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**Common Shoulder Injuries and Preventative Approaches in Volleyball  
Workshop for Physiotherapy Students Satakunta University of Applied  
Sciences**

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<p>Title of publication</p> <p>Common shoulder injuries and preventative approaches in Volleyball players, workshop for physiotherapy students in Satakunta applied science university.</p>		
<p>Abstract</p> <p>Shoulder injuries are one of the most common injuries in volleyball athletes. Spiking and serving are the quickest motions in volleyball, generating significant rotational and compressive forces in the shoulder. Due to the high loads, repetitive movements and athlete-specific factors, volleyball players are more prone to shoulder injuries. Injury prevention through targeted condition not only reduces health and profession impact but also decreases the cost on both athletes and their sport. To apply the effective preventative approaches, a physiotherapist must understand the volleyball biomechanics, shoulder biomechanics, and the knowledge of the injury risks and identification of them.</p> <p>The aim of this thesis is to improve the knowledge of physiotherapy students and having a workshop on common shoulder injuries, associated risks, and preventative approaches in volleyball. By following a narrative methodology, the findings of the current literature were used to enhance learning material for musculoskeletal physiotherapy at Satakunta University of Applied Sciences. This material includes biomechanics, injury risk, injury prevention, and common shoulder injuries in volleyball and overhead sports. The physiotherapy material was piloted as a workshop for physiotherapy students.</p>		

Shoulder injury prevention in volleyball is restricted by the lack of high-quality, long-term research involving large groups of attendance. Despite of the limitation, the study material provided in this thesis is based on widely accepted recommendation in current literature on injury risk factors.

Key words: Shoulders, sport injuries, Volleyball, Athletes, physiotherapy, biomechanics, preventative, SLAP, Rotator cuff, Scapula dyskinesia, GRID,GH instability, shoulder impingement, MRI.

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## 1 INTRODUCTION

### 1.1 Background, aims, and objectives

Volleyball is reputed a safer sport in comparison with other sports, like handball, baseball, and football, where there are more regular contacts and tackles. Nonetheless, volleyball athletes would be at injury risk regarding the sport techniques and skills, for instance, spiking, blocking, serving, and jumping. Volleyball shoulder injuries are almost similar to other overhead sports; shoulder issues may be caused by repetitive spiking and serving. (Bere et al., 2015a)

Shoulder injuries are considered the most common overuse injuries among volleyball players. Most volleyball shoulder movements consist of overhead movements, which require repetitive arm elevation to 90 degrees at the shoulder level or beyond. The shoulder joint is designed more for mobility than stability, making it particularly susceptible to injuries, especially in sports involving overhead movements, such as baseball, volleyball, tennis, swimming, etc. Volleyball skills, including spiking and serving, apply significant force on the shoulder complex. Moreover, these movements are performed within an extensive active range of motion at high speed. Additionally, it has been approximated that high-level volleyball players will engage in 40000 spikes in one season of contests. As a result, there is more vulnerability to shoulder injuries. (Reeser & Bahr, 2003, p.118)

According to Verhagen et al. (2004), and James et al. (2014), the rate of shoulder overuse injuries is reported as 16-32% of all volleyball overuse injuries. In one study that investigated 2,352 volleyball athletes, 46% of shoulder injuries were reported (Reeser et al., 2010).

The most common volleyball shoulder-related injuries are glenohumeral (GH) instability, impingement syndrome (rotator cuff tendinopathy), and suprascapular neuropathy (Reeser & Bahr, 2003, p.119). Moreover,

glenohumeral internal rotation deficiency (GRID) is reported in the dominant shoulder of overhead players such as volleyball (Thomas et al., 2009).

Research and studies between 2000 and 2024 indicate that the common shoulder injuries in volleyball are severe and can lead the player to end his/her career. These injuries are reported in 22-33% of all overuse injuries in volleyball (Beneka et al., 2007, 2009). 15-23% of volleyball players were suffering from shoulder injuries during a season (Forthomme et al., 2013). These types of injuries could cause an absence of 6.2 weeks for volleyball players in training sessions/competitions (Verhagen et al., 2004).

The primary aim of this study is to analyze data on common shoulder injuries among volleyball players and investigate various practical approaches for prevention, treatment, injury management, risk factors, and evidence-based recommendations for decreasing shoulder injury incidence. The objectives consist of reviewing existing literature and clinical data related to shoulder injuries and identifying the injury prevalence, assessing the biomechanical and physiological factors of these injuries.

The final goal is to improve SAMK physiotherapy students' knowledge about common shoulder injuries and prevention in volleyball.

## 2 STRUCTURE OF THE SHOULDER COMPLEX

The shoulder joint is known as one of the most complex joints in the human body, which involves four different articulations: glenohumeral, acromioclavicular, scapulothoracic, and sternoclavicular joints (Goetti et al., 2020). The shoulder joint has significant mobility because of its ball-and-socket structure, which includes a shallow glenoid cavity and a large humeral head, as well as the loose joint capsule. However, this also causes less stability. Stability comes from the rotator cuff muscles, ligaments, the biceps tendon, and a

fibrocartilaginous rim called the glenoid labrum that surrounds the glenoid cavity .(Agur & Dalley 2013, pp. 481-610)

## 2.1 Osteology and Arthrology of the Shoulder Complex

The shoulder girdle bony structure consists of the sternum, clavicle, ribs, scapula, and humerus Figure 1 (Donald A. Neumann, 2017, p.119).

### 2.1.1 Osteology

The osteology of the sternum features manubrium, xiphoid process, body, clavicle facets, costal facets, and jugular notch Figure 2 . The first two ribs are attached to the sternum at the costal facets bilaterally. The clavicles are connected to clavicular facets. At the superior part of the manubrium, between the clavicles, there is a jugular notch. (Donald A. Neumann, 2017, pp.119-120)

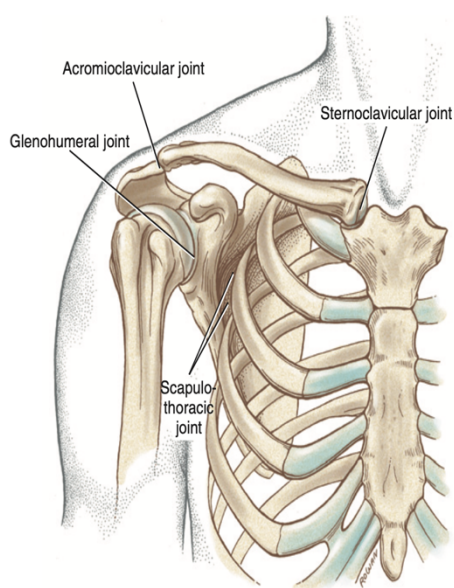


Figure 1. The joints of the right shoulder.(Kinesiology of the Musculoskeletal System, , p.120, 2017)

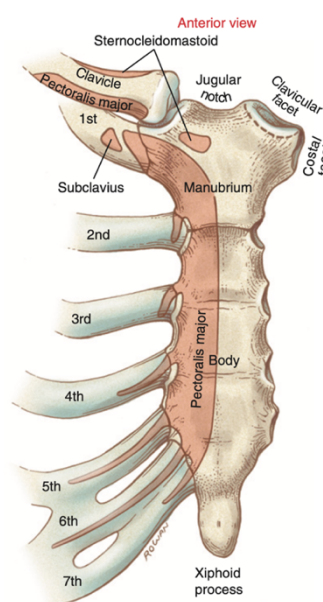


Figure 2. An anterior view of the manubrium (Kinesiology of the Musculoskeletal System, p.120, 2017)

The clavicle's osteology consist of the shaft, sternal end, costal facet, costal tuberosity, acromial end, acromial facet, conoid tubercle, and trapezoid line. Among these, the sternal end is notably one of its most prominent features,

where the clavicle and sternum are articulated together. At the acromial facet, the clavicle and the end of the acromion form a joint which is called the acromioclavicular joint. (Donald A. Neumann, 2017, p.120)

The scapula osteologic aspects are inferior, superior, and lateral angles, medial, lateral, and superior borders, supraspinous, infraspinatus, and infraspinatus fossa, spine, acromion, clavicle facet, glenoid fossa, coracoid process at the glenoid fossa, there is an articulation with the head of the humerus Figure 3 (Donald A. Neumann, 2017, p.122).

