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Overuse shoulder injuries among competitive male volleyball players in Kuwait

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Overuse Shoulder Injuries among Competitive Male Volleyball Players in Kuwait

Tasneem Basel Al-Zaid Alnaser

A thesis submitted in partial fulfillment of the requirements of
Sheffield Hallam University
for the degree of Doctor of Philosophy

May 2023

Dedication

I dedicate this thesis to

My mother, May Al-Khudhairi.

My Uncle, Waleed Sayed Awadh. I pray that his soul

rests in peace.

Candidate Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organization, whilst undertaking my research degree.
2. None of the material contained in the thesis has been used in any other submission for an academic award.
3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully. acknowledged.
4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.
5. The word count of the thesis is 49,102.

Name	Tasneem Basel Al-Zaid Al-Naser
Date	May 2023
Award	PhD
Research Institute	Health Research Institute
Director(s) of Studies	Dr. Andrew Barnes

Thesis abstract

Overuse shoulder injuries are common in overhead sports including volleyball. The development of injury prevention programs requires a holistic understanding of the multiple risk factors involved in their occurrence. In addition, performance-driven contexts and other contextual determinants contribute to the complexity of overuse shoulder injuries. To our knowledge, no study investigated overuse shoulder injuries of male competitive volleyball players in Kuwait. Therefore, this thesis aimed to investigate overuse shoulder injuries in a population of male sub-elite volleyball players in Kuwait. This research adopted a pragmatic, mixed methods research design and a revised "Sequence of Prevention" framework that considers context. This involved three studies: 1. one-season prospective cohort study, 2. cross-sectional study, and 3. qualitative study.

In line of the first step of the "Sequence of Prevention", the extent of the overuse shoulder injury problem has been established through the first study which includes: the prevalence of overuse shoulder injuries which was high (39%; 95% CI 37.45% to 40.3%), the incidence of overuse shoulder injuries that were 2.46/1000 hours (95% CI: 2.1, 2.8), as well as severe impacts on performance (*U = 297*), pain (*U =159*), training volume (*U = 228*), and task difficulty (*U = 290.5*) ($P \leq 0.001$). As

the second step of the “Sequence of Prevention”, the multiple risk factors were investigated via study one (personal and training-related risk factors) and study two (physical risk factors). Although, there were no significant personal or training-related risk factors (RR=0-4%), rotator cuff muscle weakness (IER=10, IIR=13.5, EER=13.6) and glenohumeral range of motion deficiencies (ER=6.4°, IR, *U = 149.5*) of external rotation and internal rotation were indicated as a significant physical risk factors of overuse shoulder injuries ($P \leq 0.05$). In a way to retrieve step one and two of “Sequence of Prevention” model, a qualitative study (study three) was conducted using semi-structured interviews with injured volleyball players. Contextual determinants of injury were perceived at multiple stakeholder levels: individual (e.g., lifestyle), interpersonal (e.g., unsupportive coaches), organizational (e.g., too many games), and at the policymaker level (lack of professionalization).

This research is the first which provides an evidence-based, and context-driven understanding of overuse shoulder injuries in a population of male sub-elite volleyball players in Kuwait. Therefore, our data can be used as a reference for many regional countries. Further research with larger sample size and gender variation are needed. The findings are a call to action for translating this research into injury prevention programs that take into consideration the context and levels of the socioecological framework. Guidelines and recommendations may be

produced for the different stakeholders to help prevent these injuries in volleyball players.

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Abu Huraira reported: A *man* asked the Messenger of Allah (Prophet Mohammed), peace and blessings be upon him, "Who is most deserving of my good company?" The Prophet said, "**Your mother**." The man asked, "Then who?" The Prophet said, "**Your mother**." The man asked again, "Then who?" The Prophet said,

“**Your mother**.” The man asked again, “Then who?” The Prophet said, “**Your father**.” Source: Ṣaḥīḥ al-Bukhārī 5971, Ṣaḥīḥ Muslim 2548.

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Publications and conference presentations

Abstract Publications related to this PhD

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Predictors of overuse shoulder injuries in male Kuwaiti volleyball players: A regression analysis abstract in the Journal of Sports sciences 2022 (Journal of Sports Sciences, Volume 40 Issue sup1, are now available for you to access via tandfonline.com).

Conference presentations related to this PhD

Prevalence of overuse shoulder injuries within competitive male volleyball players in Kuwait as a 5 in 5 Free Communication presentation- at the British Association of Sport and Exercise Sciences conference 2021 on 18 November 2021 (online).

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Chapter 1.0: Introduction

1.1 Introduction

Volleyball is a popular participation sport worldwide, particularly in Kuwait, where there is a large number of players (Briner, & Kacmar, 1997; Wang & Cochrane, 2001a; & Edouard et al., 2013). Most estimations place volleyball's global popularity right behind football (soccer) with the great success of the world competitions organized by the Federation International of Volleyball (FIVB) (Seminati & Minetti, 2013). Volleyball is a complex sport with high tactical, technical and athletic demands on the players who engage in different sport-specific skills on the volleyball court (Briner, & Kacmar, 1997; & Kugler, Krüger-Franke, Reininger, Trouillier, & Rosemeyer, 1996). Due to the repetitive nature of the vigorous activity, the extremes in range of motion (ROM), and the high velocities generated, volleyball puts the shoulder at a significant risk of injury. Due to the forceful arm motion used in competitive volleyball, shoulder injuries are common that comprise up to 23% of all injuries incurred by volleyball players (Briner & Kacmar, 1997).

Overuse sports injuries are related to repeated micro-trauma without a single, identifiable event (Andersson, Baher, Clarsen & Myklebust, 2017; & Aicale, Tarantino & Maffulli, 2018). In volleyball, overuse shoulder injuries can occur due to movement repetitions of abduction and external rotation (ER) of the shoulder

followed by forceful extension and internal rotation (IR) as the ball is contacted during overhead hitting (Briner & Kacmar, 1997; & Kugler et al., 1996). Overuse shoulder injuries are characterized by pain, shoulder instability, and scapular dysfunction, which in many cases would influence an athlete's performance (Myklebust, Hasslan, Bahr, & Steffen, 2013). It is typically difficult to determine the aetiology of an injury retrospectively because the injury typically develops long before any physical complaints do (Van Wilgen & Verhagen, 2012). The most common overuse shoulder injuries in overhead throwing sports are glenohumeral internal rotation deficit (GIRD), superior labrum anterior posterior (SLAP) tears, internal impingement, and partial-thickness rotator cuff tears (Jobe, Coen & Screnar, 2000; Manske, Grant-Nierman, Lucas & Manske, 2013; Trofa & Ahmad, 2016; Lin, Wong & Kazam, 2018). These overuse shoulder injuries in overhead throwing sports account for 51% of the total shoulder injuries respectively (Laudner & Sipes, 2009).

Musculoskeletal overuse injuries in volleyball account for most of the 2.5 injuries per 1000 hours of exposure that have been reported, with the shoulder being the most common site of injury (Kilic, Maas, Verhagen, Zwerver, & Gouttebarge, 2017; Seminati & Minetti, 2013; Asker et al., 2018; & Edouard et al., 2013; & Clarsen, Myklebust, & Bahr, 2013). Overuse shoulder injuries had a

significantly higher incidence rate than any other injury among overhead throwing athletes varying between 0.2/1000 hours and 1.8/1000 hours of practice or competition (Laudner & Sipes, 2009; Asker et al., 2018: & Clarsen, Baher, Andersson, Munk, & Myklebust, 2014). Moreover, Gohlke, Lippert & Keck (1993) conducted a prospective study in which they found that sports which contained a overhead throwing or hitting action had a higher incidence of overuse-shoulder complaints (e.g. handball (40%) and volleyball (25%)), compared to sports which did not contain throwing or hitting actions (e.g. basketball (3.5%)). Seminati & Minetti (2013) reviewed studies that investigated the prevalence of the two most common overuse-related injury sites in volleyball: shoulder and back/spine. The analysis showed that this type of injury accounted for 19.0±11.2% of the total, which is a higher injury rate compared to back/trunk injuries (16.8±9.7%).

In addition, Verhagen, Voogt, Bruinsma & Finch (2004) estimated a mean value of 0.6 injuries per athlete per 1000 played hours for the incidence of the overuse shoulder injuries rate (from 0.1 to 0.3 both for shoulder and back) by conducting a one season prospective cohort study (Seminati & Minetti, 2013). Wang & Cochrane (2001a) showed that overuse type injuries (19/29) were the main shoulder injuries in top-level English male volleyball players. Furthermore, these injuries resulted in prolonged shoulder pain symptoms with 3.0 injuries/1000 hours

of exposure and 2.3 ± 1.3 (± SD) months (Wang & Cochrane, 2001a). However, the shoulder injuries in this study were classified into new injury, re-injury, and chronic injury (Wang & Cochrane, 2001a). Moreover, the results showed high incidence rates of shoulder injuries among volleyball players, but because this study investigation did not separate the overuse type from acute injuries appropriately and record their incidence accurately, it provided only limited insight. Therefore, further research is needed regarding the incidence rate of overuse shoulder injuries, specifically among cohorts of professional and recreational volleyball participants (Asker et al., 2018).

In Kuwait, volleyball reported the highest percentage of injuries of any sport within a 12 month period and throughout their lifetime (79%), while football (soccer) athletes reported the lowest prevalence (Marwan et al., 2012). These differences may be attributed to more advanced coaching and sports medicine approaches in football (soccer), but point towards a need to better understand volleyball-related overuse injuries to help reduce their incidence (Marwan et al., 2012). Although there are some studies that have established the prevalence of overuse shoulder injuries, these are limited to elite populations. However, sub-elite competitive volleyball players represent a large cross section of the playing population in Kuwait, understanding this group represents an important step in

helping to reduce the risk of injury and efficiently manage those injuries that do occur.

Sports-related injuries have been a main consideration by sports organizations since low athletes' performance and frequent absence from the training and competition affects the team structure and productivity (Clarsen, 2015; & Leppänen, Aaltonen, Parkkari, Heinonen & Kujala, 2014). Overuse injuries are a substantial source of performance impairment and disability for athletes. The mean absence from volleyball competitions due to overuse injuries is 4.09–6.2 weeks, with the shoulder leading to the most absence period length (6.29-9.4 weeks) (Bahr & Reeser, 2003).

Sports injuries are detrimental to an athlete's health and career and may also incur major societal costs (Leppänen et al. 2014). The multifactorial nature of overuse shoulder injuries means understanding their interaction can help support the development of a preventive programme (Aicale et al., 2018; & Seminati & Minetti, 2013). Exercise-based injury prevention programmes have been proved to be effective in various sports (Leppänen et al. 2019). However, there is very scarce attention in sports literature to prevent overuse injuries (Clarsen et al., 2013).

A high incidence of the injury often results from increasing the intensity of training, match loading, insufficient recovery, and low preparedness (Richards, Ajemian, Wiley, & Zernicke, 1996; & Aicale et al., 2018). Shoulder ROM deficits have been associated with overuse shoulder injury in throwing players (Edouard et al., 2013). These deficits may increase the stress placed on the static and dynamic stabiliser muscles during the throwing action (Clarsen, 2015), while repetitive stress eccentric and overload on the tendons of the shoulder rotator cuff muscles and capsule are suggested to be the main causes of overuse shoulder injuries (Rokito, Jobe, Pink, Perry & Brault, 1998). Furthermore, lateralisation and depression of the dominant scapula compared with the non-dominant side among overhead throwing athletes are associated with overuse shoulder injury due to the functional instability and spectrum of rotator cuff pathology (Reeser, Verhagen, Briner, Askeland & Bahr, 2006). Currently, there is limited research examining risk factors for overuse shoulder injuries among volleyball players (Andersson et al., 2017; & Challoumas, Artemiou & Dimitrakakis, 2017).

At present , there is limited evidence for understanding the complexity of the sport context in which an injury occurs. Alongside the measurement and quantification of the problem, qualitative methods can help to explore this complexity of the broader injury context and provide in-depth insights from

multiple perspectives. This can be vital because they may offer a more thorough explanation of the "sports injury" issue and a better grasp of how injuries occur. The various viewpoints on sports injury result from various assumptions and beliefs that influence how an athlete would act (Bolling, van Mechelen, Pasman & Verhagen, 2018). This requires more comprehensive context-sensitive studies on the problem description, which address gaps in our understanding of the process and can provide a contextual perspective on the problem.

This thesis aims to establish a chain of investigations about overuse shoulder injuries among male competitive volleyball players in Kuwait to develop an evidence-based understanding of overuse shoulder injuries. This has been achieved through a series of studies, investigating the prevalence and incidence of injury and risk factors such as the wider context in which injuries occur.

1.2 Doctoral philosophy

This doctoral programme is underpinned by the “Sequence of prevention” model first proposed by van Mechelen, Hlobil & Kemper (1992). This applied approach permits progressive and iterative research in an applied and robust manner. Adopting this approach has ensured that each study builds on the last to culminate in answering a practical question that would inform and progress

practice. Additionally, the “Sequence of Prevention” framework has practiced and guided research toward injury prevention strategies over the last 25 years. This can be accomplished by combining a systematic way of working (the scientific method) with a pragmatic philosophical approach (Ruddock, Boyd, Winter, & Ranchordas, 2019; Creswell & Clark, 2017; Feilzer, 2010). Pragmatists consider an existential reality: a world with multiple levels, ambiguities, nuances and possibilities (Dewey, 1925). Hence, a four-step model is adopted to present a systematic logic from injury issue evaluation to the design of an evidence-based solution. The first step describes the extent of the injury problem, followed by the second step which investigates the injury mechanisms and the etiological factors. The third step develops evidence based injury prevention measures, and the fourth step evaluates the prevention measures. These procedures must be followed in order for interventions to be implemented successfully, intended to reduce or prevent the occurrence of musculoskeletal injuries in sports (Kilic, Van Os, Kemler, Barendrecht & Gouttebarge, 2018).

In addition, the revision of the first step of van Mechelen et al.’s ‘sequence of prevention’ model (1992) proposed by Bolling et al. (2018) puts an emphasis on the context complexity of the overuse-shoulder injury, by taking into account the nature of sports and the context in which it is played. As a result, knowledge about

the infrastructure, culture, and the setting related to the sports injury is required, and might be referred to as “contextual determinants” of the injury prevention process (Bolling et al., 2018).

This thesis has been designed to follow only the first and second steps of this model, establishing the incidence and aetiology of overuse shoulder injuries in volleyball sport. Philosophical reasoning, which is regulated by viewpoints on ontology (the study of being and the essence of reality) and epistemology (how knowledge is acquired), serves as the foundation for scientific inquiry (Allmark & Machaczek, 2018). Research paradigms are commonly prescriptive in character, frequently reasserting already-established theories to the exclusion of others and potentially limiting intellectual curiosity and innovation. A research paradigm is a recognized model organizing a philosophical viewpoint (Kuhn, 1962). Scientific research, however, should adhere to the Systéme International d'Unite's (SI) principles and be flexible, adaptable, and flawed in order to answer specific problems using the best instruments and methodologies (Winter & Fowler, 2009).

In order to combine objective quantitative analysis with contextual and subjective inquiry based on experiences and interpretations of qualitative research, this PhD thesis adopted a pragmatic philosophical approach (Creswell & Clark,

2017; & Feilzer, 2010). This mixed method technique and an applied framework were used to make each research study progressive, comprehensible, and useful. This strategy can assist in identifying research-related obstacles, providing investigations with practical significance, enhancing practical representativeness, and bridging the gap between research and the applied field (Drust & Green, 2013; Harper & McCunn, 2017; & Thompson, 2020). Table 1 demonstrate how Applied context-driven 'Sequence of Prevention' model (Bolling et al., 2018) applied to the doctoral programme of study.

1.3 Thesis aims and objectives

This thesis aimed to investigate overuse shoulder injuries in a population of male sub-elite volleyball players in Kuwait. In order to achieve this aim and in line with the proposed model of Bolling et al. (2018), a series of objectives have been developed.

To address these aims, the following research objectives were developed:

1. To determine the incidence/prevalence of overuse shoulder injuries among competitive male volleyball athletes in Kuwait.
2. To investigate the relationship of personal and training related risk factors with overuse shoulder injury incidence and the impact on severity measures.
3. To identify physical risk factors for overuse shoulder injuries in a population of male sub-elite volleyball athletes.
4. To explore the contextual determinants of overuse shoulder injuries in a population of male sub-elite volleyball athletes.

Table 1. Applied context-driven 'Sequence of Prevention' model (Bolling et al., 2018) applied to the doctoral programme of study.

Applied Sequence of prevention of overuse injuries	Evidence from (Bolling et al., 2018)	PhD Study	Content
Step1: Description of the Injury Problem and Context	The severity of sports injuries indicators and injury incidence are frequently used to define the extent of the sports injury problem. Typically, epidemiological research and measurements are utilized to quantify the "injury" problem. In a wide range of sports, incidence, prevalence, injury profiles, severity, costs and time lost have all been explained and characterized by participation level, sex, age, experience, sports, etc.	Epidemiological perspective overuse shoulder injury surveillance (Chapter 3)	− Establish prevalence and incidence of overuse shoulder injuries in Kuwaiti volleyball players . − Investigate the severity of overuse shoulder injuries among male competitive volleyball players in Kuwait.
		Context-driven self-confrontation qualitative interviews (Chapter 5)	Explore the contextual determinants of overuse shoulder injury. It provides a clearer understanding of the several injury prevention strategies that coaches, clinicians and managers have decision whether to apply a preventative measure program in place.
Step 2: Etiological Factors and Injury Mechanisms with Contextual Determinants	The mechanisms and aetiology of the injury are identified. Biomechanical, biomedical, and epidemiological research primarily establishes knowledge regarding risk factors.	Epidemiological perspective overuse shoulder injury surveillance (Chapter 3)	− Identification of the overuse shoulder injury mechanism based self-report. − Investigate training related risk factors. − Investigate personal risk factors.
		Cross-sectional physical risk factors of overuse shoulder injuries (Chapter 4)	Investigate physical risk factors of overuse shoulder injuries among male competitive volleyball players in Kuwait.
		Context-driven self-confrontation qualitative interviews (Chapter 5)	Retrieving step 2 of model: in-depth understanding of the context in which injuries occur.

Chapter 2.0: Literature Review

2.1 Introduction

The aim of this literature review is to both provide an overview of what is currently known about overuse shoulder injuries in volleyball as well as to identify the current knowledge gaps that underlie the thesis research objectives. The available prevention strategies and the lack of research into effective volleyball-specific injury prevention programs will first be presented. The design and evaluation of future injury prevention strategies can be achieved by applying the first two steps of the van Mechelen "sequence of prevention model". In recent years, various authors such as Bolling et al. (2018) have also called for taking into consideration the complexity of the context when applying this model.

In addition to following a valid and comprehensive injury prevention model, the study of overuse shoulder injuries in volleyball also requires an understanding of the complexity of the shoulder, as well as of the complex kinematics of the overhead movements. Conventional methods of injury surveillance that rely on time-loss definitions of injury have failed to fully capture the extent of overuse injuries. This review will thus reveal the needs for further research into the areas of prevalence/ incidence using valid tools that take into account the gradual-onset of these injuries, and their severity and impact. The identification of the different personal, training-related and physical risk factors that may be involved in their

occurrence will be discussed. Finally an overview of the use of qualitative research methods and of the socioecological framework will be provided, as these can help gain a more holistic understanding of contextual determinants of injury and of the end-users of injury prevention programs.

2.2 Prevention of Overuse Shoulder Injuries in Volleyball

Volleyball is one of the most popular team sports worldwide, with an estimated 800 million people playing at least once a week at some level (recreational or other) and has been included in the Olympics games since 1964 (Wang & Cochrane, 2001a; & Seminati & Minetti, 2013). Volleyball's international governing body, the Federation Internationale de Volleyball (FIVB) is the world's largest sports federation with over 220 member nations, including Kuwait (The Washington Post, n.d.). Volleyball, as a non-contact sport, has lower injury rates compared to other sports such as football (Marshall, 2018). Volleyball had the lowest injury rate of any team sport played in the Athens 2004 Olympics (Junge et al., 2006). Volleyball is a dynamic and demanding team sport that includes jumping, landing and significant overhead hitting actions (Wang & Cochrane, 2001a; & Seminati & Minetti, 2013). Despite relatively low injury rates, volleyball players are prone to overuse injuries particularly at the shoulder (Briner & Kacmar, 1997).

Other "overhead" sports that also demand repetitive arm elevation to 90 degrees or above, such as baseball, tennis, and swimming, are similarly prone to shoulder injury (Ferretti & DeCarli, 2003).

Overuse shoulder injuries in throwing sports result from cumulative micro-trauma due to the amount of low magnitude overhead motion at high velocity (Andersson et al. 2017). The repetitive nature of the explosive overhead movements required in volleyball and other overhead sports makes the shoulder particularly prone to overuse injury (Hoppe et al., 2022). Although many overhead athletes experience a painful shoulder, they often tolerate this, continuing to train and compete, leading to the recurring shoulder problems (Barker & Barker, 1997).

Treatment of overuse shoulder injuries includes a period of rest and recovery, the use of anti-inflammatory drugs, and rehabilitation programs (muscle training for strength and control, plyometric exercises) (Seminati & Minetti, 2013). In some cases, surgery may be required. Several strategies have been recommended for the prevention of overuse shoulder injuries in volleyball athletes (Reeser et al, 2006; Seminati and Minetti, 2013), including optimization of spiking technique, instruction of alternative spiking techniques, reduction of the training load/volume, stretching/warm up before the game, resistance training programs,

core strengthening/stability training programs, and effective rehabilitation. Despite these strategies, there is a lack of research about overuse shoulder injury prevention in volleyball and insufficient evidence in the literature to support the effectiveness of shoulder injury prevention measures.

A review by Asker et al. (2018) found that although a comprehensive strength and conditioning training program by Andersson et al. (2017) had a primary preventive effect on the risk of shoulder injury in symptom-free handball players, more and larger studies about the impact of injury prevention interventions are needed. Most of the provided strategies for sport injury prevention and treatment are not adequate to achieve the appropriate intervention to manage sport injuries, particularly if that injury is complicated due to other factors related to the behaviors, lifestyle or training load system.

The impact of an 8-week "FIFA 11 + shoulder" (11 + S) program on young volleyball players in Iran was examined by Zarei et al. in 2021, as the implementation of the "FIFA 11 + Shoulder" programme has led to the reduction of the incidence of upper extremity injuries among soccer goalkeepers but has also been recommended for overhead sports. The results showed that the 11 + S injury prevention program can improve volleyball players' shoulders' dynamic stability,

which would improve performance and, if used long-term, could reduce the risk of injury. However, more research would be required through a long-term cohort study to confirm this hypothesis.

Another study conducted by Al Attar et al. (2022) in Gulf Cooperation Countries (GCC) including Kuwait examined the current implementation of the Oslo Sports Trauma Research Center Volleyball Injury Prevention Exercises amongst volleyball players, which includes shoulder injury prevention exercises. Only about half of the participants implemented these exercises. The authors attributed this to the fact that volleyball is practiced mainly in elite and semi-elite sports clubs. Thus, the players may not be aware of the exercises to prevent or reduce the likelihood of developing injuries and the authors recommended more awareness campaigns and training to ensure more implementation. This survey however only studied implementation of these exercises without examining prevalence, severity or effectiveness of the exercises, and recent data on volleyball players in GCC is scarce. Therefore, more volleyball-specific shoulder injury prevention research and interventions are required.

2.3 The revision of the “sequence of prevention” Van Mechelen et al. (1992) model

The approach to effectively prevent injuries in sports is described previously by van Mechelen et al. (1992) as the “sequence of prevention” recognized as the most influential model in the past 25 years (Kilic et al., 2018). According to van Mechelen et al. (1992), it is necessary to know the extent of the injury problem first through injury surveillance (step 1), followed by understanding related risk factors and mechanisms (step 2) in the population of interest. These steps can lead to the development and validation of injury preventive strategies (step 3) of which the efficacy should be evaluated through studies that measure the impact of the prevention strategy using appropriate surveillance (step 4) (Cornelissen, Kemler, Verhagen & Gouttebarge, 2020). These four steps of van Mechelen et al.'s “sequence of prevention” are essential for a successful implementation of interventions aiming to prevent or reduce the musculoskeletal injuries occurrence in sports (Kilic et al., 2018).

Numerous studies conducted since the publication of the "sequence of prevention" of sports injuries model have demonstrated that it is possible to lower the incidence, severity, and financial burden of sports-related injuries under ideal

(i.e., controlled) and practical (i.e., real-world) conditions. The ideal research method to assess the effectiveness of a preventative strategy is a randomized controlled trial (RCT); however, when an RCT is not feasible, quasi-experimental or observational cohort studies are used (Emery, Roy, Whittaker, Nettel-Aguirre & Van Mechelen, 2015). Gouttebarge, van Sluis, Verhagen & Zwerver (2017) first developed an exercise-based warm-up programme ("VolleyVeilig") to reduce the occurrence of musculoskeletal injuries among recreational adult volleyball players in the Netherlands (step 3 of the sequence of prevention). They then conducted an RCT to assess the effectiveness of the programme on the burden and severity of such injuries on players' availability to play according to step 4 of the sequence of prevention. The results showed that the programme was effective at reducing acute injuries, but did not reduce overuse injuries which suggests the need for more specific research and interventions that target overuse injuries.

Sports injuries are 'complex' phenomena (Bolling et al., 2018) and require a more comprehensive approach that includes multiple views. By taking into account the nature of sports injuries and its contextual characteristics, Bolling et al. (2018) offered a revision of the first stage of van Mechelen et al's "sequence of prevention" model (1992) problem that focused on the context complexity of sports injury. Emery et al. (2015) conducted a systematic review and meta-analysis

to evaluate the efficacy of injury prevention neuromuscular training strategies in youth sport, and highlighted the need to focus on the implementation context and real-world effectiveness in evaluating prevention strategies. Other studies have indicated the relevance of understanding the practical context for a successful implementation of injury prevention interventions (Verhagen et al., 2014; Finch, 2006; & Bolling et al., 2018). The Translating Research into Injury Prevention Practice or TRIPP model (Finch, 2006) emphasizes the significance of understanding both behavioral inputs and outputs in connection to sports injury prevention in order to better understand the context for implementation of injury prevention. Verhagen et al. (2014) integrated context into the first two steps of their Knowledge Transfer Scheme (KTS) tool that translates evidence into practical action.

2.4 Complexity of Overuse Shoulder Injuries in Volleyball

Shoulder injuries are some of the most prevalent volleyball-related overuse injuries (Ferretti & DeCarli, 2003). In order to understand the complexity of the overuse shoulder injury problem, it is necessary to take into consideration the complexity of the shoulder joint and as well as the volleyball overhead movements (spiking and serving) as they interact together and contribute to the risk of injury.

2.4.1 The Shoulder Complex

The shoulder is the human body's most flexible and mobile joint, capable of moving in several planes of movement (Carnevale et al., 2019). It is a complex anatomic structure referred to as the as the "shoulder complex" that is composed of 4 articulations:

- the acromioclavicular (AC) Joint: The connection between the collarbone (clavicle) and the shoulder girdle (scapula).
- the scapulothoracic joint: the connection between the shoulder girdle (scapula) and the rib cage.
- The sternoclavicular joint: located where the clavicle meets the sternum at the base of the neck.
- the glenohumeral joint (GHJ): the ball and socket joint between the humeral head (ball) and glenoid portion (socket) of the shoulder girdle.

Because the shoulder joint is designed for mobility rather than stability, it is prone to injury when subjected to the demands of overhead sports (Ferretti & DeCarli, 2003). Glenohumeral stability is influenced by a number of factors and is the consequence of a hierarchy of "active" (dynamic) and "passive" (static)

mechanisms. The glenoid labrum, a rim of fibrocartilage acts to deepen the glenoid fossa, this is further strengthened by the superior, middle, and inferior glenohumeral ligaments, these structures make up the passive mechanism, or static stabilisers, of the shoulder. The rotator cuff, specifically the subscapularis muscle-tendon unit works in conjunction with the tendon of the long head of the biceps brachii to actively mediate dynamic stability (Ferretti & DeCarli, 2003).

A shoulder that is functionally unstable can be caused by the dysfunction of one or more of these parts (Ferretti & DeCarli, 2003). Research by Rokito et al. (1998) illustrates the complex sequence of shoulder muscle activity required to play competitive volleyball. These authors used electromyographic (EMG) analysis to investigate activity in 8 shoulder muscles during the volleyball serve and spike in 15 professional and collegiate volleyball competitors. The anterior deltoid and supraspinatus worked together to position and elevate the humerus during all phases of the spike. The infraspinatus and teres minor muscles were found to work together to rotate the humerus externally during the cocking action. However, during arm acceleration, these muscles responded differently; teres minor activity remained strong but infraspinatus activity decreased. During cocking and acceleration, the muscles of the anterior wall worked as internal rotators to slow down the humerus. Similar patterns were observed in the serve's muscle activity

as they were in the spike, but the serve's amplitudes were lower. Thus each phase of spiking and serving movement sequence engages different shoulder muscles in a complex manner. Any dysfunction of these muscles caused by these complex movements can contribute to loss of stability of the shoulder.

2.4.2 Complex Kinematics of Overhead Movements in Volleyball

In volleyball, the serving and spiking overhead movements place a heavy burden on the shoulder girdle. Spikes are the most explosive of the overhead movements in volleyball (Reeser et al., 2010) and are usually performed at high velocity, with ball speeds that may approach 28 meters per second. It has been estimated that elite volleyball players playing 16 to 20 hours per week may perform up to 40 000 spikes per season, but the actual volume may be higher (Reeser et al., 2006). With that many spike repetitions, they place the shoulder at risk for overuse injuries.

A serve initiates every point in the game. There are two main styles: float serve, and the jump serve. The jump serve, which is a faster serve, is more likely to cause shoulder problems than the float serve (Reeser et al, 2010). The stabilising mechanism of the shoulder, which consists of the four rotator cuff muscles: supraspinatus, infraspinatus, teres minor, and subscapularis, as well as static

stabilisers like the glenohumeral joint, glenoid labrum, and ligamentous shoulder capsule, must absorb and dissipate these forces (Ferretti & DeCarli, 2003). The mechanics of the arm swing and the distribution of overhead swings between practice and competition are two factors that will likely affect the final load; it is clear that repeated spiking and serving exposes the shoulder girdle to a significant cumulative load (Reeser et al., 2006). The kinematics of throwing in baseball and spiking and serving in volleyball are similar, despite some differences (Ferretti & DeCarli, 2003). Both skills put repetitive strain on the dominant shoulder girdle. Overloading the shoulder can cause cumulative damage over time if these pressures are applied faster than the rate at which tissue repairs itself (Ferretti & DeCarli, 2003). Medical practitioners should therefore be familiar with the kinematics of the volleyball spike and serve in order to better comprehend the mechanism of overuse shoulder problems in volleyball athletes (Ferretti & DeCarli, 2003). There has been a lot of research into the kinetics and kinematics of the overhead throwing motion, but the most of the studies that have been published have been about baseball, with very few studies concentrating explicitly on volleyball-related shoulder pathologies. However, the biomechanical characteristics of the many overhead sports share enough similarities (Reeser et al., 2006). Wagner et al. (2012) showed that biomechanically the spike and the

serve are volleyball-specific overhead skills that are very similar to the act of pitching, tennis serves and handball throwing. Despite the fact that the movements in several overhead sports appear to be similar, the outcomes vary since some are throws and others are hits; a hit is the result of an overarm movement in volleyball (Bergün, Mensure, Tuncay, Aydin, & Çigdem, 2009).

