporting the upper limb, the sternoclavicular joint along with the clavicula and sternum, plays an essential role in protecting these structures as they enter the thorax. (N. Epperson; C. Black; Varacallo, 2023)



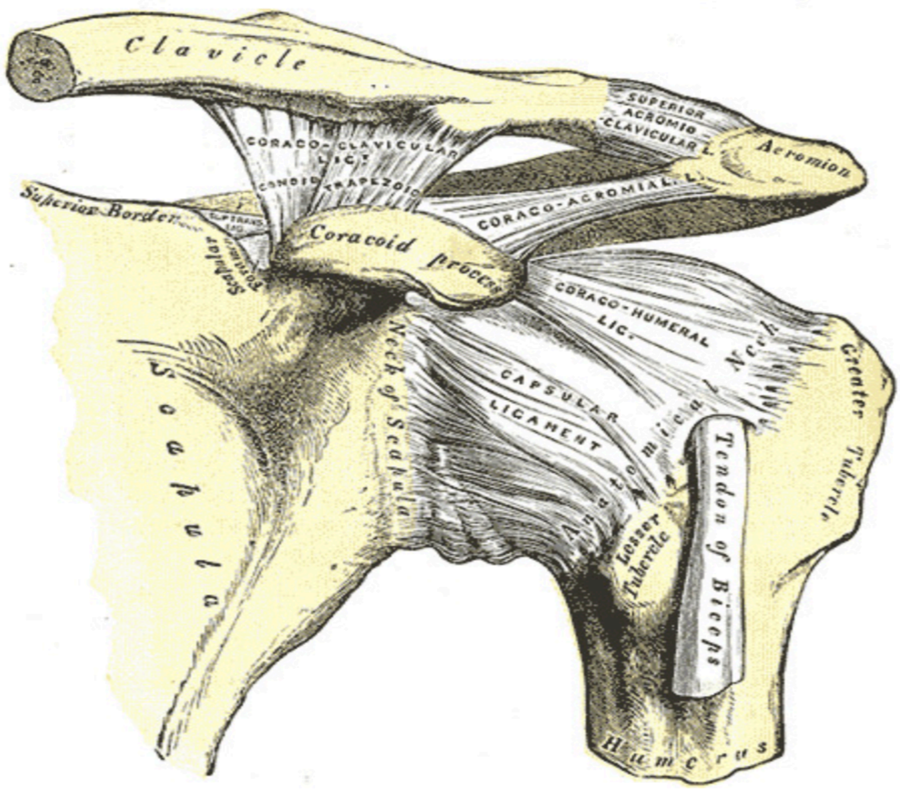
Picture 3: Sternum and associated joints (Agur, Anne M.R.; Dalley, Arthur F, 2008, p. 13)

2.2.2 Acromioclavicular joint

The acromioclavicular (AC) joint connects the lateral end of the clavicle to the acromion, which extends forward from the scapula. This joint contributes to the stability and mobility of the shoulder complex.

This plane-type synovial joint is typically permitting only gliding movement. As seen from picture 4, by attaching the scapula to the thorax, the AC joint provides additional range of motion to the scapula and aids in movements such as shoulder flexion and abduction. It also facilitates the transmission of forces from the upper arm to the rest of the skeleton.

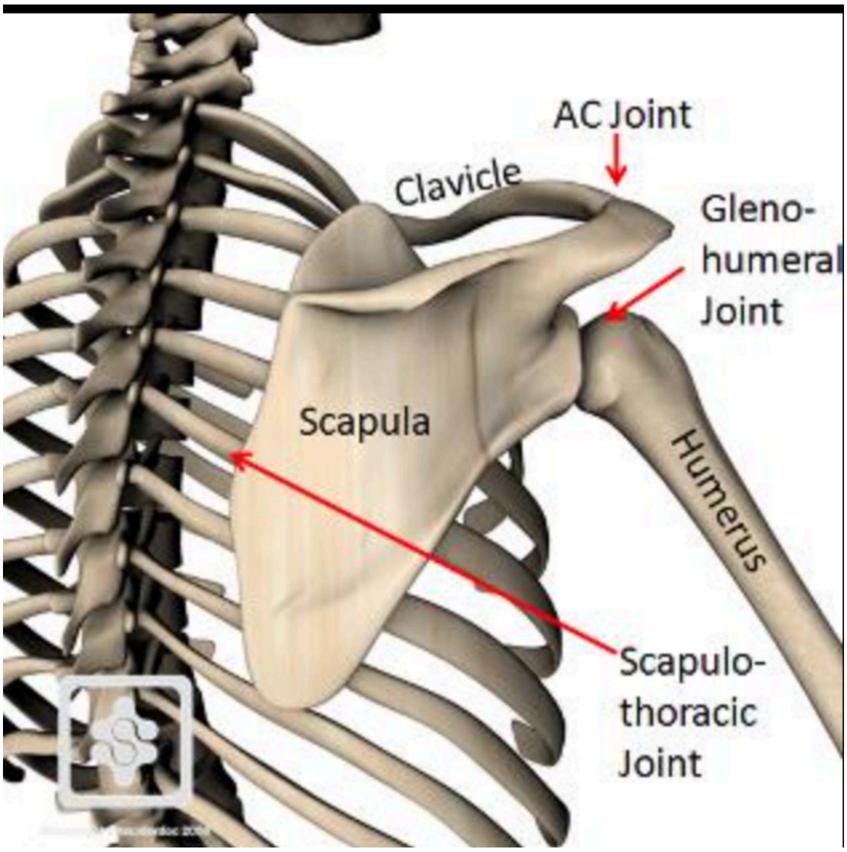
It is frequently injured, with damage ranging from sprains to complete tears, and sometimes necessitates surgical intervention. (Wong; Kiel, 2023)



Picture 4: Anatomy, shoulder and upper limb, acromioclavicular joint (Wong; Kiel, 2023)

2.2.3 Scapulothoracic joint

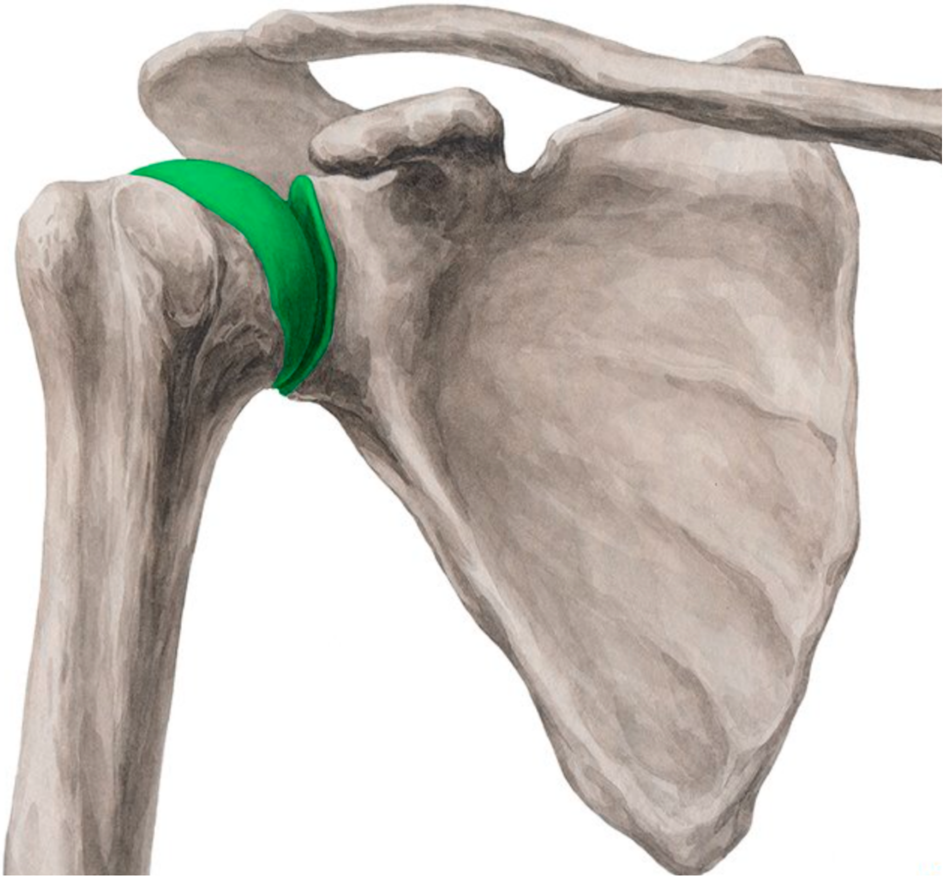
As seen from the picture 5, the scapulothoracic (ST) joint is not your typical kind of joint. It is considered anatomically not a true joint, because of it lacks the typical characteristics of a joint such as cartilaginous, union by fiber, or synovial tissues. Instead of it being a “normal” joint, it’s a functional articulation between the scapula and the thorax and its relying on the integrity of acromio-clavicular and sternoclavicular joints. (Physiopedia, 2019)



Picture 5: Scapulothoracic joint (physiopedia, 2019)

2.2.4 Glenohumeral joint

Picture 6 shows that the glenohumeral joint is a highly flexible ball-and-socket synovial joint, stabilized by the rotator cuff muscles that connect to the joint capsule, along with the tendons of the biceps and triceps brachii. In this joint, the humeral head meets the glenoid fossa of the scapula, forming a relatively shallow articulation, as the fossa accommodates less than a third of the humeral head. The labrum, a fibrocartilaginous ring attached to the outer rim of the glenoid fossa, provides additional depth and stability, securing the humeral head in place. Surrounding the joint capsules are several fluid-filled sacks, known as bursae, which aid in mobility. These include the subcoracoid, subacromial, subdeltoid, and subscapular bursae. (Miniato, Anand, Varacallo, 2023)



Picture 6: Glenohumeral joint (Kenhub, 2023)