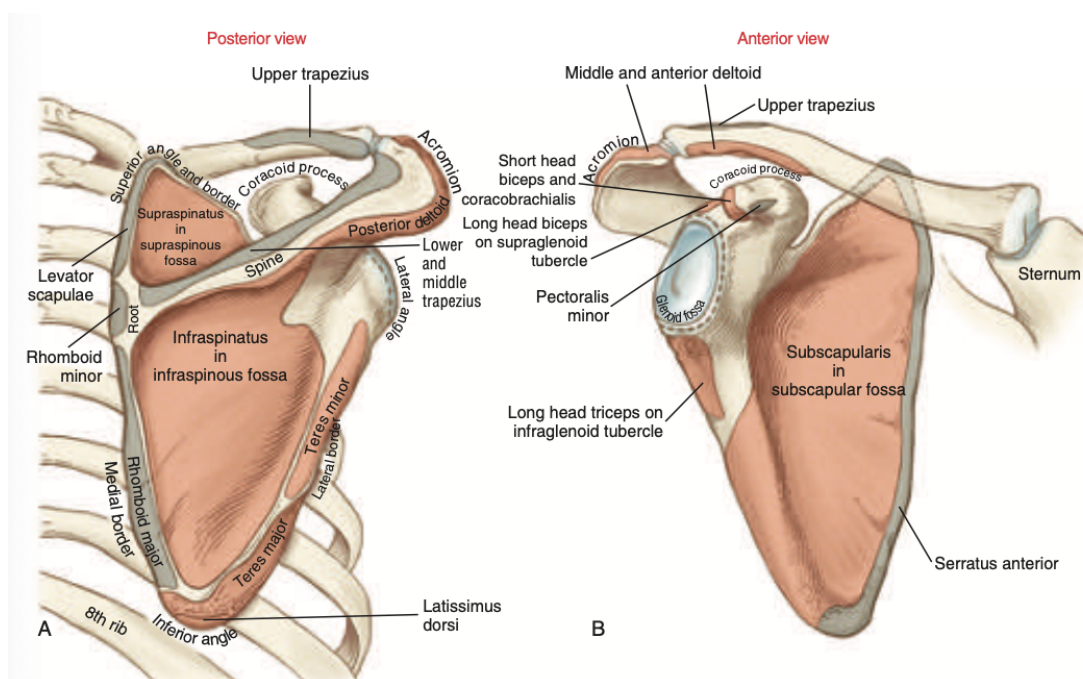


Figure 3. The anterior and posterior view of the scapula (Donald A. Neumann, 2017, p.121).

The shoulder joint is a ball and socket joint, and the head of the humerus, mostly the proximal to the mid humerus is the convex feature of the glenohumeral joint (Donald A. Neumann, 2017, p.122).

The humerus osteology comprises the head of the humerus, the anatomic neck, the lesser tubercle, the greater tubercle, the bicipital and radial groove, and the deltoid tuberosity (Donald A. Neumann, 2017, p.123).

### 2.1.2 Arthrology

The arthrology of the shoulder comprises sternoclavicular (SC), acromioclavicular (AC), scapulothoracic, and glenohumeral joint (Donald A. Neumann, 2017, p.125).

The sternoclavicular joint which is abbreviated as an SC joint is the most proximal joint at the shoulder complex. It is formed by the sternum and clavicle. The SC articulation consists of anterior SC, posterior SC, costoclavicular, and interclavicular ligaments Figure 4 . (Van Tongel et al., 2012)

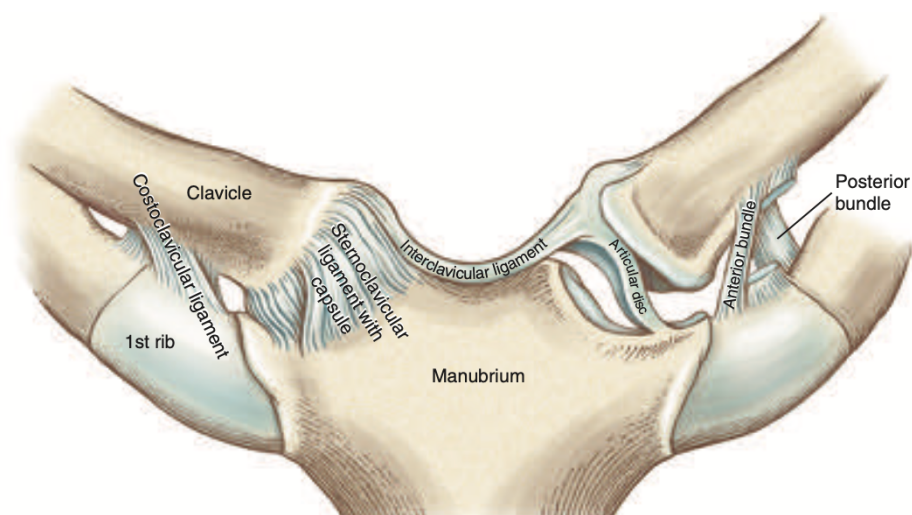


Figure 4. The sternoclavicular joints and their ligaments. (Kinesiology of the Musculoskeletal System, 2017, p.126,).

The Acromioclavicular (AC) joint is shaped by the distal part of the clavicle and the acromion process of the scapula. At AC joint gliding movement is exhibited, so it is a plane joint. (Donald A. Neumann, 2017, p.128) The AC joint is stabilized by inferior, superior AC joint ligaments and articular disc, coracoclavicular ligament, and deltoid and upper trapezius (Donald A. Neumann, 2017, pp.128-129).

The scapulothoracic joint is not considered a true anatomic joint. The anterior surface of the scapula is connected to the thorax wall. The scapula lies

between the 2nd and 7<sup>th</sup> ribs. The majority of movements at the scapulothoracic joint result from the coordination between the SC and the AC joints. Any limitation in the range of motion (ROM) of the AC and the SC can substantially restrict the ROM at the scapula, and eventually of the whole shoulder. (Donald A. Neumann, 2017, p.130-131).

The glenohumeral (GH ) joint is articulated by the spherical head of the humerus and the glenoid fossa of the scapula. This joint plays a vital role in moving the shoulder girdle and the scapula. The GH joint is regarded as the most mobile and unstable joint in the human body, and it is a synovial and multiaxial joint (ball and socket joint) that experiences more dislocation. A synovial membrane at the synovial joints minimizes the friction between the joint surfaces .(Donald A. Neumann, p.133, 2017; Jahn et al., 2016; Cowan et al., 2023; Rugg et al., 2018)

### 3 SOFT TISSUE STRUCTURE OF THE SHOULDER COMPLEX

#### 3.1 Capsule

The glenoid rim is surrounded by the loose fibrous capsule (Glenohumeral Joint, 2023). This capsule is connected along the glenoid rim and continues to the anatomical head of the humerus. The inner side of the capsule is lined by a synovial membrane. (Donald A. Neumann, 2017, p.134) The laxity of this capsule allows the upper extremities mobility. It is stabilized by the ligaments and muscle tendons. (Glenohumeral Joint, 2023) The stabilization of the GH is reinforced passively by the ligaments and actively supported by the local muscles, particularly rotator cuff muscles (Donald A. Neumann, 2017, p.134; Magee 2014, p.252).

### 3.2 Capsular ligaments

The primary ligaments at the GH joints include Coracohumeral ligament, and the superior, middle, and inferior glenohumeral ligaments, and the Table 1 (Donald A. Neumann, 2017, p.134).

Main Glenohumeral joints capsular ligaments	
Ligaments	Motions
Superior glenohumeral ligament	External rotation, inferior and anterior translations of the humerus head
Middle GH ligament	Anterior translation of the humerus head, external rotation
Inferior GH ligament: Anterior band, posterior band, and connecting to the axillary pouch.	Axillary pouch: 90 abductions Anterior band; 90 abductions of the full external rotation Posterior band: 90 abduction and full internal rotation
Coracohumeral ligament	Inferior translation of the humerus head, external rotation

Table 1. Main Glenohumeral capsular ligaments. (Donald A. Neumann, 2017, p.136).

## 4 THE SHOULDER GIRDLE FUNCTION

The angular movements at the glenohumeral joint are listed as flexion, extension, abduction, adduction, internal rotation, and external rotation (Baba & Luijckx, 2015b). Arthrokinematics of the GH include spin, inferior and superior glide, and posterior and anterior glide (Pratt, 1994).