Similar to the baseball throwing action, the mechanics of spiking and serving skills can be broken down into three phases: cocking, acceleration, and deceleration/follow-through (Tullos and King, 1973; & Ferretti & DeCarli, 2003). The period between preparation for movement and when the shoulder starts the explosive phase of acceleration is known as the cocking phase. This stage has also been called "cocking the hammer" (Ferretti & DeCarli, 2003). At first, the athlete flexes the elbow while abducting and externally rotating the hitting limb at the shoulder. The upper limb is abducted 90 degrees or more and the shoulder is maximally externally rotated and extended at the end of this phase. While "float" servers often retain a more neutral trunk position, spikers and jump servers sometimes combine this movement pattern with trunk rotation and lumbar extension (Ferretti & DeCarli, 2003). In fact, lumbar flexion, and trunk derotation signal the start of the acceleration phase. The momentum created in this way is channelled up through the scapula to the shoulder girdle and then onto the wrist

and hand (the most distal links in the kinetic chain), where it is released. A combination of flexion, adduction, and internal rotation is used by the "cocked" upper limb as it advances and starts to accelerate (Ferretti & DeCarli, 2003). The upper limb is normally abducted to 150° to 180° (almost vertical) at the point of contact with the volleyball, slightly flexed to make contact with the ball out in front of the body, and extended at the elbow to make contact with the ball at the highest position possible. Additionally, the moment arm of the upper limb is maximized in this position, leading to a quicker arm swing and a stronger spike (Ferretti & DeCarli, 2003). The acceleration phase starts when the ball makes contact. Deceleration/follow-through phase's main goal is to disperse energy built up during acceleration while attempting to reduce shoulder tension (Ferretti & DeCarli, 2003). Follow-through is accomplished through a combination of shoulder internal rotation and upper limb adduction, and it is mediated by the eccentric rotator cuff movement. In fact, the shoulder joint would dislocate anteriorly following every spike or jump serve if it were not for the dynamic stabilising action of this set of four muscles (Ferretti & DeCarli, 2003). Therefore, the shoulder travels through a wide active range of motion while moving quickly during the spiking or overhead serving motion.

The structures of the shoulder girdle are at high risk of injuries because the upper limb generates significant force (Ferretti & DeCarli, 2003). Bergün et al. (2009) compared the kinematics of the overarm movements for volleyball and handball. They investigated back swing and acceleration phases, as well as kinematic analyses and technical distinctions, to demonstrate two distinct overarm actions, one in throws and one in hits. There were significant differences in the angular breadth, velocity, and acceleration during the backswing phase ($p<0.01$) between the volleyball players and handball players on the transverse, vertical, and sagittal planes of the motions. The angular width of the arm segment motion was statistically different during the acceleration phase on the transverse plane ($p<0.05$). The angular width of the arm segment motion on the transverse plane was shown to be statistically different during the acceleration phase ($p<0.05$). The angular width, velocity, and acceleration of the arm motions between the volleyball and handball players were significantly different on the sagittal plane ($p<0.05$). The forearm motion of handball players on the sagittal plane had higher values of angular width, velocity, and acceleration compared to volleyball players. These findings indicate that volleyball players utilize vertical flexion more frequently, lengthening the time it takes to generate velocity. Players of handball quickly transition from horizontal to vertical flexion at the same velocity. Thus, this study

demonstrates that volleyball players are subject to unique shoulder demands compared to other overhead sports and its results support the call for specific-context research in investigating sport injuries.

2.4.3 Volleyball-specific biomechanical adaptations

Studies have shown that volleyball players' shoulders have a variety of sports-specific adaptations that cause differences between their dominant and non-dominant sides. These are regarded as typical adaptations to the sport because they are frequently observed and don't necessarily lead to an increased risk of injury or shoulder complaints (Skazalski, 2023). Adaptations can be viewed as a 'biomechanical enhancement' that may improve performance in the sport; however they may progress into a painful shoulder or an asymptomatic shoulder that is structurally impaired (Gelder, 2018). Bony changes such as humeral torsion are normal in the dominant arm of overhead athletes, which lead to an increase in ER ROM and a decrease in IR ROM in comparison to the non-dominant arm (Hellem, Shirley, Schilaty & Dahm, 2019; & Schwank et al., 2022). Decreased IR ROM is frequently documented in volleyball, generally with concurrent ER increase, but occasionally it result in shoulder pathology (Challoumas, Stavrou & Dimitrakakis, 2017; Forthomme, Wieczorek, Frisch, Crielaard & Croisier, 2013; Reeser et al. 2010;

Wang, Macfarlane & Cochrane, 2000; & Wang & Cochrane, 2001b). Up to 33% of volleyball players were found to have infraspinatus muscle atrophy in their dominant arm, a condition associated specifically with the sport (Holzgraefe, Kukowskib & Eggert, 1994). An apparent wasting of the infraspinatus muscle (caused by suprascapular neuropathy) has been found to be present in both symptomatic and asymptomatic athletes and often remains unrecognized by the players for years, particularly as they do not perceive any functional impairment when playing. In addition, according to a study by Skazalski, Bahr & Whiteley (2021), most volleyball players' dominant shoulders had thicker subacromial bursa (SABs) than their non-dominant shoulders. Due to the repetitive unilateral nature of spiking throughout a player's career, this is probably a normal adaptation in the dominant arm in response to loading of the shoulder. Similar to observations of asymptomatic rotator cuff tears, it has been proposed that asymptomatic thickening of the SAB may be common (Awerbuch, 2008). Therefore not all volleyball-specific adaptations may lead to symptoms of shoulder injury.

2.5 The Extent of Overuse Shoulder Injuries in Volleyball

2.5.1 Prevalence and Incidence of Overuse Shoulder Injuries in Volleyball

Overuse shoulder injuries and shoulder pain are common in overhead athletes, particularly volleyball players (Asker et al., 2018; & Clarsen et al., 2014). According to Reeser et al. (2006), in both male and female volleyball players, shoulder pain syndromes are the second most common overuse injury, accounting for 8–20% of all injuries, and the third most common injury overall. Moreover, in a study by Wang and Cochrane (2001a) 32% of injuries to English division one volleyball players were to the shoulder. However, they did not use the term "overuse" in their study: the shoulder injuries were classified into new injury, re-injury, and chronic injury (Wang & Cochrane, 2001b). In addition, their results showed high incidence rates of shoulder injuries among volleyball players, but because this study investigation did not separate the overuse type from acute injuries appropriately and record their incidence accurately, it provided only limited insight. However, some prevalence studies have more specifically investigated overuse shoulder injuries, giving us a better idea of the magnitude of the problem. For volleyball players with shoulder complaints, Clarsen et al. (2015) reported a point prevalence of 16% in junior-level volleyball in Norway, while in another study

in Iran by Mohseni-Bandpei, Keshavarz, Minoonejhad, Mohsenifar & Shakeri (2012), the point prevalence was 22% for university players. In collegiate club-level players, Reeser et al. (2010) found a 43% season prevalence and a 58% lifetime prevalence of shoulder problems, with 46% of those athletes reporting decreased sport performance as a result. According to Jacobson & Benson (2001) competitive amateur volleyball players with shoulder pain, participants reported symptoms developing over a period of more than three years (mean: 40 months, range: 2-180 months), and 60% of players had to take time off owing to shoulder pain (mean: 96 days, range: 7-365 days). Furthermore, 60% of players felt pain while hitting all locations of the court, and 77% of players said that pain limits how hard they can spike. While most of these prevalence studies have been conducted with junior or amateur players, more studies of sub-elite and elite volleyball players are required especially with such common injuries.

Moreover, Bolling et al. (2018) demonstrated that context matters in sports injury research. Therefore, to study the complex phenomena of overuse shoulder injuries, we need to focus on specific populations, as the characteristics of each population can influence the context in which injuries occur (Howe, 2003). Male competitive volleyball players in Kuwait represent a unique case of professionalism, considering cultural, social, political, and other features. This population adopts a

mixed professionalism condition and can be identified as semi-professional athletes. They practice seasonal volleyball alongside their full-time jobs. Their dedication to volleyball is professional due to intensive competition, training schedules, and annual participation in international leagues. However, the players are not compensated enough to leave their specialized jobs. Consequently, they must balance their jobs with their favourite sport without compromising their required training schedule. Typically, the players work seven to eight hours a day, fulfill social duties, and then head directly to clubs to practice volleyball. Such a condition for this sports population is rare in other countries (Marwan et al., 2012).

The context of Kuwaiti volleyball presents unique circumstances in which injuries occur. Neglecting players' personal circumstances while scheduling competitions and training sessions can lead to injuries due to inadequate physical preparation and rehabilitation. Therefore, investigating overuse shoulder injuries specifically among male competitive volleyball players in Kuwait was the aim of this thesis.

Female players are not included in this targeted population because they do not share similar characteristics and context with male players in Kuwait. Firstly, females possess different physiological and physical characteristics compared to

males (Lewis, Kamon, & Hodgson, 1986; Ziv & Lidor, 2009). Secondly, their opportunities for strength and conditioning training in Kuwait are rare and less extensive than those provided to male players. Additionally, female players lack the structured sports framework available to male competitive players in Kuwait in terms of leagues and schedules.

2.5.2 Severity and Impact of Overuse Shoulder Injuries in Volleyball

Overuse shoulder injuries can have a significant impact on volleyball players. Verhagen et al. (2004) reported shoulder injuries resulted in the longest absence from the game of all overuse injuries with a mean period of 6.29± 9.4 weeks absence. This can result in high healthcare costs due to hospitalizations, reported to be of 4.6 million euros a year and 11 million euros a year due to absenteeism (Kilic et al., 2017). The success of the athletes, teams and organizations are affected by pain, reduction of physical performance and sports participation (Clarsen, 2015).

It is important to include information on the severity of injuries in any sports injury registration system. It is an integral part of the first step of van Mechelen et al.'s "sequence of prevention" (see section 2.3). Various indicators to describe the severity of sports injuries can all be part of a sports injury surveillance system (van Mechelen, 1997): (i) nature of sports injury; (ii) duration and nature of treatment;

(iii) sporting time lost; (iv) working time lost; (v) permanent damage; and (vi) monetary cost. However as Clarsen et al. (2013) highlight, the impact of injury goes beyond time-loss, and should include any chronic complaint reported by athletes.

2.5.3 Recording Overuse Injuries

Several methodologies have been utilized to record overuse injuries. They present different advantages and disadvantages, and their selection depends on time and resources available as well as research aims.

- *Retrospective studies*

Retrospective studies are more time and resource efficient and may also promote more athlete compliance with participation requirements, particularly for populations of elite athletes and team sports players (Murkerjee, 2015). However, the main issue with retrospective study designs is memory recall bias as most studies are based on self-reported data (Mukherjee, 2015).

Even though retrospective studies can collect data for any period of time in the past, limiting the time period over which the athletes are asked to recall the events can lessen recall bias. It makes sense that shorter time frames have higher recall accuracy. Evidence suggests that a 12-month recall period is effective

(Mukherjee, 2015). As a result, it appears prudent to limit the recall duration in retrospective injury surveillance studies to 12 months. This also suggests that for season-based studies, data should be collected as soon as the season is over. A carefully thought-out retrospective study design can have features of validity, credibility, and reliability to produce systematic, high-quality data that may be useful for revealing injury risk factors and mechanisms and developing injury preventive tactics (Mukherjee, 2015).

- *Cross-sectional studies*

Cross-sectional studies are the most effective technique to measure prevalence at a particular point in time and are beneficial for discovering relationships that can then be examined more thoroughly in a cohort study or randomized controlled trial (Mann, 2003). The most significant advantage of cross-sectional studies is that they are generally rapid and inexpensive. Because there is no follow-up, the study requires fewer resources to run. The most difficult challenge with this type of research is distinguishing between cause and effect and simply association. However, they are frequently used to produce hypotheses that can be investigated later on using prospective cohort studies or other research methods (Mann, 2003).

- *Prospective study designs*

Verhagen, Van der Beek, Bouter, Bahr & Van Mechelen (2004) one-season prospective cohort study of acute and overuse volleyball injuries aimed to fill the gap of knowledge at a time when most studies had been retrospective. Although there were very few acute shoulder injuries, 32% of the overuse injuries were shoulder-related. However the authors acknowledged that only injuries that forced the player to stop playing were included in the injury registration. Because of this, overuse injuries may have been underestimated in their study. Overuse injuries result in pain and discomfort, but they are not always enough to make a player stop competing. In some sporting situations, time-loss and medical attention injury definitions may be suitable, but in a study of FIVB beach volleyball injuries, Bahr (2009) questions "how appropriate this methodology is if it is applied to sports with few acute, traumatic injuries but a preponderance of overuse injuries''. In Bahr's study, he compared time-loss injuries reported through a "traditional" injury surveillance method (using a time-loss definition) with a survey asking about past and present knee, low back, and shoulder pain to analyse injuries among FIVB beach volleyball players. Both approaches were conducted retrospectively which may introduce recall bias, which the author tried to limit by limiting the recall period and connecting the questions to specific events and tournaments. While

survey data showed a high prevalence of knee, low back, and shoulder pain both during the current week (64%) and the prior two months (83%), use of the time-loss injury definition in the injury registration led to the conclusion that there was very little risk of injury. Between these two approaches, there are significant differences. The use of the pain survey allows for reporting of all symptoms rather than specific injuries; this probably gives a more realistic picture of the burden of knee, low back, and shoulder problems but limits further understanding about specific injuries. Following the results of his study, Bahr (2009) recommended the following research design elements in order to provide a methodological framework to investigate and record overuse injuries symptoms in sports:

1. Prospective studies with serial measurements are required:

   While retrospective studies and cross-sectional studies are easier to implement than prospective studies, they have an element of recall bias. With prospective studies, symptoms can be assessed at regular intervals (for example, once a week or once a month). Bahr also recommends prospective studies for the cohort studies of injury risk factors and injury prevention interventions.

2. Valid and sensitive data collection tools are needed to measure pain and other symptoms in overuse injuries: by using valid and appropriate instruments, all physical complaints related to participation (examples: pain, loss of function, loss of range of motions or effect on participation and performance) can be recorded.

3. Overuse Injuries should be reported as prevalence and not incidence: Incidence measures reflect new injuries and are more appropriate for acute or traumatic injuries; however, overuse injuries tend to be chronic, so prevalence measures are therefore more appropriate by capturing the percentage of athletes experiencing overuse injuries at any given time. By studying prevalence, injuries can be assessed over the course of an entire season.

4. Severity measures should focus on impact on function and performance rather than time-loss: It should be possible to indicate an athlete's functional level or performance limitation in proportion to full function if reliable and accurate scoring tools can be created.

Bahr (2009) suggested that overuse injuries should be defined and analysed separately with new methodological approaches to avoid the underestimation of

its prevalence (Seminati & Minetti, 2013). Epidemiological studies should evaluate not only the time-loss parameter, but also all physical complaints from athletes even if the only symptom is mild pain. Also, overuse injuries should be handled in a separate category from acute, in order to obtain reliable results (Seminati, & Minetti, 2013). Traditional injury surveillance techniques may not be appropriate for researching overuse injuries since they rely on a clearly identified onset and only measure severity by reporting how much the time-loss was incurred through the injury (Bahr, 2009; & Clarsen et al., 2015).

- *The OSTRC- Overuse Injury Questionnaire: an effective method of improving overuse injury surveillance*

Following Bahr (2009) recommendations, the OSTRC- O questionnaires were created and developed. In an effort to improve overuse injury surveillance, the OSTRC-O was developed in 2013 by Clarsen et al. to obtain a more valid picture of the extent of overuse injuries among players and help guide the direction of future injury prevention research (Bere, Kruczynski, Veintimilla, Hamu & Bahr, 2015; & Clarsen et al., 2015). The OSTRC-O uses four questions that ask athletes about any pain they may be experiencing in relation to their sport as well as how much their problems are affecting their participation, training volume, and performance. The

knee, lower back, and shoulder were the three anatomical regions selected as part of the questionnaire's initial validation procedure, however this questionnaire can be used to gather data for any anatomical area that would be pertinent for a specific sport (Clarsen et al., 2013). Regular use of this questionnaire (e.g., weekly) enables active monitoring and provides insights into how these issues develop over time, particularly over the course of a whole season. In addition, it requires little time to complete.

In a 2015 study, Clarsen et al. studied the prevalence and impact of overuse injuries in five sports in Norway: cross-country skiing, cycling, floorball, handball, and volleyball. They used the OSTRC-O questionnaire as a newly designed method for recording overuse problems, that is based on direct reporting from athletes and found a relatively high prevalence of shoulder complaints. This approach relies on the athletes to self-report levels of difficulty with participation, reduced training volume, affected performance, and pain due to sport participation (Roos & Marshall, 2014). Moreover, it is not limited to information on time- loss injuries and is not subject to systematic bias in injury definitions from data reporters or analysts (Roos, & Marshall, 2014). The effectiveness of the novel surveillance techniques in comparison to the traditional technique (which uses a time loss definition of injury) has been studied by a number of researchers. According to Clarsen et al., the

OSTRC-O captured 10 times more overuse injuries than the traditional technique. Weiss, Allen, McGuigan & Whatman (2017) used the OSTRC-O to evaluate professional basketball players over the course of a season, and they discovered 6.5 times as many overuse injuries as they had with the traditional approach. Thus, the OSTRC-O overuse injury questionnaire they developed has been able to more fully capture the impact of overuse injuries including shoulder injuries to different sports including volleyball and has been adapted for use in different languages and contexts.

While athletes are not health-professionals, Clarsen et al. believe that players may be best placed to rate their injuries and their effect on their performance (Clarsen, 2015), and therefore their methodology utilizes self-administered questionnaires. Self-reporting also requires less resources. Sport science research in the 20th century rarely used large-scale prospective data collection, presumably because managing mail-based questionnaires and data entry into computers is so laborious and time-consuming (Nielssen, 2012). Advances in information technology (email and other internet-based solutions, smartphone apps) have greatly facilitated this process, making it also easy to send reminders and follow-up with participants. Data analysis is also facilitated in this way. To prevent missing data or athletes failing to report complaints, it is critical to

incorporate measures that will boost athlete adherence and motivation while implementing any kind of program. An investigation of end-user impressions of an online version of the OSTRC-H was conducted with national elite athletes from judo, swimming, and volleyball in Brazil (Barboza, Bolling, Nauta, Mechelen, & Verhagen, 2017) between April 2014 and January 2015. The questionnaire was administered every two weeks for judo athletes and weekly for swimming and volleyball athletes. Poor adherence was noted, with overall response rates of 50% across the three athletic groups (judo, swimming, and volleyball). It was interesting to note that response rates were approximately 80–100% for the first few surveys of the season before gradually declining to significantly less than 50 percent after 10–11 questionnaires. The review panel that updated the OSTRC questionnaires suggests the following measures to improve adherence from athletes when completing these questionnaires: (1) providing feedback to athletes; (2) prompt follow-up by clinicians when responding to reported health problems; and (3) interpersonal interaction that encourages athlete participation. Therefore, OSTRC is a valid tool for overuse shoulder injury monitoring, provided measures to encourage and improve adherence are implemented.

2.6 Overuse shoulder injuries definition

2.6.1 Diagnosis-based definition

It can be challenging to clinically evaluate overhead athletes. Diagnosis of overuse shoulder injuries can use imaging tools such as MRI, MRA, ultrasound and computed tomography arthrography (CTA) to identify overuse shoulder injuries. The best imaging technique for the initial evaluation of shoulder complaints that gradually appear in volleyball players is routine MRI of the shoulder, as it allows the assessment of the entire joint with good soft tissue contrast resolution (Crema & Murakami, 2016). Another imaging technique used to detect overuse shoulder injuries is the use of MR arthrography (MRA) with intra-articular injection of a dilute gadolinium solution (Magee, 2009; Magee, Williams, & Mani, 2004; & De Jesus, Parker, Frangos & Nazarian, 2009). This method will distend the joint and enable better visualization of intra-articular structures and detection of labral tears and under-surface rotator cuff tears and is recommended as the next step after the initial MRI in case a diagnosis cannot be made with confidence by the radiologist (Crema & Murakami, 2016). However, some studies have shown that despite imaging results, players may be asymptomatic. Sher, Uribe, Posada, Murphy & Zlatkin (1995) found that 34% of the 96 MRIs they acquired in a healthy,

asymptomatic population contained partial or full-thickness rotator cuff tears, and a number of studies looking at the pitching shoulders of asymptomatic elite baseball pitchers have discovered partial rotator cuff tears in 21% to 52% of baseball pitchers and labral tears in 45% to 62% of baseball pitchers. According to these studies, there is no connection between MRI results and subsequent shoulder symptoms. Shoulder MRI was used in a study of asymptomatic elite volleyball players by Lee et al. (2019). The results confirmed the author's hypothesis that MRI would demonstrate extensive shoulder pathology in the dominant shoulder that would not prevent the asymptomatic player from competing. Close to 100% of the participants showed shoulder pathologies despite being asymptomatic. Surgery would usually be recommended if only considering MRI results alone; however the results prove that other steps must be considered especially when an unsuccessful surgery might threaten an athlete's ability to play. Therefore, the management of overuse shoulder injuries must take into consideration other evidence and criteria. Suprascapular neuropathy, rotator cuff tendinitis, shoulder labrum tears and shoulder impingement syndromes are common overuse shoulder injuries in volleyball:

- Suprascapular neuropathy: occurs when the suprascapular nerve, which runs from the neck and through the shoulder blade, becomes compressed

or damaged. This nerve is responsible for controlling the movement and sensation of the shoulder joint and the muscles around it. Symptoms include weakness, pain, numbness in the shoulder and arm, and difficulty moving the shoulder and arm in overhead motions. Volleyball players had the highest incidence of suprascapular neuropathy among athletes who participate in overhead sports. This illness affects about 33% of volleyball players at some point in their careers (Boykin, Heuer, Vaishnav & Millett, 2010)

- Rotator Cuff Tendinitis: This occurs when the tendons that attach the rotator cuff muscles to the shoulder blade become inflamed due to repetitive overhead motions. Symptoms of tendonitis include pain, weakness, and difficulty raising the arm overhead.

- Shoulder labrum tears: The labrum and glenohumeral joint endure repetitive stresses from overhead movements like hitting a volleyball. The top (superior) aspect of the labrum is where repetitive overload injuries occur most frequently, and both the front and back of this area can be injured. One of the two tendons from the long head of the biceps brachii muscle attaches to the labrum and rim of the glenoid bone here. A SLAP lesion is a common term for these kinds of tears. If overhead activities, such

as serving, become challenging and there is dull pain and shoulder weakness, labral tears may be suspected (Lee, Guy, Connell, Saifuddin & Lambert, 2007)

- Shoulder impingement syndromes: these injuries occur when the tendons or bursa in the shoulder joint become pinched or compressed during overhead movements, causing pain and inflammation. Symptoms of impingement syndrome include pain when reaching overhead or behind the back, as well as weakness and loss of mobility in the shoulder. Internal (or posterior-superior glenoid) impingement and external impingement have been described as the two main kinds of shoulder impingement (Cools, 2017). According to Gohlke et al. (1993), attackers frequently exhibit impingement because they rotate their glenohumeral joint inward to about 150° when serving or spiking.

2.6.2 Mechanism-based Overuse injuries definition

Overuse injuries are highly prevalent in sport, particularly in endurance and athletic disciplines (Clarsen et al., 2013). Overuse or chronic injuries are repetitive and cumulative micro-trauma injuries, resulting from a number of repeated low magnitude impacts applied over a considerable time period (Hamill, Palmer, & Van Emmerik, 2012). Despite their prevalence, overuse injuries have received limited

research attention. Moreover, the mechanisms of overuse sport injuries have received less focus in previous sport research than the mechanism of traumatic sports injuries (Jelvegård, Timpka, Bargoria, Gauffin & Jacobsson, 2016). In order to record injuries and measure the prevalence of overuse shoulder injuries with any degree of accuracy, it is essential to adopt a clear definition of overuse injury. However, the term "overuse" is used inconsistently throughout the sports injury epidemiological literature (Neil, Winkelmann & Edler, 2018). While some studies use a diagnosis-based definition of "overuse," others consider it to be a mechanism of injury (Roos & Marshall, 2014). Epidemiologic research and clinical practice are now separated by limitations brought on by various definitions of overuse (Neil et al., 2018). Clinicians should make use of the accepted working definitions to close the gap between epidemiologic research and clinical practice (Neil et al., 2018). By using a clear working definition of “overuse”, researchers and clinicians can target modifiable risk factors and causative mechanisms in order to conduct interventions to prevent overuse injuries (Neil et al., 2018). In their systematic review, Neil et al. (2018) recommended using the term overuse when referencing the mechanism of injury. This definition should emphasize that overuse injuries are characterized by a mechanism of gradual onset, and an underlying pathogenesis of repetitive microtrauma and adopt it within injury surveillance (Roos, & Marshall, 2014). This

will limit the misclassification between overuse injuries and acute mechanisms of injury (Roos & Marshall, 2014). Moreover, it will provide more information about athletic trainers' workloads and the time allotted for preventing and managing injuries that resulted from an overuse mechanism (Neil et al. 2018). Previous injury studies of these sports have used methods poorly suited to prospective recording of overuse injuries (Clarsen et al., 2015). Therefore, there is a need for prospective studies addressing athlete-based methods, specifically to capture the true burden of overuse injuries in a more thorough manner than the current surveillance systems (Roos & Marshall, 2014). Thus, there is a lack of knowledge about overuse injuries, possibly due to their nature. Traditional methods of injury registration that rely on a time-loss definition of injury to record injuries fail to capture the true magnitude of the problem. Athletes will typically continue to train and participate in competitions, especially in the early phases of an injury, despite overuse injuries symptoms such as pain or functional limitation, because these symptoms appear gradually or may come and go. It is only when the problem starts to worsen that athletes will take injury management measures (adapting to or avoiding certain activities, or eventually seeking medical treatment) and stop training and competing (Clarsen et al., 2013).

2.7 Overuse Shoulder Injuries Mechanisms and Etiological Factors in Volleyball

Sports injury epidemiology is important to supply information about injuries that occur frequently and have serious consequences, and to describe their aetiology, in order to provide a basis for preventive measures and to develop effective preventive strategies (Kilic et al., 2017; and Verhagen et al. 2004). Unfortunately, prospective studies investigating associated risk factors for overuse shoulder injuries in volleyball are scarce, despite their prevalence. Identification of the mechanism and risk factors (intrinsic and extrinsic) for volleyball-specific shoulder injuries is essential to have effective preventive measures and to establish injury causation (Kilic et al., 2017). These may be categorized as modifiable through physical or behavioral interventions, or non-modifiable through such interventions (James, Kelly & Beckman, 2014). There is currently little knowledge of the risk factors influencing the epidemiology of shoulder issues in volleyball (Reeser et al., 2010).

2.7.1 Risk factors

A significant problem in studying overuse injuries is that there are multiple interactions among the risk factors making it difficult to determine the etiology of the injury. Some of the factors are biomechanically-related (Hamill et al., 2012).

Knowledge about risk factors and injury mechanisms is necessary to fully understand the causes of sports injuries. Measures aimed at controlling and reducing the risk factors for the development of a sports injury are critical to primary, secondary, and tertiary injury prevention (Jones, Griffiths & Mellalieu, 2017). However, there is less evidence available for prevention of overuse shoulder problems and research on the causes of overuse shoulder injuries in volleyball is limited.

Following the “sequence of prevention” model , Meeuwisse (1994) created a multifactorial model that took into consideration how intrinsic and extrinsic risk factors interacted before an “inciting event” (examples: cumulative tissue overload, collision, fall, non-contact acute event). Meeuwisse, Tyreman, Hagel & Emery (2007) would then update this model to take into account the effects of repeated exposure and participation; emphasizing that injury etiology is not a linear sequence of events, rather a recurring loop with ever-changing risk. With their comprehensive model for injury causation, Bahr & Krosshaug (2005) built upon these models and emphasized the significance of comprehending both the risk factors and particular mechanisms causing injury. They underlined that in order to focus injury prevention efforts, a precise description of the “inciting event” is essential. These models all emphasize the complexity of sports injuries. Each

player's injury risk is different, and it changes over time after repeated or prolonged exposure.

The majority of human health conditions are complex, according to Bittencourt et al. (2016), who built on earlier models. They noted that the reductionist view in sports injury research, which reduces a phenomenon to the sum of its parts and views causality in a linear and unidirectional way, has largely failed to consistently identify risk factors for sports injuries. They recommend adopting a complex systems approach and shifting away from trying to identify isolated risk factors in favor of risk pattern recognition, which seeks to uncover the intricate pattern of interactions among a “web of determinants”, a set of variables with varying degrees of weak and strong interactions. Moreover, according to Windt & Gabbett (2017) the impact of training and competition loads on the dynamic character of injury risk have not been taken into consideration by these existing models of injury aetiology. Athletic injuries are closely correlated with overall workloads and, more significantly, spikes in workloads (high acute:chronic workload ratios), despite the fact that few mechanisms have been presented to explain how workloads cause injuries. In their ‘workload—injury’ model, workloads influence an athlete's dynamic injury risk through three pathways:

1. They expose athletes to both external risk factors and probable inciting events, increasing the likelihood that an athlete would sustain an injury;

2. They cause "fatigue," which refers to adverse physiological effects that change internal risk factors and increase risk of injury.

3. They cause "fitness," or positive physiological changes, which minimize the chance of future injuries by positively impacting internal risk factors.

Long-term studies with repeated workload measurements and modifiable risk factor measurements may start to reveal these relationships and offer more information about the dynamic nature of injury aetiology (Windt and Gabbett, 2016).

Case-control studies of injured and uninjured athletes have become rather widespread in the field of epidemiology, but their retrospective nature and associated problems restrict their ability to effectively identify risk factors (Finch, 2005). Prospective cohort studies are considered to be the best and most effective for determining risk and protective factors, although their execution can be challenging. In these studies, groups of people who are not injured are monitored over time until they become injured (Finch, 2005). It is recommended that modifiable risk factors should be continuously tracked over time through a

prospective study design (Bahr & Krosshaug, 2005; Nielsen, Malisoux, Møller, Theisen & Parner, 2016). This may be especially true for training-related factors, which are known to play a significant role in many sports-related injuries, especially those brought on by chronic overuse (Nielsen et al. 2016). Up until the start of the 21st century, the identification of training errors, however, has been very difficult because a large number of athletes must be included for an extended study period, particularly when focused on injury types that are less common. Thanks to the development of information technologies, however, large-scale prospective studies with follow-up of athletes have increased, where the athletes were monitored over a period from eight weeks to one year (Nielsen et al, 2016).

2.7.2 Risk factors in volleyball

Volleyball-related shoulder conditions share many of the same risk factors as other overhead sports. However, there are certain volleyball-specific risk factors that are related to the unique biomechanical demands of the sport. It is important to understand these risk factors in order to provide optimal care for overuse injuries and to prevent shoulder problems in volleyball athletes. Reeser et al. (2006) categorized risk factors for shoulder injuries as modifiable/non-modifiable (through physical or behavioral interventions) and intrinsic/ extrinsic. Non-

modifiable intrinsic (also known as internal) risk factors include anatomy, previous injury, age and sex. The classification of athletes into high, medium, and low-risk groups is based on the interaction of modifiable and non-modifiable risk factors for these injuries (James et al., 2014).