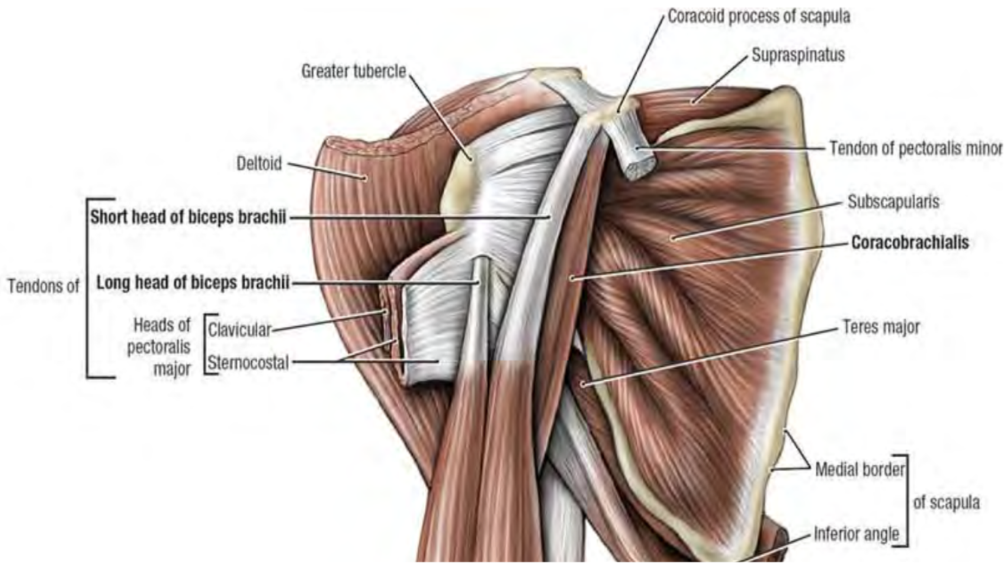
2.3 Muscles and nerves of the shoulder girdle

TABLE 1 shows the muscles that attach the scapula and/or clavicle to the humerus. The TABLE 1 lists the muscle, function, origin, insertion, and innervation. Picture 7 shows the visualization of these muscles.

TABLE 1. Shoulder muscles that attach the scapula and/or clavicle to the humerus

Muscle	Function	Origin	Insertion	Innervation
Deltoid	Anterior part: Flexion and Medial rotation of the arm. Middle part: Abduction of the arm up to 90°. Posterior part: Extension and lateral rotation of the arm.	Scapular spine, lateral clavicle, and acromion	Deltoid tuberosity	Axillary nerve (C5, C6)
Teres major	Medial rotation and adduction of the arm.	Posterior surface of the scapula at its	Intertubercular groove of the proximal humerus on	Lower scapular nerve (C5, C6)

		inferior angle.	its medial aspect.	
Supraspinatus (rotator cuff)	Initiating arm abduction for the first 15°, stabilizes glenohumeral joint	Superior to the scapular spine/supraspinous fossa, Posterior scapula	Top of the greater tubercle of the humerus	Suprascapular nerve (C5, C6)
Infraspinatus (rotator cuff)	Stabilize glenohumeral joint, Lateral rotation of the arm	Posterior scapula, inferior to the scapular spine/infraspinous fossa	Greater tubercle of the humerus, between the supraspinatus and teres minor insertion	Suprascapular nerve (C5, C6)
Teres minor (rotator cuff)	Stabilize glenohumeral joint, lateral rotation of the arm	Inferior angle of the scapula	Inferior aspect of the grater tubercle	Axillary nerve (C5, C6)
Subscapularis (rotator cuff)	Adduction and medial rotation of the arm, stabilize glenohumeral joint	Anterior aspect of the scapula	Lesser tubercle of the humerus	Subscapular nerves (C5, C6, C7)



Picture 7: Muscles of anterior aspect of arm (Agur, Anne M.R.; Dalley, Arthur F, 2009, p. 523)

TABLE 2 shows the other muscles that affect the movement at the shoulder joint. Just like TABLE 1, TABLE 2 lists the muscles, functions, origins, insertions, and innervations. Visualization of these muscles can be seen from picture 8 & 9.

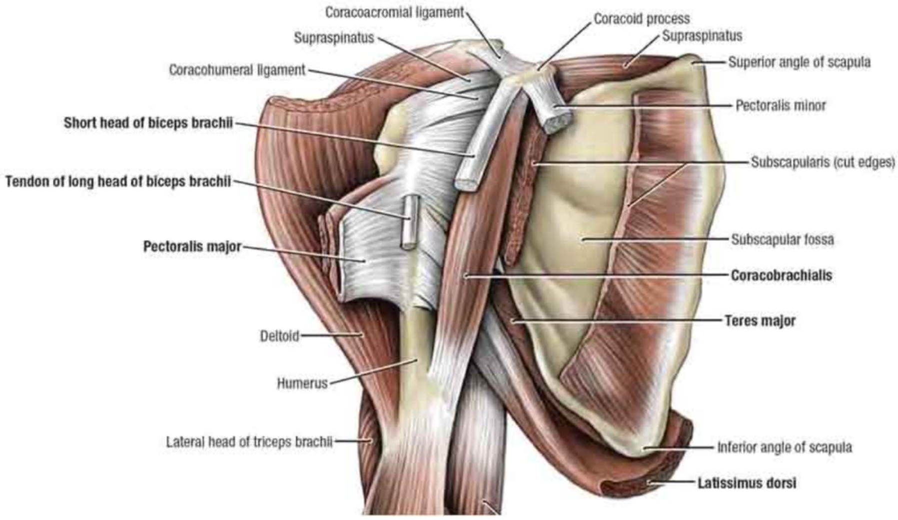
TABLE 2. Other muscles that affect the movement at the shoulder joint.

Muscle	Function	Origin	Insertion	Innervation
Latissimus dorsi	Adducts, extends, and medially rotates the upper limb	Iliac crest, spinous process of T6 to T12, thoracolumbar fascia, and the inferior three ribs	Intertubercular sulcus of the humerus	Thoracodorsal nerve (C6, C7, C8)

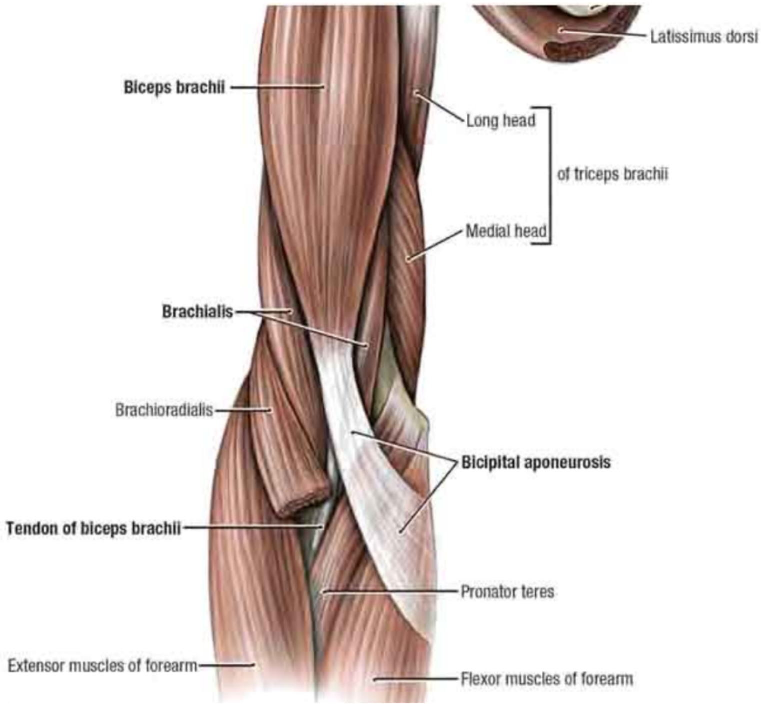
Levator scapulae	Elevates the scapula	Transverse process of the C1 to C4 vertebrae	Medial border of the scapula	Dorsal scapular nerve (C5)
Rhomboid major	Rotates and retracts the scapula	Spinous process of T2 to T5 vertebrae	Inferomedial border of the scapula	Dorsal scapular nerve (C5)
Rhomboid minor	Rotates and retracts the scapula	Spinous process of C7 to T1 vertebrae	Medial border of the scapula	Dorsal scapular nerve (C5)
Serratus anterior	Fixes the scapula into the thoracic wall, and aids in rotation and abduction of the arm (90° to 180°)	Surface of the upper eight ribs at the side of the chest	Along the entire anterior length of the medial border of the scapula	Long thoracic nerve (C5, C6, C7)
Pectoralis major	Sternal head adducts and medially rotates the arm, clavicular head flexes and adducts the arm, accessory for inspiration	Clavicular head→medial half clavicle Sternocostal head→Lateral manubrium and sternum, six upper costal cartilages and external	Intertubercular groove of the proximal humerus on its lateral aspect	Medial and lateral pectoral nerves (C6, C7, C8)

		oblique aponeurosis		
Pectoralis minor	Protraction of the scapula, depression of the shoulder	3rd, 4th, and 5th ribs close to their respective costal cartilages	Coracoid process	Medial pectoral nerve (C8, T1)
Subclavius	Stabilization and depression of the clavicle	First rib medially	Middle of the clavicle, inferiorly	Nerve to subclavius (C5, C6)
Coraco-brachialis	Flexion and adduction of the arm	Coracoid process	Middle of the humerus, medial aspect	Musculocutaneous (C5, C6, C7)
Biceps brachii	Supination and flexion of the forearm. Resists dislocation of the shoulder	Short head→Coracoid process Long head→Supraglenoid tubercle of the scapula and superior labrum	Radial tuberosity of radius and forearm fascia	Musculocutaneous nerve (C5, C6)
Triceps brachii	Resists dislocation of the shoulder, major	Medial head→Below the radial	Olecranon process of ulna and	Radial nerve (C6, C7, C8)

	extensor of the forearm	groove of the humerus Lateral head→Above the radial groove of the humerus Long head→Infraglenoid tubercle of the scapula	forearm fascia	
Trapezius	Lower fibers pull the scapula inferiorly, middle fibers retract the scapula, and upper fibers elevate the scapula and rotate it during abduction of the arm (90° to 180°)	Spinous process of C7 to T12, nuchal ligament, and skull	Scapular spine, acromion, and clavicle	Accessory nerve (C5, C6)



Picture 8: Muscles of anterior aspect of arm (Agur, Anne M.R.; Dalley, Arthur F, 2009, p. 523)



Picture 9: Muscles of anterior aspect of arm (Agur, Anne M.R.; Dalley, Arthur F, 2009, p. 523)

2.4 Ligaments

Ligaments are soft tissue structures that connect bones to bones. Below you can see the important ligaments in the shoulder.