The range of motion of a healthy shoulder can vary among individuals. Typically, a healthy shoulder should actively flex between 160° and 180°, extend

between 50° and 60°, externally rotate between 80° and 90°, internally rotate between 60° and 100°, and adduct between 50° and 75°. Normal abduction, which varies from 170° to 180°, it includes 120° of humeral abduction and 60° of movement resulting from the external rotation and upward movement of the scapula. After the initial 30° of abduction, scapular movement begins during the final 90° of the motion, with the humerus externally rotating by 90°. The coordinated movements of the humerus, scapula, and clavicle is known as scapulohumeral rhythm. Any disruption in this rhythm may indicate muscle weaknesses or issues with the stabilizing structures of the scapula or humerus. (Magee, 2014, p. 271-275)

## 5 BURSAE

Additionally, to synovial fluid, which minimizes friction within the GH joint, several synovial bursae that act like cushions surrounding the GH joint also help reduce friction. (Jahn et al., 2016; Lau & Weerakkody, 2016)

The five main shoulder bursae comprise as subacromial-subdeltoid (SASD), subscapular recess, subcoracoid, coracoclavicular, and supra-acromial bursae (Lau & Weerakkody, 2016). The SASD is commonly considered the primary bursa affected in shoulder disorders (Kennedy et al., 2017).

## 6 MUSCLES OF THE SHOULDER GIRDLE

The muscles of the shoulder complex can be divided into two functional groups: proximal stabilizers and distal mobilizers. The proximal stabilizers, which include muscles like trapezius and serratus anterior, originate from spine, ribs, and cranium and insert onto the scapula, and clavicle. On the other hand, the distal mobilizer muscles such as the deltoid and biceps brachii,

originate from the scapula and clavicle and insert onto the humerus or the forearm. The more coordinated, kinetic interaction between the stabilizers and mobilizer muscles makes the muscles function better at the shoulder complex. (Donald A. Neumann, 2017, p.149)

The rotator cuff muscles, including the supraspinatus, infraspinatus, teres minor, and subscapularis, are the primary muscle group responsible for stabilizing the shoulder joint. This group of muscles forms the musculotendinous cuff. Other muscles are followed by the pectoralis major and minor, the deltoids, the trapezius, and the serratus anterior. (McCausland et al., 2023)

The rotator cuff muscles, as mentioned above, are one of the most important stabilizers of soft tissues in the shoulder complex. The supraspinatus originates from the supraspinatus fossa, located above the scapula's spine. It crosses the shoulder joint and passes beneath the coracoacromial arch and over the glenohumeral joint before attaching to the greater tubercle of the humerus. (Okwumabua et al., 2023) The origin of the supraspinatus is from the infraspinatus fossa under the spine of the scapula, and the insertion of that is on the greater tubercle of the proximal humerus beneath the supraspinatus tendon. The teres minor is located inferiorly to the infraspinatus and originated inferiorly at the dorsal scapula at the lateral border of the scapula. The origin of the subscapularis is from its fossa, and the insertion is on the lesser tubercle of the humerus. (McCausland et al., 2023)

Rotator cuff muscles help to abduct the humerus up to 30 degrees and stabilize the GH joint, with the supraspinatus playing a key role (Okwumabua et al., 2023). The infraspinatus muscle is responsible for the external rotation of the humerus, while the teres minor assists with both the humerus abduction and external rotation. The subscapularis functions as an internal rotator and abductor of the humerus. (McCausland et al., 2023)

The rhomboid muscles (major and minor) insert on the medial border of the scapula. The rhomboid minor originates from the nuchal ligament and the spinous process of the C7-T1, while the rhomboid major arises from the spinous

process of T2-T5. (Okwumabua, Black, & Thompson, 2023) The rhomboid muscles serve as a downward rotators and retractors of the scapula (Donald A. Neumann, 2017, pp.152-153).

The trapezius is shaped like a large triangle that is located superiorly on the posterior part of the shoulder. The trapezius muscle is divided into three parts lower, middle, and upper. The muscle originates from the nuchal line of the occipital bone, the cervical, and the upper thoracic regions, and inserts laterally on the clavicle, acromion, and the spine of the scapula .(McCausland et al., 2023) The upper trapezius elevates the scapulothoracic joint and supports the posture of the shoulder girdle (Donald A. Nemann, 2017, p.149). The middle trapezius is one of the primary retractors of the scapula (Donald A. Neumann, 2017, p.153).

The deltoid muscles are located underneath the trapezius muscle. It abducts the humerus. The deltoid muscles are composed of three muscles that originate from the clavicle body, the scapula spine, and the acromion. The three deltoid muscles are inserted on the deltoid tuberosity of the humerus. The anterior deltoid facilitates flexion and medial rotation of the humerus, the middle deltoid functions as an abductor, and the posterior deltoid is responsible for extending and externally rotating the humerus. (Precerutti et al., 2010) Primary muscles for the scapulothoracic muscle actions are mentioned in Table 1. The rotator cuff functions are listed in Table 2.

Muscles Actions at the Scapulothoracic Joint	
Elevators	Upper trapezius, Levator scapulae, major and minor Rhomboids.
Depressors	Lower trapezius, Latissimus Dorsi, Pectoralis minor, Subclavius
Protractors	Serratus anterior
Retractors	Middle trapezius, Rhomboids (major and minor)
Upward Rotators	Serratus anterior, Upper and lower trapezius
Downward Rotators	Rhomboid, Pectoralis minor

Table 1. Muscle for the shoulder elevation (Kinesiology of the Musculoskeletal System, p.153,2017).

The role Rotator Cuff Muscles	
Supraspinatus	Abduction, stabilize the head of the humerus in Gh
Infraspinatus	External Rotation
Teres minor	External rotation
Subscapularis	Internal rotation

Table 2. Summary of rotator cuff function at the GH joint.

## 7 NERVE AND BLOOD SUPPLY

The brachial plexus innervates the entire upper limb, created by the merging of the ventral rami from C5 to T1 nerve roots. Most of the muscles which are located at the shoulder complex are innervated from 2 regions of the brachial plexus. (Donald A. Neumann, 2017, p.148) It is important to know the brachial plexus and the muscles that are innervated by them Table 1.

Brachial plexus Nerves and innervate the primary muscles			
Upper subscapular	Posterior cord	C5, C6	Upper fibers of subscapularis
Lower subscapular	Posterior cord	C5, C6	Lower fibers of subscapularis
Lateral pectoral	Proximal and lateral cord	C5, C6, C7	Pectoralis minor

Medial pectoral	Proximal and medial cord	C8, T1	Pectoralis minor and major
Subscapular	Upper trunk	C5, C6	Supraspinatus and infraspinatus
Subclavian	Upper trunk	C5, C6	Subclavius
Dorsal scapula	C5 nerve root	C5	Rhomboids, Levator scapula
Long thoracic	Proximal to trunks	C5, C6, C7	Serratus anterior
Nerve	Relation with Brachial plexus	Primary Nerve Roots	Muscles Supplied
Auxiliary	Posterior cord	C5, C6	Deltoid and teres minor
Thoracodorsal (Middle subscapular)	Posterior cord	C6, C7, C8	Latissimus dorsi

Table 1. Brachial plexus Nerves and innervate the primary muscles, (Kinesiology of the Musculoskeletal System, p. 148, 2017).

## 8 BIOMECHANICS OF VOLLEYBALL (SPIKE AND SERVE)

Although volleyball is globally regarded as a safe sport, most players are still at risk for specific injuries that result from the sport's structure and physical requirements. As a result, experience shoulder injuries, pain, and dysfunction are common among volleyball players. (Reeser et al., 2010b)

One of the most complex and specific overhead actions that is performed repeatedly in volleyball is “Spike” or attack. Professional athletes may perform this movement as many as 40,000 times a year. (Kugler et al., 1996b) Most of the shoulder pain is related to spikes, according to Shih and Wang (2019). The spike movement consists of several phases:

- **Windup phases:** The player begins by raising the arm to more than 90 degrees, with slight abduction (Figure 1; positions 1–2).
- **Cocking Phase:** The shoulder reaches maximum abduction and external rotation (Figure 1; positions 2–4).
- **Acceleration Phase:** The shoulder rotates quickly and adducts as the hand makes contact with the ball (Figure 1; positions 4–8).
- **Deceleration and Follow-Through Phases:** The shoulder continues to rotate and adduct to decrease the momentum of the arm (Escamilla & Andrews, 2009 & Rokito et al., 1998).