Non-modifiable risk factors

- Non- modifiable intrinsic factors

An important finding from Jones et al. (2017) systematic review is that the individual characteristics such as fitness, body composition, playing level, injury history, years of athletic practice, body mass index and age have a significant impact on internal training loads placed on the athlete and therefore the subsequent increase in the risk of injury. In a cross-sectional study on shoulder pain in a range of sports, including volleyball, Mohseni-Bandpei et al. (2012) found that having a history of shoulder discomfort was linked to having a higher body mass index, more than five years of practice, and playing at the national level. Seminati & Minetti, (2013) stated in their systematic review of overuse in volleyball practice that age is considered as the main risk factor for overuse upper limb injuries, both for professional and recreational athletes. In their systematic review of risk factors for shoulder injuries in overhead athletes, Tooth et al. (2020) found that years of

athletic practice, body mass index, sex, age, and level of play seem to have modest influence on risk of shoulder injury. However none of these prospective studies that investigated these personal factors focused on volleyball. Asker et al. (2018) systematic review examined risk factors and prevention measures for shoulder injuries in overhead sports. Risk factors included participation level (competition vs training), sex, biomechanics, playing position, shoulder ROM (GIRD, total rotation deficit, flexion deficit, or insufficient ER), history of injury, and external workload. They found limited evidence for all investigated potential risk factors for shoulder injury in overhead sports, with most of these factors being non-modifiable, such as sex. However, target populations for initiatives aimed at preventing injuries can be determined by using non-modifiable factors (Asker et al., 2018). Therefore further investigation of personal risk factors is justified.

Modifiable risk factors

Modifiable risk factors are more useful elements in injury prediction as they can largely be managed through training practices (Eckard, Padua, Hearn, Pexa & Frank, 2018). They can be intrinsic or extrinsic.

- Modifiable intrinsic risk factors

Modifiable intrinsic (also known as internal) risk factors include biomechanics, ROM/muscle, conditioning/core stability, GIRD and scapular dyskinesis (SICK scapula). Large GIRDs in the dominant compared to the non-dominant shoulder is a significant risk factor for shoulder injury. This is thought to be due to the alteration of the GHJ kinematics, leading to increased stress on capsular structures, the glenoid labrum and the static glenohumeral stabilisers. It has been found to be a risk factor for shoulder injury among throwing athletes (Clarsen, 2015). A variety of intrinsic factors predisposing athletes to injury have been reported in the literature, including agonist/antagonist muscle ratios for endurance and strength. More recently, it has been proposed that other significant intrinsic risk factors for injury include neuromuscular control, core instability, and contralateral muscle imbalances. Contralateral imbalances may also appear after injury has already occurred, resulting in compensatory strategies, muscular inhibition, or both (Chorba, Chorba, Bouillon, Overmyer & Landis, 2010).

Glenohumeral joint range of motion, shoulder strength, and scapular dyskinesis are modifiable, biomechanical intrinsic risk factors that have been investigated in a prospective cohort study of handball athletes (Clarsen et al., 2014). These factors were found to have a significant association with shoulder injury, and should be targeted in injury prevention programs. It would thus be

relevant to study the same factors in volleyball athletes especially given the lack of research in this area. A broader approach to assess physical risk factors for shoulder injury by measuring the impairments, such as reduced glenohumeral range of motion, rotator cuff muscle weakness and scapular dyskinesis is required in order to develop successful measures to prevent injury (Hogan et al., 2021; & Asker et al., 2018). Physical examination is used primarily to record the severity of upper extremity impairments. Impairment is defined as abnormality or a limitation of physiologic or function or anatomic structure at the organ level such as reduced glenohumeral range of motion, rotator cuff muscle weakness and scapular dyskinesis (Marx, Bombardier, & Wright, 1999).

The physical examination elements should be valid and reliable. A test's results are of limited use if they cannot be reliably repeated by the same (intra-observer reliability) or different physicians (inter-observer reliability). Procedural variability resulting from the technician's performance or equipment may potentially have an impact on measurement reliability (Marx et al., 1999). Moreover, An examination is not an effective tool if it does not precisely quantify the phenomenon of interest (Marx et al., 1999). Furthermore, there are other variables that have not been researched that may impact the reliability of these tests, such as patient characteristics or physician experience. Therefore, a reliable

and accurate evaluation of physical shoulder assessment tools through a test retest correlational study offering an reliability and accurate evaluation of the physical shoulder assessment tools applied in cross-sectional study is advisable to investigate physical risk factors overuse shoulder injuries.

- Glenohumeral joint range of motion

Studies comparing the dominant and non-dominant shoulders of overhead athletes consistently show that the dominant shoulder loses internal rotation while gaining external rotation (Clarsen, 2015). This is thought to be due to the alteration of the GHJ kinematics, leading to increased stress on capsular structures, the glenoid labrum and the static glenohumeral stabilisers. It has been found to be a risk factor for shoulder injury among throwing athletes (Clarsen, 2015). However, a more recent systematic review of prospective cohort studies of overhead athlete's shoulder and elbow ROM by Pozzi et al. (2020) found that absolute shoulder ROM or shoulder ROM differences do not appear to be consistent risk factors for shoulder and elbow injuries in different overhead athletes. Also limited evidence revealed that preseason ROM screening may not be useful for identifying handball, softball, volleyball, and tennis players at risk for shoulder and elbow injuries. The review revealed that most research has focused on baseball players,

and also found only one prospective study of volleyball athletes by Forthomme et al. (2013), which demonstrated that absolute shoulder ROM or shoulder ROM deficits were not associated with shoulder pain in professional volleyball players.

Another review by Challoumas et al. (2017) focused on volleyball athletes concluded that the GIRD in volleyball players appears to be anatomical as a response to the repetitive overhead movements, unlike other overhead sports, and is not connected to shoulder pain or injury. Tooth et al. (2020)'s systematic review commented on this and noted that the sample size was too small to draw any conclusions and that therefore more research is required in volleyball and other overhead sports. Studies of range of motion of overhead athletes measured shoulder internal and external rotation ROMs with either a goniometer or a digital inclinometer with participants in a supine position with shoulder abducted at 90° and elbow flexed at 90° (Pozzi et al., 2020).

Goniometry has been used to measure both active and passive range of motion of the shoulder for measures of shoulder impairment. Several studies have shown the intra-observer variation to be satisfactory (intraclass correlation coefficients = 0.89). Williams and Callaghan found that visual estimation by experienced and skilled therapists was equal to measurements by goniometry

(Marx et al., 1999). The disadvantage of goniometry is that it requires the clinician to use both hands in the assessment of shoulder external (ER) and internal (IR) rotation ROM, making stabilisation of the of the trunk and the scapula more difficult, and thus increasing the risk of measurement errors in reading the instrument (Kolber, & Hanney, 2012; & Cools et al., 2014). Digital inclinometers are lightweight, portable, and require training similar to that of goniometry. However, the disadvantages of digital inclinometer are that it is more expensive than traditional goniometers and necessitates the examiner to precisely and consistently set the zero point of the digital inclinometer before use in order to reduce the risk of measurement errors (Kolber and Hanney, 2012). A reliability study by Kolber and Hannery (2012) found both techniques are reliable and may be used interchangeably.

- Muscle strength

A decrease in the external rotators/internal rotators strength ratio has been shown to be a risk factor in handball (Edouard et al. 2013) and volleyball athletes (Forthomme et al., 2013). In addition, studies have found a strong link between external rotation weakness and shoulder injury in baseball pitchers (Byram et al.,2010), and in handball players (Clarsen et al., 2014). The gold standard for

muscle testing is the isokinetic dynamometer (ID) (Chamorro, Arancibia, Trigo, Arias-Poblete & Jerez-Mayorga, 2021). Maximum torque can be produced over the whole range of motion, and results are not understated if the examiner is unable to exert sufficient resistance against the muscular strength being measured. Despite being the gold standard, isokinetic testing is only occasionally used in clinical settings due to its high cost and need for a laboratory setting. In contrast, portable dynamometers (HDD) are inexpensive, practical in size, and simple to use. In addition, several studies have established its reliability (Cools et al. 2014, Cools et al. 2015, Johansson et al., 2015; Coinceicao et al. 2018).

- Scapular dyskinesis

Scapular dyskinesis is a disorder that impairs the normal control of scapular motion and may increase the risk of shoulder injuries in throwing athletes (Clarsen, 2015). Because the scapula's position is a key factor of poor scapular control can cause primary or secondary impingement syndromes, glenohumeral joint alignment and increase stress on passive joint structures like the glenoid labrum impair rotator cuff muscle function (Kibler & Sciascia, 2010).

A study of elite volleyball attackers by Kugler et al. (1996) revealed the consequences of overload on their dominant shoulder girdles. They found

lateralisation and depression of the dominant scapula compared with the non-dominant side. Similar physical changes, also referred to as the "SICK scapula" (scapular malposition, inferior medial border prominence, coracoid pain and malposition, and scapular dyskinesis), have been observed in other overhead athletes. It is associated with shoulder pain due to the functional instability and spectrum of rotator cuff pathology. According to Reeser et al. (2006), the SICK scapula may play a role in the development of suprascapular neuropathy, a peripheral mononeuropathy affecting up to 45% of elite volleyball athletes. The authors hypothesized that the scapular lateralization and dyskinesis that are characteristic of the SICK scapula syndrome may exert enough traction to compromise the suprascapular nerve as it passes through the spinoglenoid notch. A systematic literature review by Burn, McCulloch, Lintner, Liberman & Harris (2016) found that scapular dyskinesis has received increased research interest in recent years due to its greater prevalence among overhead athletes (61%) compared to non-overhead athletes (33%). Despite its high prevalence, there is still mixed evidence of an association with shoulder injury in overhead athletes. In another recent systematic review of risk factors of overuse shoulder injuries in overhead athletes by Tooth et al. (2020), some prospective cohort studies confirmed scapular dyskinesis to be a risk factor in shoulder injury (McKenna,

Straker & Smith, 2012; Clarsen et al. 2014; Struyf et al., 2014), while others did not find any association (Myers, Oyama & Hibberd, 2013; Hjelm, Werner & Renstrom, 2012). However, none of these studies specifically focused on volleyball athletes. Therefore, more research is needed to assess scapular dyskinesis as a risk factor in volleyball.

Visual observation tests are used to assess the presence of scapular dyskinesis. To classify scapular control as "normal" or "dyskinesis," these need dynamic observation of the scapulae during numerous repetitions of humeral elevation (e.g., flexion and abduction). Dynamic scapular dyskinesis test that dichotomizes scapular control into ‘‘normal’’ or ‘‘dyskinesis’’, is used to examine static scapular posture and dynamic scapular movement. Uhl, Kibler, Gecewich & Tripp (2009) assessed the inter-rater reliability and validity of 2 clinical assessment methods of categorizing scapular dyskinesis (the yes/no method and 4 type method). They found that the inter-rater percent agreement and the degree of this agreement as measured by kappa statistic showed that the yes/no method produced a higher inter-rater percent agreement (79%, kappa = 0.40) than the 4-type method (61%, kappa = 0.44). They therefore recommended establishing the absence or presence of scapular dyskinesis by observation is encouraged particularly when testing subjects in shoulder forward flexion.

- Modifiable extrinsic risk factors

Modifiable extrinsic (also known as external) factors are modifiable factors that include training-related factors (competitive situation, load). Extrinsic risk factors may contribute to overuse shoulder injuries due to repetitive load on the shoulder without enough recovery time (Pozzi et al., 2020). Athletes are at an increased risk of injury significantly at key stages in their training and competition, including training duration, frequency and volume (Jones et al., 1994). Training-related risk factors for overuse injuries have been studied in endurance sports. A 12-month retrospective study was conducted by Ristolainen, Kettunen, Waller, Heinonen, & Kujala (2014) that utilized anthropometric self-reporting and training-related variables (starting training age, years of active training, weekly resting days hours trained yearly and competition hours) and overuse injuries occurrence, and showed that a high amount of training and a low number of recovery days are training-related risk factors for overuse injuries in top-level endurance athletes. A higher number of tendon overuse injuries in older than younger athletes was also reported and may indicate that age-related degeneration plays an important role in the etiology of tendon injuries. Training-related risk factors have also been studied in volleyball and other overhead sports. In a cross-sectional study on shoulder pain in a range of sports, including volleyball, Mohseni-Bandpei et al.

(2012) found that having a history of shoulder discomfort was linked to playing more than four days per week. The retrospective data collection in this study however introduces a degree of recall bias. In their systematic review of prospective studies examining risk factors in overhead athletes, Tooth et al. (2020) found training-related factors such as field position, time of season, condition of practice (match/training), and training load were also found to have an influence on shoulder injury occurrence. In addition, they found that all the studies investigating training load and frequency of matches found it to be an important modifiable risk factor. Again none of these studies studying training-related risk factors focused on volleyball.

A season-long prospective study by Timoteo et al. (2018), examined the influence of workload and recovery on injuries in elite male volleyball players. The session rate of perceived effort scale was used each day to track workloads, and the Total Quality Recovery (TQR) scale was used to evaluate recovery status. The athletes' total exposure to training and games was 4,573.31 hours (h), with a 13.99 injury incidence rate per 1,000 hours. 83% of all injuries (11.58 injuries per 1,000 hours) resulted from overuse, and 17% (2.40 injuries per 1,000 hours) from trauma. When compared to injured players, healthy players had lower acute:chronic workload ratio (ACWR) ($p = 0.002$). Comparing the healthy group to the injured

group, the Total Quality Recovery (TQR) was greater for the healthy group (p= 0.001). Therefore, volleyball injuries may be influenced by an athlete's workload and level of recovery. However, despite the high level of overuse injury captured, the study included all injuries and did not provide data on anatomical location. Overall, there is a lack of research about training-related risk factors for overuse shoulder injuries in volleyball-specific studies and more prospective studies are required.

2.8 Overuse Shoulder Injury Risk Factors/Impacts Model

In injury surveillance studies, having a theoretical framework is valuable because it helps to analyze injury data in a way that directly informs strategies for preventing injuries. A theoretical framework is required to understand how factors representative of the target population influence injuries and its impacts (Fagher, Jacobsson, Timpka, Dahlström, & Lexell, 2016).

Author of this thesis proposed Overuse Shoulder Injury Risk Factors/Impacts Model (Figure 1). This conceptual model help researcher to clarify and communicate her ideas, assumptions, and perspectives in her knowledge or understanding. In study one, while acknowledging the importance of other risk factors, the theoretical model specifically focuses on personal and training-related

factors in relation to overuse shoulder injuries. It highlights how these factors impact the quality of performance and participation within the context where these injuries happen. This model is limited to the potential risk factors outlined in section 2.7.1 of chapter 2, pertaining to the specific context of overuse shoulder injuries. It made the most feasible and practical relative outcome measures of overuse shoulder injuries. It demonstrates the incidence/prevalence of overuse shoulder injuries and their impact among competitive male volleyball athletes in Kuwait. In addition, it demonstrates the relationship of personal and training-related risk factors with overuse shoulder injury incidence and the impact on severity measures. According to the purpose of modeling, to investigate specific population in unique context, this model can be used for other research with specific context considerations that will expand this model with more potential risk factors or reduce it. Certainly, This model isn't an exhaustive representation of all risk factors. Instead, it specifically examines the connection between certain training-related and personal factors in the context of overuse shoulder injuries. It focuses on these specific elements within the Overuse Shoulder Injury Risk Factors/Impacts Model.

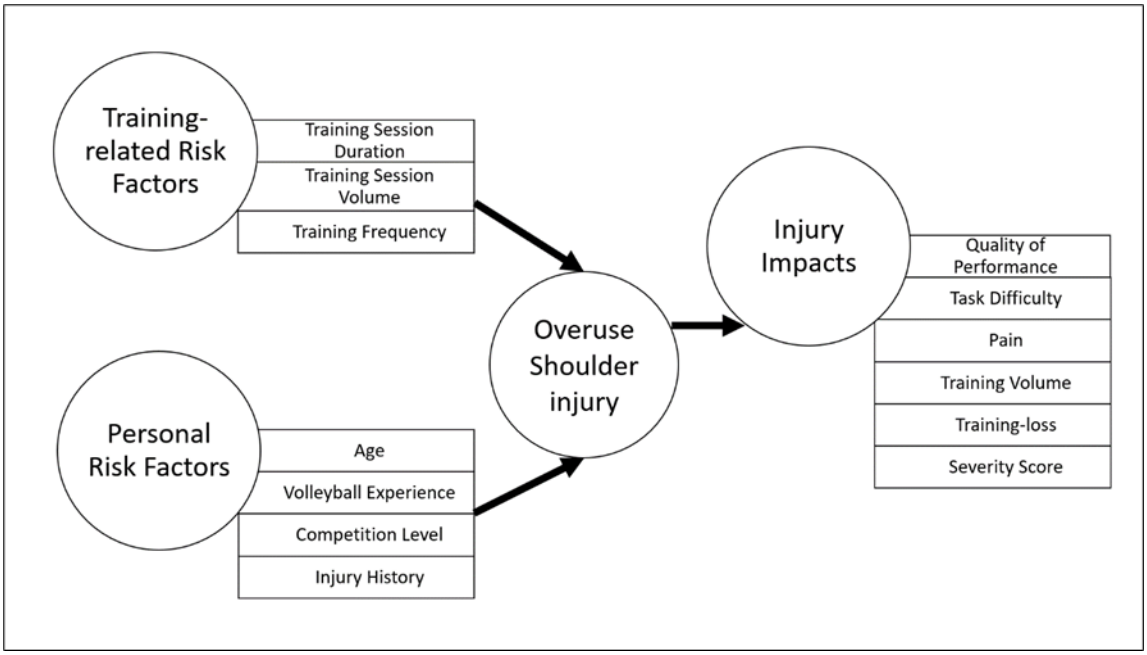

Figure 1. Overuse Shoulder Injury Risk Factors/Impacts Model

2.9 Context-driven Qualitative Approach in sports injury research

Understanding the environment, culture, and infrastructure surrounding sports injuries is necessary as they may act as so-called contextual determinants of the injury prevention process (Bolling et al., 2018). Multiple individual features and extra-individual factors define injuries (Bolling et al., 2018). As athletes, coaches, and medical professionals are the primary users of injury surveillance systems and injury prevention programs, it is crucial to comprehend how injuries are perceived and described by these groups (Bolling et al., 2019). They recommend the use of qualitative methods in future sports injury research in order to explore the practical

context. The fact that interview methods are still widely used for research despite the introduction of more cost efficient quantitative methods is proof of their relevance, as interviews are very effective for the in-depth understanding of a phenomenon (Lim, 2002).

2.9.1 Applying the socio-ecological framework in sports injury research

Bolling et al. (2018) recommended the application of a socioecological framework with the injured athlete at the center, that includes context at multiple levels (i.e. individual, sociocultural and environmental), as a practical lens through which to view the injured athlete. Reeves, Albert, Kuper & Hodges (2008) recommend the use of a theoretical framework in qualitative studies as the use of theory-driven research questions; data collection (for example, by creating a theory-based interview guide) and analysis can help clarify causes or influences of complex phenomena. The Ecological Systems Theory (EST) proposed by Bronfenbrenner in the 1970s has been suggested as a useful theoretical framework through which to view and explore the complex nature of injury contexts and injured athletes' perspectives (Bolling et al., 2018). McLeroy, Bibeau, Steckler & Glanz (1988) redefined the EST as a socioecological framework to promote changes in health behavior; since then it has been frequently used for medical interventions

and health policies. In more recent years the socioecological framework has been increasingly used in sports medicine studies, particularly regarding sports injury prevention (Bolling et al. 2018; Bogardus, Martin, Richman & Kulas, 2019; & Bruder, Crossley, Donaldson & Mosler, 2021). Despite the benefits of using the socioecological framework as a possible theoretical foundation for studying the factors associated with sport-related injury, it has not frequently been applied to developing sports medicine interventions (Scarneo et al., 2019). However in recent years, more sports medicine studies have started to utilize the socioecological approach.

Bolling et al. (2018) built on previous models and proposed their own adaptation of the socioecological framework in order to study sports injuries in their specific context. Using a qualitative research approach together with the application of this model enables the collection of in-depth information about the context in which injuries occur and provides a more comprehensive understanding of how the different levels of the socio-ecological model interact in the athlete's personal experiences. A deeper understanding of volleyball athletes' perceptions of their overuse shoulder injuries may support the future development of theory-based injury prevention and rehabilitation interventions that specifically address

overuse injuries in these performance-driven contexts, by taking into account the different levels of the socio-ecological framework.

As an application of their context-driven approach, Bolling, Delfino Barboza, van Mechelen & Pasman (2019) performed a qualitative study to explore how elite athletes, coaches, and physiotherapists from diverse internationals Olympic sports perceive a sports injury in their elite sports context; and also, to explore how the context influences the perception of an injury. Participants most commonly defined an injury based on the athlete's performance limitation. Although primarily used to assess severity, pain and participation level were important considerations in the classification of an injury. Numerous internal and external factors, including self-motivation, pain coping strategies, and the value of competition, were highlighted as having an impact on how an injury was perceived, and consequently, how it was defined. A sports injury was presented as the end-result of an interaction between athlete features within the athletes' context. Therefore, it would be useful to adopt a similar approach to studying overuse shoulder injuries in volleyball, as an example of another performance-driven sport.

2.9.2 Qualitative studies of overuse injuries

Qualitative approaches have been previously used to explore perceptions of overuse injuries. Tranaeus, Johnson, Engstrom, Skillgate & Werner (2014) and van Wilgen & Verhagen (2012) used single-shot semi-structured interviews to identify a number of non-physical factors associated with overuse injuries in a variety of sports (such as indoor floor hockey, swimming, and volleyball), including culture, stress, staleness, passion, and identity. This underlines how crucial it is to take both the environment and the individual into account. However, while these studies have contributed to the literature, they concluded that there is still a lack of understanding of the dynamic nature of overuse injuries, and how sport culture influences their occurrence and experience (Cavallerio, Wadey & Wagstaff, 2016). Cavallerio et al. (2016) attempted to address this gap by adopting an ambitious 12-month ethnography study that included 43 participants (including gymnasts, parents, coaches, a physiotherapist and 8 qualitative methods, in order to develop an in-depth understanding of overuse injuries in rhythmic gymnastics and to explore how sport culture impacts overuse injuries. The creative nonfiction stories that came out of their research reflect the differences in the interpretation of the same situations and the cultural norms, values and behaviors that influenced the occurrence and experience of overuse injuries, and presented athletes' experiences

using an innovative approach that is accessible to non-academic audiences. The output of the research honored athletes' role in society and their perceptions and confirmed other research done in similar sports contexts where pain is normalized and even glorified. Therefore it is important to explore the normalization of pain in any performance-driven context such as competitive volleyball in order to understand overuse injury.

In another qualitative study about overuse injuries in sports, van Wilgen & Verhagen (2012) conducted in-depth interviews and described the beliefs of Dutch athletes and coaches practicing different sports about the subjective definition of an overuse injury, as well as the intrinsic and extrinsic risk factors that underlie overuse injuries. Athletes and coaches define overuse injuries by combining somatic, psychological (behavioral and cognitive), and sociological factors. The notions of intrinsic factors included those of technique, psychology, inheritance, and physical factors. The situational and social conditions, coach and training were all extrinsic factors. The dimensions discovered in this study reflect a bio-psycho-social, or holistic, view of athletes and coaches on overuse injuries (van Wilgen & Verhagen, 2012). However, one of the limitations of their study is that team sports were largely underrepresented and so the social dimension (team mate factors) was not prominent. As volleyball is a team-sport, the social aspects of volleyball

need to be taken into consideration. Also while these qualitative studies do provide valuable insights on overuse injuries, they lack the wider context that was later proposed by Bolling through the more practical application of a socio-ecological model that enables us to view the athlete at the center of a wider multi-level issue that includes country and policy issues. There is a lack of qualitative volleyball-specific studies on overuse shoulder injuries, therefore more research is required. Recently, Bruder et al. (2021) applied a socioecological model (adapted from the one by Bogardus et al., 2019) to study the perspectives and experiences of injury prevention practices in women playing elite Australian football. The different levels outlined in their model are: the athlete level (individual), the team level (intrapersonal), the club level (organization), Australian Football leagues and players association (community level) and the government level (policy makers). Although the study is about a different team sport and is more focused on injury prevention practices, their interpretation and adaptation the socioecological framework offers a clear lens through which to view sports injuries.

In summary, more volleyball-specific qualitative studies are required to explore players' perceptions of overuse shoulder injuries and gain a deeper understanding of the dynamic aetiology and contextual determinants of overuse shoulder injuries. The application of a socio-ecological framework will help to

identify stakeholders and their role in injury prevention and contribute to the development of future injury prevention interventions.

2.9.3 The course of action

The course of action framework is a useful tool used in qualitative studies that has been previously used in sports medicine to analyse sports performance. In ergonomics, the analysis of activity often examines a variety of factors of how workers carry out their tasks in work environments (Cahour, Salembier & Zouinar, 2016). Recently, researchers have increasingly been interested in subjective or lived experience in ergonomics (Cahour et al., 2016). Subjective experience of an activity is defined by Cahour et al. (2016) as *"the stream of actions, emotions, thoughts and perceptual sensations generated while performing an activity, which the subject is or can be made aware of"* (Page 267). The course-of-action theoretical framework was first developed in the field of ergonomics in the 1980s (Poizat & San Martin, 2020) as a methodological framework focusing on subjective experience as a means to analyse activity (Cahour et al., 2016).

The course of action is described by Theureau (2003) as the agent's course-of-experience (also known as "intrinsic organization of the course of the action") and the relationships it has with the relevant extrinsic characteristics of his/her

observable activity, state, situation (including other agents and partly shared by these other agents), and culture (also partly shared with other agents). It has continued to evolve and has experienced a resurgence in the fields of creative, cultural, and mediation activities, sports sciences and sports interventions, and educational and training sciences (Poizat & San Martin, 2020). The course of action takes into account all relevant factors, including the limitations present, the activity as it is experienced by the actor, as well as the physical, situational, and cultural effects on the subject (Theureau, 2006).

Self-confrontation is a privileged way to acquire access to the course of experience and understand all aspects of a particular activity (Cahour et al., 2016). Self-confrontation interviews are the usual methodology used to document the subjective experiences explored through the lens of the course of action framework. Self-confrontation interviews were first applied in action psychology to settings like children interacting in a playroom (Cranach, 1982) and cooperative group work (Von Cranach, Ochsenbein & Valach 1986; Cranach, 1996). In order to facilitate the recollection of events, self-confrontation interviews—which have been widely used in the fields of psychology and ergonomics—typically rely on the "traces" of an activity, such as written descriptions and video and/or audio recordings (Cahour et al., 2016). The researcher presents actors with video

recordings of their actions and asks them to describe, demonstrate, imitate, recount, and remark on aspects that have personal significance for them. The actors' engagement during the self-confrontation is primarily focused on "re-living" the previous activity (Poizat & San Martin, 2020). Lim (2002) compiled the traditional steps of the self-confrontation interview process (based on Cranach, 1982; Cranach & Kalbermatten, 1982; Cranach, et al., 1982; & Kalbermatten, 1982):

1. Asking subjects to engage in the analysed behavior.
2. Filming the subjects' actions.
3. Having the subjects watch the videos of their own actions.
4. Pausing the videos at key points and asking subjects to describe any thoughts or feelings they had while engaging in those actions.
5. Transcribing the interviews and correlating the actors' thoughts and feelings with their actions.

Another methodology that is still underdeveloped when compared to self-confrontation interviews is the reenactment interview (Poizat & San Martin, 2020). In the reenactment interview, the traces are usually discrete and material traces of the actor's prior behavior, traces of the activity's environmental impact, or traces

of the environment's ongoing changes (Donin & Theureau, 2007). The constitution, dating, and serialization of the material traces are necessary for this strategy, which is an extension of the ideals and successes of self-confrontation. These traces take the place of the self-confrontation's video recording of behavior.

Reenactment interviews using material traces are especially helpful when recording is not possible or when activity is recorded over long and discontinuous periods of time. Examples of material traces used for the reenactment interview include digital traces, produced by the researcher, written traces left by the actor's activity, photo traces, digital traces and data, the actor's self-produced photo or video traces and even material traces left in the actor's body (Poizat & San Martin, 2020). The activity, the environment, the research, as well as other circumstantial elements, all influence the choice or articulation of these methods. It is feasible to overcome the limitations of video recordings, examine longer time periods, and document experimentally and a posteriori, for instance, the experience of actors during unforeseeable events, through reenactment interviews using material traces (Poizat & San Martin, 2020). While it has not been applied to sports injuries research, the course-of-action framework may offer an advantage by fully engaging the player cognition in specific injury events to self-analyse contextual factors associated with the reported injury. In the field of sports science, the course-of-

action framework was first introduced by Saury, Durand & Theureau (1997), and has been used in variety of studies to analyse the different elements of elite athletes' activity during competition, particularly their cognitions (D'Arripe-Longueville, Saury, Fournier & Durand, 2001; Hauw, Berthelot, & Durand 2003; & Sève, Poizat, Saury, & Durand, 2006).

This situated-cognition approach responds to the need for specific protocols to study individuals' cognitions in context (e.g. Lave, 1988; Suchman, 1987). A study on the experiences of table tennis players revealed the existence of distinct mindsets (Sève et al. 2006). These authors pointed out that studies based purely on behavioral observations would not have been able to identify "attitudes" of three different types, focusing on exploration, execution/performance, and cheating. This research was based on the course of action and course of experience theory and data obtained using self-confrontation methods. It is important to note that the authors' recommendations for developing table tennis training programs were influenced by the findings of this research on evoked experience (Cahour et al., 2016). Therefore, course of action methodology may play a similar role in qualitative research of players' experiences with sport injuries and contribute to developing context-informed injury prevention programs.

2.10 Summary

The literature reviewed in this chapter underscores the prevalence of overuse shoulder injuries in volleyball (Asker et al., 2018; Clarsen et al., 2014). Various strategies have been recommended for preventing these injuries in volleyball athletes (Reeser et al., 2006; Seminati and Minetti, 2013). However, research on preventing overuse shoulder injuries in volleyball remains inadequate, lacking sufficient evidence in the literature to substantiate the effectiveness of these measures. Many proposed strategies for preventing and treating sports injuries are insufficient, especially when complications arise due to behavioral, lifestyle, or training load-related factors. Sports injuries are complex phenomena (Bolling et al., 2018) requiring a multifaceted approach encompassing multiple perspectives. Consequently, more volleyball-specific research and interventions focused on shoulder injury prevention are necessary. Understanding the complexity of overuse shoulder injuries demands consideration of both the intricate nature of the shoulder joint and the specific volleyball movements like spiking and serving, which collectively contribute to the risk of injury.