2.4.1 Glenohumeral ligaments

Comprising a middle, superior, and inferior ligament, these three ligaments work together to create the glenohumeral joint capsule. It connects the glenoid fossa to humerus. Their strategic positioning helps safeguard the shoulder and prevents anterior dislocation, making this group of ligaments the stabilizer of the joint. (Chang, Anand, Varacallo, 2023)

2.4.2 Coracoclavicular ligament

The ligament consists of the conoid and trapezoid ligaments, extending from the coracoid process to the clavicle. It plays a crucial role in stabilizing the clavicle in coordination with the acromioclavicular ligament. Significant forces can lead to the rupture of these ligaments during injuries to the acromioclavicular joint. (Chang, Anand, Varacallo, 2023)

2.4.3 Coracohumeral ligament

This ligament reinforces the upper portion of the joint capsule. It is a robust fibrous structure that links the base of the coracoid process to the greater and lesser tuberosities. At its origin, the ligament is broad and thin, approximately 2 cm in diameter at the base of the coracoid. Laterally, the coracohumeral ligament divides into two separate bands that encircle the long head of the biceps tendon at the proximal end of the bicipital groove. (Chang, Anand, Varacallo, 2023)

3 SWIMMING TECHNIQUES/BIOMECHANICS AND PAIN

Swimming is often categorized alongside other overhead sports and activities like throwing, pitching, volleyball, and tennis. Nonetheless swimming has unique mechanical demands that necessitate a closer examination of shoulder mechanics.

In swimming, the force for propulsion primarily originates from the muscles around the shoulder girdle, which sets it apart from most other sports, where power typically comes from the legs through the trunk and arms. This difference makes the shoulders more susceptible to injury, especially when the scapula does not provide a stable foundation for the muscles controlling the glenohumeral joint. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.1 Freestyle

3.1.1 Technique, mechanics, and pain

The technique and mechanics of the freestyle stroke can be broken down into four phases, shown also in picture 10:

1. Arm entry and early pull-through
   The stroke begins when the arm enters the water, extending forward in line with the shoulder. This marks the start of the pull-through phase, where the arm begins its backward movement. The swimmer should position the palm and forearm facing backward, with the fingertips pointing downward for as long as possible to maximize propulsion.

2. Mid Pull-Through

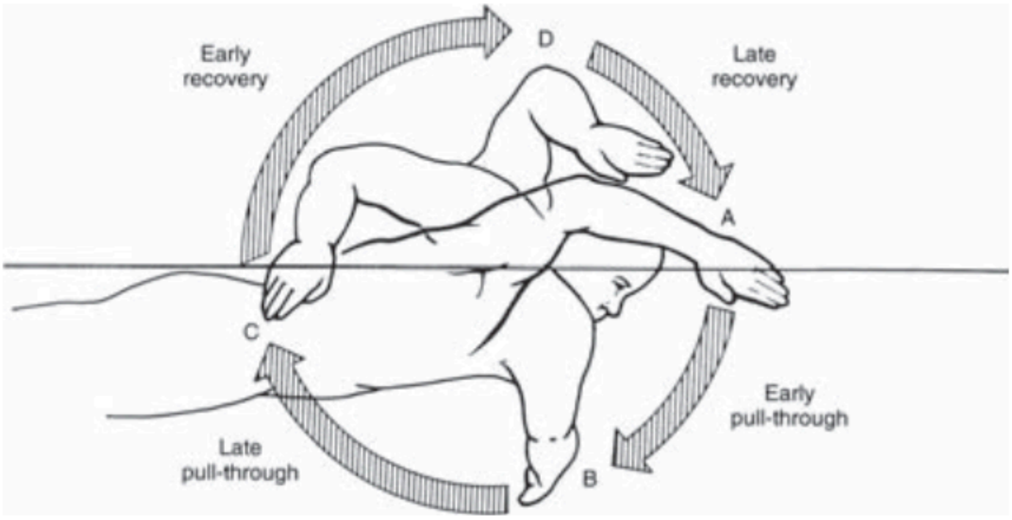
As the arm continues moving backward, the point where the upper arm (humerus) becomes perpendicular to the body marks the mid pull-through phase. This Is a key moment in the stroke as it sets up the power phase that follows.

3. Late pull-through
   Following the mid-pull through, the hand moves back toward the hip. The hand continues this motion until it exits the water, with the elbow leading the exit.

4. Recovery phase
   After the arm exits the water, the recovery phase begins. In this phase, the arm swings above the water to get back into position for the next stroke. The body also rotates naturally with each stroke, helping maintain fluidity and efficiency

Swimmers often experience shoulder pain during two phases of the freestyle stroke: early to mid-pull-through and hand exit to mid recovery. These phases increase the risk of humeral hyperextension, leading to discomfort. To compensate, swimmers may alter their stroke by widening hand entry or shortening the pull-through, which can reduce pain but may further increase hyperextension risks, especially with excessive body rotation during breathing.

To reduce strain, swimmers can adjust stroke timing to “catch-up” timing, where the recovery arm overlaps slightly with the underwater arm. This limits body rotation and decreases hyperextension risk. Additionally, a wider arm swing and relaxed recovery, without emphasizing a high elbow or wrist flick, can help prevent shoulder stress. Leading the recovery with the elbow ensures better mechanics and reduces injury risk. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)



Picture 10: Freestyle stroke (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.1.2 Muscle activity

Shoulder issues during freestyle stroke are often linked to the serratus anterior muscle. In healthy shoulders of swimmers, this muscle works continuously above 20% of its capacity to stabilize the scapula, but its prone to fatigue due to long swim distances. In Swimmers with shoulder pain, the muscles activity decreases, causing the rhomboids to compensate, which can lead to impingement on the rotator cuff.

The subscapularis muscle also works above 20% in healthy swimmers, but its activity similarly decreases in those with shoulder pain. In contrast, power muscles like latissimus dorsi and pectoralis major show no significant difference between swimmers with and without pain. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.2 Butterfly

3.2.1 Technique, mechanics, and pain

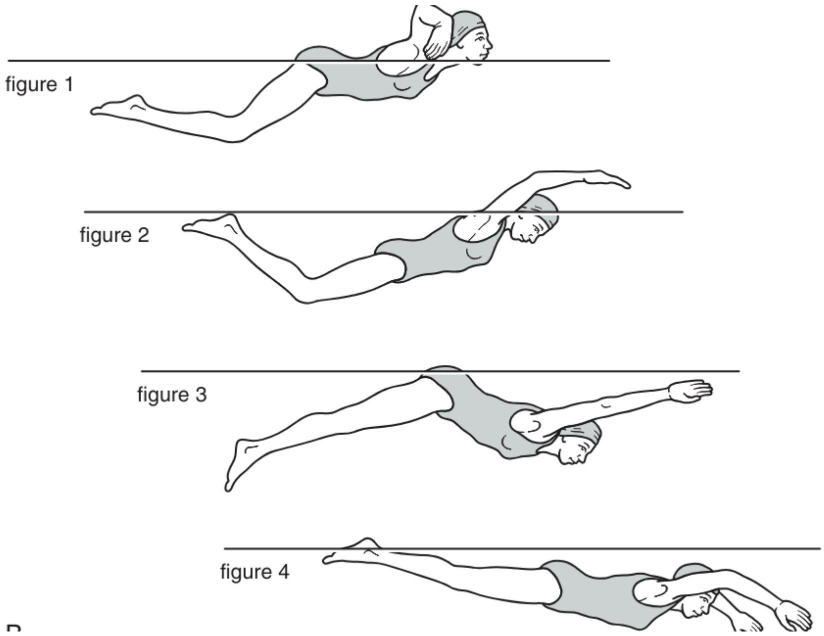
The butterfly stroke differs from freestyle and backstroke, as it involves a bilateral movement pattern where both arms move simultaneously, rather than in an alternating fashion. The body mechanics are also distinct, with an S-shaped pulling motion, seen from picture 11, and a body pivoting up and down at the hips, unlike the rotational movement around the body's central axis seen in freestyle and backstroke.

When doing butterfly stroke, the hands enter the water with arms extended forward, in alignment with the shoulders. As the arms enter the water, the upper body presses downward, helping to generate momentum and support forward movement. It's important for the arms to stay extended forward during this press, rather than angled downward. The degree to which the swimmer presses the chest down greatly impacts the following pull-through and the potential shoulder strain. If the chest presses too deeply, with the arms positioned above the torso, this can lead to humeral hyperextension, increasing the risk of shoulder pain during the early pull-through. Swimmers who feel discomfort in this phase can benefit from adjusting the depth of the upper body press, ensuring their arms remain in the line with or in front of the body. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

Picture 11: Butterfly stroke (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

Shoulder strain can also occur during the transition from the late pull-through to the recovery phase. At the start of the late pull-through, the arms are bent, and the hands are positioned beneath the hips. As the arms extend and hands sweep outward, they lift up and out of the water to initiate recovery. During this arm exit and recovery, there is a chance for internal rotation of the humerus, which can cause discomfort. To avoid this, swimmers should not overly emphasize lifting their hands high out the water during this phase. Instead, swimmers should aim to keep their hands close to the water's surface as they enter the recovery phase.