Figure 1. Phases of the volleyball spike. 1–2: Windup phase; 2–4: Cocking phase; 4–8: Acceleration phase; 8–9: Deceleration and follow-through phases, Seminati et al. (2015).

Another repetitive overhead movement in volleyball is the “Serve”, and it is played in 2 styles: “float” serves, and “jump” serves. Float serving is usually done where the volleyball players’ feet are on the floor and strike the ball in a way that causes the ball to float,” jump” serve is often more powerful than float serve, the volleyball players toss the ball into the air, jumps and strike it in a

motion similar to a spike. Although the volleyball serve has not been studied as comprehensively as the spike, most authors agree that “float” serving carries a notably lower risk of shoulder injuries than “jump” serving. This is because the float serve requires less extreme shoulder position, lower angular velocities, and places less force on the shoulder. (Reeser, Joy, et al., 2010; Seminati & Minetti, 2013)

The repeated performance of these technical movements (spike and serve) can lead to functional, structural, and biomechanical changes in the dominant shoulder, such as range of motion (ROM) changes, muscle strength, the shoulder capsule, and the scapula. (Borsa et al., 2008 ; Myers et al., 2005b)

Athletes who perform a throwing movement similar to a volleyball spike often experience an increase in the ROM of external rotation gain (ERG) and a decrease in the ROM of the glenohumeral internal rotation deficit; GIRD) in their dominant shoulders compared to the non-dominant shoulder. In addition, these athletes commonly have muscular imbalances in the dominant shoulder with lower ER strength than IR strength, which may be associated with shoulder pathology .(Noffal, 2003b; Yildiz et al.,2005)

## 9 COMMON SHOULDER INJURIES

Recent articles and studies indicate that the most common injuries prevalent among volleyball players are caused by repetitive movements, including SLAP tears, rotator cuff tendinopathy, scapular dyskinesis, GIRD, and biceps tendinopathy. This chapter will provide a detailed discussion of these injuries.(Shoulder Injuries in the Throwing Athlete - OrthoInfo - AAOS, 2024)

Different phases of rotator cuff injuries in elite athletes are classified from an acute phase of trauma or chronic overuse and repetitive microtrauma (Weiss et al., 2018b). Rotator cuff (RC) injuries can vary from mild contusions and

tendonitis to more severe conditions like chronic tendinopathy, partial tears (PTTs), and full-thickness tears (FTTs). The pathology of the RC can impact any individual, from casual to elite professional athletes, and in all ages, the RC is reported. (Varacallo et al., 2023) while subacromial impingement syndrome (SIS) is the leading cause of shoulder pain, rotator cuff tendinitis is frequently connected with shoulder impingement (Harrison & Flatow, 2011; Weiss et al., 2018).

Most of the RC injuries or ruptures occur at the posterosuperior junction where the supraspinatus and infraspinatus tendons attach to the humerus (Braun et al., 2009). The RC contusion is caused by acute traumatic mechanisms such as falling on the shoulder or direct contact with another player. The RC tendinopathy is common in players who were involved in repetitive overhead activities. Partial thickness ruptures may occur with tendinosis on the articular aspect of the RC tendons. (Weiss et al., 2018) Full-thickness rotator cuff ruptures extend from the bursal surface to the articular surface, and are not less common than the partial-thickness tears. (Feger & Weerakkody, 2018)

Scapular dyskinesia (SD) is a disorder that is marked by an irregular position at the resting of the scapula and irregular scapular movements while the upper extremities function, causing degeneration of the scapulohumeral rhythm. The most popular abnormal SD is scapular winging. In this disorder, the medial edge of the scapula is prominent. In this disorder, the long thoracic nerve is paralyzed, or scapular muscles are weakened. SD or scapular winging consequently can result in a lack of muscle strength, upper limb ROM restriction, and pain. (Pesen & VergiLi, 2023; Martin & Fish, 2007) SD frequently occurs in overhead sports regarding repeated motions in the shoulder joint, such as volleyball, basketball, and handball. This injury or disorder leads the shoulder joint to have other injuries, for instance, muscle strain, overuse due to fatigue, etc. (Pesen & VergiLi, 2023) The study of 12 investigations involving of 1401 athletes, including 1257 overhead and 144 non-overhead athletes, revealed that SD is more common in overhead athletes (61% ), such as volleyball compared to non-overhead athletes( 30%) (Burn et al., 2016).

Glenohumeral internal rotation deficit (GRID) is a progressive condition in overhead sports, where athletes experience a deficiency in internal rotation. GRID is accompanied by the loss of IR, which is  $> 20$  degrees or greater in comparison with the opposite shoulder. GRID injury involves tightness in the posterior aspect of the GH joint and rotator cuff muscles, which is caused by the repeated backswing phase during overhead movements, such as overloading the shoulder in volleyball. (Rose & Noonan, 2018) Forthomme et al.(2013) investigated high-level Belgian volleyball, which indicated notable GIRDs and ERGs in the preferred shoulder with no changes in the total range of motion( TROM). The combination of GRID and ERG in the dominant shoulder as opposed to the non-dominant shoulder, may lead to poster-superior impingement, which results from posterior capsule tightness and anteroinferior laxity of GH in a group of semi-professional volleyball athletes (Martelli et al., 2013).

One of the other common shoulder injuries is labral tears or lesions, divided into Bankart and SLAP(superior labral anterior posterior) injuries. Bankart lesion occurs at the anteroinferior aspect of the labrum, and it might cause a SLAP rupture to the biceps. (Magee, 2014, p.318) According to Snyder et al. (1990), the SLAP lesion classification is in four types: Type I is when the superior labrum is significantly frayed, but its attachments remain intact. In Type II, a small tear occurs in the superior labrum, causing instability in the labral-biceps complex, which is the most common type of SLAP injury. In type III, a bucket handle rupture of the labrum may move into the joint, but the labra-biceps attachments remain intact. In Type IV, the bucket handle rupture of the labrum continues to the bicep's tendon, allowing partial dislocation of the joint. Type II SLAP tears are more frequent in overhead sports such as baseball, volleyball, etc. Especially when there is an excessive lateral rotation, medial rotation deficiency, and posterior capsule tightness. This injury can cause shoulder instability and pain during overhead activities, which are critical for volleyball players. (Magee, 2014, p.318-319)

## 10 ASSESSMENT AND EVALUATION OF THE SHOULDER INJURIES

A proper and comprehensive evaluation of the patient is essential in musculoskeletal (MSK) assessment. Therefore, one of the most crucial factors in diagnosis is having a precise patient's history. The differential diagnosis process involves clinical signs and symptoms, physical examination, understanding of pathology and injury prevention, palpation tests, and imaging. To have an accurate diagnosis and treatment, a proper medical and injury history is essential. In this process, the examiner should listen to the patient and note the red flags signs, and symptoms. that would present the issue is not just related to MSK or more related to severe issues. Thus, the patient should be referred to the proper medical providers. Moreover, yellow flag symptoms and signs are significant as well for examiners. The physiotherapist should arrange sort of questions that are easy to answer and understand. (Magee, 2014, p.1-2) A series of questions are presented below:

1. What is the client's age and gender? A variety of conditions arise within particular age groups such as shoulder impingements in young individuals (15-35 years).
2. What is the client's post in volleyball?
3. Why has the client come to the physiotherapy?
4. Was there any microtrauma? To rephrase, what was the injury mechanism? Listen carefully to the patient, for instance, anterior dislocation of the shoulder often happens when the arm is in abduction and lateral rotation over its ROM.
5. Did the injury begin gradually or all at once? Does the pain get worse?
6. What areas are affected by the patient's symptoms? Check both the dominant and non-dominant sides. Patient descriptions themselves show the symptoms which leads the clinician to have a better diagnosis.
7. Where was the pain? Is it irritable or severe? Has the pain moved or spread?
8. What movements and activities do cause the pain?
9. Has the client already experienced this condition?

10. Is there an increase in the intensity, duration, or frequency of pain or other symptoms? The answer of these sort of question would help the examiner to have higher performance in treatment based on the present condition.