Moreover, this review highlights the intricate nature of overuse shoulder injuries and their associated risk factors, with personal characteristics, training loads, and physical shoulder attributes identified as potential contributors to the

high prevalence of overuse shoulder injuries in male competitive volleyball players in Kuwait. However, research has disproportionately focused on the mechanisms of traumatic sports injuries rather than overuse injuries (Jelvegård, Timpka, Bargoria, Gauffin & Jacobsson, 2016). To accurately record and measure the prevalence of overuse shoulder injuries, adopting a clear definition of these injuries is crucial. Unfortunately, the term "overuse" lacks consistency in the sports injury epidemiological literature (Neil, Winkelmann & Edler, 2018), and previous studies inadequately addressed the prospective recording of overuse injuries (Clarsen et al., 2015). Hence, there's a pressing need for prospective studies employing athlete-centered methodologies to comprehensively capture the true burden of overuse injuries, surpassing current surveillance systems (Roos & Marshall, 2014).

Consequently, due to the nature of overuse injuries, there's a lack of comprehensive understanding, particularly since traditional injury registration methods relying on time-loss definitions fail to capture their full extent. Sports injury epidemiology is vital in providing insights into frequently occurring injuries with serious consequences, describing their causes, and forming the basis for preventive measures and strategies (Kilic et al., 2017; Verhagen et al., 2004). However, evidence for preventing overuse shoulder problems is scant, and research on the causes of these injuries in volleyball is limited.

Understanding overuse injuries presents challenges due to the intricate interplay of risk factors, making it difficult to ascertain their exact etiology. Knowledge about these risk factors and injury mechanisms is crucial for understanding sports injury causes. However, none of the existing studies specifically focused on sub-elite volleyball athletes. Consequently, more research is imperative to evaluate risk factors in volleyball. This review urges future epidemiological studies to employ precise definitions of overuse shoulder injuries, adopt prospective cohort designs, and utilize reliable and valid measurement tools suitable for volleyball players with overuse shoulder injuries to enhance overall research quality (Kilic et al., 2017).

Furthermore, a context-driven qualitative approach has shown effectiveness in deeply understanding overuse shoulder injuries in volleyball (Lim, 2002). This review advocates for the integration of qualitative methods in future sports injury research to explore practical contexts. Despite the introduction of more cost-efficient quantitative methods, interviews remain widely used due to their effectiveness in deeply understanding phenomena (Lim, 2002). The dearth of qualitative volleyball-specific studies on overuse shoulder injuries necessitates further research. Additionally, course of action methodology may similarly

contribute to qualitative research on players' experiences with sport injuries and aid in developing context-informed injury prevention programs.

Chapter 3.0: Study 1 - Effect of Personal and Training Related Risk Factors in Prevalence of Overuse Shoulder Injuries Among Sub-elite Volleyball Players in Kuwait

3.1 Introduction

Despite the incidence and prevalence of overuse shoulder injuries being previously established in volleyball players (see section 2.5.1 in chapter 2), there is a paucity of evidence focusing on risk factors that influence the epidemiology of volleyball-related shoulder problems compared to other overhead athletes (see section 2.7.2 in chapter 2). Moreover, overuse shoulder injuries can have significant impacts in volleyball players (see section 2.5.2 in Chapter 2). According to the van Mechelen "sequence of prevention", effective injury prevention requires knowledge of the extent of the problem as well as of the aetiology (see section 2.3 in chapter 2).

In addition, the nature of overuse shoulder injuries can result in athletes continuing to train and play when players are asymptomatic or when symptoms may be mild (Yang et al., 2012). Therefore, previous surveillance methods in sport injury epidemiology studies which rely heavily on time-loss for injury definitions and severity measurements, may underestimate their true impact (Clarsen, 2015). Epidemiological studies should evaluate not only the time-loss parameters, but also physical complaints from athletes even if the symptoms are only mild pain. These functional consequences of injury should form the basis of severity measures, rather than time-loss, to be more sensitive in capturing overuse injury impact

(Clarsen, 2015). Use of the OSTRC-O overuse injury self-report questionnaires (see section 2.5.3) has been shown to more fully capture the prevalence impact of overuse injuries than questionnaires that rely on time loss definitions of injury. Therefore, it is important to obtain a more valid picture of overuse problems among volleyball players in Kuwait which reflects the athlete's self-assessment of their pain and the impact that the problem has had on their participation, training volume and sports performance (Bere et al., 2015).

Moreover, several personal and training-related risk factors have been identified for overuse shoulder injuries (see section 2.7.2 in Chapter 2). While personal factors such as age may play a modest influence in injury causation in overhead athletes (Tooth et al. 2020), they are non-modifiable. However non-modifiable factors may help define the populations that are at risk. Training-related factors are modifiable and play an important role in overhead athletes (Tooth et al. 2020). Knowledge of modifiable factors such as training-related risk factors is more useful for injury prevention efforts. Vanderlei et al. (2013) found that greater age and years of playing were associated with the occurrence of injuries among volleyball players participating in the High School Olympic Games of the State of São Paulo (Brazil). In addition, independently of personal and training characteristics, training was found to be the moment in which most injuries

happened (93 injuries; 75%) (Vanderlei et al., 2013). However, these findings represent all injuries in a younger population; therefore it is worth investigating personal and training-related risk factors for adult male volleyball players, more specifically for overuse shoulder injuries.

The aim of this study is to determine the incidence/prevalence of overuse shoulder injuries and their impact among competitive male volleyball athletes in Kuwait, and to investigate the relationship of personal and training-related risk factors with overuse shoulder injury incidence and the impact on severity measures.

The current study proposed an overuse shoulder injury risk factors/impacts model for the relationship between the personal and training related risk factors and the overuse shoulder injuries followed by the consequences relating to the quality of performance and participation (Figure 1). This study sought to test the proposed model within a specific population (see section 2.8 in chapter 2).

3.2 Method

3.2.1 Research Design

Following institutional ethics approval, a prospective cohort study of competitive male volleyball players in Kuwait during a 30-week sport season (2020-2021) was conducted. The approach for this study was a descriptive survey, investigating overuse shoulder injuries rate, injury risk factors/impacts and measuring of the consequences of an overuse shoulder injuries. Each Friday during the competitive sport season (2020/2021), targeted volleyball players received an online weekly survey addressing their shoulder health and sport participation condition in the last previous week. Players with and without overuse shoulder injuries were identified using self-injury description. Prevalence and incidence rate were counted.

3.2.2 Population and Recruitment

All 264 competitive male volleyball players registered in the Kuwaiti volleyball federation and playing in the two highest leagues [First degree league, Excellent league] during the 2020/2021 volleyball season were the target population for this study. A sample of 157 volleyball players was sampled using

purposive sampling technique. The formula below was used to detect the sample size.

$N=z^2\ pq/d$

Where: N=required sample size (N=264) Z=confidence level (95%) p=estimated prevalence of sport injuries in general population, if not known 50% will be used q=1-p and d=marginal error=0.05 (Sumaila, Zakari, & Sulaiman, 2016).

An electronic invitation and registration form including information about the study was distributed to all relevant players through the Kuwaiti volleyball federation at the beginning of the annual competitive season. 173 potential eligible players registered to participate in this study. All those that responded provided informed consent to participate included in the registration form.

Inclusion Criteria

The participants included in this study had the following criteria.

1. Volleyball players must be playing within 2020/2021 local sport Kuwaiti tournaments.

2. Volleyball players must be aged above 18 years.

3. Volleyball players must have a registration in the Kuwaiti volleyball federation and play for one of the eleven governmental local team clubs.

4. Volleyball players must be male in sex.

Exclusion Criteria

1. Any sport players other than volleyball players were not considered in this study.
2. Female players (See 2.5.1 section)

3.2.3 Data Collection Instruments

An electronic single registration form and 30-weeks course study season monitoring self-report was developed using Qualtrics software to collect the required data to achieve the study objectives. Since all volleyball players in Kuwait speak originally Arabic, both questionnaires; registration and weekly self-report were translated from English to Arabic language. This translation was carried out by a certified translation centre. Back-translated method demonstrated in the Sperber (2004) report was adopted to validate the translated self-report for this study-specific context. These electronic questionnaires underwent a piloting stage. Three bilingual participants (one physiotherapist, two volleyball players) had a chance to independently review the registration form and weekly self-report

considering some elements raised by the researcher; comparing between English self-report and Arabic self-report, and feasibility and practically of filling both forms. Revisions were made based on feedback.

Data collection instruments used in this study include:

Single Registration Form

All those that responded to the registration form provided baseline information including anthropometrics, playing level and years of playing volleyball (Marwan et al., 2012; & Andersson et al., 2018). Furthermore, these responded forms provided respondents' contact details that were used to distribute a weekly monitoring survey during the 30-weeks course study.

30-Weeks Course Study Repeated Self-Report

Eight questions were included in the questionnaire adopted from previous studies reflecting the objectives of the study and addressing the key elements of the overuse shoulder injury risk factors/impacts model:

Injury identification, prevalence and incidence rate

Two questions were used to measure prevalence and incidence rate of overuse shoulder injuries. Moreover, this measure has been used to identify injured players and their injury type. First question is to determine either the shoulder compliant presence or not in the previous week. Secondly, the type of injury incident multiple choice question was implemented to detect the overuse shoulder injuries among injured players in each week during a 30-week study course (Owoeye, Wiley, Walker, Palacios-Derflingher, & Emery, 2018). Each statement choice gives a meaning for the injury type; gradual onset without a single, identifiable event responsible for the injury (overuse injury), sudden onset (non-contact trauma) resulting from a specific and identifiable event, recurrence of previous injury, and sudden onset (contact trauma) resulting from a specific and identifiable event. Particularly, mechanism of injury ‘‘overuse’’ is used to refer to the causation of the injury and decrease the confusion and misclassification of

diagnoses (Roos & Marshall, 2014). Variety of injuries statements enable players to differentiate between injury status and select the most accurate option of his complaint. Moreover, this self-description approach in identifying overuse shoulder injuries has been adopted from several previous studies having similar study design and interest (Clarsen et al., 2015; Challoumas et al., 2017; & Frisch et al., 2017). Therefore, Volleyball players with overuse shoulder injury and no injury during volleyball sport season (2020/2021) were able to be included and categorized for statistical analysis. Player with overuse shoulder injury is the player who experienced overuse shoulder injury not before the second week of the course study period. Non-injured player is the player who does not experience injury during the course study period (Appendix B).

Training-related Risk Factors

One scale measuring the daily training session duration in minutes has been used to measure the training related risk factors: training session duration, frequency and volume (Griffin, Kenny, Comyns & Lyons, 2020).

1) Training session duration; Duration in minutes that have been spent in each daily training session (Saturday, Sunday, Monday, Tuesday, Wednesday, Thursday)

2) Training frequency; Number of the training sessions in one week.

3) Training volume; Duration in minutes that have been spent in one week.

Overuse Shoulder Injury Impacts

Four multiple choice questions adapted from the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O) and one training-loss measurement scale were used to investigate the impact of overuse shoulder injuries among the volleyball players performance and participation (Clarsen et al., 2013). The OSTRC-O contains 4 key items on the presence of physical shoulder complaints during the past 7 days, their effect on sports activity (volume and performance), and the intensity of symptoms (Bailón-Cerezo, Clarsen, Sánchez-Sánchez, & Torres-Lacomba, 2020). OSTRC-O questionnaire included four questions referring to players shoulder status during the previous week; (1) the effect of shoulder pain on the ability to participate in training and match play (Task Difficulty), (2) potential reduction in training volume (Training Volume), (3) the effect of shoulder pain on the performance (Quality of Performance), and (4) pain experience during sport participation (Pain) (Figure 2) (Clarsen et al., 2013).

Please answer all questions regardless of whether or not you have problems in your shoulders. Select the alternative that is most appropriate for you, and in the case that you are unsure, try to give an answer as best you can anyway.

The term ''shoulder problems'' refers to pain, aching, stiffness looseness or other complaints in one or both of your shoulders.

Question 1

Have you had any difficulties participating in normal training and competition due to shoulder problems during the past week?

☐ Full participation without shoulder problems
☐ Full participation, but with shoulder problems
☐ Reduced participation due to shoulder problems
☐ Cannot participate due to shoulder problems

Question 2

To what extent have you reduced your training volume due to shoulder problems during the past week?

☐ No reduction
☐ To a minor extent
☐ To a moderate extent
☐ To a major extent
☐ Cannot participate at all

Question 3

To what extent have shoulder problems affected your performance during the past week?

☐ No effect
☐ To a minor extent
☐ To a major extent
☐ Cannot participate

Question 4

To what extent have you experienced shoulder pain related to your sport during the past week?

☐ No pain
☐ Mild pain
☐ Moderate pain
☐ Severe pain

Figure 2. Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O) for Shoulder Region (Clarsen, 2015).

3.2.4 Data Collection

A single registration form have been accompanied with the electronic invitations for a single measure of the personal risk factors. The contact details were used to send 30-weeks course study season monitoring self-report through electronic link to all participants for repeated weekly measures of the overuse shoulder injuries prevalence and incidence rate, training-related risk factors and overuse shoulder injuries impact. Every Friday (1^{st} weekend day in Arabic calendar) throughout the season, players were asked to complete the online questionnaire based on the previous week. Reminders were sent to non-respondents twice, after one day and two days from the initial request if no response was received. If after three days no response was received, players were contacted by phone and encouraged to respond. The instructions were provided for responding to the questionnaire efficiently.

3.2.5 Data Analysis

173 participants' raw data of 30 weeks were exported from Qualtrics software to the Microsoft Excel spreadsheet (Microsoft 365 MSO, Version 2207) for data categorizing, inclusion, exclusion and management purposes. Only 72 players achieve the inclusion criteria filtration and are included for data analysis.

The participants included in the statistical analysis must either experience at least one onset of overuse shoulder injuries after the second week of the study course season or not experience any type of injuries during volleyball sport season (2020/2021). Volleyball players who experience other types of shoulder injuries during volleyball sport season (2020/2021) were excluded. Moreover, volleyball players who started the first week of study course season with overuse shoulder injuries or other types of injuries were excluded. They have been divided into overuse shoulder injured players (no. = 28) and non-injured players (no. = 44) according to the proposed classification system provided by the first two questions of the 30-weeks course study season monitoring self-report outcome.

Initial designed framework was created in the Microsoft Excel spreadsheet (Microsoft 365 MSO, Version 2207) to prepare variables data for data analysis. It includes 11 variables for 30 weeks; Injury status, first onset of injury week number, average of daily training session duration in minutes for one week, training session frequency, training session volume, training-loss, task difficulty, quality of performance, pain, training volume and severity. The responses to each of the four questions adopted from the Oslo Sports Trauma Research Centre. A numerical value from 0 to 25 is assigned to the Overuse Injury Questionnaire (OSTRC-O), and this sum is used to determine a severity score from 0 to 100. For each question, the

response values were assigned so that 0 means no problems and 25 means the highest level. Questions one and four are scored 0-8-17-25, and questions two and three are scored 0-6-13-19-25. The severity scores for each week an injury was reported were then summed in order to get a cumulative severity score (Clarsen et al., 2013).

This framework had been transferred to the final framework utilized for statistical data analysis. This framework was used to have a single value for each variable, determine injury status groups (injured or non-injured) and manage missing data for data analysis. All variables have been divided and counted according to the injury status group. It includes nine weekly modifiable variables; training session duration, training session frequency, training session volume, training-loss, task difficulty, quality of performance, pain, training volume and severity. All nine weekly modifiable variables data of non-injured group were averaged. This imputation method is appropriate to have a single representative value of each variable used in the data analysis function and to overcome the missing data due to participants' response inconsistency (Pampaka, Hutcheson & Williams, 2016). Computing the overall mean is one of the most basic imputation method specifically when dealing with missing data; it is the only function that has been tried that does not benefit from the features of time series data or the

relationships between the variables (Moore, 2009). Although, it might cause variance reduction in the dataset, it has limited impact on the overall dataset characteristics of this study relating to the injury status context. The mean is a measure of central tendency that provides the arithmetic average of all the values in a skewed dataset which is the typical value of the data (Moore, 2009). This approach has been applied for the non-injured group in a variety of previous well-established studies sharing similar context of this study (McGuine, 2006; Pluim, Loeffen, Clarsen, Bahr, & Verhagen, 2016; Messier et al., 2018; Stubbe et al., 2015; Perera, Kountouris, Kemp, Joseph, & Finch, 2019; & Von Rosen, Heijne, Frohm, Fridén, & Kottorp, 2018).

However, these variables in injured group have been counted according to each aspect of the overuse shoulder injury risk factors/impacts model. Training related variables for this group are an single value of each variables selected from the week of the injury onset. This approach of selection excluded other weekly data including the missed responded weeks data. However, injury impact related variables data is the an single value of each variables selected from the post one week of the injury onset week (Wang & Cochrane, 2001a). Selecting a single value to represent injury parameters can simplify analyses and align with certain research or clinical objectives. This is considered as a time-Series Specific method is a

common statistical approach to the analysis of longitudinal repeated measures data where some follow-up observations may be missing. This method produced reasonable results due to well established analysis assumption that inhibit analysis bias (Rubin, 2018). Using a single value to represent the entire dataset would result in addressing missing data and providing a meaningful value of overall dataset. A single value at a specific time point is sufficient as it is an immediate clinical decision. There are many advantages recorded in previous well-established studies implementing this approach; e.g. simplicity and standardization implementation and clinical relevance (one week post-injury align well with clinical practice) (Benson, Stilling, Owoeye & Emery, 2021; Thomee et al., 2007; Burahee, Barry, Sutcliffe& Mahroof, 2021; Pape et al., 2010; & Kou et al., 2013).

Impact related variables data of six injured players have been excluded due to non-response in the post one week of the injury onset week required for data analysis inclusion (missing data). This led to include only 22 impact related variables data in the data analysis which is an exceptional to other types of data in the model.

Deletion is one approach to manage missing data in a dataset if the dataset is small, it may be the most efficient method to eliminate those cases from the analysis considering the potential consequences (Graham, 2012). Excluding cases

with missing data is a straightforward and easy-to-implement approach that simplifies data analysis and to avoid Completeness that the remaining data are complete and can be readily analysed without the need for imputation methods (Little, & Rubin, 2019).

In addition, age, height, mass, years of volleyball and playing level data (personal variables data) have been included in this framework Microsoft Excel spreadsheet (Microsoft 365 MSO, Version 2207).

Descriptive Statistics

Demographic and anthropometric characteristics of the study athletes and all overuse shoulder injury risk Factors/impacts model variables were described statistically by calculating their mean, median and standard deviation using Windows statistical program of IBM SPSS 26 software (United Kingdom). Both Poisson regression and Mann-Whitney U tests do not need parametric assumptions such as scale of measurement (interval), normal distribution and homogeneity of variance (Cameron & Trivedi, 2013; & Graczyk, Lasota, Telec, & Trawiński, 2010).

Prevalence and Incidence Rate

Injury prevalence was calculated as the number of players who were diagnosed with an injury during the season (Maestro et al., 2022) using the formula:

(number of players who were diagnosed with an injury during the season / All population) x 100

The incidence rate for each month was calculated using the formula (Stevenson, Hamer, Finch, Elliot & Kresnow, 2000; & Wang & Cochrane, 2001a):

(Initial onset of injury amount / Volleyball exposure time) x 1000

The confidence interval for prevalence and incidence rate were calculated using this formula (Morris & Gardner, 1988):

Square root (Rate / All population) x 1.96

Descriptive statistics in the form of the amount of skewness and histogram bar chart were used for testing the time distribution of overuse shoulder injury incidence within the 30 week study course. In order to determine whether the degree of skewness was significant, the distribution's normality was tested using the one-way Kolmogorov-Smirnov method. The statistical significance was set at 5% (Shafizadeh, Lago-Penas, Gridley, & Platt, 2014).

Training-related and Personal Risk Factors

Poisson regression was run to predict overuse shoulder injuries among male competitive volleyball players in the sport season (2020/2021) based on the

personal risk factors; participant age, competitive level, volleyball experience and training related risk factors; training session duration, frequency and volume. A P value of ≤ 0.05 was taken as an indication of statistical significance. The windows statistical program of IBM SPSS 26 software (United Kingdom) was used to perform the analyses.

Overuse Shoulder Injury Impacts

Mann-Whitney U test is used to measure the overuse shoulder injuries impact by comparing the task difficulty, quality of performance, pain, training-loss and severity perception between injured and non-injured groups. A P value of ≤ 0.05 was taken as an indication of statistical significance. The windows statistical program of IBM SPSS 26 software (United Kingdom) was used to perform the analyses.

3.3 Results

Response Rate

The response rate of 72 players through the 30 weeks-study course was 66.3%.

Descriptive Statistics

Table 2 presents the characteristics of each participant injury group.

Table 2. Demographic and anthropometric characteristics of participants (N = 72) [α]

	Players with overuse shoulder injury (n = 28)	*Players without injury (n = 44)*
Personal Risk Factors		
Age, y, mean (SD)	*27.7 (5)*	*27.2 (5.2)*
Height, cm, mean (SD)	*183.3 (6.1)*	*182.9 (8.8)*
Mass, kg, mean (SD)	*79.3 (12.7)*	*80.3 (12.7)*
Years of volleyball, median (IQR)	*16 (13-22)*	*14.5 (11-20)*
Playing level (n = 72)		
Excellent league, n (%)	*14 (19.44)*	*22 (30.55)*
First-degree league, n (%)	*14 (19.44)*	*22 (30.55)*
Training-related Risk Factors		
Training session duration, mean (SD)	*90 (30.2)*	*87.4 (31.6)*
Training session volume, mean (SD)	*538.8 (182.6)*	*521.5 (188.3)*
Training session frequency, n, mean (SD)	*5.4 (1.1)*	*5.1 (1.2)*
	Players with overuse shoulder injury (n = 22)	*Players without injury (n = 44)*
Overuse Shoulder Injury Impacts		
Task difficulty, mean (SD)	*4.4 (4.9)*	*0.4 (1.6)*
Quality of performance, mean (SD)	*3.6 (4.6)*	*0.4 (1.1)*
Training volume, mean (SD)	*5.7 (4.9)*	*0.8 (2.9)*
Pain, mean (SD)	*8.2 (6.9)*	*0.3 (0.7)*
Severity, mean (SD)	*21.9 (17.8)*	*1.9 (5.2)*
Training-loss, mean (SD)	*0.7 (1.6)*	*0.4 (0.8)*
[α]*IQR, interquartile range.*		

Prevalence and Incidence Rate

28 separate overuse shoulder injuries among male competitive volleyball players were reported with a prevalence rate of 39% (95% CI 37.45% to 40.3%) in the sport season (2020/2021). The incidence of overuse shoulder injuries 2.46/1000 hours (95% Cl: 2.1, 2.8). Histogram illustrated that the prevalence of overuse shoulder injuries tended to be highest at the beginning of the season. The distribution of overuse shoulder injury incidence over time in the injured group is presented in Figure 3. The distribution showed a significant positive skewness (K-SZ =0.192, S=1.235, p=0.010) so that most incidents of overuse shoulder injury occurred very close to the early season weeks. The results showed that the incidence of overuse shoulder injury peaked near to 2-3 weeks of the early season.

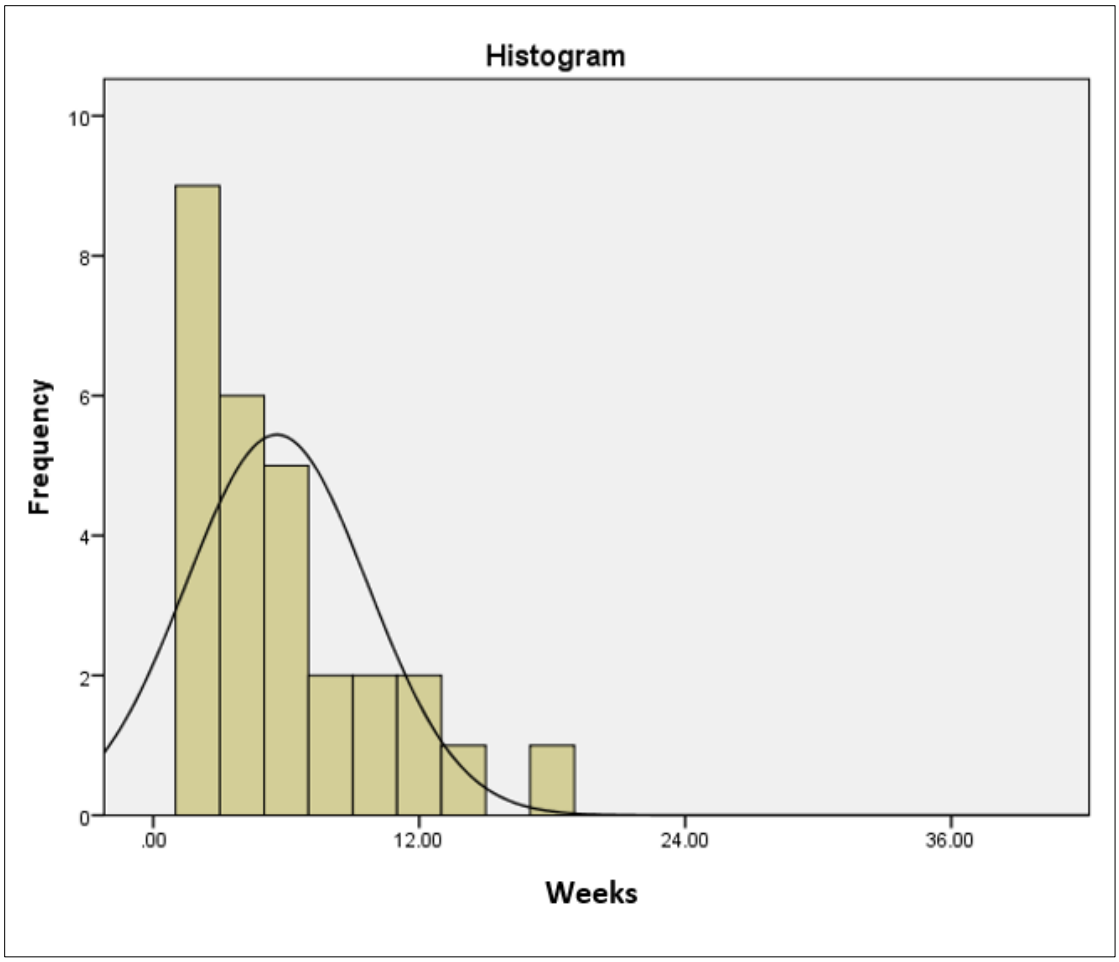

Figure 3. Frequency Distribution of Overuse Shoulder Injury Incidence Over Time.

Personal Risk Factors

Figure 4 shows the personal predictors of overuse shoulder injuries. All the independent variables in the risk factors model have a *p*-value of 0.999, indicating a statistically non-significant overall model. As the age is increasing by one unit, the expected number of overuse shoulder injuries increases by a factor of 1.007 (95% CI, 0.945 to 1.072) or about 1%. Although players' age does in fact influence 1% rate of overuse shoulder injuries risk ratio, it is statistically non-significant

(*p*=0.831). For every extra player experience year practicing volleyball 0.99 (95% CI, 0.938to 1.045) times less incidence of overuse shoulder injuries. Although players' expertise in volleyball does in fact influence the 2% reduction rate of overuse shoulder injuries risk ratio, it is statistically non-significant (*p*=0.716). Moreover, competitive level does in fact influence 2% rate of overuse shoulder injuries incidence, it is statistically non-significant (*p*=0.933).

Training-related Risk Factors

Figure 4 shows the training-related predictors of overuse shoulder injuries. All the independent variables in preventive model have a *p*-value of 0.999, indicating a statistically non-significant overall model. For every extra minutes trained per session on volleyball, 1.003 (95% CI, 0.933 to 1.078) times more overuse shoulder injuries occurred, a statistically non-significant result, *p* = 0.929. For every extra minutes trained per week on volleyball, 1 (95% CI, 0.987 to 1.012) times more overuse shoulder injuries occurred, a statistically non-significant result, *p* = 0.950. For every extra number of sessions trained per week on volleyball, 0.96 (95% CI, 0.749 to 1.232) times less overuse shoulder injuries incidence, a statistically non-significant result, *p* = 0.750.

Overuse Shoulder Injury Impacts

Figure 4 shows the severity and consequences of overuse shoulder injuries. Task difficulty in the injured group (Mean = *4.4, SD = 4.9)* was significantly higher than the non-injured group (Mean = *0.4, SD = 1.6)* (*U* = 290.5, *p* = 0.001). The quality of performance in the injured group (Mean = *3.6, SD = 4.6)* was significantly higher than the non-injured group (Mean = *0.4, SD = 1.1)* (*U* = 297, *p* = 0.002). Pain in the injured group (Mean = *8.2, SD = 6.9)* was significantly higher than the non-injured group (Mean = *0.3, SD = 0.7)* (*U* = 159, *p* = 0.000). Training volume in the injured group (Mean = *5.7, SD = 4.9)* was significantly higher than the non-injured group (Mean = *0.8, SD = 2.9)* (*U* = 228, *p* = 0.000). Severity score in the injured group (Mean = *21.9, SD = 17.8)* was significantly higher than the non-injured group (Mean = *1.9, SD = 5.2)* (*U* = 164, *p* = 0.000). No significant differences in Training-loss were observed (*U* = 435.5, *p* = 0.471).

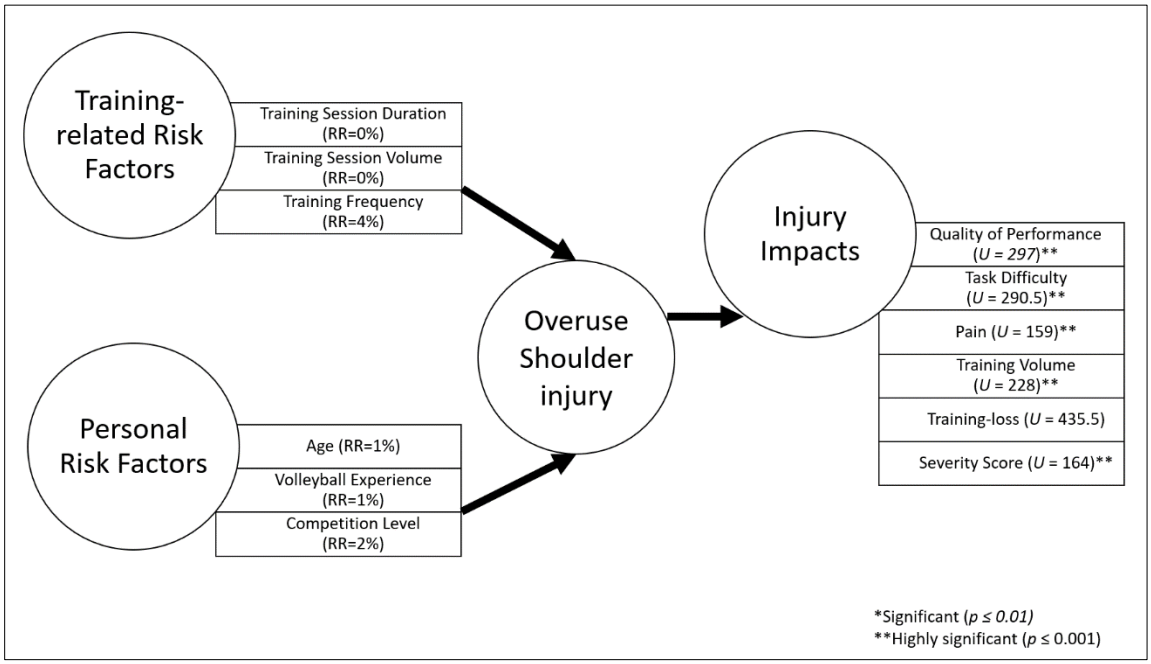

Figure 4. Applied Overuse Shoulder Injury Risk Factors/Impacts Model

3.4 Discussion

This prospective cohort study addressed the relationship of personal and training-related risk factors with the prevalence and incidence of overuse shoulder injuries among competitive male volleyball athletes in Kuwait. Moreover, the impact that injuries have on participation, training volume, sports performance, task difficulty, pain, and training-loss were also investigated.