The stroke also features a body motion, where the swimmer lifts the upper body to take a breath during the underwater pull-through, as seen from picture 12. Ideally, the swimmer should use the momentum generated by the pull to raise their head and shoulders just enough to clear the water. However, many swimmers make the mistake of forcefully arching their back and throwing their head upward to breathe. This can disrupt the stroke's rhythm and place unnecessary strain on the body. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)



Picture 12: Butterfly stroke (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.2.2 Muscle activity

Shoulder pain often stems from altered activation of the serratus anterior and teres minor in the butterfly stroke. Both muscles are important for stabilizing the scapula. Swimmers with discomfort typically adopt a wider hand entry, reducing scapular rotation needs and lowering serratus anterior activation. During the pull phase, this reduced activity limits scapular stability, likely due to fatigue, making the serratus anterior less effective at supporting the shoulder.

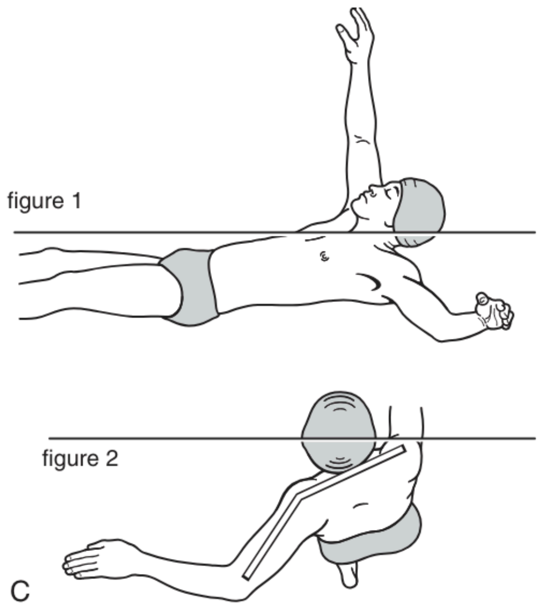
With an unstable scapula, the teres minor fights to control arm rotation driven by the pectoralis major, affecting propulsion and shoulder control. This muscle also shows reduced activation at the end of the recovery, adapting to the wider hand entry. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.3 Backstroke

3.3.1 Technique, mechanics, and pain

As seen from picture 13, the backstroke, like freestyle, uses alternating arm strokes, trunk rotation, and coordinated leg kick. Unlike freestyle, backstroke is performed in supine position. This position required attention to shoulder mechanics to avoid injury. Backstroke phases align closely with the freestyle phases. The pull-through starts as the hand enters the water, with the arm pushing toward the feet. At mid pull-trough, the humerus in perpendicular to the body, and in late pull-through, the elbow straightens as it exits the water, making the arm ready for the overhead recovery.

Proper rotation in the body is essential to protect the shoulder and maintain stroke efficiency. Ideally, the torso should rotate in sync with the arm's angle, yet many swimmers experience a delay, resulting in improper hand entry and humeral hyperextension. To prevent this, body rotation should begin at mid-recovery to keep the shoulders level at hand entry, continuing through pull-through with support from a strong leg kick. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)



Picture 13: Backstroke stroke (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

In the early pull-through phase, a deep arm position or downward press after hand entry can risk hyperextension if body rotation doesn't align promptly. Top backstrokers tend to keep their palms orientated toward the feet shortly after entry, maintaining the arm closer to the body to minimize strain. Swimmers experiencing shoulder pain might benefit from a shallower pull and keeping the arm near the body.

During late pull-through, exiting the water thumb-first is crucial to avoid excessive internal humeral rotation, which can pinch the supraspinatus against the acromion. In mid-recovery, the hand should rotate to allow re-entry with the pinkie leading and the palm facing out, optimizing shoulder positioning and entry alignment. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.3.2 Muscle activity

In backstroke, the muscle engagement differs from other strokes due to the swimmer's supine position. Teres minor and subscapularis are the primary muscles working during the pull-through phase. Yet these muscles are not ideally suited for generating high power. Even at peak pull-through moments, the latissimus dorsi, which is the power muscle in most strokes, exhibits around 30% less activity than teres minor and subscapularis in swimmers with healthy shoulders. This imbalance requires these smaller rotator cuff muscles to act as the primary drivers, which increases the strain on the shoulder.

Teres minor and subscapularis also act as endurance muscles. Remaining active at around 30% of their capacity throughout the pull-through. In swimmers with shoulder pain the activity in teres minor and rhomboids decreases during early recovery, weakening scapular retraction and limiting humeral clearance under the acromion, which can lead to impingement.

The supraspinatus also shows reduced activation in painful shoulders during mid pull-through, and this diminished engagement across key rotator cuff muscles may make it harder to position the shoulder correctly under the acromion, raisin the risk of discomfort and injury. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

3.4 Breaststroke

3.4.1 Technique, mechanics, and pain

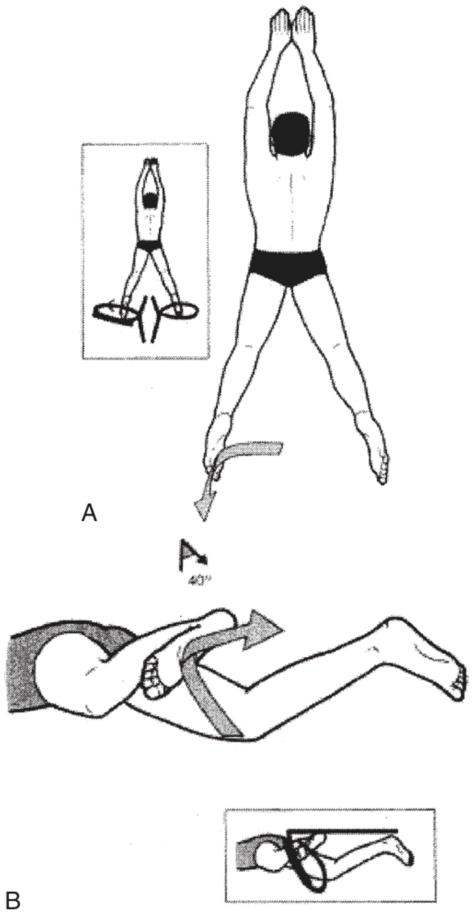
Breaststroke, the oldest of the competitive swimming strokes, is unique since the swimmer's arms remain in the water throughout the motion. Unlike other strokes, the legs serve as the main drivers of propulsion, with the arms playing the secondary role. Breaststroke tends to have lowest shoulder pain complaints, as there is minimal rotation of the body and the reduced risk of humeral hyperextension.

In breaststroke the arms move in bilateral pattern. They reach forward, sweep outward at the start of the pull-through while the elbows bend and then move inward in a circular motion towards the chest. After that the arms are extending forward to the recovery phase. This keeps the arms in front of the body, lowering the risk of shoulder strain.

In breaststroke, the body movement centres around the hips, like the butterfly. For breathing, swimmers lift their heads, and due to the natural motion of the arms, the action helps elevate the upper body more easily, reducing strain on the spine and lower back compared to the butterfly.

The breaststroke kick style, as seen from the picture 14, is the whip kick, which is a symmetrical and bilateral action. The kick starts with the legs fully extended, the knees bending as the heels move toward the buttocks, followed by an outward foot rotation where the toes point to the side. The legs push backward and inward until they are fully extended and together again. Forward momentum is mainly driven by the inside of the feet and lower legs pushing against the water. However, the foot and knee positioning during the propulsive part of the kick can sometimes lead to knee discomfort or groin strains.

Proper warm-up routines and conditioning exercises are recommended to help reduce these risks. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)



Picture 14: Breaststroke kick (M. Pink, T. Edelman, Mark, A. Rodeo, 2010).

3.4.2 Muscle activity

In breaststroke swimmers with shoulder pain, there is a notable increase in activity in both the subscapularis and latissimus dorsi muscles during the pull-through phase. This heightened subscapularis engagement, paired with the reduced teres minor activity, results in relatively greater internal shoulder rotation. This internal rotation can position the arm in a way that increases the risk of impingement. The increased activity of latissimus dorsi may be helped by depressing the humeral head, which could alleviate some of the impingement risk. (M. Pink, T. Edelman, Mark, A. Rodeo, 2010)

4 AIM AND PURPOSE OF THIS THESIS

The aim of this thesis is to increase the knowledge about the most common shoulder injuries in competitive swimming and how to prevent those injuries from occurring. The objective of the thesis is to give the swimmers, healthcare professionals, and coaches the knowledge and tools to prevent shoulder injuries through clear explanation of the theory and by doing the guidebook.

4.1 Research question

1. What kind of shoulder injuries are the most common in competitive swimming?
2. What kind of exercises a competitive swimmer should do to prevent shoulder injuries?

5 RESEARCH METHODS AND METHODOLOGY

5.1 Narrative literature review

Narrative reviews are a valuable way to summarize broad research topics, providing interpretation and critique rather than focusing on narrow questions like systematic reviews. They are flexible, allowing researchers to explore a topic from multiple perspectives, making them ideal for complex or evolving fields.

To ensure quality, narrative reviews should have a clear rationale, defined scope, transparent criteria for included studies, and an acknowledgment of any biases. Authors should explain why a narrative review is suitable for their

question and clearly describe their choices in selecting and interpreting the literature.
While narrative reviews don’t provide exhaustive evidence like systematic reviews, they offer accessible, nuanced insights. They are especially useful for education and identifying gaps in research, providing meaningful summaries that can guide future research and inspire fresh ideas. (Sukhera J, 2022)

The author chose to use narrative literature review because it allowed a broad exploration of diverse studies, offering flexibility to include wide range of research on different injury types, causes, and prevention methods.

5.2 Literature search

Conducting a literature review, the author needs to find studies and scientific articles related to the topic. The databases used for the review were PubMed, Google scholar, Urheilututkimukset.fi, and EBSCO. The databases were used to search studies and articles related to most common shoulder Injuries in competitive swimming and preventive exercises for these injuries. Keywords used in the search in English were Shoulder injuries in swimming, common injuries in swimming, competitive swimming, injury prevention in swimming, prehabilitation exercises for swimmers, shoulder injury prevention for swimmers, shoulder exercises for swimmers. In Finnish the keywords were Kilpauinti, olkapäävammat kilpauinnissa, olkapäävammojen ennaltaehkäisy uimareilla, yleisimmät olkapäävammat uinnissa ja harjoitteet olkapäävammoihin uinnissa.