11. Dose the pain effect on the patient's situation?

12. Is the pain accompanied by rest, activity, certain posture?

13. Describe the pain? Cramping, dull, aching, sharp, shooting, burning etc.

... .

## 10.1 Special tests, signs, and symptoms

### 10.1.1 Tests for shoulder instability

There is a key point to differentiate between laxity and instability. A hypermobile or lax joint is not referred to as an unstable joint. Laxity indicates a certain looseness pathologically in a joint, thus the excessive ROM does not affect the shoulder function, and it is the same on both sides. If instability is present, it is typically unilateral, and the client is unable to control or stabilize the joint during the movement or when in a static position. In the stability case, muscle weakness or imbalance is often reported. (Magee, 2014, p.299)

The shoulder instability tests with moderate to high accuracy for posterior, anterior, inferior, and multidirectional instability are mentioned in Table 1.

Shoulder (GH)instability
Apprehension Test (anterior instability): moderate to high sensitivity, the accuracy rate is 81.7 %. (Gw et al., 2022)
Crank (apprehension) and relocation test (anterior instability): sensitivity of 46% and specificity of 56%. (Munro & Healy, 2009b)
Jerk test (posterior instability): a sensitivity of 73% and specificity of 98%. (Dhir et al., 2018)

Sulcus sign (inferior and multidirectional GH instability)
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Table 1. Shoulder (glenohumeral joint) instability tests. (Dhir et al., 2018; Munro & Healy, 2009b ; Gw et al., 2022).

### 10.1.2 Test for impingement

Primary and second shoulder impingement both happen at the anterior aspect of the shoulder. They are known as anterior primary and secondary impingements. The third shoulder impingement occurs posteriorly which is called internal impingement. Internal shoulder impingement is mostly seen in overhead sports such as volleyball. Shoulder impingement and instability usually happen together in throwing pattern movements. There are four different grades of shoulder impingement. Grade I refers to an injury with no symptoms of instability. Grade II is characterized by secondary impingement and instability caused by capsular and labral microtrauma. Grade III involves secondary impingement and instability resulting from laxity, while grade IV presents both primary instability and no impingement. (Magee, 2014, pp.299-300)

There are some special tests related to shoulder impingement syndrome in Table 2 .

Impingement tests
Hawking-Kennedy test: Sensitivity (62 – 92) %, Specificity (25 – 100) %. (Park, 2005)
Neer sign: sensitivity (0-93) %, specificity (31-100) %. (Hegedus et al., 2007)
Supine impingement test: for rotator cuff pathology, sensitivity of 76%, a specificity of 85%. (Meister et al. 2004)
Zaslav test: sensitivity 88%, specificity 96%. (Zaslav, 2001)
Coracoid impingement and Yokum test: like Hawking-test but a modified version. (Magee, 2014, p.315)

Table 2. Special tests for shoulder impingement.

### 10.1.3 Labral lesion tests

The players with SLAP tears experience localized pain at the posterior or posterior-superior part of the GH joint, particularly in shoulder abduction. The pain increases in overhead and behind-back arm movements. Popping, catching, and grinding sensations at the shoulder are reported by athletes. (Cools & Reeser, 2017)

Two main labral lesion tests are mentioned below in Table 3 .

Labral Lesion Tests
O'Brien test: specificity (28-73%) and sensitivity (63-94)% (Ebinger et al., 2008; Guanche & Jones, 2003)
Kim test: specificity 94%, sensitivity 80%. (Kim et al., 2005)

Table 3. Labral lesion tests .

### 10.1.4 Tests for muscle or tendon pathology

There are four different types of orthopaedic special tests regarding tendon pathology and muscle at the shoulder joint in Table 4.

Muscle or Tendon Pathology Tests
Speed test: sensitivity 20% and specificity 78% (Physiotutors, 2021)
Yergason's test: sensitivity 43% and specificity 79%. (Holtby & Razmjou, 2004)
Drop arm test: specificity 97 % and sensitivity 7.8 %. (Magee, 2014, p.290)
Empty can test: Pain 55%, muscle weakness 68%(specificity) and pain 36%, muscle weakness 77%9 sensitivity. (Magee, 2014, p.290)

Table 4. Special tests for Muscle or tendon pathology of shoulder joint.

### 10.1.5 Scapula Dyskinesis test

Scapular load test has the most specificity (85%) and sensitivity (90%) results among other Scapular Dyskinesis Tests (Magee, 2014, p.290).

Signs and symptoms of sick scapula are listed in Table 5.

<b>“SICK” Scapula Signs and Symptoms</b>
<ul style="list-style-type: none"> <li>• Prominence of inferior medial border of scapula</li> <li>• Protraction of scapula</li> <li>• Acromion less prominent</li> <li>• Coracoid is palpable.</li> <li>• Pectoral mine is tight.</li> <li>• Lack of full forward flexion</li> <li>• Short head of biceps is tight.</li> </ul>

Table 5. SICK SCAPULA, Orthopedic Physical Assessment, 2014,p.290.

Overhead athletes such as volleyball players with RC injuries may show excessive passive external rotation and restricted internal rotation when the shoulder is abducted to 90 degrees. This imbalance is referred to as GRID which means the deficiency of internal rotation in the affected shoulder of 20 degrees or more in comparison with the healthy side, which may be caused by both muscular and capsular tightness. (Burkhart et al., 2003b; W. B. Kibler et al., 2013) At the acute phase of RC contusion, transient reflex inhibition of the deltoid and RC muscles can be presented which shows muscle weakness. To differentiate the symptoms, it is important to rule out the cervical spine and elbow as potential sources of shoulder referral pain. (Weiss et al., 2018b)

GRID cases usually have localized pain posteriorly at the shoulder, and late backswing movement is often stimulating (Spiegl et al., 2014). Palpating the joint line posteriorly and soft tissues around of the affected shoulder can replicate the pain (Winter & Hawkins, 2014).

## 10.2 GIRD Test

The shoulder-specific test such as passive IR and total range of motion should be performed in supine to assess the GIRD. The test should be applied to 90 degrees of shoulder abduction and 90 degrees of elbow flexion. Both sides left and right need to be assessed, measured by a goniometer, and compared with each other. (Rose & Noonan, 2018)

posterior-shoulder tightness assessment, the player lies on the non-dominant shoulder, the dominant shoulder faces up, with 90 degrees of shoulder abduction and neutral rotation, and the dominant arm is optimally adduction, the transformation of the medial epicondyle of the humerus needs to be documented. This measurement should be performed on both sides, then compared both sides, dominant and non-dominant. Every 1 cm loss of adduction associates approximately with 5 degrees of loss of IR. Thus, a 4cm loss would be equal to 20 degrees of IR deficiency, because of that GRID is positive .(Rose & Noonan, 2018)

## 11 INJURY PREVENTION AND RISK FACTORS

### 11.1 Risk factors

The shoulder joint is one of the highest-risk injury areas in the human body particularly in overhead sports, especially in throwing and hitting, such as volleyball, baseball, tennis, and handball (Kibler & Safran, 2000). This chapter discusses most strategies related to preventing shoulder injuries and risk factors in volleyball.

The repeated performance of the technical overhead movements in spiking and serving can lead to functional, structural, and biomechanical changes in the dominant shoulder, including ROM changes, the capsular part of the shoulder, muscle strength, and scapula. These changes are modifiable. (Borsa et al., 2008; Myers et al., 2005c ) Some of those modifiable risk factors for shoulder injuries in volleyball are mentioned in Table 1 (Reeser et al.2006b).

Risk Factors
Intrinsic factors

Biomechanics, conditioning, core stability, GH internal rotation deficit, SICK dyskinesia, sex
Extrinsic Factors
Competitive situation and load

Table 1. Risk factors for shoulder injuries in volleyball players. (Reeser et al.2006b)

The connection between the adaptation and the frequency of shoulder injuries has been widely studied recently (Tooth et al., 2020) .There are certain intrinsic factors, like a reduced range of in internal rotation (Burkhart, Morgan, & Kibler, 2003; Shanley et al., 2012, 2015; Tyler, Mullaney, Mirabella, Nicholas, Munk 2014), and external rotator weaknesses have been linked to the higher risk of injuries (Clarsen et al., 2014; Forthomme et al., 2013; Wang & Cochrane, 2001). However, the impact of shoulder dyskinesia on shoulder injuries is not well-defined; some think that it could be a risk factor (Clarsen, Bahr, et al., 2014; Hickey et al., 2018; Struyf et al., 2013).