3.4.1 A high prevalence and incidence of overuse shoulder injuries

The current study found a high prevalence of overuse shoulder injuries in volleyball players (39%) (95% CI 37.45% to 40.3%), which despite issues with comparing with previous studies using different methodologies (see section 2.5.1 in Chapter 2), supports results that have shown the shoulder is a common location for overuse injury in volleyball (Wang & Cochrane, 2001a; Clarsen et al., 2014; Mohseni-Bandpei et al., 2012; Reeser et al., 2010; & Frisch et al., 2017). The study was able to capture a high prevalence due to the use of the "gradual-onset" definition of overuse injury in the self-report weekly survey. In contrast, Bahr & Reeser (2003) study of injuries in beach volleyball found a prevalence of only 10% for overuse shoulder injuries; although a gradual-onset definition to identify the overuse injuries was used, only injuries that caused time-loss or required medical

attention were recorded in their study, leading to a low prevalence. However overuse injuries may not cause absence and not all players may seek medical attention. Therefore the approach adopted by this current study was able to capture the extent of the problem more accurately.

The incidence of overuse shoulder injuries in this current study was 2.46/1000 hours, which is similar to findings in the Wang and Cochrane (2001a) prospective study of shoulder injuries in English top level volleyball athletes (3.0/1000 hours). However, this number in their study represents "chronic" injury. Chronic injury might not be an appropriate definition as some acute injuries that were not adequately managed or treated at the time of injury occurrence, and that then converted into chronic pain might also be included. In our study however, the "gradual-onset without a single, identifiable event responsible for the injury" definition of overuse injury used in this study avoids the inclusion of acute injuries more clearly.

In contrast to this study's results, the prospective study by Verhagen et al. (2004) found a much lower incidence of overuse shoulder injuries in Dutch national volleyball divisions (0.2/1000 hours). This is likely because injury registration in their study was limited to injuries that stopped the athlete from playing, however

overuse injuries may cause pain, discomfort and reduced function without causing absence.

Despite the high incidence reported, the use of incidence measures to quantify overuse injury has been criticized in the literature, and the measures only reflect new injuries and may be more suitable for acute or traumatic injuries (Bahr, 2009). Prevalence measures however capture chronic problems and can therefore be used to monitor the presence of overuse injuries over an entire season. In this study, recording prevalence prospectively over the course of the whole season allowed us to monitor the changes in prevalence from week to week, over 30 weeks. The prevalence of overuse shoulder injuries in the current study tended to be highest at the beginning of the study as most incidents of overuse shoulder injury occurred very close to the early season weeks (2-3 weeks) (also known as preseason), as shown in figure 3 (K-SZ =0.192, S=1.235, p=0.010). This supports findings by Clarsen et al. (2014), the prevalence of all recorded problems for all sports including volleyball and for all anatomical areas tended to be also highest at the beginning of their study. Shoulder complaints for volleyball players in their study had a prevalence of around 25% at the beginning of the study, then fell to just over 10% in the second week before starting to rise again during week 5 to reach under 20% until the end of their 13 week study. Therefore this

epidemiological investigation supports the previous evidence of the significantly high presence of overuse shoulder injuries among volleyball players in the beginning of competitive sport season. This may be due to the sudden spike in training load after the offseason, which is a period without training and with reduced exercise and fitness levels (detraining and lack of physical preparation). In a season-long (27 weeks) study of Brazilian elite male volleyball players by Timoteo et al. (2018) the influence of workload and recovery on injuries was investigated. The authors noted that there was a sudden increase in the incidence of injuries during week 26, following the players' return to the season on week 25 (a sudden spike in workload) after just a week off (week 24). Therefore even short periods of time off and detraining can lead to injury occurrence with sudden spikes in workloads. Spikes in loads are strongly associated with injuries (Windt & Gabbett, 2016). It's important for athletes to work on their strength and conditioning during the off-season to be better prepared for the new season, and then for coaches and athletes to gradually increase the training load once the new season starts to avoid injuries. For instance, male collegiate soccer players were three times more likely to have a non-contact time-loss injury to the low back or lower extremity when they spent less time in strength and conditioning training during the off-season before the start of the preseason (Brumitt et al., 2017). Piggott, Newton &

McGuigan (2009) found that 40% of injuries among Australian football players were linked to a quick change (>10%) in the weekly training volume during the week before (2009). Gabbett (2016) recommends practitioners to keep weekly training load increases under 10% in order to reduce the risk of injury.

3.4.2 Personal Risk Factors

In this study, the investigated personal factors (age, height, body mass, years of playing, and playing level) were not found to be significant risk factors for overuse shoulder injuries.

Age

For age, our results align with Wang and Cochrane (2001a) that found age is not a risk factor for shoulder injuries. However they are in contrast with the systematic review of overuse injuries in volleyball by Seminati & Minetti (2013) which found that age is considered to be a main risk factor for overuse upper limb injuries, both for professional and recreational athletes. Vanderlei et al. (2013) also found that age was associated with the occurrence of injuries among volleyball players participating in the High School Olympic Games of the State of São Paulo

(Brazil). However since their study was done on young players only, it might be difficult to compare.

Body mass and Height

Body mass and height were not risk factors for overuse shoulder injury in this study, which supports results from other studies of elite volleyball players (Wang & Cochrane, 2001a; Cuñado-González, Martín-Pintado-Zugasti & Rodríguez-Fernández, 2019). In contrast, Fattahi, Sadeghi & Ameli (2011) found that all injuries have a significant relationship with greater weight in volleyball players in Iran. Vanderlei et al. (2013) also found that taller (OR: 2.76; CI 95%: 1.83–4.17) and heavier (OR: 2.90; CI 95%: 1.92–4.38) players are at risk of injuries, mainly to the ankle and foot; however weight and height were also risk factors for other areas such as the shoulder ($p < 0.05$, for all differences).

Playing level

This study found that players in both levels of competition in Kuwaiti leagues (first degree and excellent) have a similar chance of having overuse shoulder injuries. This is in line with Cuñado-González et al. (2019) that found no significant relationship between leagues and the number of injuries per player in elite Spanish volleyball.

Years of playing

Years of playing volleyball was not found to be a risk factor unlike other previous studies which found it to be associated with injury (Wang & Cochrane, 2001a; Frisch et al. 2017). Wang & Cochrane (2001a) stated that the history of regular training makes a significant difference, with the injured top level English male volleyball athletes having a longer history of training/competition at the highest level. Frisch et al. (2017) study, also indicating that the incidence of shoulder complaints may be associated with the amount of previous volleyball experience in high school female volleyball players. Vanderlei et al. (2013) also found that greater duration of training in years was associated with the occurrence of injuries among volleyball players participating in the High School Olympic Games of the State of São Paulo (Brazil). This may mean that a longer period of physical adaptation and exposure to high demand training and competition load may increase the chance of suffering a shoulder injury or a painful shoulder (Wang, & Cochrane, 2001a).

However, our findings support those of Reeser et al. (2010) who also found that years of playing volleyball was not associated with shoulder problems in collegiate volleyball players. It is possible that the selected populations and other

contextual or biomechanical factors may be influencing the results leading to the mixed evidence in the literature.

3.4.3 Training-Related Risk Factors

This study did not find any training-related risk factors (training session duration, volume and frequency) for overuse shoulder injuries, in line with Cuñado-González et al. (2019) study where the number of injuries per player did not correlate with hours of volleyball practice per day (training session duration). In contrast, there was limited evidence that a high number of training hours per week (>16 hours/week) was associated with a higher injury risk among youth baseball pitchers and catchers (Asker et al., 2018). The differences between the findings of studies may be related to differences in sample, research design and injury definitions as well as contextual factors such as the role of sport policies in different countries. In addition, the weekly self-report approach to quantifying workload used in this study may have not been accurate. Gabbett (2015) outlined other methods of measuring workload. External loads can be monitored in real-time by GPS devices which athletes can wear during training and matches, and that collect information on speed, distance covered, and sport-specific activities such as jumps in volleyball. Internal loads are usually measured based on the athlete's perception

of effort. The internal training loads of athletes have been measured using the session-rating of perceived exertion (RPE) scale. The Rating of Perceived exertion (RPE) method is a very well-known and popular tool to track an athlete's effort after training (Foster, 1998). Athletes rate the intensity of each training session on a scale of 1 to 10 at the end of each session. The training load is calculated by multiplying the session's intensity by the length of the session. The units are known as "RPE units×minutes" (also previously known as arbitrary units). According to research, doing the sRPE test about 30 minutes after a training session gives athletes time to appropriately assess their performance and deliver a more accurate score (Foster, 1998). It is advised that athletes be given a trial time to get experience assessing their own levels of effort and RPE in order to ensure that the data gathered is accurate (Foster, 1998). Such an approach applied to future studies on overuse shoulder injuries in volleyball athletes may be advised to better quantify the training load but requires consistent data collection that may be difficult to manage for larger sample sizes. Nevertheless, training-related risk factors may be worth studying further, as the link between workload and injury suggests that managing effort is a key factor in preventing sports injuries (Veugelers, Young, Fahrner & Harvey, 2016).

3.4.4 Overuse Shoulder Injury Impacts

This study found that overuse shoulder injuries have a significant impact on most severity measures. Performance (U = 297, p = 0.002), training volume (U = 228, p = 0.000), pain (U = 159, p = 0.000) and task difficulty (U = 290.5, p = 0.001) were all significantly higher for injured volleyball players than for non-injured players.

This supports results from other studies of competitive volleyball players. In a study by Reeser et al. (2010), 46% of athletes with shoulder problems reported decreased sport performance. In another study of volleyball players with shoulder pain by Jacobson & Benson (2001), 60% of players felt pain while hitting all locations of the court, and 77% said that pain limits how hard they can spike. These severity measures demonstrate that overuse shoulder injuries are not only common in volleyball but also affect player's well-being and performance. Importantly, this study showed that no significant differences in training-loss were observed (U = 435.5, P = 0.471). This is consistent with the nature of overuse injuries which can result in athletes continuing to train and play when players are asymptomatic or when symptoms may be mild (Yang et al., 2012). In contrast, a total of 33% of female high school volleyball athletes with overuse injury reported taking time off from practice due to the pain (Frisch et al., 2017), the mean absence from Dutch national volleyball because of an overuse shoulder injury was 6.2 (9.4)

weeks during the season (Verhagen et al., 2004). However their study only recorded injuries that caused time loss or required medical attention. Therefore, it is possible that players waited until the overuse shoulder injury became a lot more severe before taking time off to recover. This demonstrates the danger of neglecting overuse injuries in their early stages.

3.4.5 Strengths and Limitations

This study is the first to establish the incidence/prevalence of overuse shoulder injuries and to define/identify the relationship of personal and training-related risk factors with overuse shoulder injury incidence and the impact on severity measures among competitive male volleyball athletes in Kuwait.

The current study has strong contextual study design features to highlight the key issues. The longitudinal cohort study design used in this study provides good evidence to support the development of overuse shoulder injury prevention programs that address training strategies. Other prospective studies have successfully used weekly questionnaires such as Clarsen et al. (2013) and Clarsen et al. (2015). Weekly monitoring in this study raised the quality of evidence and limited the errors in the findings such as recall bias. Although the current findings

may offer a good start for future guidance, it is important to be aware of the present study's limitations.

Firstly, this study relies on self-reporting to identify overuse injury based on the mechanism of injury that has a good approval from a systematic review (Roos & Marshall, 2014). Self-reporting of injuries using gradual onset definition was clearly able to capture more overuse injuries. However, athletes may sometimes be unable to distinguish pain from normal soreness resulting from practice. Not all "pain" in sports is due to injury. Pink, Edelman, Mark & Rodeo (2011) refer to soreness as a "generalized feeling in the muscles", while pain is "a deeper, and sometimes sharper, more localized feeling". Pink and Tibone (2000) advise educating athletes and coaches about the difference between pain and soreness, as well as discouraging the "no pain, no gain" mentality. This can minimize damage from injury and accelerate return to play. Therefore, it is possible some participants may actually be reporting soreness instead of true injury, while others may not report an injury thinking it is normal soreness from practice. When it comes to evaluating pain according to a scale, true accuracy is obtained by including the observations of the athlete, of the coaches, and of the medical staff (Pink et al., 2011).

Also, the self-report survey cannot provide a diagnosis of the specific type of overuse shoulder injury, as the amount of details that can be collected from athletes directly through the questionnaire is limited. The only information gathered by the questionnaire is related to the anatomical location, not the type of injury or specific diagnosis, which should ideally be made through a clinical examination (Clarsen et al., 2013). This can have implications for effectively managing, treating and preventing these injuries. However, Owoeye et al. (2018) evaluated the diagnostic accuracy of an OSTRC-P questionnaire (OSTRC-patellar tendinopathy questionnaire, which is the adapted OSTRC Overuse Injury Questionnaire for patellar tendinopathy) in detecting patellar tendinopathy (jumper's knee) in youth basketball players, when compared to clinical evaluation by a physical therapist. They found that that the OSTRC-P questionnaire's diagnostic accuracy for self-reporting patellar tendinopathy and patellar tendinopathy severity had an acceptably high level, and that it offers a low-cost alternative to clinical evaluation for identifying patellar tendinopathy and rating its severity in large-scale surveillance studies and athlete care (Owoeye et al., 2018).

This current study can be an initiation to encourage further studies to establish a gold standard measurement tool to identify and manage overuse injuries. Combining self-reporting, medical evaluations, and clinical imaging (MRI)

can help create more specific preventive and management strategies based on the type of injuries. For example, Serner et al. (2021) conducted a one year prospective case study with 16 competitive male athletes who had an adductor longus tendon avulsion injury and received an exercise-based treatment. The completion of a supervised, structured, criterion-based rehabilitation regimen was advised to all athletes. A standardized clinical examination, a modified Copenhagen Hip and Groin Outcome Score (HAGOS), the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O), and a detailed magnetic resonance imaging (MRI) assessment were carried out at 3 points during the year: after inclusion in the study, on the day of the treatment protocol's completion (return to sport), and at the 1-year follow-up after injury. The authors found that athletes had high self-reported function, minimal performance restrictions, normal adductor strength and range of motion, and evidence of partial or complete tendon continuity as indicated on MRI at the 1-year follow-up after injury. Similar comprehensive protocols that include both clinical examinations and imaging measures with self-report questionnaires could be designed to monitor the progress of injured volleyball players with overuse shoulder injury. In addition, with regards to severity, measures such as pain, performance and task difficulty are also subjective concepts that may depend

on other psychological factors such as the participants' stress levels, and personal ambition and motivation.

Secondly, the quantitative survey approach used in this study provides limited insights into other contextual factors that may be contributing to the risk of injury and severity measures. This led the author to conduct qualitative interviews with players with overuse shoulder injuries to address the gaps identified in this quantitative study (Chapter 5).

Thirdly, this cohort study included a large number of participants that self-reported weekly about overuse shoulder injuries and training load, which affected the consistent and successful follow-up of the participants by the researcher. This led to some missing data that required data management by the author. All variables have been counted according to the injury status group. Non-injured variables data of all 30 weeks have been averaged. However, injured variables data have been counted according to each aspect of the overuse shoulder injury risk factors/impacts model (Perera et al., 2019).

These carried approach have many limitations that need to be considered in presenting the findings. Imputing missing values with the mean can introduce bias into estimation. However, the estimation in this study were established according

to the previous evidence (Moore, 2009). It can lead to reduce the variability by tending to be closer to the mean, thus potentially underestimating the true variability in the data and produce in accurate data relationship and pattern, however this is not the case in this study (Rubin, 2018). Reduction in sample size in this approach can affect the power of statistical tests, making it more challenging to detect significant effects or relationships. Loss the information about the reasons for missing data due to imputation, which can be valuable in understanding the underlying data generation process, may affect the accuracy and validity of the findings (Graham, 2012). Therefore, there are some considerations to address these issues by elevating player reporting adherence and provide supervision or external recording and follow-up approach.

Moreover, recruit larger sample size make excluding participants with missing data is not issue. There are a number of reasons why observational data may be missing, however, in circumstances where the pattern of missingness cannot be ignored. For example, the data may have been recorded but later lost or deleted, poor athlete/team adherence, time constraints, injuries sustained during a game or practice, or equipment malfunction (Benson, Stilling, Owoeye, & Emery, 2021). While efforts are made to lower the occurrence of missing data, it is thought that in reality it is difficult to completely eliminate missing data. However, when the

pattern of missingness is unavoidable, the missing data are frequently imputed or replaced with substituted values (Benson, Stilling, Owoeye, & Emery, 2021).

In this epidemiological prospective study, as a descriptive study design, the researcher tried to recruit the whole population (all players in the season) to model the raw data accordingly. The drop out of the participants relative to the target population size was not systematic (by a chance) and interpretation of results is not affected by number of participants (in descriptive study).

Finally, the exceptional situation due to the COVID-19 pandemic and its consequences on the sport season have affected the standardization of the findings and how these might be reflected onto the regular sport season situation. However, the author took this into consideration earlier while designing the methodology of this study by addressing the effect of this pandemic in the sport season, then excluding it to have more reliable findings that reflect the usual sport season experience.

3.4.6 Conclusion

Although no training-related or personal risk factors were found to predict overuse shoulder injury in volleyball players, the study demonstrated a high prevalence and severity of injury. The highest prevalence was found towards the

beginning of the season most likely due to detraining and lack of physical preparation in the offseason and a sudden spike in training load upon return to practice. Moreover, severe impacts on performance, participation, training volume, pain and task difficulty were found. Despite these severity measures, training-loss was not significant, with players continuing to play despite their injuries, which is consistent with the nature of overuse injuries especially in competitive settings.

These findings suggest that overuse shoulder injuries among male competitive volleyball players in Kuwait are an important issue to address. The development of effective volleyball specific prevention strategies for overuse shoulder injuries should therefore be a priority. In particular, safe training practices that address severity measures in volleyball in Kuwait should be promoted by stakeholders in order to manage overuse shoulder injuries. Implementation of preventive strategies early on in the season is necessary to limit overuse shoulder injuries experienced throughout the competitive sport season. To get a clearer, more holistic understanding of the overuse shoulder injury problem (especially since no personal or training-related risk factors were found in this study) it is necessary to also study other potential, physical risk factors (Chapter 4) and to understand the context in which these injuries occur (Chapter 5).

This prospective cohort study is the first in investigating the extent and magnitude of the overuse shoulder injuries among competitive male volleyball players in Kuwait, moreover, identifying personal and training-related risk factors. In addition, it achieved the essential process of the context-driven “sequence of prevention” model to prevent overuse shoulder injuries among competitive male volleyball players in Kuwait (Bolling et al., 2018).

Chapter 4.0: Study 2 - Physical Risk Factors of Overuse Shoulder Injuries in Male Competitive Volleyball Players in Kuwait

4.1 Introduction

Our recent prospective study (Chapter 3. Study1) found that overuse shoulder injuries are significant in male competitive volleyball players in Kuwait, in line with previous studies of volleyball players. However, no significant personal or training-related risk factors were found. Other modifiable, physical risk factors such as glenohumeral joint range of motion, muscle strength and scapular dyskinesis (discussed in section 2.7.2 of Chapter 2) can be investigated in order to understand the high prevalence of these injuries. The complexity of interactions among the risk factors makes it challenging to determine the eitiology of injury, which is a substantial problem in investigating overuse injuries. However, identification of the physical risk factors for volleyball-specific shoulder injuries is essential to have effective preventive measures and establish injury causation (Kilic et al., 2017).

Volleyball players may perform 40,000 spikes a year, which may result in shoulder injuries as well as various adaptations of the throwing shoulder (Challoumas et al., 2017). Moreover, the overhead throwing athletes share similar physical shoulder characteristics in terms of changes in the throwing shoulder strength, range of motion and muscular balance compared with non-throwing shoulders (Asker et al., 2018; & Challoumas et al., 2017). A study by Clarsen et al. (2014) study identified a number of internal modifiable risk factors associated with

shoulder problems among elite male handball players, including glenohumeral range of motion, external rotation strength and scapular dyskinesis. It would thus be relevant to study the same factors in volleyball athletes especially given the lack of research in this area. These are a call to take a broader approach to assess physical risk factors for shoulder injury by measuring the impairments, such as reduced glenohumeral range of motion, rotator cuff muscle weakness and scapular dyskinesis to develop successful measures to prevent injury (Hogan et al., 2021; & Asker et al., 2018).

In addition, the tools used in the physical examination should be reliable and valid. Therefore, a reliable and accurate evaluation of physical shoulder assessment tools through a test retest correlational study offering an reliability and accurate evaluation of the physical shoulder assessment tools applied in cross-sectional study is advisable to investigate physical risk factors overuse shoulder injuries.

This cross-sectional study aimed to investigate physical risk factors of overuse shoulder injuries among male competitive volleyball players in Kuwait. To our knowledge, this study is the first that investigates physical risk factors of overuse shoulder injuries among male competitive volleyball players in Kuwait using reliable physical shoulder assessment instruments.

4.2 Aims and objectives

This study aimed to investigate physical (modifiable-intrinsic) risk factors of overuse shoulder injuries among male competitive volleyball players in Kuwait.

To address this aim, the following research objectives were developed:

1. To establish inter and intra-rater reliability for clinical measures assessing rotator cuff muscle strength, glenohumeral range of motion and scapular dyskinesis among male competitive volleyball players in Kuwait.
2. To discriminate the physical shoulder characteristics; glenohumeral range of motion, rotator cuff muscle strength and scapular dyskinesis between dominant-injured shoulders of players with overuse shoulder injuries and dominant shoulders of players with no shoulder injuries experience.
3. To determine the physical shoulder characteristics that discriminate between the affected shoulders and non-affected shoulders of male competitive volleyball players with overuse shoulder injuries in Kuwait.

4.3 Reliability of Applied Physical Assessment Model to Measure Physical Risk Factors of Overuse Shoulder Injuries in male Kuwaiti Volleyball Players.

4.3.1 Method

4.3.1.1 Research Design

Following institutional ethical approval, a laboratory study was conducted to establish test- retest reliability of physical risk factors linked to overuse shoulder injury. The reliability of the following variables were established: shoulder glenohumeral joint external and internal rotation range of motion, scapular dyskinesis and eccentric and isometric internal (IR) and external (ER) rotation muscle strength. A sample of twelve male volleyball players were examined on two separate occasions by two physiotherapists with similar years clinical experience (9 years).

4.3.1.2 Participants and Recruitments

Twelve competitive male volleyball players registered in the Kuwaiti volleyball federation and playing in the youth category of volleyball sport (2020/2021) were the targeted population for this study. Youth category of volleyball sport includes players who are playing in local leagues that are lower one

degree than first degree league. These players were temporarily not exposed to the volleyball sport due to it being the off-season. The sample size was made according to the targeted population for volunteering and previous studies who used similar numbers (Lu et al., 2011; Romero-Franco, Fernández-Domínguez, Montaño-Munuera, Romero-Franco & Jiménez-Reyes, 2015; & Kolber & Hanney, 2012). An electronic invitation and registration form including information about the study was distributed to all relevant players through the Kuwaiti volleyball federation and informed consent was obtained.

Inclusion Criteria:

The participants included in this study had the following criteria.

1. Volleyball players must be playing for the youth category of local Kuwaiti volleyball sport.

2. Volleyball players must be aged above 18 years.

3. Volleyball players must have registration in the Kuwaiti volleyball federation and play for one of the eleven governmental local team clubs.

4. Volleyball players must be males in sex.

5. Volleyball players do not have a history of shoulder pain and no current shoulder injury.

6. Volleyball players are temporarily not exposed to the volleyball sport due to off-season term.

Exclusion Criteria:

1. Any sport players other than volleyball players were not considered in this study.
2. Volleyball players who had a history of shoulder injuries defined by self-report.
3. Volleyball player who is involved in any sport including volleyball during study course.

The sample of this study were 12 healthy volleyball players with mean of age of 24.92 years, body mass of 80 Kg, height of 185 cm.

4.3.1.3 Instruments and Procedure

A shoulder physical examination model is used to document physical shoulder measurements for this thesis. This model has been developed to identify glenohumeral joint range of motion, rotator cuff muscle strength and scapular

dyskinesis based on Clarsen et al. (2014). All pictures in the following sections were taken with permission of participants.

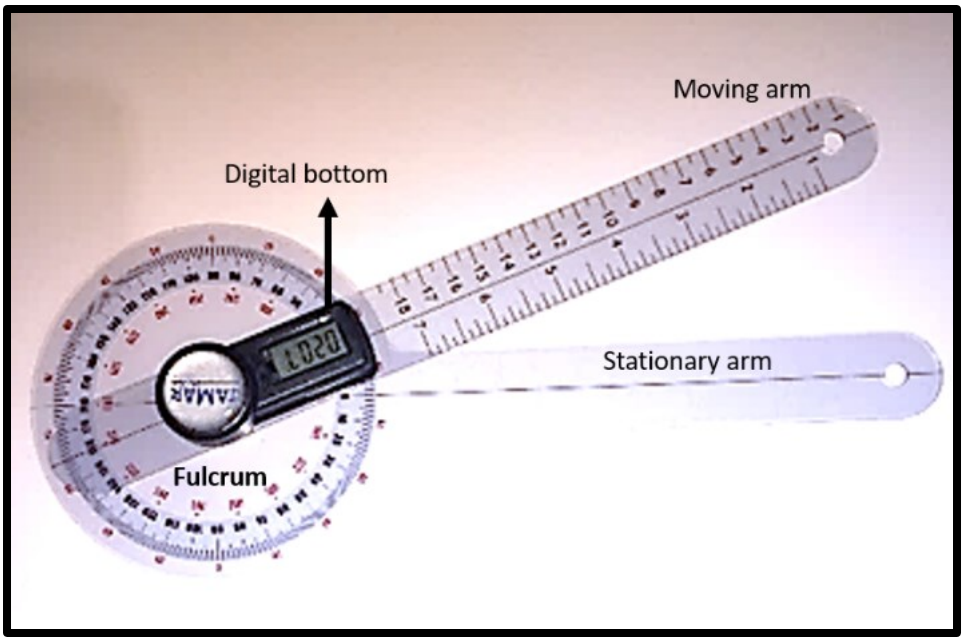

Figure 5. Digital plastic goniometer-12.5” (JAMAR PLUS+, PATTERSON MEDICAL LTD, UK).

Table 3. Overview of digital plastic goniometer procedure for measuring shoulder external rotation and internal rotation ROM (Figure 6)

ROM	External Rotation	Internal Rotation
Player body position	Lying supine over the physiotherapy clinical bed and in the scapular plane to better stabilise the scapula with the hips and knees flexed to approximately 45° to limit trunk compensation.	
Fulcrum placement	Positioned over the olecranon process.	
Stationary arm placement	Perpendicular to the floor.	
Moving arm placement	Aligned with the shaft of the ulna and styloid process.	
Rater stabiliser-hand placement	Thenar eminence and thumb of the rater on the coracoid process and four fingers grasping the spine of the scapula posteriorly to stabilise the scapula and trunk.	
Rater mobilizer-hand placement	The rater holds the shaft of the ulna.	
Player arm start-point	The tested arm was supported on the table in 90°of abduction, elbow flexed to 90°, and the wrist in neutral. A towel roll was placed under the humerus to achieve neutral horizontal alignment; It was necessary for the humerus to be level with the acromion process based on a visual inspection (frontal plane).	
Player arm end-point	Arm rotated and palm facing the ceiling.	Arm rotated and palm facing the floor.
Measuring procedure	The rater started passively to rotate the player arm 90° abducted backward as far as possible without discomfort so that their palm facing the ceiling with the force of gravity acting on the arm to end range (the point where the end feel is perceived.	The rater started passively to rotate the player arm 90° abducted forward as far as possible without discomfort so that their palm facing the floor with the force of gravity acting on the arm to end range (the point where the end feel is perceived.
Measurement reading point	Once the players' end-range ability was achieved The examiner was able to align the tool and press the hold digital button to keep the current measurement displayed. Measurement value presented in degree.	
Precaution	The end of ROM was defined as the point at which the scapula was felt to move into anterior rotation and elevated off the examination table. The humeral head stabilisation was avoided to not alter the normal glenohumeral arthrokinematics.	
(Mullaney et al., 2010; Kolber & Hanney, 2012; Cools et al., 2014; Clarsen et al., 2014; Reeser et al., 2010; Shitara et al., 2017; Wilk el al., 2011)		

Figure 6. Digital plastic goniometer procedure for measuring shoulder external rotation and internal rotation ROM

Glenohumeral Joint Range of Motion

Digital plastic goniometer-12.5” (JAMAR PLUS+, PATTERSON MEDICAL LTD, UK) measurements were taken for measuring shoulder external rotation and internal rotation ROM in this thesis following well established guidelines that have previously reported in the literature (Mullaney, McHugh, Johnson & Tyler, 2010; Kolber & Hanney, 2012; Cools et al., 2014; Clarsen et al., 2014; Reeser et al., 2010; Shitara et al., 2017; Wilk el al., 2011) (Table 3).

Figure 7. Handheld dynamometer (HHD) (Lafayette Instruments, Lafayette, IN)

Table 4. Overview of Handheld dynamometer procedure for measuring eccentric and isometric shoulder rotator cuff strength (Figure 8)

Shoulder rotator cuff Strength	Eccentric of external rotation	Isometric of external rotation	Isometric of internal rotation
Player body position	Seated position, feet at shoulder width, the lower back supported against a chair. This position was chosen because of its similarity with the actions that volleyball players perform in most of the throwing techniques and because it was used previously.		
HHD placement	Positioned at a point 2 cm proximal of the processus Ulnar styloid and placed on the dorsal side of the forearm.	Positioned at a point 2 cm proximal of the wrist, by matching the force exerted by the subject.	
Player arm handling style	Held the elbow and shoulder at a position of 90° of abduction and 90° of external rotation (90– 90) with support from the raters hand and forearm.	The arm supported in 90° of abduction with 90° or ER.	
Measuring procedure	The subject performed a maximal external rotation force on the counting of the investigator, controlled by a metronome. The investigator pushed the arm over a 3-s period from maximal external rotation (90°–90°) to 90° of abduction in neutral rotation (90°–0°).	The participant was asked to do the glenohumeral ER or IR against resistance of the HHD. A “make contraction” was applied rather than a “break contraction”. Participants were asked to increase their force over a 2-s period gradually to a maximum voluntary endurance and hold the maximal voluntary endurance for 5 s.	
Measurement reading	Measurements were recorded in Newton (N).		
Cools et al. (2015)			

Figure 8. Handheld dynamometer procedure for measuring isometric shoulder rotator cuff strength

Rotator Cuff Muscle Strength

A handheld dynamometer (HHD) (Lafayette Instruments, Lafayette, IN) was used to measure eccentric and isometric internal (IR) and external (ER) rotator cuff muscle strength following guidelines by Cools et al. (2015) (Table 4).