Beside the keywords the author also made other limitations for the search. On of the limiters is that it must be either English or Finnish text, because of the authors limited language skills. The author also wanted to use ferly recent studies so it was decided that the publishing year must be between 2014-2024 for reflecting the current state of my topic. The author also wanted to make sure that the texts were full texts, so one limitation was that the full text is free to read or accessible by Satakunta university of applied sciences status.

The author also wanted to make sure that the research is reliable and valid. So only peer -reviewed research was selected for the review. From TABLE 3, all the inclusion and exclusion criteria are shown.

TABLE 3. Research material inclusion and exclusion criterias

Inclusion criterias	Exclusion criterias
The literature is related to the most common shoulder injuries in competitive swimming and the exercises to prevent shoulder injuries	The literature is not related to the most common shoulder injuries in competitive swimming and the exercises to prevent shoulder injuries
Is peer-reviewed	Is not peer-reviewed
Finnish or English literature	Other language literatures than Finnish or English
Published between 2014-2024	Published before 2014
The full text is free to read or accessible by SAMK status to read the full text	Is not free to read the full text or accessible by SAMK status to read the full text
The title, abstract or keywords of the material contains at least one of the following keywords: Shoulder injuries in swimming, common injuries in swimming, competitive swimming, injury prevention in swimming, prehabilitation exercises for swimmers, shoulder injury prevention for swimmers, shoulder	The title, abstract or keywords of the material does not contain at least one of the following keywords: Shoulder injuries in swimming, common injuries in swimming, competitive swimming, injury prevention in swimming, prehabilitation exercises for swimmers, shoulder injury prevention for swimmers, shoulder

exercises for swimmers, Kilpauinti, olkapäävammat kilpauinnissa, olkapäävammojen ennaltaehkäisy uimareilla, yleisimmät olkapäävammat uinnissa ja harjoitteet olkapäävammoihin uinnissa	exercises for swimmers, Kilpauinti, olkapäävammat kilpauinnissa, olkapäävammojen ennaltaehkäisy uimareilla, yleisimmät olkapäävammat uinnissa ja harjoitteet olkapäävammoihin uinnissa

5.3 Search results

In November 2024 an English search was conducted in databases PubMed, Google scholar, urheilututkimukset.fi, and EBSCO. Search phrases for these databases were: Shoulder injuries in swimming **OR** common injuries in swimming **OR** competitive swimming **OR** injury prevention in swimming **OR** prehabilitation exercises for swimmers **OR** shoulder injury prevention for swimmers **OR** shoulder exercises for swimmers. PubMed resulted total of 899 studies, which 21 were taken into a closer examination based on the title and abstract, and which 8 were taken into the review as a full text. In Google scholar there was 155 results, which of 10 was taken into closer examination and 2 of them by full text. In Urheilututkimukset.fi there was 0 result by the search phrases and terms. In EBSCO there was 11 results which none was taken, because they didn’t match with the search criteria.

Searches in Finnish was also done in October 2024 in database Urheilututkimukset.fi. Using search phrases Kilpauinti OR olkapäävammat kilpauinnissa OR olkapäävammojen ennaltaehkäisy uimareilla OR yleisimmät olkapäävammat uinnissa OR harjoitteet olkapäävammoihin uinnissa. There were 0 results, therefore 0 was taken into the review.

TABLE 4. Selection process

Database	Results with limiter	Included by tittle and abstract	Included by full text
Pubmed	899	21	8
Google Scholar	155	10	2
Urheilututkimukset.fi	0	0	0
EBSCO	11	0	0
Studies or articles included to the research			10

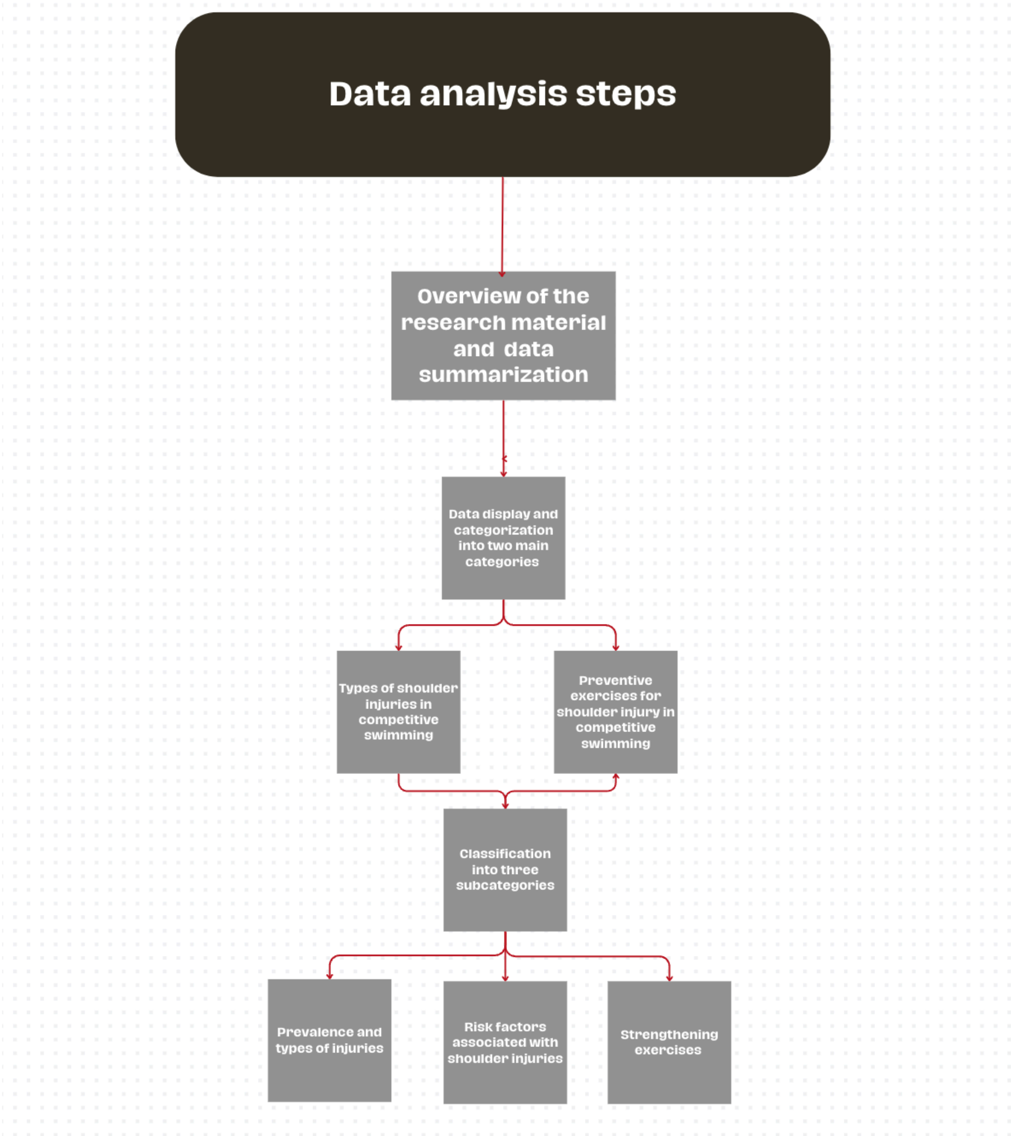
5.4 Analyzing the findings

Qualitative analysis is a process of interpreting and condensing data into a theoretical form. It involves examining what the data contains and meanings it conveys. The analysis aims to enhance the informational value of the data, guided by previous research and methodological frameworks. Various methods can be used, requiring researcher to select approaches that align with their research questions and theoretical contexts. Traditional tools included coding and thematic analysis, which are still relevant, but specialized methods exist as well.

Data analysis is a multi-step process, as seen from picture 15, that begins with familiarization and technical preparation of the data, such as transcription. The analysis itself involves careful examination and interpretation, moving from specific observations to broader insights. Various technical tool can aid in this process, but manual methods are also effective. Ultimately, researcher must clearly describe their analysis process, justify their choices, and explain their findings to ensure credibility and transparency. (Günther, Hasanen, Juhila, 2021)

Because the author conducted a narrative literature review, the analysis will involve qualitative synthesis. The author will summarize, interpret, and evaluate the findings from the studies to identify patterns, themes, and gaps.

Picture 15: The steps of the analysis



6 FINDINGS

In this chapter the author examines the findings of the 11 studies included in the literature review through the research questions found in chapter 4.

6.1 Prevalence and types of injuries

Brian J Tovin's (2006) study provides an overview of swimmer's shoulder, detailing symptoms, anatomical structures affected, and common types of injuries. Particularly focusing on soft tissue pathologies like rotator cuff issues. According to the study. Swimmer's shoulder is characterized by pain and dysfunction in the shoulder due to overuse, misuse, or abuse during training, it is typically related to structural issues and can involve various underlying pathologies. The main types of injuries falling under the "swimmer's shoulder" term are Rotator cuff pathologies, subacromial impingement, bursitis, glenohumeral joint issues, labral tears, and acromioclavicular joint injuries.

Tessaro, Granzotto, Poser, Plebani & Rossi (2017) study is examining the shoulder pain and its prevention in competitive teenage swimmers in Italy. It's a retrospective epidemiological cross-sectional study of prevalence. The study found 51% prevalence of shoulder pain among teenage swimmers over the past 12 months. The term "Swimmer's shoulder" according to the study refers to a non-specific condition prevalent amid competitive swimmers. Characterized by pain and dysfunction in the shoulder area, particularly in the anterior region during or after training. It was initially described by Kennedy and Hawkins in 1974. The study claims that there is no consensus on the specific causes of swimmer's shoulder, but the etiology is understood to be multifactorial.