Extrinsic factors such as positioning on the court affect injury risk. Attacking players tend to experience injuries more than defensive players (Bere et al., 2015).

Rehearsal training and exercising load or the different conditions such as match/training sessions could impact the injury risk rate ( Verhagen et al., 2004).

Proprioception is as significant as muscle coordination dynamic stability to the shoulder joint in overhead sports such as volleyball (Zarei et al., 2021). A lack of proprioception can disrupt muscle nerve control, leading to muscle imbalances and joint instability (Fyhr et al., 2015). Despite the fact the proprioception exercises training impact is not evident enough, proprioception could be improved by adapting the muscle spindles' sensitivity and enhancing the awareness of the joint position (Ashton-Miller et al., 2001). To perform the spike and services, which are considered a high-demand throwing activity in

volleyball, necessitates well-developed muscle coordination at the shoulder joint. This harmony is accomplished through the proprioception. (Seminati et al., 2015b)

Environmental injury, such as the court, equipment, spectators, temperature, and weather, is reported as one of the general risk factors in volleyball-related injuries. The most arguable environmental factor is heat illnesses. For instance, heat stress may cause heat cramps, heat exhaustion, and heat stroke. The player might experience dizziness, restlessness, confusion, etc. (Reeser & Bahr, 2003, pp.87-89)

## 11.2 Prevention program

To prevent repeated injuries in athletes involved in overhead athletes, four key steps should be followed: 1. The risk factors should be specified for injuries and re-injury; 2. The risk factors should be defined as return-to-play requirements; 3. Numbers 1 and 2 must be assessed and measured by reliable, valid tools and procedures; and 4. In every single athlete training program, preventative approaches need to be arranged and planned to prevent re-injury. (Cools et al., 2015)

To prevent sports injuries in overhead sports such as volleyball, baseball, etc., the knowledge of the sport demands and the mechanism of the sport is essential (Pasanen & Leppänen 2020).

One of the prevention strategies for shoulder injury prevention in volleyball is having an effective and useful warm-up before the training. These exercises should be performed two times a week. (Tooth et al. 2023)

According to Tooth et al. (2023), the preventative program in Table 1 is reported to be effective for volleyball players. Moreover, this program was more productive and useful for men than women players. This warm-up plan

concentrates mostly on neuromuscular control, eccentric and concentric rotator cuff muscle strength, scapular stabilization, and core stability. (Tooth et al., 2023)

<b>Running exercises-3 minutes</b>	
Running	45 seconds
Shoulder circumduction	45 seconds
Cocking movements	45 seconds
Change of directions	45 seconds
Block and jump	45 seconds
Sprint	45 seconds

<b>Strengthening-core stability-proprioception- 18 minutes</b>	
Shoulder External strengthening with resistance band: <ul style="list-style-type: none"> <li>• 90 abductions</li> <li>• 90 abductions+ rotation</li> <li>• Standing on one leg+ abduction in 90</li> </ul>	30 reps for each exercise
Core stability: The player is kneeling down on the floor, Infront of the wall, he/she are leaning on a medicine ball on the wall, trunk is in a plank position( sagittal plan). <ul style="list-style-type: none"> <li>• 90-degree shoulder flexion</li> <li>• 120 degree of shoulder flexion</li> <li>• In lung position with 120-degree shoulder flexion</li> </ul>	3 * 30 seconds
Proprioception I:	20 reps on each side

<p>The player is standing on one leg in front of the wall and hold a medicine ball.</p> <ul style="list-style-type: none"> <li>• Single leg</li> <li>• On tiptoes</li> <li>• On tiptoes with a jump at the end of each repetition</li> </ul>	
<p>Proprioception II: with a resistance band</p> <p>Standing on both leg, shoulder in cocking position, to perform shoulder stabilization rhythm.</p> <ul style="list-style-type: none"> <li>• Forward and backward movements of shoulder</li> <li>• Shoulder movements to right and left.</li> <li>• Shoulder movements in Multi direction(forward, backward, left, and right)</li> </ul>	30 reps
<p>Passing:</p> <p>Facing the wall, in squat positioning (knee flexion 90 degree), performing passing movements against the wall</p> <ul style="list-style-type: none"> <li>• With volleyball</li> <li>• With 2-kg medicine ball</li> <li>• Medicine ball elastic ball</li> </ul>	3 *30 seconds
<p>Polymetric training: external rotators</p> <p>Arm in cocking position, dropping, and catching a ploy-ball.</p> <ul style="list-style-type: none"> <li>• Lung positions</li> <li>• On tiptoes +lung position</li> <li>• Single leg squat</li> </ul>	3*30 reps

Push up: Plank position, hands are at shoulder width. <ul style="list-style-type: none"> <li>• Push-up (normal)</li> <li>• Push-up with leg extension</li> <li>• Push-up on medicine ball</li> </ul>	2*30 reps
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Table1. Warm-up routine for volleyball players. (Tooth et al., 2023)

The final exercise is performed in a way that the players are standing in line, approximately 20 meters away from a wall. The first player is responsible for sprinting to the wall, smashing against the wall, and returning to his/her position. All players should perform the same. The aim is reaching to possible repetitions during three minutes by controlling the ball and no ball dropping. (Tooth et al., 2023)

Proper and precise spiking and serving techniques should be taught and adopted by all players in volleyball and athletes in overhead sports. In addition, shoulder exercises in the training should be carefully managed, if the loading and intensity is to be increase, it is suggested to minimize additional loads and stress on the shoulders. Regarding this, the “backswing” style spike technique may be more safer and efficient ( providing 5% increase in spike speed) for the shoulder in comparison with the “elevation” style. (Seminati et al., 2015b)

A shoulder prevention program stated by FIFA in “FIFA II+ Shoulder” for goalkeepers is recommended for overhead sports such as volleyball. (Ejnisman et al., 2016; Eshghi et al., 2020) The FIFA program includes three parts: general warm-up, strength and balance development training of the shoulder, elbow, wrist, and finger muscles, and advanced exercises for core stability and muscle control. The entire program concentrates on neuromuscular control, eccentric rotator strength, core stability, and agility. The players should be trained based on this program three times a week. The warm-up should be performed for 7 minutes, strength and balance training should be done for 9-10 minutes at three sets of 15 repetitions, and the last one, the player must perform the

exercises at high velocities with 5-6 sets of 15-20 repetition, not more than 9-10 minutes Table 2 . (Ejnisman et al., 2016b)

<p><b>Warm-up</b></p>	<ul style="list-style-type: none"> <li>• Run: relaxed walking and running, the speed can be increasing in 5 minutes step by step.</li> <li>• Throw the ball in the chest (1 min)</li> <li>• Spinning movements with the hands (1 min)</li> </ul>
<p><b>Strength and balance of shoulder with Tera band and weight</b></p>	<p>External rotation:</p> <ul style="list-style-type: none"> <li>• Neutral external rotation</li> <li>• ER in 45-degree shoulder abduction.</li> <li>• ER in 90-degree shoulder abduction</li> </ul>
	<p>Internal rotation:</p> <ul style="list-style-type: none"> <li>• 90-degree elbow flexion</li> <li>• 90-degree elbow flexion+ 45-degree abduction</li> <li>• 90-degree elbow flexion+ 90-degree abduction</li> </ul>
	<p>Push up:</p> <ul style="list-style-type: none"> <li>• Plank (normal push up)</li> <li>• Push up with extra weight (5 kg), put the weight on the back.</li> </ul>

	<ul style="list-style-type: none"> <li>• Push up+ more than 5kg+ raising the leg (left and right)</li> </ul>
<p><b>Core stability and muscle control with advanced exercises</b></p>	<p>Scaption:</p> <ul style="list-style-type: none"> <li>• Rise the arm+ ER (30 degrees in frontal plane) to the shoulder height, hold the weight.</li> <li>• The same as before+ heavier weight</li> <li>• Hold heavier weight than previous level.</li> </ul> <ul style="list-style-type: none"> <li>• Jump and throw the ball over the head (elbow extended within jumping)</li> <li>• Throw the ball over the head with one arm (change the hand, time to time)</li> <li>• Throw the ball to the sides with an extended elbow.</li> <li>• Plank positioning, jump on the mini trampoline with the arms, palms on the mini trampoline, keeping the elbows straight.</li> <li>• Walking on hands, with legs up, move backward, and forward to the sides.</li> <li>• Plyometric external rotation: flexed elbow 90 degrees, flexed and abducted arm in 90 degrees, doing by elastic band, movement from neutral to lateral rotation quickly.</li> </ul>

Table 2. FIFA 11+ shoulder injuries prevention program (Ejnisman et al., 2016).