Figure 9. Participant positioning during Uhl et al. (2009) classification system application for identifying scapular dyskinesis

Scapular Dyskinesis

A well-established (Uhl et al., 2009) classification system based on visual observation was used as the evaluation method for dynamic scapular motions to identify scapular dyskinesis. Players removed their shirts to do observation of the posterior thorax. Players performed five repetitions of bilateral, active, weighted shoulder flexion and bilateral, active, weighted shoulder abduction (frontal plane) while the examiner observed two to three meters away from the back to have posterior and superior views (Figure 9). Players were instructed to simultaneously raise their arms as high as they could go in the "thumbs-up" position to a three-second count and then lower them to a three-second count. The movement began

with arms at the side of the body, elbows straight, and shoulders in neutral rotation. Movements were performed with players holding dumbbells based on body mass, 2.3 kg (5 lb) for those weighing 68.1 kg or more and 1.4 kg (3 lb) for those weighing less than 68.1 kg (150 lb). Any prominent area of the bilateral scapula medial border is noted as either "yes" (present) or "no" (absent). As a result, the examiner was no longer required to select a single predominant pattern when several planes of asymmetry may have been visible (Uhl et al., 2009). The yes/no method allows multiple-plane asymmetries to be considered in clinical assessment, thus rendering it a good screening tool for the presence of scapular dyskinesis (Uhl et al., 2009).

4.3.1.4 Data Collection

Clinical assessment was conducted in the physiotherapy-outpatient clinic of Al Amiri general Kuwaiti governmental hospital (Kuwait capital city). This procedure was repeated on two occasions one week apart; one carried out by one examiner and another one carried by two examiners. Each examiner followed the same procedure regardless which occasion was involved. All participants completed multiplanar shoulder movements as a standardized warm-up procedure and procedure of the Shoulder Physical Examination Model mentioned in 4.3.1.3. The Examiner repeated measures included in the Shoulder Physical Examination Model

completing three attempts with a pause in between trials of 20 s for each measurement. The order of the tests was randomized between sides and between the procedures in order to control the procedure for learning effects and fatigue. The second session included two examiners carrying out individually the same triple repeated measures of the Shoulder Physical Examination Model in random order. The outcome parameters have been documented using an electronic designed survey of Qualtrics software directly by each examiner electronic device. This will keep the data blinded to other examiner and easier to be extracted for statistical analysis.

4.3.1.5 Data Analysis

Raw data were exported from Qualtrics software to Microsoft Excel (Microsoft 365 MSO, Version 2207). Demographic characteristics of the study athletes and measurement values were described statistically by calculating their mean and stand deviation using Windows statistical program of IBM SPSS 26 software (United Kingdom).

The inter and intra-rater reliability of digital goniometer and handheld dynamometer was established using intraclass correlation coefficient (ICC) with the corresponding 95% confidence intervals (95% CIs) (Rankin & Stokes, 1998;

Johansson et al., 2015; Koo & Li, 2016; & Coinceicao et al., 2018). Reliability was reported as excellent (ICC ≥ 0.90), good (ICC between 0.80 and 0.89), moderate (ICC between 0.70 and 0.79) and low (ICC < 0.70) based on the guidelines of Fleiss (Cools, et al. 2014; & Coinceicao et al., 2018). The windows statistical program of IBM SPSS 26 software (United Kingdom) was used for computing ICC values.

The standard error of measurements (SEM) was calculated as SD × √1 − ICC, where SD is the SD of all scores from the participants (Johansson et al., 2015; & Coinceicao et al., 2018). Additionally, the SEM is displayed as SEM%, which was created by dividing the SEM by the test value average (Johansson et al., 2015). A good measurement tool should have low SEM values to be used to detect changes in the clinical trial (Lu et al., 2011).

Bland-Altman analysis was used to assess absolute reliability and systematic bias (Lu et al., 2011; & Katoh, 2015). The 90% limits of agreement were calculated by using the formula:

90% limits of agreement = (mean of diffs) ± 2(SD of diffs)

(Portney & Watkins, 2009; as cited in Kolber et al., 2012).

95% limits of agreement (LOA) are calculated as:

LOA = SDd * 1.96

where SDd is the standard deviation of the difference between two repeated measures on a sample.

The procedure for determining the typical error can be derived from the fact that the variance of the difference score (sdiff 2) equals the sum of the variances that indicate the typical error in each trial: sdiff 2 = s2 + s2, so s = sdiff/√2. In order to determine the change scores or difference scores for each mean, simply divide the difference scores' standard deviation by √2.

The Microsoft Excel spreadsheet (Microsoft 365 MSO, Version 2207) was used to illustrate Bland and Altman plots for all measures and for calculating SEM, SEM% values, typical error value and 95% LOA.

The reliability for the comprehensive scapular dyskinesis classification test was determined using k coefficient (McClure, Tate, Kareha, Irwin, & Zlupko, 2009). The k coefficient was defined as 0.8 excellent, 0.61-0.8 substantial, 0.41-0.6 moderate, 0.21-0.4 fair, and 0-0.2 slight/poor (Landis & Koch, 1977). For Cohen's kappa coefficient, we analysed the reliability with categorical data (Yes/No) and applied this method with two raters for inter-rater reliability and two events for intra-rater reliability and multiple players in this study (McClure et al., 2009).

Cohen's kappa coefficient was calculated using this formula (Wongpakaran, Wongpakaran, Wedding & Gwet, 2013):

$k = po - pc / 1- pc$

po : percentage value of agreement

pc : percentage value of expected agreement by guessing

The Microsoft Excel spreadsheet (Microsoft 365 MSO, Version 2207) was used for calculating k coefficient.

4.3.2 Results

Reference Values for Male Competitive Volleyball Players in Kuwait

Table 5. Overview of ROM and muscle strength values for both raters and sessions.

	Side	Rater 1 (SD)	Rater 2 (SD)	Session 1-Rater 1 (SD)	Session 2- Rater 1 (SD)
ROM°					
ER	R	101.8 (4.4)	101.5 (5.6)	102.2 (4.4)	102.4 (4.9)
	L	95.9 (6.9)	96.6 (7.5)	96 (7)	97.4 (7.2)
IR	R	47.6 (5.6)	48.3 (5.8)	47.7 (5.4)	47.5 (5.3)
	L	47.9 (6.3)	48.1 (5.9)	48.1 (6.2)	48.6 (6.2)
Strength (N)					
EER	R	110.6 (22.4)	110.9 (21.1)	113 (19.9)	114.6 (18.4)
	L	104.9 (23)	104.7 (23.2)	110.8 (18.6)	111.6 (19.9)
IIR	R	112.6 (14.7)	113.5 (14.6)	112 (14.5)	110.5 (15.4)
	L	108.8 (18.8)	108.9 (17.4)	108.3 (18.6)	109 (17.8)
IER	R	81.7 (8.3)	82.3 (10.1)	81.7 (8.3)	81.9 (8.5)
	L	74.8 (9.2)	77.1 (8.4)	74.8 (9.3)	76.5 (9.3)
Abbreviations: N= newton; EER= eccentric external rotation; IIR= isometric internal rotation; IER = isometric external rotation ; R= right side; L= left side; SD= standard deviation					

Mean values and standard deviation for ROM and muscle strength values for both raters and sessions are displayed in Table 5.

Table 6. Inter-rater within-day reliability measures for digital goniometer (rater 1 vs rater 2).

ROM°		ICC (95% CI)	SEM (%)	Typical error	Bland-Altman analysis	
				Value (90% confidence limit)	BIAS (SD)	LOA
ER	R	0.961 (0.865 - 0.989)	0.385 (0.376)	1.397 (-1.276 - 0.576)	-0.35 (1.88)	3.823 (-4.010 – 3.310)
	L	0.956 (0.849 - 0.987)	0.619 (0.643)	2.085 (-0.709 – 2.092)	0.691 (2.82)	5.780 (-4.842 – 6.225)
IR	R	0.961 (0.864 - 0.989)	0.438 (0.915)	1.570 (-0.318 - 1.790)	0.736 (2.12)	4.351 (-3.429 - 4.901)
	L	0.977 (0.921 - 0.993)	0.227 (0.577)	1.290 (-0.700 - 1.033)	0.17 (1.75)	3.575 (-3.256 - 3.589)
Abbreviations: ROM°= range of motion degree angle; ER= external rotation; IR= internal rotation; R= right side; L= left side; SD= standard deviation; ICC = intraclass correlation coefficient; 95% CI= 95% confidence interval; LOA= limit of agreement; SEM= standard error of measurements. *Correlation is significant at the 0.05 level (2-tailed)						

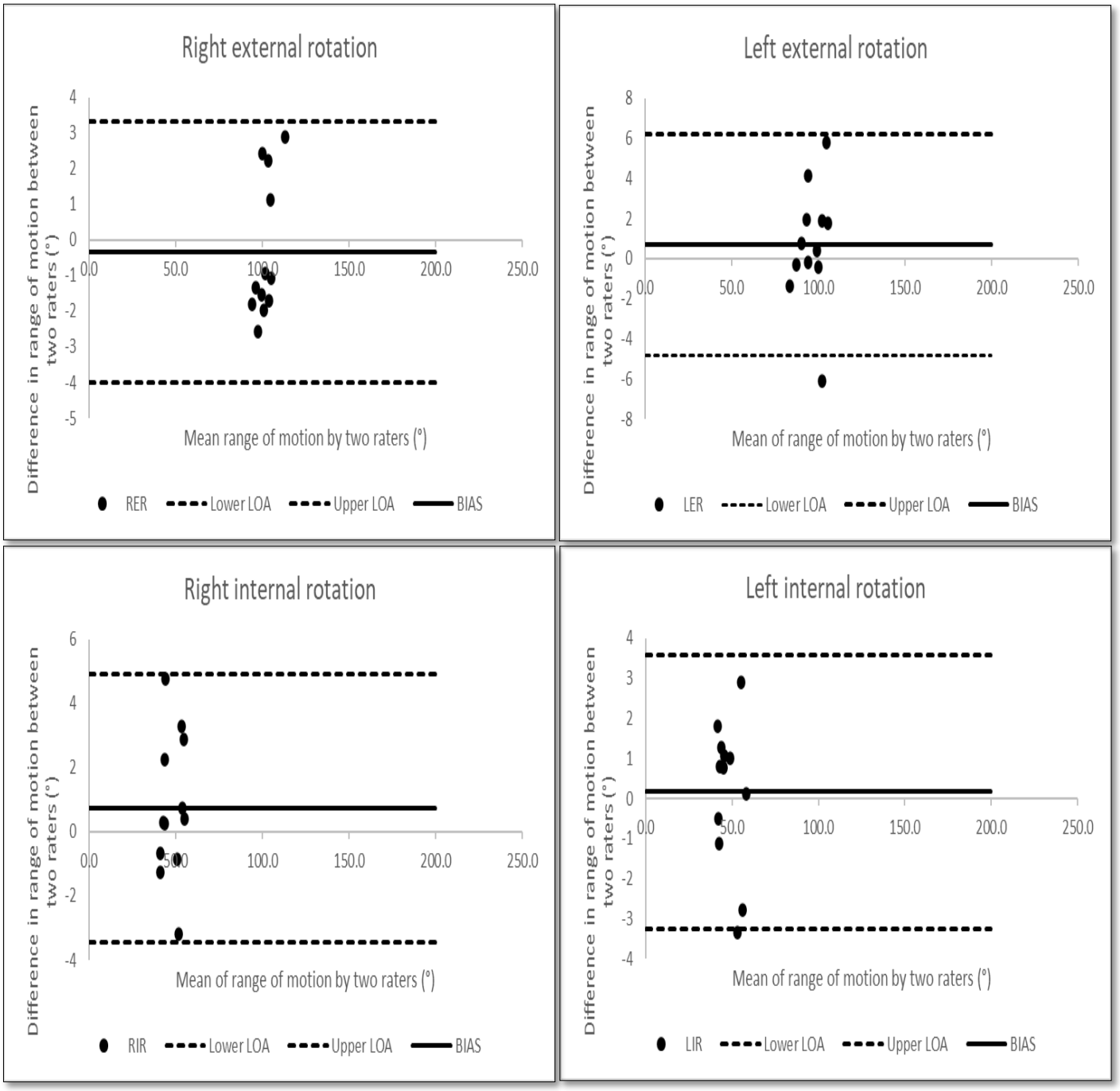

Figure 10. Bland–Altman Plot of ER, IR Right and Left index scores in Volleyball athlete, inter-rater, ROM

Table 7. Intra-rater between-day reliability measures for digital goniometer (rater 1 vs rater 1)

ROM°		ICC (95% CI)	SEM (%)	Typical Error	Bland-Altman analysis	
				Value (90% confidence limit)	BIAS (SD)	LOA
ER	R	0.918 (0.751 - 0.975)	0.565 (0.55)	1.395 (-0.761 - 1.111)	1.05 (3.11)	3.867 (-5.042 – 7.142)
	L	0.923 (0.765 - 0.977)	0.696 (0.72)	1.773 (0.256 – 2.638)	1.45 (2.40)	4.917 (-3.260 – 6.154)
IR	R	0.936 (0.802 - 0.981)	0.502 (1.055)	1.401 (-1.099 - 0.782)	-0.16 (1.90)	3.884 (-3.877 - 3.560)
	L	0.936 (0.802 - 0.981)	0.572 (1.183)	1.598 (-0.559 – 1.587)	0.51 (2.16)	4.432 (-3.729 – 4.757)

Abbreviations: ROM°= range of motion degree angle; ER= external rotation; IR= internal rotation; R= right side; L= left side; SD= standard deviation; ICC = intraclass correlation coefficient; 95% CI= 95% confidence interval; LOA= limit of agreement; SEM= standard error of measurements. *Correlation is significant at the 0.05 level (2-tailed)

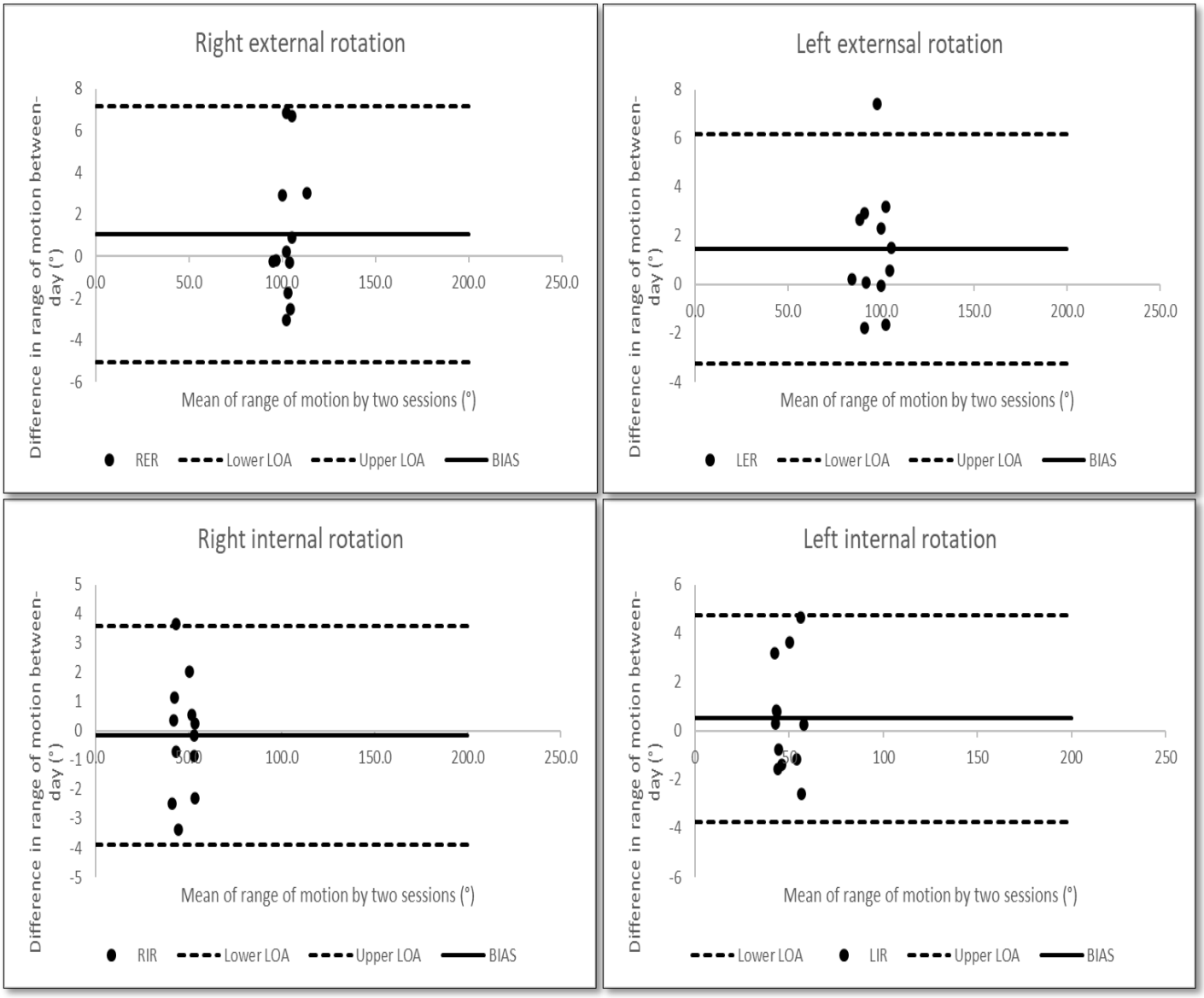

Figure 11. Bland–Altman Plot of ER, IR Right and Left index scores in Volleyball athlete, intra-rater, ROM

Table 8. Inter-rater within-day reliability measures for handheld dynamometer (rater 1 vs rater 2)

Strength (N)		ICC (95% CI)	SEM (%)	Typical Error	Bland-Altman analysis	
				Value (90% confidence limit)	BIAS (SD)	LOA
EER	R	0.994 (0.980 - 0.998)	0.24 (0.021)	0.220 (-0.273 - 0.023)	-0.12 (0.30)	0.609 (-0.708 – 0.458)
	L	0.981 (0.934 - 0.995)	0.868 (0.796)	4.451 (-3.272 – 2.706)	-0.28 (6.03)	12.339 (-12.096 – 11.530)
IIR	R	0.982 (0.938 - 0.995)	1.665 (1.498)	8.773 (-1.213 – 10.569)	4.68 (11.88)	24.318 (-18.604 – 27.960)
	L	0.992 (0.973 - 0.998)	0.282 (0.259)	2..231 (-1.376- 1.620)	0.12 (3.020)	6.183 (-5.797 – 6.042)
IER	R	0.935 (0.775 - 0.981)	1.166 (1.483)	3.233 (-1.535 – 2.807)	0.64 (4.4)	8.963 (-7.945 – 9.217)
	L	0.971 (0.898 - 0.992)	0.51 (0.672)	2.118 (0.942 – 3.786)	2.36 (2.87)	5.870 (-3.256 – 7.984)

Abbreviations: N= newton; EER= eccentric external rotation; IIR= isometric internal rotation; IER = isometric external rotation ; R= right side; L= left side; SD= standard deviation; ICC = intraclass correlation coefficient; 95% CI= 95% confidence interval; LOA= limit of agreement; SEM= standard error of measurements.
*Correlation is significant at the 0.05 level (2-tailed)

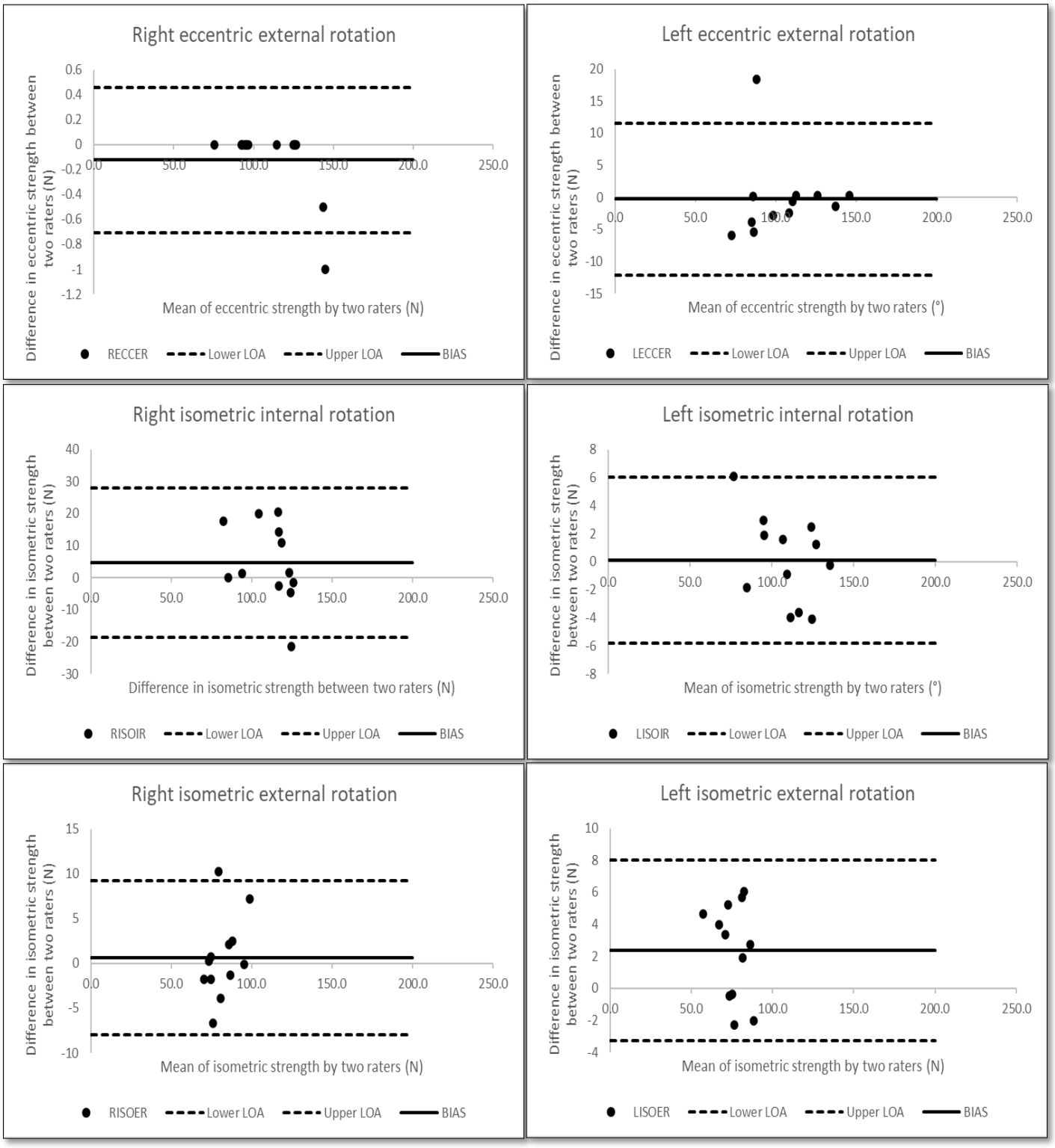

Figure 12. Bland–Altman Plot of ER, IR Right and Left index scores in Volleyball athlete, Inter-rater, STRENGTH

Table 9. Intra-rater between-day reliability measures for handheld dynamometer- (rater 1 vs rater 1)

Strength (N)		ICC (95% CI)	SEM (%)	Typical Error	Bland-Altman analysis	
				Value (90% confidence limit)	BIAS (SD)	LOA
EER	R	0.973 (0.912 - 0.992)	0.728 (0.646)	3.112 (-0.553 – 3.626)	1.54 (4.21)	8.627 (-6.723 – 9.796)
	L	0.987 (0.958 - 0.996)	1.620 (1.501)	2.212 (-0.685 – 2.285)	0.80 (2.99)	27.944 (-5.070 – 6.670)
IIR	R	0.916 (0.745 - 0.975)	1.795 (1.614)	4.377 (-4.511 – 1.367)	-1.57 (5.93)	12.132 (-13.188 – 10.044)
	L	0.994 (0.982 - 0.998)	0.139 (0.128)	1.322 (-0.207 – 1.568)	0.68 (1.79)	3.664 (-2.828 – 4.187)
IER	R	0.948 (0.838 - 0.985)	0.641 (0.784)	1.911 (-1.132 - 1.543)	0.20 (2.70)	5.520 (-5.079 – 5.490)
	L	0.919 (0.753 - 0.976)	1.010 (1.334)	2.502 (-0.002 – 3.358)	1.68 (3.39)	6.935 (-4.962 – 8.318)

Abbreviations: N= newton; EER= eccentric external rotation; IIR= isometric internal rotation; IER = isometric external rotation ; R= right side; L= left side; SD= standard deviation; ICC = intraclass correlation coefficient; 95% CI= 95% confidence interval; LOA= limit of agreement; SEM= standard error of measurements.
*Correlation is significant at the 0.05 level (2-tailed)

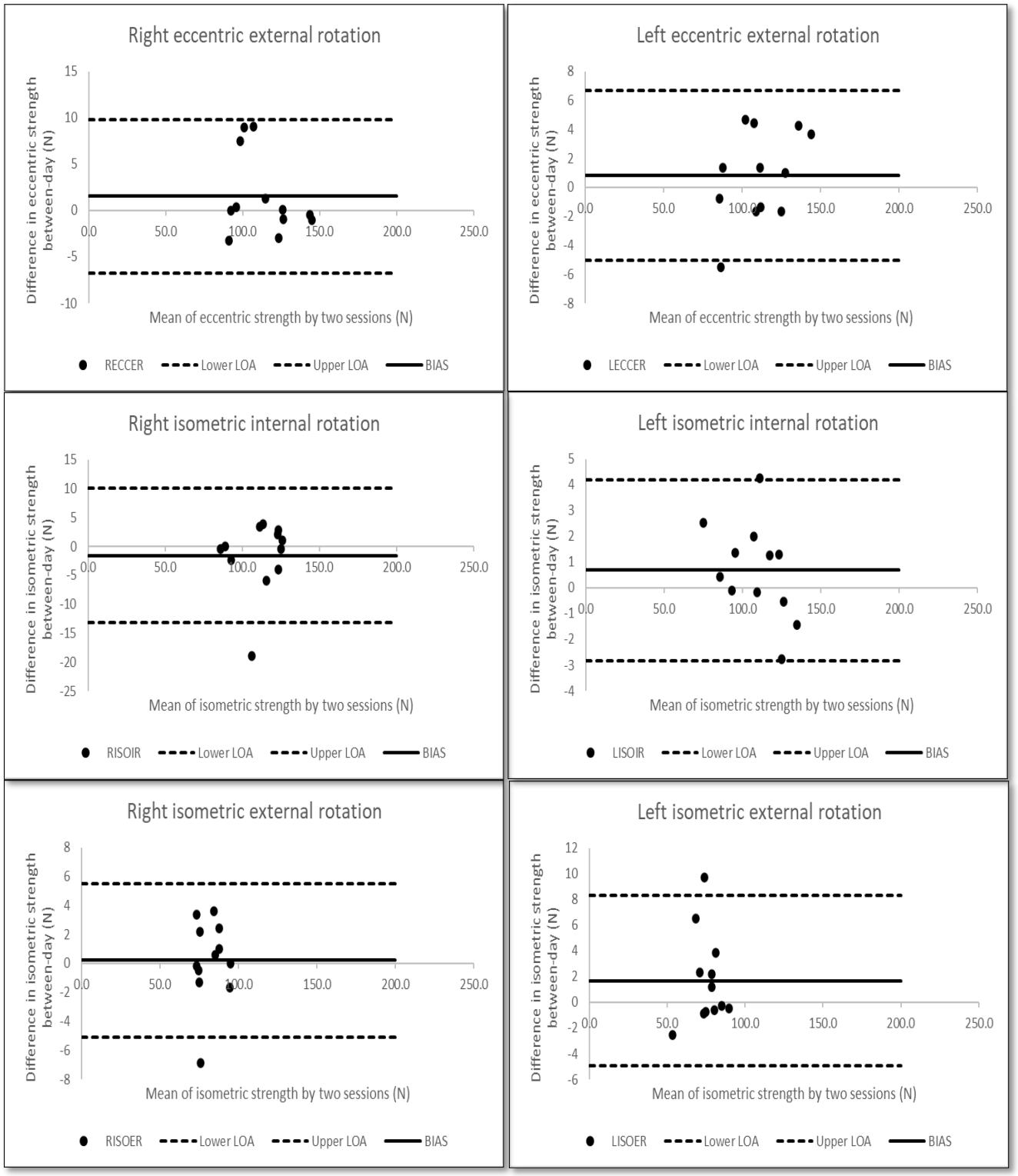

Figure 13. Bland–Altman Plot of ER, IR Right and Left index scores in Volleyball athlete, Intra-rater, STRENGTH

Intraclass Correlation Coefficient (ICC)

Inter-rater ICCs, analysis of 95% revealed all variables were excellent (ICC ≥ 0.90) and ranged from 0.935 to 0.994 for both the goniometer and handheld dynamometer (Table 6 & 8). Intra-rater ICCs, analysis of 95% revealed all variables were excellent (ICC ≥ 0.90) and ranged from 0.916 to 0.994 for both the goniometer and handheld dynamometer (Table 7 & 9).

The Standard Error of Measurements (SEM)

The SEM and SEM% for the right and left measurements of shoulder joint ROM inter-rater reliability were as follows: external rotation, R= 0.38° (0.38%) and L= 0.62° (0.64%) and internal rotation, ranging R= from 0.44° (0.91%) and L= 0.28° (0.58%) (Table 6). The SEM and SEM% for the right and left measurements of shoulder joint ROM intra-rater-reliability were as follows: external rotation, R= 0.56° (0.55%) and L= 0.7° (0.72%) and internal rotation, R= 0.5° (1%) and L= 0.6° (1.2%) (Table 7). This gives confidence in using a digital goniometer instrument to measure the right and left shoulder joint ROM.

The SEM and SEM% for the right and left measurements of shoulder strength inter-rater reliability were as follows: EER, R = 0.24 N (0.02%) and L = 0.868 N (0.8%) IIR, R = 1.66 N (1.5%) and L = 0.28 (0.26%) and IER, R = 1.2 N (1.5%) and L = 0.51

(0.67%) (Table 8). The SEM and SEM% for the right and left measurements of shoulder strength intra-rater-reliability were as follows: EER, R = 0.73 N (0.64%) and L = 1.62 N (1.5%) IIR, R = 1.8 N (1.61%) and L = 0.139 N (0.128 %) and IER, R = 0.64 N (0.8%) and L = 1 N (1.33%) (Table 9). This gives confidence in using a handheld dynamometer instrument to measure the right and left shoulder muscle strength.

Bland-Altman Plots

Bland-Altman plots showed absolute agreement between two raters and between two sessions for both the goniometer and handheld dynamometer (Figure 10, 11, 12 & 13). The inter-rater limit of agreement (LOA) for the right and left measurements of shoulder joint ROM were as follows: external rotation, 3.82 and 5.8 and internal rotation, 4.35 and 3.6 (Table 6). The intra-rater limit of agreement (LOA) for the right and left measurements of shoulder joint ROM were as follows: external rotation, 3.87 and 4.9 and internal rotation, 3.9 and 4.43 (Table 7).