The study done by Stirling, Sum, Baek, Michener, Barrack, and Tate (2024) is a multi-site survey study about shoulder pain in competitive swimmers. The study was done in the United States of America and the study stated that there are around 2.8 million youth competitive swimmers in the country, with shoulder pain being the most prevalent complaint reported among this population. The study highlights that nearly 50% of youth competitive swimmers experience shoulder pain, with notable prevalence among older, more experienced swimmers, and those with a history of shoulder injury.

The study by Sadek (2016) is examining the effects of TRX suspension training as a prevention program to avoid the shoulder pain for swimmers. The article states that the swimmer's shoulder incidence varies widely, reported as low as 3% and getting up as high as 67% among swimmers. When defined specifically as "significant shoulder pain that interferes with training", an incidence of 35% is noted in elite and senior-level swimmers.

6.2 Risk factors associated with shoulder injuries

A prospective study on the association of strength imbalance and shoulder injuries in swimmers done by Drigny, Gauthier, Reboursière, Guermount, Gremeaux, and Edouard (2020) examines the relationship between muscle strength imbalances in internal and external rotators and shoulder injury risk, highlighting that strength imbalance is a notable intrinsic factor in swimmers. The study highlights the notable association between shoulder rotator strength imbalances and the risk of shoulder injuries in adolescent swimmers. Specifically, a functional eccER (eccentric external rotators to concentric internal rotators) ratio below 0.68 prior to the season. It indicates a substantially increased risk for injury, suggesting that monitoring and improving rotator strength ratios could be crucial in injury prevention strategies for swimmers.

A cross-sectional study done by So, Lau, Kwok, Tse, and Man (2023) is investigating supraspinatus condition and shoulder pain. The study mentions that shoulder pain, due to high physical demand on shoulders during swimming, is prevalent among elite swimmers. The supraspinatus muscle plays a crucial role as a key mover and stabilizer of the shoulder but is very vulnerable to overloading and tendinopathy. The study was done with 44 elite swimmers from Hong Kong China swimming association. A significant finding was that 82 shoulder (93.18%) exhibited supraspinatus tendinopathy or tears. The study concluded that while structural changes in the supraspinatus tendon were not directly associated with shoulder pain, they may be indicative of shoulder strength levels. The findings suggest that practitioners should focus on evaluating and potentially improving shoulder strength, especially external rotator strength, to reduce injury risk.

Tovin’s (2006) study outlines that there are several intrinsic and extrinsic risk factors contributing to shoulder injury. These include improper biomechanics, muscle imbalances, scapular instability, and rotator cuff weakness. According to the study, overuse and repetitive shoulder movements are central to developing shoulder pain, because repetitive movement often lead to cumulative strain on the shoulder complex. Scapular instability and imbalances between internal and external rotators are both significant factors in shoulder injuries and increase of the likelihood of injury. The study also highlights that training errors such as excessive intensity, lack of warm-up, and improper form can increase the risk of shoulder injuries.

A review made by McKenzie, Larequi, Hams, Headrick, Whiteley, and Duhig (2023) examines shoulder pain and injury risk factors in competitive swimmers. It highlights that sudden increase in training load and reduced posterior shoulder strength endurance are significant risk factors. Swimmers experiencing shoulder pain also often showed increased activation of shoulder stabilizers, like the serratus anterior, which may indicate strain and compensatory stress on the shoulder.

Opposite to this, factors like internal and external range of motion, training frequency, stroke specialty, and age showed a small association with injury, suggesting they may be less crucial in assessing risk.

6.3 Strengthening exercises as a prevention

The study made by Tommasina, Trinidad-Morales, Martínez-Lozano, González-de-la-Flor, and Del-Blanco-Muñiz (2023) examined the effects of dry-land shoulder strengthening program with elastic bands. It focuses on balancing shoulder strength by addressing the imbalance often caused by repetitive internal shoulder rotations during swimming. Over eight weeks, an experimental group of swimmers used stretch band exercises in a diagonal Kabat pattern, and the control group continued to only do swimming training.
Results of the study indicated a slight improvement in external rotation strength and greater balance between the internal and external rotator muscles in the experimental group, although the changes were not statistically significant.

Tavares, Dias, Carvalho, Vilas-Boas, and Castro (2022) made a study examining the effectiveness of therapeutic exercise in musculoskeletal risk factors in relation to Swimmer's shoulder. The researchers highlighted the positive impact of strength focused programs, especially out of water exercises using elastic bands for improving shoulder rotator strength and endurance. Programs combining strength and stretching exercises showed potential benefits for shoulder posture, particularly in decreasing acromial distance and correcting forward head posture. Still, it did not significantly improve strength and endurance outcomes. Effective programs normally lasted 6 weeks and were conducted 2-3 times a week with progressive intensity. Out of water exercises in open kinematic chains, elastic band exercises targeting external and internal rotators and scapular muscles for example, led to more notable improvements. The study also highlighted substantial variability and low methodological quality across studies, indicating a need for further research to validate the findings.

The study done by Sadek (2016) investigated whether TRX suspension training could help prevent shoulder injuries in young swimmers by improving shoulder strength, flexibility, and stability. Ten youth swimmers underwent an 8-week TRX program, training three times weekly. Results showed significant improvements in strength, flexibility, and core stability. These are essential for supporting shoulder mechanics and lowering the risk of overuse injuries common in swimming. The study concluded that TRX training effectively strengthens the shoulder and core muscles, increasing balance and reducing injury risk, making it a valuable addition to swimmers conditioning programs.

A study made by Batalha, Paixão, Silva, Costa, Mullen, and Barbosa (2020) aimed to evaluate the acute effects of a shoulder rotators injury prevention training program using strengthening exercises in swimmers. The program contained resistance band exercises designed to improve shoulder rotator strength, muscle endurance, and balance. 23 national level swimmers participated in the study, undergoing isokinetic testing to assess internal and external rotator strength before and after the training program. Results showed no significant changes in shoulder strength or muscle balance following the program. Although some small non-significant shifts in muscle endurance were observed. The study concluded that the shoulder rotators strengthening program did not impair strength, endurance, or muscle balance. Based on the study, coaches can safely include shoulder strength exercises before swimming sessions.

6.4 Summary of the findings

From TABLE 5 you can see the summary of the 10 studies. The TABLE gives a visual summary of the key points reviewed in this literature review.

TABLE 5. Summary of the findings

Prevalence and types of injuries	- Swimmer’s shoulder is highly prevalent, showing rates ranging from 3% to 67% in competitive swimmers - Youth swimmers report high rate of shoulder pain and

	disability, particularly among those with more years of experience or those in higher age groups. - Among Italian and American youth swimmers, 49% to 51% experience shoulder symptoms over a year. - Injuries are often centred around the rotator cuff and anterior shoulder structures, with pain primary affecting the subacromial region. - Shoulder pain frequently impacts training progression and may vary in severity across levels of competitive swimming, emphasizing the need for early intervention and prevention strategies.
Risk factors associated with shoulder injuries	- Strength imbalances between the internal and external rotators, particularly in eccentric movements, were significantly associated with higher injury risk - Overuse and poor training mechanics were identified as key external risk factor, contributing to improper shoulder muscle recruitment and increased sensitivity to injury

	- Tendon abnormalities, such as in the supraspinatus tendon, were common, but not always directly associated with pain. Suggesting that underlying structural changes might influence performance without immediately resulting in discomfort. - Workload ratio and reduced posterior shoulder endurance were also linked to higher injury risk, indicating that training load management and endurance training could be preventive factors.
Strengthening exercises	- Dry land shoulder strengthening (isokinetic or weight training) can improve shoulder stability, though gains may vary based on exercises selection and load progression - Open kinetic chain (OKC) exercises performed out of water, were particularly effective for shoulder rotator strength and endurance, as shown in strength programs with five of fewer OKC exercises. - TRX suspension training showed positive results in improving physical conditioning for shoulder stability,

	suggesting it may help prevent swimmer's shoulder by targeting the shoulder stabilizers - A combination of strength-focused exercises improves strength endurance, a key modifiable risk factor, potentially reducing swimmer's shoulder incidence.

6.5 Comparison and reflection of the research material and findings

6.5.1 Study purpose and focus

Each study had unique focal points. The purpose and focus varied significantly across studies. Reflecting a blend of descriptive research and interventional research. Notably, only few studies directly explored qualitative impacts of specific exercise programs on shoulder health, suggesting a need for further emphasis on outcome-driven intervention analysis.

6.5.2 Study design and population

The studies lacked consistency in design and sample characteristics. Larger sample sizes and more consistent age groups would strengthen the findings, especially for interventions. Moreover, standardized strength assessment methods and randomized control trial designs would enhance comparability across studies.

6.5.3 Key findings on shoulder injury prevalence and risk factors

Findings in injury prevalence and risk factors are mostly consistent across studies. The studies are emphasizing muscle imbalance and overuse as primary contributors to shoulder pain. However, few of the studies explored individual biomechanical analyses or detailed assessments of swimmers' technique, which could provide more specific guidance on addressing risk factors.

6.5.4 Key findings on preventive exercise programs

Preventive exercise programs with strength focus were found beneficial across the studies. However, the studies varied in the types and intensity of exercises used, highlighting high variability in exercise program characteristics. This inconsistency suggests a need for standardized guidelines on effective exercise protocols and dosage of shoulder injury prevention.

6.5.5 Strengths and limitations of the studies

While each study contributed unique strengths, the lack of longitudinal and high-quality randomized control trial studies limits the ability to form a specific conclusive recommendation. Further research that standardizes exercise protocols and follows swimmers over longer periods could address these limitations and strengthen future conclusions.

The reviewed studies collectively emphasize that shoulder pain and injuries are prevalent among competitive swimmers, with risk factors largely centred around muscle imbalances, workload, and biomechanical inefficiencies. Preventive exercises focusing on shoulder strength show promise in mitigating these risks, though study variability in exercise protocols limits generalizability.