As stretching exercises are significant for practitioners, based on two systemic reviews which were reported by Ellenbecker (1995) for clinic sports medicine and Van Der Hoeven and Kibler (2006), have indicated that there is no definitive proof to value and validate flexibility to prevent injuries. In both studies, however, it is emphasized that there is no adequate justification to stop the stretching exercises in the training program.

Stretching and mobilization exercises of the shoulders should be considered in volleyball training to enhance and prevent capsular tightness which tends to shoulder injury (Challoumas et al. 2016b).

According to the study done by Maenhout et al. (2012b), the stretching exercises for tendinopathy are suggested to be done on 3 repetitions of 30 s with a 30-second rest between the repetitions, 2 to 3 times per week.

In the study which is done by Cools et al. (2012b), the effect of two types of stretching was compared for internal rotation deficit in both sides left and right, angular (A) and non-angular (NA) stretching. The angular stretching consists of “sleeper-stretch”, and “cross-body-stretch”, and the non-angular stretching group includes “end-range dorsal glide mobilization”, and “mid-range caudal glide mobilization”. As a result, both types of stretching A and NA would increase ROM and function, and decrease the VAS scores regarding shoulder impingement for overhead sports such as baseball, volleyball, etc.

It is recommended to perform both modified “sleeper-stretch” and “cross-body-stretch” for asymptomatic athletes, 30 seconds minimum 4 repetitions with each stretch (Wilk et al., 2013).

One of the other stretching techniques that is offered by Hammons EdD et al., (2015), is the prone passive stretching technique. This stretch should be applied passively for 30 seconds each time, 3 times a week, and a minute break

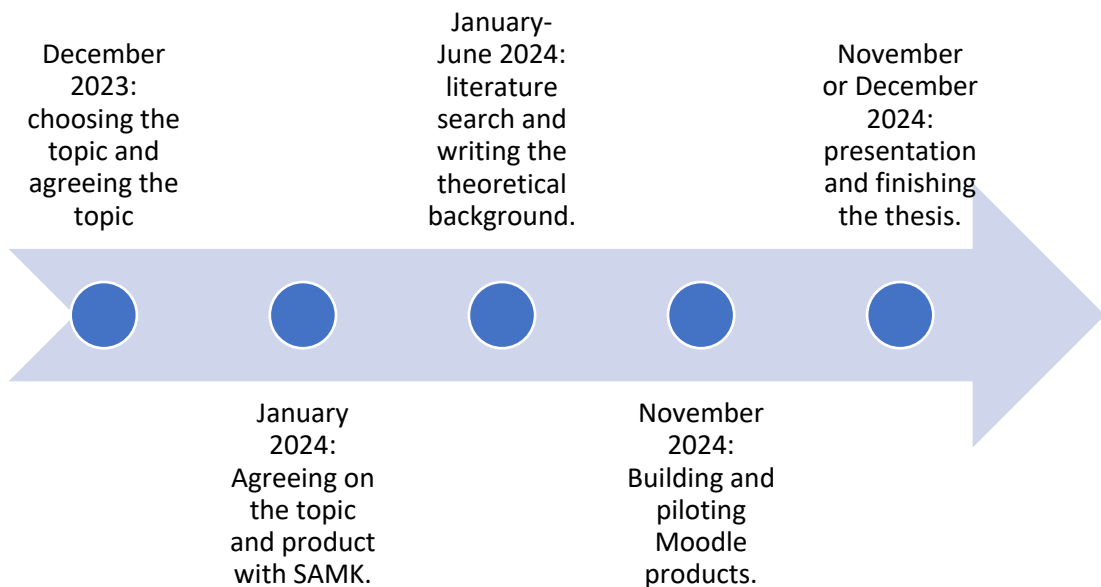
between each stretch. In conclusion, the prone-passive stretch is equally effective as the cross-body stretch in improving ROM in GH internal rotation. ( Hammons EdD et al., 2015)

The stretching exercises should be performed slowly and continuously and maintain the stretching position for a minimum of 45 minutes. Nonetheless, excessive stretching exercises would cause more laxity and shoulder instability in GH joints in players with a lax GH. It is essential to consider that the stretching program should be individual. (Reeser & Bahr, 2003, p.103)

The strength training program should consist of primary shoulder stabilizers of GH, rotator cuff muscles, and scapula stabilizers. Some strength exercises, such as bench presses, pull-downs, and pullovers, can increase the risk of shoulder injuries if performed alone. Since these exercises target only the deltoids, pectoralis major, and latissimus dorsi, they may enhance arm speed and torque, causing extra strain on the stabilizers of GH. If these exercises were combined with rotator cuff strength and scapular control exercises, the risk factor would be minimized. (Reeser & Bahr, 2003, p.103-104)

It is recommended that prevention strategies for shoulder injuries in volleyball should emphasize decreasing the spikes and jump serve repetition (load), improving technique, and fixing potential strength and flexibility muscle imbalances through a proper training program that consists of scapular stabilization and core strengthening. (Seminati & Minetti, 2013; Smith et al., 2008 )

## 12 THESIS PROCESS



## 13 DESCRIPTION OF THE METHODS

To appropriately assess and evaluate the body of research on shoulder injuries and preventive strategies in volleyball players, this narrative thesis used a systematic clinical trial, randomized controlled, narrative review, and cohort studies.

All SAMK physiotherapy students got clear information and structures about the workshop's purpose. Everyone needed to understand about the subjects and that there were some physical activities.

Whatever personal stories or examples were shared in the workshop were kept private. Everybody respected each other's privacy.

Taking part in the workshop was their choice, and they could decide to stop anytime without any problems.

When every student did practical activities, especially things like hands-on therapy and tests, safety was prioritized. There was supervision and clear examples to avoid any chance of feeling uncomfortable or getting hurt.

Every individual was asked to respect everyone's individuality, gender, and cultural differences. The goal was to create a friendly and supportive learning environment.

Everybody had a chance to share their thoughts about the workshop – what they liked, how it was organized, and who led it. Their feedback was kept anonymously on the paper. For the feedback, individual papers were distributed to each participant for them to write their thoughts freely.

### 13.1 Search strategy

In this comprehensive search, firstly, it would be identified books such as Kinesiology of the Musculoskeletal System by Neumann, Orthopedic Physical Assessment by Magee, management of Common Musculoskeletal Disorders by Kessler, etc., utilizing electronic databases such as PubMed, Scopus, Google Scholar, Pedro, Finna, American journal of sports, Journal of Orthopaedic and sports physical therapy, British journal of sports medicine and Thesus with a combination of keywords, including “shoulder injuries,” “volleyball,” “overhead sports,” “preventative approaches,” “Shoulders,” sports injuries,” “Athletes,” “physiotherapy,” “biomechanics,” SLAP,” “Rotator cuff,” “Scapula dyskinesia,” “GRID,” GH instability,” MRI.”

### 13.2 Inclusion and Exclusion

This thesis includes articles concerning shoulder injuries in volleyball and overhead sports and various ways to prevent them, especially in overhead movements. The review covered shoulder anatomy, shoulder biomechanics, volleyball biomechanics, exercises, therapies, and techniques to help volleyball

players avoid shoulder injuries. It mainly included high-quality articles from respected journals, systematic reviews, RCTs, clinical trials, meta-analyses, etc. Also, this thesis focused on studies published in the last few years. In exploring shoulder injuries and prevention in volleyball, studies about sports other than volleyball were excluded. Non-English writing and older research before 2000 were as well excluded to better focus on recent knowledge.

## 14 DISCUSSION

Although musculoskeletal injuries are common in volleyball athletes, with an injury rate of 1.7-11.2 injuries per 1000 hours of practice, the implementation of the shoulder injury prevention program in high-level or recreational volleyball teams is still uncommon. One of the reasons could be that there is no specific evidenced-based recommendation or suggestions for shoulder injury prevention in volleyball in the literature till now (Kilic et al., 2017). The primary goal of this thesis is to provide shoulder injury prevention approaches for volleyball players and physiotherapy students. The key findings of this thesis work are the following.