The inter-rater limit of agreement (LOA) for the right and left measurements of shoulder strength were as follows: EER, 0.61 and 12.34, IIR, 14.32 and 6.2 and IER 8.96 and 5.9 (Table 8). The intra-rater limit of agreement (LOA) for the right and left measurements of shoulder strength were as follows: EER, 8.63 and 27.94, IIR, 12.13 and 3.66, and IER 5.52 and 6.93 (Table 9).

Bland-Altman plot showed good agreement in digital goniometer and handheld dynameter measurements taken on different days and by two raters where all values fall within 2SD of the mean difference.

Scapular Dyskinesis

Strength of agreement between two raters and two sessions were excellent (k = 1).

4.3.3 Discussion

The first aim of this study was to establish the inter and intra-reliability for glenohumeral joint external and internal rotation range of motion, scapular dyskinesis and eccentric and isometric internal (IR) and external (ER) rotation muscle strength.

Reliability of glenohumeral joint ROM and rotator cuff muscles strength measurements

In this study, Intra and inter-rater reliability were excellent for shoulder ROM and strength measurements made with the goniometer and handheld dynamometer; therefore, both instruments can confidently be used to reliably measure shoulder ROM and strength. It has been suggested that ICCs should exceed 0.90 for clinical measurements and that values below 0.70 indicate low

reliability based on the guidelines of Fleiss (Cools, et al. 2014; & Coinceicao et al., 2018). In this current study, all intra and inter-rater values exceeded 0.9 for both the goniometer and handheld dynamometer. The findings in this study are in alignment with Mullaney et al. (2010) who determined the intra- and intertester reliability of a standard universal goniometer for measurements for active assisted shoulder range of motion (ROM). Shoulder internal rotation (IR), and external rotation (ER) ROM were measured using a goniometer bilaterally, on two different occasions by two physical therapists, in 20 patients with unilateral shoulder pathology (9 males, 11 females, 18–79 years old). Intratester ICCs ranged from 0.91 to 0.99. Moreover, intrarater analysis in Kolber & Hanney (2012) study also suggested excellent reliability for all measurements ICC (95% Cl); ER = 0.94(0.87–0.97) and IR = 0.95 (0.89–0.98) with standard baseline 12-inch plastic goniometer ranging from, ICC (3,k) =0.94–0.98.

Our findings also are similar to Cools et al. (2014) who also established good to excellent intra- and intertester reliability and absolute and relative reliability for isometric external and internal rotation strength measurements examined by Hand-Held-Dynamometer (HHD) in different patients' positions, and shoulders' positions (ICC = 0.85-0.99). However, results could be impacted by equipment and patient positioning. Therefore, for sport specific measurements, strength should be

measured in positions, resembling the throwing position. Moreover, Cools et al. (2016) results confirmed the good-to-excellent reliability for eccentric and isometric strength measurements, established by Cools et al. (2014). In addition, Johansson et al. (2015) examined the absolute and relative reliability and inter and intra-reliability of a standardized eccentric strength-measurement protocol for the glenohumeral external rotators using a handheld dynamometer (HHD). The intratester reliability was excellent, whereas the intertester reliability was good.

SEM findings in this study and its variants can be used to construct confidence intervals for players scores and to determine the minimal difference needed to be exhibited for one to be confident that a true change in condition of an individual has occurred (Weir, 2005). Moreover, Intrarater analysis in Kolber & Hanney (2012) study suggested excellent reliability for all measurements SEM°, ER = 3° and IR = 2° with standard baseline 12-inch plastic goniometer. The SEM and SEM% in Johansson et al. (2015) study for the tester 1, tester 2 and between two testers were as follows: 11.10 (9.2%), 7.85 (6.8%) and 14.11 (12.0%). In contrast, this study found significantly lower values, therefore the SEM was much better than previous studies. In regards to the agreement 95% LOA, Cools et al. (2014) suggests that goniometry may range from being 20° less than to 5°. In Mullaney et al. (2010) study, Intratester LOA ranged from 31 to 91 for measurements made with the

goniometer. Intertester LOA ranged from 61 to 251. The inter-rater limit of agreement (LOA) in the current study for the right and left measurements of shoulder joint ROM were as follows: external rotation, 3.82 and 5.8 and internal rotation, 4.35 and 3.6. The intra-rater limit of agreement (LOA) for the right and left measurements of shoulder joint ROM were as follows: external rotation, 3.87 and 4.9 and internal rotation, 3.9 and 4.43.

Reliability of scapular dyskinesis clinical assessment

The inter and intra-rater reliability were excellent for the clinical assessment method of categorizing scapular dyskinesis by observation (“yes/no'') using the Uhl et al. (2009) classification system. These findings support the use of the Uhl et al. (2009) classification system (“yes/no'') as a useful screening tool for shoulder examination and promotes more clinical agreement (inter-rater and intra-rater reliability) in the observational assessment of scapular dyskinesis in the cross-sectional study (Chapter 4.3.2) without changing the reliability. In contrast, another classification method by McClure et al. (2009) found moderate interrater reliability by classifying scapular motion as “normal”, “subtle dyskinesis”, or “obvious” dyskinesis with 75% and κ_w 0.57. Therefore, the “yes/no” category is more inclusive and the clinician is no longer limited to choosing single-plane categories. The

heterogeneity of the current study between the players and raters background gives the strength of agreement of this screening tool to be applied in the cross-sectional study (Chapter 4.3.2). Same rater of this study assessed players from the same existing population in the cross-sectional study (Chapter 4.3.2).

In conclusion, all variables can be considered reliable and can be used with confidence when establishing differences in physical risk factors between groups in the following section (see section 4.4).

4.4 Physical Risk Factors of Overuse Shoulder Injuries in Male Competitive Volleyball Players in Kuwait.

4.4.1 Method

4.4.1.1 Research Design

Following institutional ethical approval, a cross-sectional experimental study was conducted to investigate physical risk factors of overuse shoulder injuries among male competitive volleyball players. Comparisons between shoulder ROM, rotator cuff muscle strength and scapular dyskinesis variables were carried out among 57 male competitive volleyball players in Kuwait. Physical assessments took

place between the second quarter (week 8) and midpoint (week 15) of volleyball competitive sport season (2020/2021).

4.4.1.2 Participants and Recruitments

173 competitive male volleyball players registered in the Kuwaiti volleyball federation and playing in the two highest leagues [First degree league, Excellent league] during the 2020/2021 season, made the sample size of the preliminary study (Chapter 3. Study 1) were the targeted population for this study. A sample of 120 volleyball players obtained from power calculation was used for purposive sampling technique. The formula below was used to detect the sample size.

$N=z^2\ pq/d$

Where: N=required sample size Z=confidence level p=estimated prevalence of sport injuries in general population, if not known 50% will be used q=1-p and d=marginal error=0.05 (Sumaila, Zakari, & Sulaiman, 2016).

An electronic invitation and registration form including information about the study was distributed to all relevant players through the Kuwaiti volleyball federation at the beginning of the annual competitive season (no. = 173). All those

that responded provided informed consent to participate included in the registration form.

4.4.1.3 Instruments and placement

Please see Section 4.3.1.3

4.4.1.4 Data Collection

Physical assessment sessions (Chapter 4.3.1.3) were carried out between the second quarter (week 8) and half (week 15) of volleyball competitive sport season (2020/2021). Furthermore, these players have been distinguished into two groups; overuse shoulder injured players and non-injured players according to the preliminary study; Chapter 3. Study 1. While monitoring players' experience of injury per week, players with sustainable overuse shoulder injury experience and players without injury experience were detected for physical examination sessions. Volleyball players who experience other types of shoulder injuries during volleyball sport season (2020/2021) or started the first week of study course season with overuse shoulder injuries or other types of injuries were excluded. Affected shoulders and non-affected shoulders of players with overuse shoulder injury have been determined through Chapter 3. Study 1 outcomes. Moreover, dominant and non-dominant were also determined for all examined players. Physical assessment

sessions took place in the volleyball hall of the local Kuwaiti clubs (permission obtained). Equipments including portable therapeutic bed, towel, Digital plastic goniometer, dumbbells weighted 1.4 kg (3 lb) and 2.3 kg (5 lb) and Handheld dynamometer were provided by the assessor in each session. Data were collected once for each individual player before the volleyball training sessions start or any physical workouts.

4.4.1.5 Data Analysis

Table 10. Study Participants Characteristics (N = 57) [α]

	Players with overuse shoulder injury (n = 24)	**Players without injury (n = 33)**
Age, y, mean (SD)	28 (4.8)	27 (5)
Height, cm, mean (SD)	179.5 (20.2)	183.2 (9.5)
Body mass, kg, mean (SD)	78.4 (13.6)	81.8 (13.2)
Years of volleyball, median (IQR)	15 (11-22)	14 (9-22)
Playing level (n = 57)		
Excellent league, n (%)	11 (19.3)	15 (26.3)
First-degree league, n (%)	13 (22.8)	18 (31.6)
Dominant side		
Right, n (%)	22 (38.6)	30 (52.6)
Left, n (%)	2 (3.5)	3 (5.3)
Injured side (Dominant)		
Right, n (%)	22 (38.6)	0 (0)
Left, n (%)	2 (3.5)	0 (0)

[α]IQR, interquartile range.

At the end of the course study (Chapter 3. Study 1), raw data were exported from Qualtrics software to Microsoft Excel (Microsoft 365 MSO, Version 2207). Players who experienced any other type of shoulder injuries following data collection, their data will be excluded. Moreover, players who have been examined while they were not injured and then followed by overuse shoulder injury, their

data were also excluded. Therefore, only 57 players' data were eligible for data analysis of this study (Table 10).

All dominant shoulders of players with overuse shoulder injuries were indicated as injured shoulders. Independent variables; ROM, muscle strength and scapular dyskinesis were grouped into three categories according to the dependent variables; non-injured dominant shoulder group; injured-affected (dominant) shoulder group and injured-unaffected (non-dominant) shoulder group.

Demographic characteristics of the study athletes and measurement values were described statistically by calculating their mean and standard deviation using Windows statistical program of IBM SPSS 26 software (United Kingdom).

Normality distribution and homogeneity tests were carried out to identify further analytical comparison tests for the variables means values; parametric or non-parametric tests.

Therefore, One-way ANOVA (Post-Hoc) had been used to compare the means of external rotation ROM, eccentric external rotation strength, isometric internal rotation strength and isometric external rotation strength values between three assessed shoulders; dominant and non-dominant shoulder of injured players and dominant shoulder of non-injured players (Bushman et al., 2016). Also, Bacon

& Mauger (2017) implemented this analysis test making it appropriate to this study. The Assumption of ANOVA tests was validated using Shapiro-Wilko test for homogeneity of variance. Furthermore, Eta-squared was computed to correlate between groups and each dependent variable and see which one was the strongest predictor of group members (Mulleta & Getachew, 2019).

However, to compare means of internal rotation ROM values, Kruskal-Wallis H test had been used (Reeser at al., 2010). Moreover, Mann-Whitney U tests were conducted to identify the significance between means of internal rotation ROM values.

Formula for Eta squared used in this case:

$ETA^2 = (H - k + 1)/(n - k);$

Where k is the number of groups, n is the overall number of observations, and H is the output of the Kruskal-Wallis H test (Tomczak, & Tomczak, 2014).

The Chi-Square test had been utilized to compare scapular dyskinesis codes between three groups of shoulders (Hartig & Henderson, 1999; & Reeser at al., 2010). Contingency coefficient as a Pearson equivalent was computed to correlate between groups and scapular dyskinesis variables and see which one was the

strongest predictor of group members. A P value of ≤ 0.05 was taken as an indication of statistical significance. The Windows statistical program of IBM SPSS 26 software (United Kingdom) was used for computing all tests values.

4.4.2 Results

Table 11. Volleyball Players Shoulder ROM and Rotator Cuff Muscle Strength Multiple Comparisons to Identify Physical Risk Factors of Overuse Shoulder Injuries (One-Way ANOVA Post-Hoc).

Shoulder	Main effects (*F* value)	*P* value	Shoulder Multiple Comparisons (Mean; SD)	Mean Difference (*P* value)	95% CI
ER ROM	4.835	0.01	Non-Injured (98.3; 12.3) × Injured-Affected (92; 9.2)	6.4* (0.035)	0.45 -12.36
			Injured-Unaffected (89.5; 11.5) × Injured-Affected (92; 9.2)	2.4 (0.456)	-4 – 8.8
EER Strength	2.816	0.066	Non-Injured (130.4; 20.2) × Injured-Affected (116.8; 27.1)	13.6* (0.024)	1.87 - 25.3
			Injured-Unaffected (121.8; 18.2) × Injured-Affected (116.8; 27.1)	-4.9 (0.44)	-17.54 – 7.68
IIR Strength	3.445	0.037	Non-Injured (113.9; 24.5) × Injured-Affected (100.4; 19.7)	13.5* (0.032)	1.17 - 25.9
			Injured-Unaffected (100; 24.3) × Injured-Affected (100.4; 19.7)	0.4 (0.953)	-12 – 13.7
IER Strength	3.398	0.038	Non-Injured (78.8; 13.7) × Injured-Affected (68.8; 20.6)	10* (0.024)	1.32 - 18.6
			Injured-Unaffected (69.7; 14.2) × Injured-Affected (68.8; 20.6)	-0.9 (0.848)	-10.2 – 8.4

Abbreviations: ROM°= range of motion degree angle; ER= external rotation; EER= eccentric external rotation; IIR= isometric internal rotation; IER = isometric external rotation 95% CI= 95% confidence interval; SD=Standard Deviation; *The mean difference is significant at the 0.05 level (2-tailed)

Table 12. Volleyball Players Shoulder IR ROM Multiple Comparisons to Identify Physical Risk Factors of Overuse Shoulder Injuries (Kruskal-Wallis H & Mann-Whitney U).

IR ROM (Mean; SD)	Kruskal-Wallis H (*P* value)	*MWW (P value)*
Non-Injured (44.3; 2.6) × Injured-Affected (36.2; 8)	15.085 (0.001)	149.5** (0.000)
Injured-Unaffected (38; 9) × Injured-Affected (36.2; 8)		243.5 (0.358)
Abbreviations: ROM°= range of motion degree angle; IR= internal rotation; *U*= Mann-Whitney; *The mean differences is significant at the 0.05 level (2-tailed)		

The results of the on-way ANOVA test for shoulder external rotation ROM and muscle strength multiple comparisons is displayed in Table 12. The results of the Mann-Whitney test for internal rotation ROM is displayed in Table 13.

There is a significant deficient in shoulder external rotation ROM 6.4° (*P* = 0.035) in players with overuse shoulder injury (Mean=92°, SD= 9.2) compared to shoulders of players with no injuries experience (Mean= 98.3°, SD=12.3). However, there was no statistically significant difference in external rotation ROM (*P* = 0.456) between affected and unaffected shoulders of players with overuse shoulder injuries.

There is a significant deficient in shoulder internal rotation ROM (U = 149.5, *P* = 0.000) in players with overuse shoulder injury (Mean=36.2°, SD= 8) compared to shoulders of players with no injuries (Mean= 44.3°, SD= 2.6). However, there was

no statistically significant difference in internal rotation ROM (U = 243.5, *P* = 0.358) between affected and unaffected shoulders of players with overuse shoulder injuries.

Isometric internal rotation and isometric external rotation muscle strength shoulders of players with overuse shoulder injuries (*IIR 13.5 N (P = 0.032); IER 10 N (P = 0.024)*) were significantly weaker than shoulders of players with no injuries (IIR (Mean = 113.9 N; SD = 24.5); IER (Mean = 78.8 N; SD = 13.7)). However, there is no statistical significance in Isometric internal rotation and isometric external rotation muscle strength (IIR 0.4 N (*P* = 0.953); IER -0.9 N (*P* = 0.848)) between affected and unaffected shoulder of players with overuse shoulder injury.

Eccentric external rotation muscle strength of shoulders of players with overuse shoulder injury (Mean=116.8 N, SD= 27.1) were significantly weaker 13.6 N (*P* = 0.024) than shoulders of players with no injuries (Mean=130.4 N, SD= 20.2). However, there is no significant difference in Eccentric external rotation muscle strength 8.6 N (*P* = 0.145) between affected and unaffected shoulder of players with overuse shoulder injury (Mean=121.8 N, SD= 18.2).

In addition, IR ROM (η2 =0.17) have practical significant effect over players shoulders than external rotation (η2 =0.11). However, eccentric external rotation

(η2 =0.07), isometric internal rotation (η2 =0.08) and isometric external rotation (η2 =0.08) strength have limited practical applications.

Chi-Square test show that there are no statistically significant differences in the appearance of scapular dyskinesis between all shoulder groups ($\chi 2 = 2.9$, $P = 0.233$). However, scapular dyskinesis has a highly practical significance effect over players shoulders (η2 =0.233).

4.4.3 Discussion

This cross-sectional study investigated physical risk factors (range of motion, muscle strength, and scapular dyskinesis) of overuse shoulder injuries among male competitive volleyball players using a reliable well-established physical assessment approach.

Glenohumeral joint range of motion

The current study found that players with overuse shoulder injuries have significant external and internal rotation ROM deficiencies in injured shoulders compared to the shoulders of players with no injury experience. Manske et al. (2013) have previously proposed that external rotation shoulder ROM deficiency may be a significant risk factor for shoulder injuries in overhead athletes.

However, the external and internal rotation ROM deficiency findings in our study are in contrast with other studies, possibly due to different study designs or differences in injury definition. A prospective study by Forthomme et al. (2013), demonstrated that absolute shoulder ROM or shoulder ROM deficits were not associated with shoulder pain in professional volleyball players. Their physical assessment was carried out in the preseason (while assessments in our study were conducted towards the end of the season) and the players were then followed prospectively by means of a weekly self-report questionnaire to record any shoulder pain experienced. Another more recent prospective study of professional volleyball players in Qatar by Skazalski et al. (2021) with preseason baseline testing and self-reporting over 12 weeks also found no relationship between internal rotation ROM and shoulder complaints. This might indicate that ROM deficiencies manifest after injury occurrence and can show the potential casual relationship between injury and physical risk factors.

In another cross-sectional study, Reeser et al. (2010) also found no association between the presence of GIRD in the dominant shoulder and shoulder problems in collegiate club volleyball players. History of any shoulder pain or dysfunction experienced in the previous competitive season was retrospectively recorded by means of one questionnaire, so there may be an element of recall bias.

Also the narrow age range of the sample may have been a factor as participants were all college students.

In addition, external rotation ROM gains existing along with internal rotation deficits in the dominant shoulder have been documented by Wang and Cochrane (2001b) in their prospective study of elite volleyball players, but they found no association between mobility impairment and injury. The authors suggested that mobility impairment from IR deficiencies is an adaptation to the demands of the sport. Their physical assessment tests were also carried out once before the beginning of the season and self-report questionnaires to document any pain or injury were completed monthly by the participants. Finally, the review of volleyball-specific dominant shoulder biomechanical adaptations and risk factors by Challoumas et al. (2017) also found that GIRD in volleyball players appears to be anatomical as a response to the repetitive overhead movements, unlike other overhead sports, and is not connected to shoulder pain or injury.

In addition, there are no significant differences in the external rotation and internal rotation ROM deficiencies between the affected shoulder and the unaffected shoulder of players with overuse shoulder injuries. Therefore, both shoulders of the players with overuse shoulder injuries share similar physical

characteristics (ER & IR ROM deficiencies) whether it's an affected or unaffected shoulder. This may indicate that external rotation and internal rotation shoulder ROM deficiencies cause overuse shoulder injuries not vice versa. The demands of throwing activity in playing volleyball may affect the shoulders with internal rotation and external rotation ROM deficiencies. Internal rotation and external rotation ROM deficiencies may have an effect on the shoulder of the volleyball players, in addition to the demand of the throwing activity. Therefore, deficiency of external rotation and internal rotation ROM may be risk factors of throwing shoulder that may cause overuse shoulder injury. However due to the cross-sectional study design carried out towards the end of the season, it is not possible to confirm in our study if shoulder ROM deficits are caused by injury or are pre-existent and may be causing injury.

Eccentric external rotation rotator cuff muscle weakness

In this study, players with overuse shoulder injuries had a significantly lower eccentric external rotation muscle strength compared to the shoulders of players with no overuse shoulder injury. These findings support studies in other overhead athletes that found a strong link between external rotation weakness and shoulder injury in baseball pitchers (Byram et al., 2010), and in handball players (Clarsen et

al., 2014). However, the findings are in contrast with those of elite volleyball athletes by Wang and Cochrane (2001b) who found external rotator eccentric muscle weakness in the dominant shoulders of participants, but did not find an association with injured or painful shoulders. The authors stated that muscle weakness of external rotator muscles may be more likely to be involved in the early stages of shoulder maladaptation than directly related to the occurrence of shoulder injury (Wang & Cochrane, 2001b). However, there are no significant differences in the eccentric external rotation muscle strength between the affected and unaffected shoulders of players with overuse shoulder injuries. Both shoulders of players with overuse shoulder injuries might share the same muscle strength.

Isometric internal and external rotation rotator cuff muscle weakness

Players with overuse shoulder injuries have significant isometric internal rotation and isometric external rotation muscle weakness compared to the shoulders of players with no overuse shoulder injury in the current study. Although a different methodology was used, this study supports findings by Reeser et al. (2010) who also found that imbalances in the isometric strength of the shoulder external or internal rotators was associated with shoulder problems, using a manual assessment. Furthermore, there are no significant differences in the

isometric internal rotation and isometric external rotation muscle weakness between both shoulders of players with overuse shoulder injuries. This may indicate that shoulder isometric internal rotation and isometric external rotation muscle weakness may cause overuse shoulder injuries, not vice versa. However as previously mentioned, due to the nature of the current study design, a definite causal relationship cannot be established.

Scapular dyskinesis

Despite the high prevalence of scapular dyskinesis in overhead athletes, there is still mixed evidence in the literature of an association with shoulder injury. In this study, there are no statistically significant differences in the appearance of scapular dyskinesis between all shoulder groups, in alignment with Wang and Cochrane's prospective study of 16 elite volleyball athletes (2001b).

In contrast, the SICK scapula score (Scapular malposition, Inferior medial border prominence, Coracoid pain and malposition, and dyskinesis of scapular movement) in the Reeser et al. (2010) study was found to correlate significantly with shoulder problems. Greater SICK scapula scores were associated with an increased likelihood of shoulder problems. It is worth noting that their physical examination study was conducted with a large number of participants (n = 276).

Clarsen et al. (2014) also found scapular dyskinesis to be a risk factor in handball athletes in their prospective study. They acknowledged the previous mixed evidence in overhead athletes and suggested that their findings had a sufficiently large sample size (206 players) that was able to establish a relationship with shoulder problems. Therefore it is possible that the small sample size in the current study and in Wang and Cochrane's (2001b) study were not able to reveal an association with shoulder injury. Future studies of physical risk factors for volleyball players should be conducted with a greater number of participants.

Study Strengths, Limitations and Implications

This is the first cross-sectional study on physical risk factors for overuse shoulder injuries among sub-elite male volleyball players. Good reliability for clinical measurements is necessary to give confidence that differences are real and not due to measurement errors. Therefore the instruments used in investigating the physical risk factors of overuse shoulder injuries were assessed for their reliability in conducting this study and were found to be reliable. However, the same method has some limitations due to the small sample size that might limit the statistical analysis and the variety in players' experiences that already have been treated through specification in exclusion and inclusion criteria.

Although the current study was not designed prospectively to address the aetiology and risk factors of shoulder injuries, it provides good findings about the possible aetiology of overuse shoulder injuries in volleyball players and associated adaptations in all shoulder physical components. However, the categorization of injured vs non-injured players was completely dependent on the athlete's self-reporting of the gradual-onset definition of overuse injury symptoms and was not backed up by a diagnostic definition with clinical assessment and imaging. Ideally a study or practical application would combine self-reporting of overuse symptoms with a gold standard diagnostic method to confirm overuse shoulder injury and diagnose the type of injury. Therefore, not knowing if injured vs non-injured player categories are accurate is a limitation.

Another limitation might be related to the timing of the assessment post-injury and towards the end of the season. It is unclear whether or not proximity or distance from when the injury was first identified may be influencing the results. For example, could the injury be causing these deficiencies or are the deficiencies causing the injury? Was the assessment conducted when pain had decreased since injury occurred? Therefore, a preseason physical assessment of all participants of the first study (Chapter 3) might have been more adequate to confirm a causal relationship.

Instruments used in the physical shoulder examination demonstrated the ability to identify potential physical risk factors of overuse shoulder injuries. Therefore, they could be utilized in the volleyball sport physical therapy practice to identify volleyball players who are prone to overuse shoulder injuries prior to the start of the sport competitive season and implement appropriate preventive strategies. However, overuse shoulder injury prevention strategies incorporating the addressed risk factors should be tested using randomized controlled trials.

Conclusion

Following a preliminary study that confirmed the reliability of clinical measurement tools (goniometer, handheld dynamometer and dynamic scapular dyskinesis test) used to establish a reliable physical shoulder assessment model, this cross-sectional study found that eccentric external rotation, isometric internal rotation and isometric external rotation muscle weakness and external rotation and internal rotation ROM may be physical risk factors of overuse shoulder injuries in competitive volleyball players in Kuwait. These are modifiable intrinsic factors and therefore of interest in the design of injury prevention interventions. However, due to the timing of the assessments towards the end of the sport season it is currently unclear whether or not these deficiencies may be contributing to injury

causation or are a consequence of the injuries. While these potential modifiable risk factors may be a good starting point for injury prevention strategies, future prospective studies with larger sample sizes and including a preseason shoulder assessment (in order to establish a baseline for the prospective cohort) are recommended to confirm causal relationships.

This is the first cross-sectional study on physical risk factors for overuse shoulder injuries among sub-elite male volleyball players using good reliability clinical measurements. Instruments used in the physical shoulder examination could be utilized in the volleyball sport physical therapy practice to identify volleyball players who are prone to overuse shoulder injuries prior to the start of the sport competitive season and implement appropriate preventive strategies.

Chapter 5.0: Study 3 - Perceptions of Overuse Shoulder Injuries in Competitive Male Volleyball Players in Kuwait

5.1 Introduction

This thesis has so far established a high prevalence and severity of overuse shoulder injuries, and potential physical risk factors, by using quantitative approaches. However, overuse injuries are multifactorial, and qualitative research approaches can help provide a more in-depth understanding of injuries and their prevention by taking the context in which these injuries occur into consideration (Bolling et al., 2018). It is important to understand how injuries are perceived and defined by athletes, coaches and healthcare providers since they are the main end-users of injury surveillance systems and injury prevention interventions (Bolling et al., 2019). Study one found that there is no significant time-loss from these injuries, despite their significant impacts on pain, performance and other severity measures. Understanding the perceptions of players regarding overuse shoulder injuries can provide insights into their awareness of injury risks, their behaviours related to injury prevention, and their attitudes towards injury management. By considering their perceptions, coaches, trainers, and medical staff can develop effective injury prevention strategies tailored to the specific needs and concerns of the players.

The socioecological model adopted by Bolling et al. (2018) is a useful tool for studying sports injuries in their specific context. Their view (see figure 14) places

the injured athlete at the centre of a socioecological model which includes context at multiple levels, i.e. individual, sociocultural and environmental (Bolling et al., 2018). Using a qualitative research approach together with the application of this model enables the collection of in-depth information about the context and provides a more comprehensive understanding of how the different levels of the socio-ecological model interact in the athlete's personal experiences. A deeper understanding of volleyball athletes' perceptions of their overuse shoulder injuries may support the future development of theory-based injury prevention and rehabilitation interventions in Kuwait. While qualitative approaches have been previously used to explore perceptions of overuse injuries (see section 2.8.2, Chapter 2), there is a lack of qualitative volleyball-specific studies on overuse shoulder injuries.

5.2 Aim

The aim of this study is to examine the perceptions and experiences of competitive male volleyball players in Kuwait who have experienced an overuse shoulder injury, by using a socioecological model as a guiding framework.

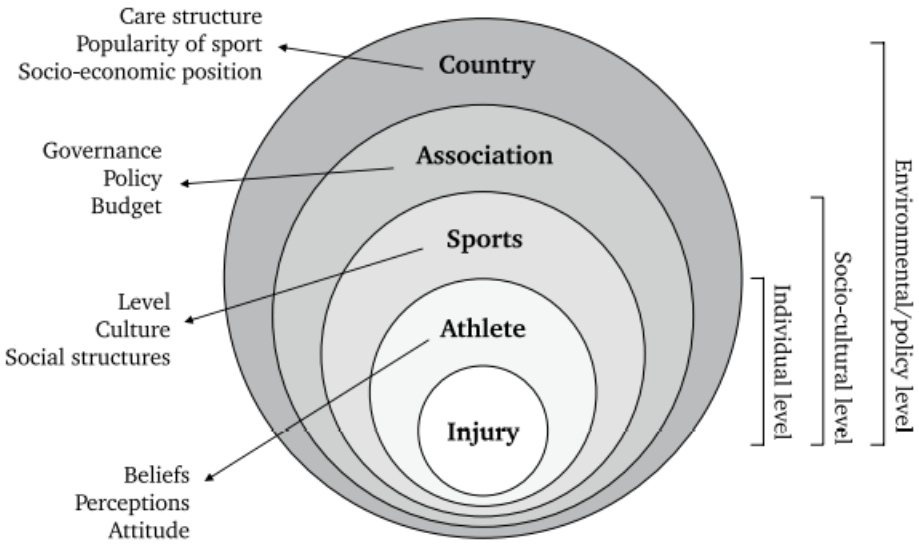

Figure 14. A socioecological view of sports injuries (Bolling et al., 2018)

5.3 Method

5.3.1 Research Design

This study adopted a qualitative method using semi-structured interviews and thematic analysis.

5.3.2 Setting

The interviews were conducted in Kuwait via ZOOM application as this method was convenient for all participants because of COVID-19 pandemic.

5.3.3 Ethical Approval

The study was approved by the Institutional Ethics Committee.

5.3.4 Sampling and Recruitment

Purposive sampling was used in the beginning of the sampling process to enable the researcher to recruit volleyball players who experienced overuse shoulder injury (n=28) during the volleyball competitive sport season (2020/2021) who participated in first study (Chapter 3). Those participants might be able to address the gap.

An invitation letter and participant information sheet (Appendix C) were sent to potential participants by text messages. The participants who were willing to participate were ask to respond to text message in order to arrange for the ZOOM meeting. All participants were informed that their participation in this study is voluntary, and they could withdraw from study at any time. The researcher ensured that the players read and understood the participant information sheet and if they had questions, she answered them all. An appointment of ZOOM meeting of the interview was made with participants who were interested in participating in this study at their convenient. Instructions and hyperlink of the meeting were sent to participants prior to the meeting.

A written consent (Appendix D) form was sent to participants at day of the interview to obtain their signature electronically before starting the interview. All interviews were video recorded. The interviewees were interviewed after the end of the competitive season. As there are eleven clubs in Kuwait, the researcher aimed to recruit at least one player from each club to enable her looking for a variety of participants to refine the categories. The researcher recruited the participants until she achieved the theoretical saturation where no new category developed when collected new data (Creswell & Creswell, 2023). Details about the participants are provided in the finding section of this chapter. In the following

sections, pseudonymous were assigned to all participants to ensure anonymity and confidentiality.