To improve the clarity and applicability of findings, future research should prioritize consistent methodologies including standardized assessments and intervention protocols, longitudinal studies to track injury outcomes and exercise program effectiveness over time, and greater use of randomized control trials to verify the impact of specific preventive exercises.

7 DISCUSSION

This thesis was done to answer two primary questions:
What kind of shoulder injuries are the most common in competitive swimming?
What kind of exercises a competitive swimmer should do to prevent shoulder injuries?
The findings from the reviewed studies provide insight into both the prevalence and nature of shoulder injuries among competitive swimmers as well as the role of specific preventive exercises.

The studies confirm that shoulder pain is a common issue between competitive swimmers, with reported rates ranging from 35% to over 50% in various youth and elite swimming populations. The types of injuries usually included shoulder impingement, rotator cuff tendinopathy, supraspinatus tendinopathy, and general pain localized in the anterior or lateral shoulder regions. These injuries are assigned to repetitive overhead movement that occur during swimming, resulting in chronic stress on the rotator cuff, supraspinatus, and biceps tendon. The supraspinatus muscle especially has been highlighted as highly susceptible to overuse and tendinopathy, further emphasizing the sensitivity of the shoulder in swimming.

Preventive strategies are important given the high injury rates in swimming. The studies show a range of exercises that may reduce shoulder injuries. Dry-land exercises, especially those targeting shoulder rotation strength and endurance, show positive but varied effects. Strength programs that include isokinetic or open kinetic chain exercises seem promising as they help improve both muscle balance and endurance, components crucial for stabilizing the shoulder during repetitive swimming movements. Suspension training, such as TRX, has also shown promise in strengthening shoulder stabilizers and preventing shoulder pain.

This thesis findings align with existing literature on swimmer's shoulder, where repetitive motion and high training volume are known to contribute to injury risk. In line with previous research, this review identifies supraspinatus tendinopathy and shoulder impingement as primary issues for competitive swimmers. Studies not included in this review have similar results that the prevalence of shoulder pain and injury often corresponds with training errors, high stroke volume, and lack of suitable shoulder strength and mobility conditioning.

Regarding preventive exercises, the review reinforces current views that dry-land training is beneficial. However, while traditional methods like resistance band and bodyweight exercises are often recommended, this analysis reveals that suspension-based exercises may offer additional stabilization benefits. Existing literature has also noted the importance of exercise programs that increase muscle balance, suggesting that imbalances between internal and external rotator strength play a role in injury onset.

7.1 Ethics

In conducting this thesis in collaboration with Porin Uimaseura, it is essential to recognize and address potential biases. To reduce selection bias, clear criteria were set for participant inclusion, there will be no participants. To prevent confirmation bias, an open-minded approach was used during data analysis.

Transparency is maintained regarding financial support from Porin uimaseura, there is no funds. Publication bias is avoided by committing to report all results impartially. Efforts will be made to counter cultural or organizational bias, aiming for balanced perspective. This thesis is committed to endorse academic integrity and contributing unbiased insight.

7.2 Future opportunities

In future there is a need for more high-quality random controlled and longitudinal studies that evaluate the effectiveness of specific exercise protocol over an extended period. This would help establishing a standard for guidelines for preventing swimmer’s shoulder. Future studies should aim to include a broader demographic, accounting for variation in age, experience, and physical conditioning to develop more inclusive preventive protocols that can benefit a wider range of competitive swimmers. Studies also should focus on stroke mechanics, training intensity, and rest intervals. That would provide further insights into modifiable extrinsic factors that contribute to shoulder pain. Research comparing the effectiveness of various stroke techniques in reducing shoulder strain could lead to better-informed coaching strategies.

8 CONCLUSION

This thesis aimed to examine the prevalence of shoulder injuries among competitive swimmers and the effectiveness of exercise-based prevention. Findings show that shoulder pain and injuries are widespread in competitive swimming, specifically involving rotator cuff tendinopathy, supraspinatus tendon issues, and shoulder impingement. These injuries are primarily attributed to the repetitive overhead motions in swimming, which place stress on the shoulder structures. To reduce these risks, dry-land exercises targeting shoulder

strength and stability were reviewed. The studies showed that resistance band routines, open kinetic chain exercises, and TRX suspension training can improve shoulder endurance, balance, and reduce injury.
For optimal prevention, coaches should integrate dry-land exercises focused on shoulder stabilization and balance into regular training, with an emphasis on muscle symmetry. However, limitations exist in current research; the lack of longitudinal studies and randomized controlled trials affects the ability to draw robust conclusions of long-term efficacy. Methodological inconsistencies across studies, including caried sample sizes and exercise protocols, further complicate direct comparison.

Overall, this thesis underscores the importance of proactive, individualized shoulder care in competitive swimming. By implementing targeted dry-land exercises and addressing early signs of shoulder discomfort, coaches and healthcare providers can play a vital role in minimizing shoulder injuries and supporting swimmer longevity and performance.

9 THE GUIDEBOOK

This guidebook is part of my thesis, and it is for the use of the coaches and swimmers of Porin Uimaseura. The exercises included in the guidebook are based on the literature review conducted in this thesis. The guidebook is done in Finnish for the understandability, because it is a Finnish swimming club.

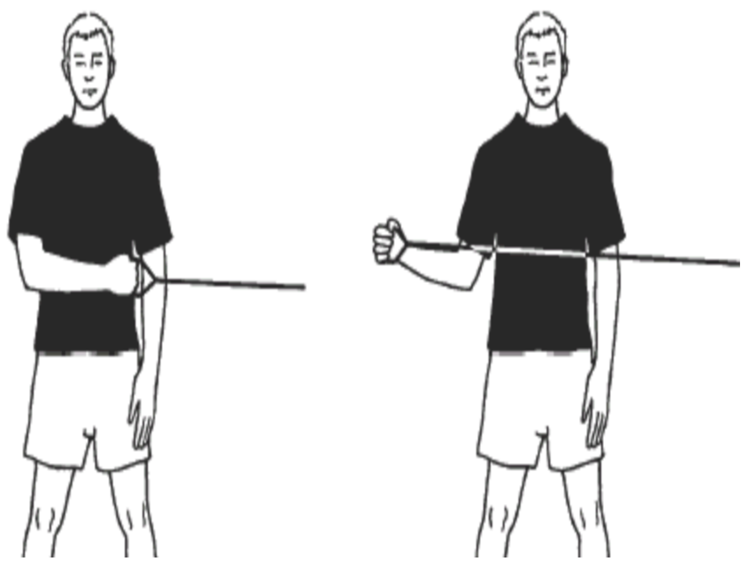
Harjoitteet kilpauimareiden olkapäävammojen ehkäisemiseksi

Harjoitteet voi tehdä joko lämmittelynä juuri ennen allastreeniä tai osana pitempää erillistä kuivaharjoittelua. Harjoitukset voi esimerkiksi tulostaa kuntosalin seinälle, josta uimarit voivat ne myös itsenäisesti tehdä.

ULKOKIERTO KUMINAUHALLA

Kiinnitä kuminauha vakaaseen pintaan kyynärpään korkeudelle. Seiso sivuttain kiinnikekohtaa kohti ja pidä nauhaa vastakkaisessa kädessä. Pidä kyynärpää 90 asteen kulmassa ja kyljessä kiinni. Vedä kättä ulospäin, keskittyen olkapään kiertoon,

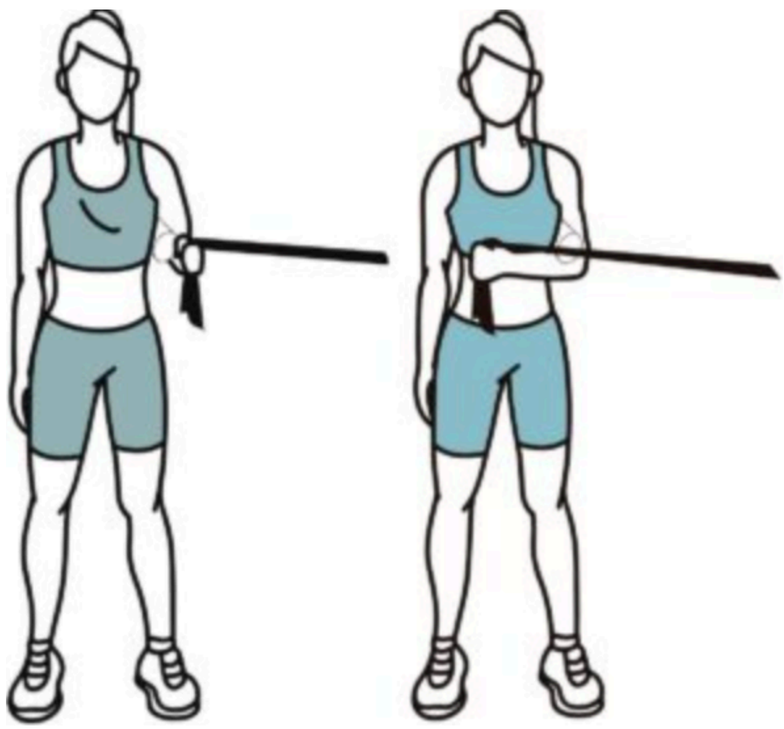
2–3 sarjaa, 12–15 toistoa per käsi



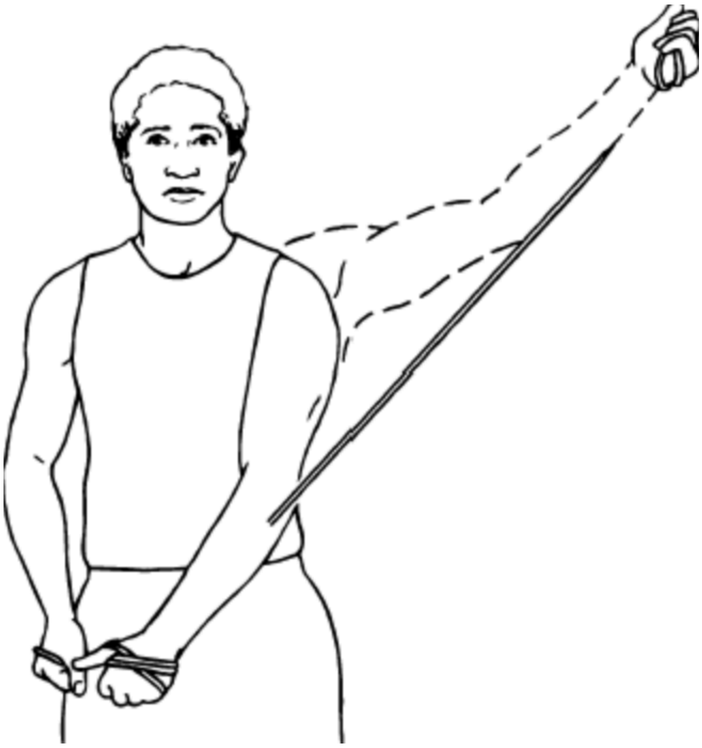
SISÄKIERTO KUMINAUHALLA

Käytä samaa asettelua kuin ulkokierrossa, mutta käytä sisempää kättä ja vedä kättä sisäänpäin.