According to studies by Tooth et al. (2023), the injury incidence was high, ranging from 5.1 to 7.1 injuries per 1000 hours of practice. However, these findings varied compare to previous research (Bahr & Bahr, 1997; Kilic et al., 2017). Moreover, the local division players are more prone to injuries than professional players (Beneka et al., 2007).

The volleyball warm-up preventative program concentrated more on scapular stabilization ,neuromuscular control, concentric and eccentric rotator cuff muscle strength, and core stability (Tooth et al., 2023). Similar to the FIFA 11+ program in football and Andersson et al. (2017) injury prevention program for handball, the “Liège University Program” appears to lower the whole rate of injury occurrence in volleyball players.

In Tooth et al. (2023) study, the rate of shoulder injury was reduced in the prevention group. Besides that, this program may be more effective and beneficial for male players rather than female players. In addition, shoulder hyperlaxity and instability can significantly impact shoulder biomechanics, and these issues are more presented in female players compared to male players (DeFroda et al., 2019; Razmjou et al., 2016). Thus, it would seem that the warmup program should be modified and adapted for the further need of the “female shoulder” (Tooth et al., 2023).

While the warm-up preventative program was efficient and effective, this program should be performed in different ways to reach the highest level of efficiency. First, this program needs to be performed accurately with minimum compensatory movements. Therefore, there should be a physiotherapist/trainer or a coach next to the players as a supervisor to give feedback to them. Second, players should start at the right level of these exercises and pass to the higher levels step by step during the season. Doing the same exercise will not lead the players to see more improvements, so they should be modified as a new challenge. Thirdly, volleyball players need to perform the exercises regularly in their training sessions, as the previous studies reported consistency is a vital key for good results. Casual players should follow this program at least once a week, but twice a week would even be better. It is more efficient if professional players involve this program in their training sessions based on their levels and needs. (Tooth et al., 2023; Padua et al., 2014; Verhagen & van Nassau, 2019)

The FIFA 11+ shoulder injury program was efficient for goalkeepers, but this program is suggested for any type of sport with overhead movements. In addition, this program affects shoulder neuromuscular control and awareness, and shoulder stability in volleyball players (Zarei et al., 2021).

The study by Zarei et al. (2021) was the first to investigate the effect of the FIFA 11+shoulder program on proprioception and dynamic shoulder stability

in young male volleyball players. Since there are no comparable studies available, this could be seen as a limitation in this area of research.

This study highlights how understanding shoulder biomechanics is essential for generating effective injury prevention and recovery in volleyball. Repetitive and intensive movements at the shoulder joints in volleyball drive players to more and longer shoulder injuries. Strength and proprioception, especially in the case of stability and rotation, are significant in reducing shoulder injuries. Research indicates that to do the exercises regularly, such as eccentric strengthening, core stability, and balance awareness, could prevent shoulder injuries. (Maenhout et al., 2012; Cools et al., 2015)

Most volleyball injuries are linked to task-specific to this sport, including repeated jumping and landing, along with movements like spiking and blocking (Bahr & Bahr, 1997; Beneka et al., 2009b). In previous studies, it was reported that most injuries happen near the net and are associated with three front players, such as attackers and opposing blockers on each team. Outside hitters showed a considerably high rate of shoulder injuries because they are considered the primary attackers. As the shoulder joint is the most mobile joint in the human body, it enables hitters to reach high for spikes, which may lead their shoulder to overuse injuries at the dominant shoulder. (Bere et al., 2015b; Seminati & Minetti, 2013)

This thesis has some limitations. The main reason was related to the topic, the content of the thesis faced difficulties and limits. In most studies, no specific exercises or preventative approaches were recommended or suggested for shoulder injuries in volleyball. Based on the Tooth et al. (2023) article, the warm-up exercise program might not cover all volleyball players' expectations and trainees'/coaches' as well. On the other hand, there was no evidence-based program or study that reported the practical and positive effects of the FIFA 11+shoulder prevention program in comparison to a standard warm-up program due to improving neuromuscular control/awareness of the shoulder (Zarei et al., 2021).

Overall, volleyball is reputed as a safe sport in the sports categories, even at the professional level, although elite players are more prone to injuries. In this study, it is believed that most risk injuries in volleyball are related to athletes' functions. Preventative approaches and measurements should concentrate on acute phase and overuse injuries such as shoulder injuries. (Bere et al., 2015)

The workshop and lecture review were designed to improve students' perception related to common shoulder injuries and prevention approaches in volleyball, providing basic knowledge and skills needed for this topic effectively in future practice. This topic was new and interesting to the SAMK students, just general shoulder issues were taught to the students, not that specific.

The role of physiotherapy in the preventative program in volleyball is significant. In implementing the special test, assessment, diagnosis, and developing a preventative plan, physiotherapists have a key impact. By offering prevention methods, physiotherapists can prepare volleyball athletes for their professional lives with fewer shoulder injuries.

Knowledge of biomechanical skills, such as spiking and serving, is crucial for implementing prevention strategies effectively. Reducing the rate of shoulder injuries in volleyball requires a strong understanding of shoulder biomechanics and volleyball techniques, the mechanism of the injury, accurate diagnosis, precise results of special tests, etc. Through the educational and practical workshop, and lecture review, the participants gained essential knowledge and skills for common shoulder injuries in volleyball, and to plan a preventative program for volleyball players or any other overhead sports players.

In author's perspective, the objectives of this thesis were successfully met. The goal was to organize a workshop for students about common shoulder injuries in volleyball and their prevention methods. Holding the workshop was valuable as it allowed the author to share knowledge and information on this topic based on the literature.

## 15 WORKSHOP AND STUDY MATERIAL

The workshop was held at SAMK University in Finland in November 15<sup>th</sup>, 2024 and is open to any physiotherapy students. An invitation was provided by the author and sent to physiotherapy students by email. Six students were registered to the workshop. Feedback from the workshop was collected by using a paper-version questionnaire related to the workshop.

To teach the thesis subject to the students, a PowerPoint was created before and shared with students on the workshop day. The workshop included the anatomy of the shoulder, such as osteology, arthrology, and the main muscles, palpation, special shoulder tests, assessment and evaluation, injury risk, and prevention programs for shoulder injuries in volleyball and prevention approaches. The workshop was more student-centered.

First, the student's knowledge of the shoulder complex structure was assessed. Because most of them had a clinical practice and the musculoskeletal course before, their level of shoulder anatomy was quite good. The students involved in the topic and they were so active.

In the end, to check the students' perception, the author asked some questions of the students about the topic. The main goal of this part was to gather some meaningful perspectives to improve the future workshop.

During the feedback time, there was a questionnaire that consisted of 3 multiple questions. The first question was, "What aspect of shoulder injuries did you find most interesting during the workshop?" most of the answers were related to prevention exercises and special tests. The second question was, "How confident do you feel about applying the prevention techniques discussed in the workshop?" 50% of answers were "somewhat confident," and 50% were "neutral." The last question was, "What is the main change you plan to make in your training or teaching approaches?" around 60% of students chose

“incorporating prevention exercise regularly,” and 40% selected “ educating others about shoulder injury prevention.” APPENDIX 1

In conclusion, based on the feedback answers, the workshop provided a beneficial learning experience, even though some participants did not have proper knowledge of shoulder anatomy, biomechanics, injuries, and volleyball skills.

Most participants found the workshop information valuable for their studies, and future career path. In general, the workshop effectively achieved its learning objectives and provided useful suggestions for future improvements.

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## 17 APPENDIX 1

## Feedback questionnaire for workshop

Workshop Feedback Questionnaire

1. What aspect of shoulder injuries did you find most interesting during the workshop?

- A) Anatomy of the shoulder
- B) Common causes of injuries
- C) Prevention exercises
- D) Special tests for diagnosis

2. How confident do you feel about applying the prevention techniques discussed in the workshop?

- A) Very confident
- B) Somewhat confident
- C) Neutral
- D) Not confident

3. After attending this workshop, what is the main change you plan to make in your training or teaching approach?

- A) Incorporating prevention exercises regularly
- B) Paying more attention to proper technique
- C) Educating others about shoulder injury prevention
- D) No changes needed

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