2–3 sarjaa, 12–15 toistoa per käsi



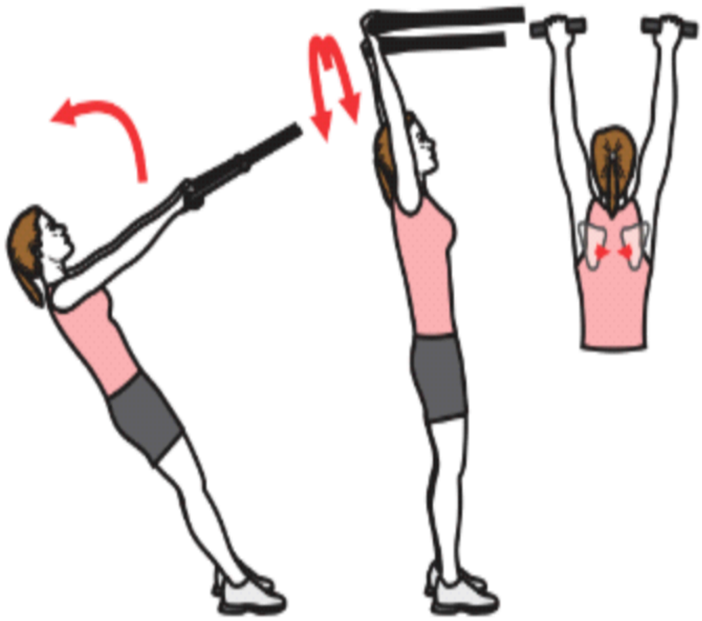
KÄDEN NOSTO SIVULLE KUMINAUHALLA



Laita kuminauha kiinni vakaaseen tasoon noin lantion korkeudelle. Aloita liike vastakkaisen lantion kohdalta ja nosta käsi sivukautta ylös. Toista liike.

2–3 sarjaa, 10–12 toistoa per käsi

TRX Y HARJOITE



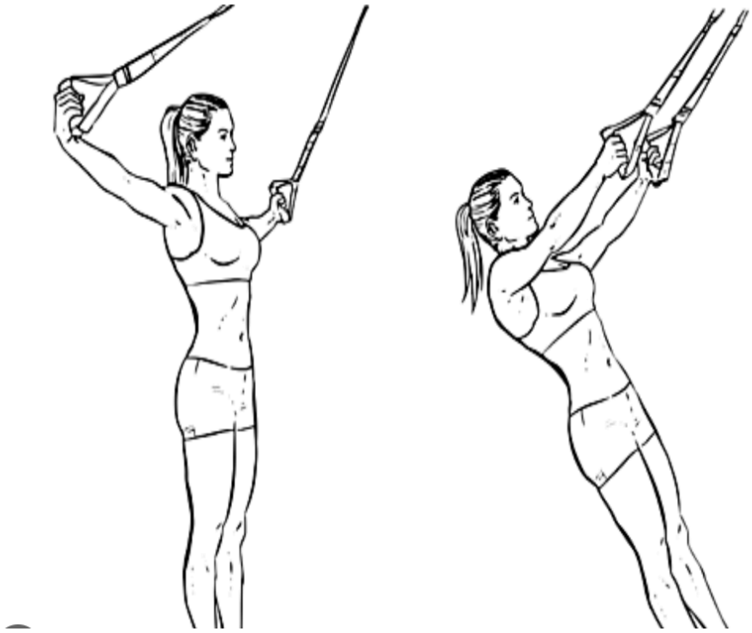
Säädä TRX harjoitushihnat sopivalle korkeudelle yläviistoon. Pidä kahvoista kiinni ja katse kohti kiinnikekohtaa. Pidä jalat tukevasti maassa ja nojaa taaksepäin keho suorana. Vedä itsesi eteen niin, että kädet menevät pään yläpuolelle Y asentoon. Toista liike. Pidä liikkeessä rauhallisuus ja hallitse liike.

2–3 sarjaa, 8–10 toistoa

TRX T HARJOITE

Pidä sama asettelu kuin Y harjoitteessa, mutta vedettäessä kädet menevät sivuille kuin T kirjain.

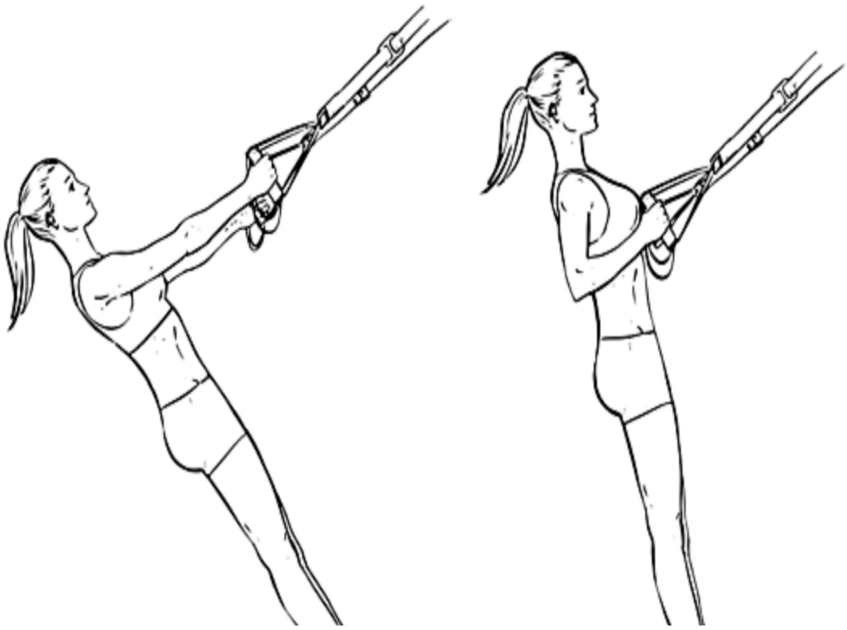
2–3 sarjaa, 8–10 toistoa



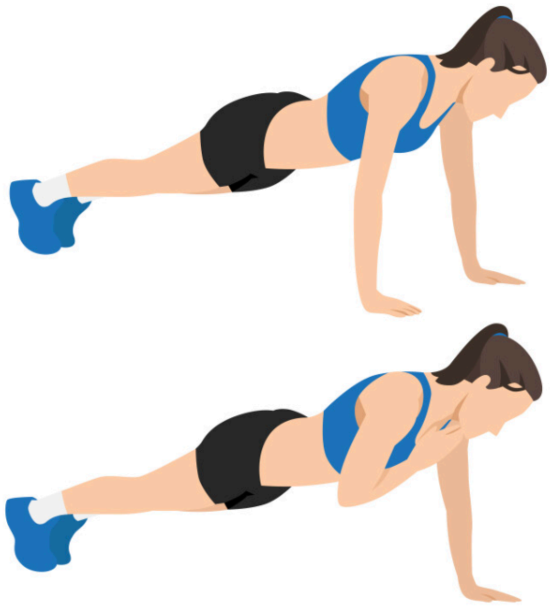
TRX SOUTU

Pidä sama asettelu kuin muissa TRX liikkeissä. Vedä itsesi ylöspäin, viemällä samalla lapaluita yhteen.

2–3 sarjaa, 8–10 toistoa



OLKAPÄÄN KOSKETUKSET PUNNERRUSASENNOSSA



Mene punnerrusasentoon ja pidä hyvä lapatuki, sekä asento tiukkana. Kosketa vuorotellen olkapäitä vastakkaisella kädelle samalla kuin minimoit vartalon muut liikkeet.

2–3 sarjaa, 10–15 kosketusta per puoli

REVERSE FLY LIIKE PIENILLÄ KÄSIPAINOILLA

Liikkeen voi tehdä kuvanmukaisesti tai seisten. Pidä käsipainoja kummassakin kädessä ja taivuta hieman lantiosta. Nosta käsivarret sivuille pitäen kyynärpäät hieman koukussa.

2–3 sarjaa, 12–15 toistoa.

TASAPAINOHARJOITE BOSU PALLON PÄÄLLÄ

Mene punnerrusasentoon bosu/jumppapallon päälle. Pidä asento tiukkana ja keskity pitämään tasapaino. Jos harjoite on liian helppo, kokeile yhdellä kädellä.

2–3 sarjaa, 30–60 sekuntia per sarja. Jos yhdellä kädellä, niin 20–30 sekuntia per sarja.

KUNTOPALLON HEITTO SEINÄÄN

Ota muutaman askeleen etäisyys seinään ja seiso kylki seinään päin. Heitä pallo seinään aloittaen liikkeen vastakkaisen lantion kohdalta. Keskity räjähtävyyteen ja vartalon kontrolliin.

2–3 sarjaa, 10–12 heittoa

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