Initially, 28 players were contacted to take part in this study; 13 were recruited for this study. Many participants (n=15) declined to take part for different reasons (e.g., not prefer to continue in study or don't want to be video recorded). Some of the participants (n=4) from those who agreed to take part in this study (n=13) after the interview appointment was scheduled, they didn't attend the appointment or replied to the researcher reminder messages. Two participants from those who agreed to take part in this study (n=13) were not interviewed as theoretical saturation was achieved with seven participants.

5.3.5 Data Collection

5.3.5.1 Semi-structured Interviews

The researcher utilized in-depth interviews to explore the players' perceptions of overuse shoulder injuries. This data collection method was used because it can provide a detailed understanding and an insightful exploration of the overuse shoulder injuries. In addition, In-depth interviews are recommended when there are potential differences in the experience and opinions of the participants, when it's possible that participants know one another and that would

limit their ability to contribute, or when there are potential concerns with status or power. The researcher chosen semi-structured interview as the method of collecting data because it offers an acceptable level of flexibility, utilizing an interview guide designed with reference to the literature. The researcher interviewed all participants and data were collected between April to May 2021.

5.3.5.2 Interview Topic Guide

The topic guide that directed the interview was designed to explore volleyball player perception of overuse shoulder injury, the severity of the overuse shoulder injuries and injury management and prevention during the volleyball competitive sport season (2020/2021) in Kuwait.

A semi-structured interview guide was developed for the purpose of this study, based on two sources of information: (a) findings of the early descriptive epidemiological study of this thesis" (Chapter 3), (b) a socioecological view of sports injuries that includes context at multiple levels, i.e. individual, sociocultural and environmental (Bolling et al., 2018) (Figure 14).

The interview guide with the topics and questions can be found in Appendix (F). For example, the "injury prevention" topic is directly related to the different levels of the socioecological framework with the question "Who is responsible for

injury prevention?" and "What do you think is required for sports injury prevention in Kuwait?". Based on participants' answers, different themes may be generated and mapped using the socioecological framework.

The course-of-action framework introduced by Saury, et al. (1997) was applied in designing this interview guide. The course-of-action framework has been used in several studies to analyse the different components of elite athletes' activity during competition, especially their cognitions (D'Arripe-Longueville et al., 2001; Hauw et al., 2003; Sève et al., 2006). This situated-cognition approach responds to the need for specific protocols to study individuals' cognitions in context (e.g. Lave, 1988; Suchman, 1987). The course-of-action framework in this study offers an advantage to fully engage the player cognition in specific injury events to self-analyse contextual factors associated with the reported injury. Course-of-action framework in the current study included viewing a colourful line chart (see chart included in Appendix F) demonstrating the individual player's weekly Mean Weekly (RPE) and severity scores over the course of the 2020/2021 volleyball sport season. These scores were calculated based on data collected as part of the Chapter 3 prospective self-report study. This was followed by a self-confrontation interview in which the player, while viewing the chart image, is urged to recall and explain what he was personally experiencing during the season. This

interview method was developed by Von Cranach & Harré (1982) and consists of confronting a person with his or her activity in a particular situation. The self-confrontation interview was used as the starting point of the semi-structured interview to resituate the player in his lived experience and lead to the questions regarding his perception of the overuse injury.

Once developed, the interview guide was scrutinized by four researchers who were experienced in qualitative injury research. The initial draft of the interview guide was then piloted with an injured volleyball player with the interview taking place in English.

Based upon the feedback from the interviewee and the four researchers who read the interview transcript, only minor changes were made to the wording of a number of questions. Then two bilingual researchers (physiotherapist, Arabic language native) transferred the topic guide and the piloted interview transcript from English version to Arabic version with agreements on the words meaning. The final interview guide is presented in Appendix 1 and contains four main sections. Section 1 explained the purpose of the study. Section 2 included a visual presentation of the line chart of the findings of early descriptive epidemiological study of this thesis" (Chapter 3). The players were asked to describe and comment

on their injury during the last season. Section 3 contains the main interview questions categorized according to the different topics explored in this study: injury perception, factors influencing injury, and injury prevention. The interview came to a close in the last phase, which also gave participants the opportunity to comment on any of the topics raised. In order to get more information and to elaborate, we employed probes throughout (Patton, 2002). Although the interviews were semi-structured, the athletes were encouraged to talk freely.

Questions were conversational and, although pre-defined, they did not follow a particular sequence. Participants were sent a copy of the interview guide one week prior to their interview to familiarize themselves with its content and to help them prepare. All interviews were done via ZOOM and were video recorded in their entirety. Interviews were conducted in Arabic and lasted 36 minutes on average (23-48 minutes). Confidentiality and anonymity were assured. All the interviews were conducted by the same primary researcher (TA). The primary researcher was familiar with the athletes and had communicated with them regularly during the course study season. All interviews were transcribed verbatim and subsequently verified by the respective participant to increase the credibility of the findings (Lincoln & Guba, 1985).

5.3.6 Data Analysis

A reflexive thematic analysis was conducted to generate an understanding of how volleyball players perceive overuse shoulder injuries in its context, according to the 6-phase model described by Braun and Clarke (2019).

The process of thematic analysis model includes six stages as described by Braun and Clarke (56), p1391-1412. (Byrne, 2022):

> **1. Familiarizing with the data:** Transcribing data, reading and re-reading the data, recording intial thoughts.
> **2. Generating initial codes:** systematic coding of interesting data features across the full data set, collating data relevant to each code.
> **3. Searching for themes:** Collating codes into potential themes, gathering all data relevant to each potential theme.
> **4. Reviewing themes:** Checking if the themes work in relation to the coded extracts and the full data set, generating a thematic 'map' of the analysis.
> **5. Defining and naming themes:** Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
> **6. Producing the report:** The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

During the first phase (data familiarization), the primary researcher listened to all the audio recordings without taking any notes. Then, each recording was listened to again, whilst doing notations, and finally each interview was read through repeatedly. For the second phase, a deductive or 'theory-driven' approach

was adopted to produce codes relative to a proposed conceptual framework (Figure 14). The researcher worked on the transcribed interviews directly highlighting sections and writing notes and initial codes in the margin of the transcript using the Word commenting feature. After completing this initial code generation, the codes were organized into potential themes, using the study aims as a guide. The themes and codes were then reviewed by merging similar themes, and removing themes that did not have enough data to support them.

The themes were then defined and named according to the socioecological framework. It is worth noting that while there are six main steps, the thematic analysis process is recursive rather than linear and going back and forth between each step is expected. While conducting the thematic framework analysis, the researcher followed the criteria for trustworthiness: confirmability, dependability, transferability and credibility (Lincoln & Guba, 1985, & Denzin & Lincoln, 2005). Two independent researchers, who are physiotherapists scrutinised the transcripts and identified themes and subthemes. Iterative discussions round data interpretation were carried out. This credibility reflects the precision of the results obtained to truthfully reflect participant perspectives. Researcher continuously challenged the identified themes and/or subthemes during interviews. Member checking and feedback strategies were applied to enhance verification within the interview. Full

description of the research context and the assumptions that were central to the research were kept. This transfers obtained results to similar research setting or enhance the ability to generalise the results obtained to other similar clinical setting (Transferability). Researcher were keeping a reflective journal and field notes which can be added to the collected data. Dependently shows how exactly the research was conducted and report the research design to allow the ability to replicate results if the research is repeated. Reflexivity as an confirmability were carried out to aid self-reflections as an attempt to monitor researcher bias. Reflections on research and a critical comparison with previous literature were applied.

The transcripts were analysed in the Arabic language. Two analysts with similar education and professional background (postgraduate physiotherapists and native Arabic speakers) separately and blinded to the other initially open-coded three interviews. They then debated and improved the analysis (e.g., by eliminating topics when not well supported by data, or by combining similar themes into a single "parent theme") until they came to an agreement. After the agreement between the two analysts, the codes were distributed over categories in a consensus meeting with all analysts. Following the consensus achieved, the remaining interviews (n = 4) were coded by the main researcher using an Excel

sheet. The extracted codes and quotations were translated to the English language for findings presentation.

Since translation is an interpretive effort, it is possible for meaning to be lost during translation (van Nes, Abma, Jonsson and Deeg, 2010). Back translation was used for trustworthiness. These translations were checked, and if needed revised, by another analyst.

5.4 Results

5.4.1 Participants' Characteristics

The participants (n=7) interviewed via ZOOM Application. Each player was interviewed once. Two participants were from same club, whereas the other five participants were from different clubs. Participant personal characteristics are provided in Table 13 which shows the variation that could contribute to the findings. As the participants were from different clubs and cities, had different level of practice and different body mass; this makes the findings more robust as it not relied on one particular area or club. Appendix E provides data about their training exposure and injury severity.

Table 13. Demographic Characteristics of Participated Players

PLAYER NO.	1	2	3	4	5	6	7	MEAN (SD)
AGE (YRS.)	25	32	33	26	20	21	34	27 (6)
BODY MASS (KG)	67	92	73	70	60	88	90	77 (13)
HEIGHT (CM)	175	177	175	187	184	188	197	183 (8)
PRACTICING YEARS	11	25	20	16	11	5	24	16 (7)
COMPETITIVE LEVEL	Excellent	First-degree	First-degree	First-degree	Excellent	First-degree	Excellent	

5.4.2 A Description of the Themes

This section describes each of the key themes and the subthemes explored during the seven interviews. These were:

a. The athlete's perception of the overuse shoulder injury

b. The factors that contribute to the overuse shoulder injury

c. Injury management and prevention measures

Selected quotes from the interviews are included to illustrate the themes. Mapping the study results onto the socioecological framework (SEF) highlighted how multiple ecological levels (i.e. individual, interpersonal, community, and organizational) are involved in the perception of the overuse shoulder injury, its occurrence, and its management and prevention, and confirmed the complexity of the overall context. Different socio-ecological levels were impacted, with a dynamic relationship between each level (Figure 15).

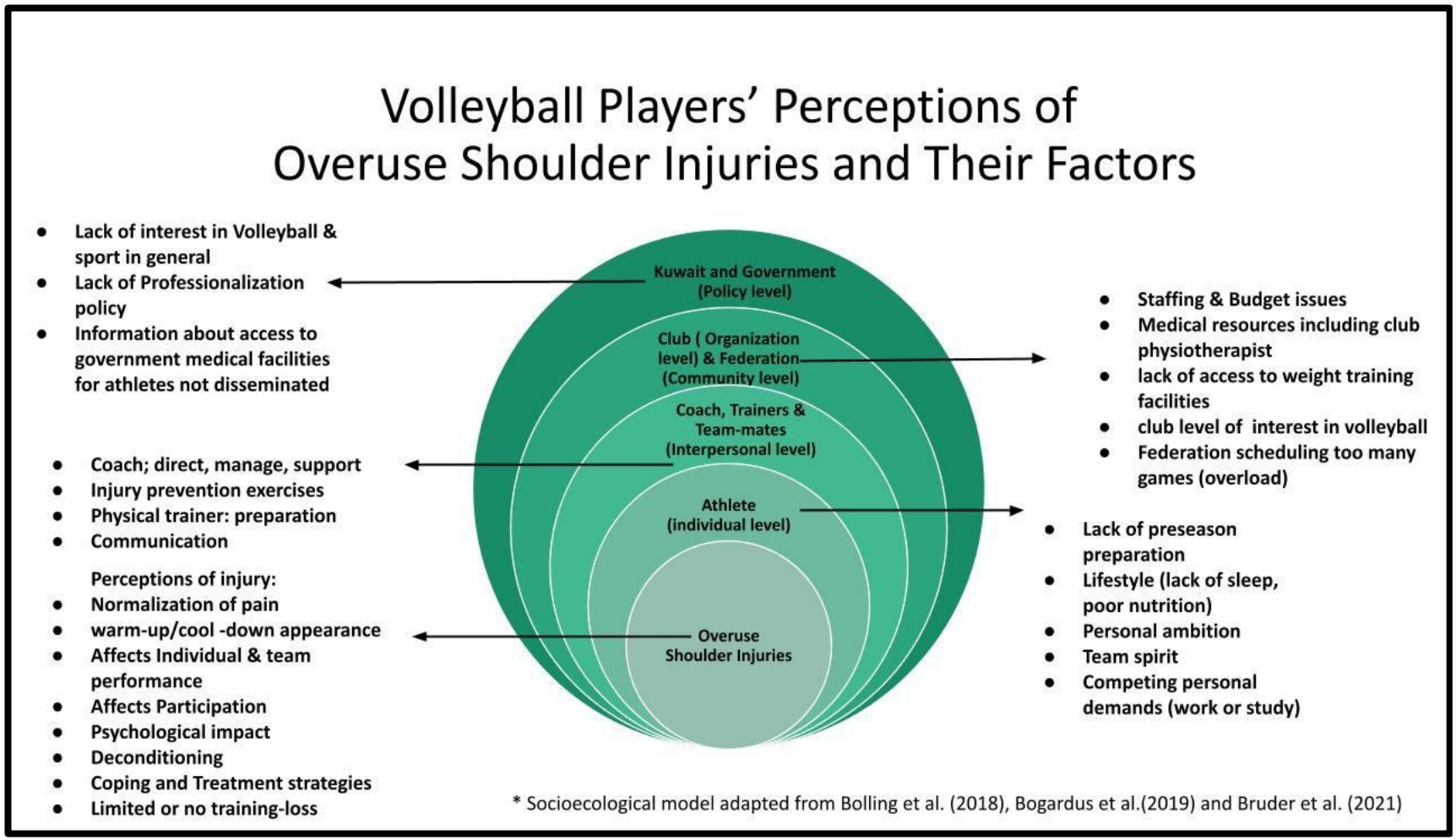

Figure 15. Applied socioecological view of sports injuries moved to the results section and the recommendations have been applied.

5.4.2.1 The Athlete's Perception of the Overuse Shoulder Injury

Pain

Most participants perceived that pain and injury are a normal part of a player's life, something that they have to deal with or manage.

"The issue is, there are no players that don't complain about pain, there are none, if you ask any player in the world, he will complain about pain".- Player 1

A few participants described pain that would disappear during warm up and then reappear when the body cooled down during breaks (consistent with the early stages of an overuse injury).

Performance

All participants stated that the injury affected their performance and led to reduced effort and load. This was a consequence of the injury, but also an injury management strategy they utilized instead of withdrawing completely from the practice.

"You want to play but you can't, you want to contribute to the team but you can't, you want to train but you can't, your fitness is reduced, your game, your level is

reduced.. why? Because you are not training properly, because you cannot… your injury is affecting you"- Player 3

Players spoke about reduced performance in terms of reduced scoring attempts and success, reduced power of their hits, and having to modify their techniques to adapt to the injury, and also in more general terms as not being able to give "their all' .

"I can't give my all because of my shoulder"- Player 4

Psychological effect of the injury

Players also mentioned that injuries also have a psychological effect, which also contributes to reduced performance:

" *A non-injured player plays while he is comfortable, he doesn't have to think of a shoulder injury or any kind of injury, meaning he plays without fear… as an injured player I am afraid of making my shoulder injury worse…. I feel tense 24 hours a day, thinking about the same injury…this is what used to stop me"* - Player 5

Impact of the injury on the team

Because their overuse shoulder injuries were associated with performing repetitive overhead movements, due to their position in the team (for example,

hitter), these injuries affected the players position within the team, with temporary changes to their position to avoid the movements that triggered the pain or injury.

"In the middle of the training you change position, you withdraw from hitting, and you perform any other skill, any other role"- Player 2

Some of them were temporarily demoted from main players to substitutes while they were managing their injuries, due to both their pain and reduced contribution to the team's overall performance. One participant mentioned that this led to further body deconditioning and detraining as substitutes are not expected to perform as well and so less time and effort is allocated to their training.

"Substitute players, especially in our club don't receive the same dose of training as main players, so your physical effort is reduced, so if you don't make personal effort, you can't, you know?(...) those that participate in matches, their level improves, and their fitness improves and everything…"- Player 3

Injured players impact the team's overall performance and success, as well as the training schedule and the coach's plans, for example when players exited the training session or game to go warm up the shoulder area once again. Injured players also increase the load on other players, making them also at risk of injury.

5.4.2.2 The Factors That Contribute to the Overuse Shoulder Injury

Individual Factors Leading to Injury Occurrence

Participants identified a number of individual factors that they perceive to have contributed to their overuse shoulder injury, or contributed to worsening of the injury.

Lack of physical preparation

The main factor mentioned by players was lack of physical preparation, especially of the shoulder area. Some players neglected pre-season physical preparation leading to a weakened shoulder.

" I hadn't prepared during the summer…. Usually, I should prepare during the summer. I lift weights to protect my shoulder…, so because of everything that happened , I couldn't train, neither with weights nor with anything, due to the circumstances , so I entered the season without any preparation for the first time…. from the start. " - Player 6

"I would like to add that from my experience, I think there should be good preparation before the start of the season"- Player 3

Personal ambition and team goals

Several players reported personal and team goals as a cause of overuse shoulder injury. Personal ambition may lead to ignoring pain signals. Team spirit also led to over-enthusiasm while playing and forgetting to reduce effort or modify technique.

" Each player has a personal goal, and the team has a goal…. so with this effort, my effort, and my team-mates's efforts, we wanted to win this championship so we trained more, so any player that had an injury sometimes ignored it in order not to affect the coach's training plans, at the same time you were sacrificing… They said sacrifice a bit, you sacrifice a bit so you can rest later. Thankfully it was a phase and we won this championship" - Player 2

"You play and you forget yourself and you forget that he told you not to use your shoulder"- Player 3

"Sometimes because of over-enthusiasm , you make more effort during the training, especially if there is an exciting atmosphere with your team-mates… so you get excited, so that's when I felt there is a problem, so I said to myself to give it some time as the coach said, and see. I waited for some time, about a month I think, then I realized this (pain) needs more attention , needs care…"- Player 6

<u>Lifestyle</u>

Players also talked about an unhealthy lifestyle (including lack of sleep and poor nutrition) playing a role in injury causation.

"There is no nutrition specialist, there isn't any, you eat what you eat and you do what you want. There are people that don't sleep well, this is one of the causes of injuries"- Player 4

Lifestyle issues are linked to the fact that players work or study during the day before going to their training practice.

"Some people don't rest…. busy since morning from 6 am to 4 pm then go straight to the club, this is an unhealthy habit, this is far from the name of "sports" , it makes us far from the word 'sport' in general , the real meaning of sport is to practice sport correctly, this is the goal of sports!" -Player 6

"For those who work all day….. when are they supposed to prepare?"- Player 7

The Role of the Coach in Injury Occurrence

<u>Lack of physical preparation during training sessions</u>

Several participants revealed that training sessions are mainly focused on the technical aspects of the game with usually little or no time dedicated to physical preparation that would help prevent injury. This was the case for most clubs. One

participant said that some coaches limit their role to training with the ball and tactical aspects, and assume that physical preparation is the responsibility of a physical trainer if available or the players' responsibility. For example some participants mentioned that they are expected to include weight training as part of their physical preparation. Yet there is little time for the players to prepare on their own during the day.

" I got injured because of too many training exercises (with the ball), the preparation should have for example weight training, strengthening, we had none of that, we just had training exercises with the ball… there is no preparation at all!"- Player 5

Unsupportive coaches

Some players considered their coach to be unsupportive, saying that they berated them for reduced performance even if they are injured.

"He used to tell me, you have to raise your level, this is not the level we expect from you!"- Player 5

Club's resources (organization level)

Limited financial and human resources

Participants mentioned their club's limited financial and human resources as a factor influencing injury occurrence. For example, not all teams have a separate physical trainer/ strength and conditioning coach.

"This season we didn't even have a physical trainer, we just started training, that's not possible!"- Player 5

Club orientation

One player mentioned that the club's choices and orientation also influences access to funding and resources, for example is it interested in competing or just participating? He elaborated about how some clubs will provide qualified coaches and trainers for some of their teams depending on their interest in the sport or the team's level of success.

Lack of facilities

Players mentioned that, due to limited club resources, there is also a lack of weight training facilities. They explained that not all clubs have such facilities, leading to players being responsible for weight training in their own free time, by joining gyms for example. This study was conducted during exceptional circumstances (the COVID 19 pandemic) during which access to gyms was

inconsistent or limited due to restrictions. Some clubs do provide weight training facilities, as explained below:

"For example the Kuwait Club, they provided weight training facilities and a training schedule. For this reason they were able to complete the whole season. And despite this, due to the pressure, their level decreased in some aspects, but overall they did well"- Player 6

Based on the interviews, it was clear that access to a physiotherapist at the on-site clinic is not uniform across clubs. Some clubs do not have physiotherapists.

"...it depends on the club's capabilities. Some of the clubs do have a specialist and physiotherapist. Others clubs don't."- Player 2

For the clubs that do have clinics with physiotherapists, the physiotherapist is responsible for all the players practicing different sports. None of the teams have a physiotherapist dedicated to the team that may help screen players with potential injuries.

The Role of the Federation (Community Level)

Some players believed that the Federation is scheduling too many games leading to overload and little recovery time. Players playing at a lower level are

expected to play 3 games a week, compared to 1 game a week for players in the higher division. Players reported that games are usually played in the evening at the end of the work day.

"We are not professional players, we work in the morning and in the evening we go play, they schedule three matches per week, this is too much. So this really causes injuries! In their opinion, this improves the level of the players , but I personally feel that no it doesn't improve the level"- Player 4

Lack of Professionalization (Policy Level)

The participants' belief that a lack of professionalization policy for volleyball in Kuwait was contributing to injuries was notable, as all players brought up the topic of professionalization without being specifically asked about it. Currently volleyball is a competitive sport in Kuwait, but not a professional one. This means fewer resources are allocated to ensuring players are provided with all they may require for injury prevention. All players either have day jobs or are university students.

One player then described in detail what he imagined a typical day would look like for him if professionalization was implemented.

“If there is professionalization , you don't have to get up at 6 am to go to work and sit for 10 hours etc…. What I can say is that you will train twice a day , when there is complete professionalization the situation will be different because now this is a profession, your profession is not a regular employee anymore, now my job is a player. This in itself will let the player completely focus on the game, not having distracted thoughts, he will notice the difference, instead of being worried about subjects, university, and at the same time worried about sport, for example if I have a final university exam in the morning and then quarter final in the evening! So this in itself is pressure on the player. I would wake up in the morning at 7, I would have guidelines about nutrition, the club would care about nutrition, the club would care about my injury, would care about everything, I would wake up in the morning in order to train in the morning, then they would give me a break, I train the evening….Your mind is clear and just focused towards the sport which is volleyball, at the same time your movements and everything you do are carefully studied by the club, this will all reflect back on the player and the season, you will see the player perform better, has better focus, not worried, physically it will make a difference cause you are training in the morning and in the evening, all of these things when we gather them in one period and we put it into one system it will reflect back positively... - Player 6

Lack of Awareness about Government Sports Medicine Facilities (Policy Level)

The participants were not aware about the existence of a Sport Leaders Training Center provided by the Public Authority for Youth and Sports (PAYS), which manages a facility for preventative and rehabilitation care for athletes. There was a question mark regarding who is responsible for this lack of awareness. Is it the club or the PAYS? One participant suggested that information about these facilities should be shared through information sessions or via emails.

Another, exceptional factor: impact of Covid-19 on physical preparation

Most participants mentioned the negative impact of Covid-19 lockdown and restrictions on their physical preparation in the 2020/21 season. A few also mentioned Covid cases within the team affecting training. They believed that disrupted training schedules and the expectation of playing "2 seasons in 1" increased loads in an inconsistent manner, with periods of deconditioning followed by sudden high intensity training that affected both performance and their injury prevention and management. The usual gradual increase in training intensity was lacking and led to the appearance of injuries. The constant changes in Covid-19 restrictions prevented participants from accessing gyms, as weight training was considered an essential part of volleyball preparation. One participant mentioned

that the clubs that provided facilities for weight training and clear schedules were able to survive these exceptional circumstances until the end of the season, with better physical preparation.

5.4.2.3 Injury Management and Prevention Measures

The Athlete's Role in Injury Prevention (Individual Level)

Participants believed they were the main party responsible for injury prevention, through making sure they were fit and prepared before the season starts, and through proper warm-up. The importance of preparing the shoulder area in particular was highlighted, and the use of proper technique was also mentioned. Participants believed practicing weight training in parallel to their volleyball training was important to protect the shoulder area.

"The players themselves should be mindful during warm- up exercises in order to completely avoid injury, so that it doesn't limit their performance."- Player 2

They also reflected about the importance of not neglecting their initial signals of discomfort as a learning lesson towards the prevention of future injuries.

"I should have spoken to the physiotherapist from the beginning of the season, this would have prevented what happened later on."- Player 4

In addition, participants mentioned the importance of proper sleep and nutrition. Getting adequate rest and sleep was also linked to the fact that these players are not playing as professionals, having to juggle the demands of their status as employees or students during the daytime and competitive volleyball players in the evenings. As for nutrition some participants stated that proper nutrition requires personal effort as well as the guidance of a nutrition specialist.

The role of the coach in injury prevention (interpersonal level)

One participant described how their coach intentionally integrated injury prevention exercises for different body parts as part of the regular training routine. This highlighted the importance of hiring staff aware about injury prevention but also actively implementing measures to prevent injuries.

"Our coach has a plan, he always always makes sure we have weight training, we have a weight training schedule and we have injury prevention , and we have stretching, so he always makes to take care of these matters, and core exercises etc, so that we are ready during the season, so that we have complete plan for the season." - Player 1

The coach plays a role in injury management and prevention by being responsible for noticing players and their symptoms and communicating with them

on how to prevent or manage their symptoms. Players also have a responsibility to inform the coach in case of pain and injuries.

"He noticed and asked if my shoulder hurts. I said yes. He said since I just joined the season, not to force from the beginning until I get used to it, then, little by little, add more effort." - Player 6

Based on what the participants shared, coaches encouraged injured players to manage the pain or discomfort rather than stop playing completely, by reducing load or changing positions for example. There was no common approach or protocol followed by the coaches and the players to investigate or diagnose the pain at the first sign of discomfort. Seeing a physiotherapist usually happened later when the pain was becoming more difficult to manage alone.

The physical trainer when and if available also contributes to injury prevention and management.

"I think it's the assistant to the coach that gives the strengthening exercises that prevent injuries in those areas"- Player 6

The role of the club physiotherapist (organization level)

Participants managed these injuries either with the assistance of the club physiotherapist, or on their own. When asked about the coach or administration referring injured players to other medical professionals, participants mentioned this was reserved for the most urgent and severe cases. This suggests that the impact of overuse injuries is underrated: as long as the player can continue to perform albeit at a reduced capacity and despite the pain, the injury is not taken as seriously by the administration.

Based on the interviews, it is clear that, in practice, the role of the physiotherapist in Kuwait was currently limited to rehabilitation post injury. Participants' experience or relationship with a physiotherapist was established post- injury rather than before the occurrence of the injury.

A combination of injury management methods was usually utilized by physiotherapists, for example electrotherapy combined with exercises, or the use of kinesiology tape. One participant believed that the most important part of physiotherapy was the exercise plan.

Most participants acknowledged that physiotherapy may play an important part in injury prevention and not just injury treatment.

"It's fundamental in the sense that any sport that has no physiotherapist has no good, effective players , no champions"- Player 3

Only one participant believed that the physiotherapist's role was only limited to rehabilitation post injury, and that the coach was responsible for injury prevention measures.

Participants believed each club should have its own physiotherapist dedicated to each sports team (in this case, volleyball) in order to establish a more personal relationship and knowledge of each participant, receive check-ups before the start of the season, diagnose any weak points and risks of potential injuries, and come up with a customized preventative care plan for each player.

"He should check what injuries you have… What are your strengths? What is your weight? What is your height? What is… I don't know. This takes care of each player, and so injuries are reduced" - Player 4

Professionalization (policy level)

All participants perceived that professionalization of volleyball would provide the right, healthy environment for injury prevention. With professionalization, participants believed that players schedules would be

completely dedicated to sports with more time to recover and to physically prepare for training and games.

Participants also believed that professionalization would also provide the funds required for better sports and medical equipment, and ensure the hiring of qualified world-class staff.

Although there has been talk of professionalization of volleyball in Kuwait, participants were unsure of the obstacles to its implementation. Some expressed skepticism regarding how to convince players to abandon their jobs and current salaries in favor of dedicating their life to the sport.

"I'm not sure what is stopping the authority from implementing complete professionalization but the authority will have to or be obliged to convince players to leave their job, meaning when you start full professionalization that means your job is volleyball player, that's it. This is your job your salary is... your market value is dependent on your performance, how will the authority convince them to leave their job if the person is a doctor , another one a consultant, another has a high rank, how will you as a government authority convince this person to leave his position that he worked hard for , because of total professionalization, so the total

professionalization should satisfy all players , this is what is stopping the authority in my opinion"- Player 6

Others wondered if there was enough interest in sport in general in Kuwait that would justify such a move.

"To be honest, there isn't a big interest in sport…. They don't let you give your all to be honest, for all sports in Kuwait" - Player 4

5.5 Discussion

The results have captured players' perceptions regarding their overuse injuries and provided valuable insights for understanding the context of overuse shoulder injuries in Kuwait and the roles played by the stakeholders found at different levels of the socioecological model in injury occurrence and prevention (Figure 15).

Although we will discuss the findings from each level separately, all the levels interact with each other dynamically.

5.5.1 Athlete (Individual) Level

Athletes' belief that pain and injury are a normal part of a player's life is largely consistent with the results of similar qualitative injury prevention studies

conducted with elite athletes (Bolling et al., 2019) and football players (Vella et al. 2021). Indeed, Cavallerio et al. (2016) noted that the normalization of pain and adopting a 'culture of risk' may be contributing to the prevalence of overuse injuries in rhythmic gymnastics (Cavallerio et al., 2016). The term "culture of risk" was first used by Nixon (1993) to describe a culture in sports that normalizes pain and injury and glorifies athletes who accept physical risks, such as training or competing while experiencing physical discomfort.

In addition, due to the gradual onset of overuse injuries, it may be difficult for players to recognize when pain is normal "soreness" from practice and when it is indicative of the start of an injury. We recommend providing more education for players regarding what overuse injuries are, their different stages, and how to prevent them, manage them (and prevent them from worsening) is important, especially as the interviews revealed that participants considered themselves to be the main party responsible for preventing injuries.

Due to the competitive level at which these players play, the impact of the injuries on their performance level was important in defining their perception of the severity of their injury. Our findings also align with other qualitative studies where participants' injuries were defined by pain, performance and participation

constructs (Bolling et al., 2019; Vella, Bolling, Verhagen & Moore, 2021). Participants in our study who complained about pain tried to manage symptoms on their own first or with the coach who advised reduced effort, changed the player's position or turned the player into a substitute player while treating his injury. In most cases an injury is perceived as at a more severe stage when it stops the player from participating in training sessions or games for a certain period of time (time loss). The most severe injuries were perceived by players as the ones where the coach or club acted by referring the player to a medical professional. This has implications for injury prevention and management strategies, in performance- driven environments. Players value their performance, however they must be given guidelines that will help them continue to practice and reduce the pain. The interviews confirmed the Chapter 3 findings that despite other high severity measures, overuse injury occurrence did not usually stop the player from participating; if it did it was usually for a limited time. This can contribute to the symptoms and injuries worsening. There needs to be a clear protocol to follow for all complaints and not just severe injuries.

5.5.2 The Team (Interpersonal) Level

The coach was perceived as playing a role in managing the player load especially during times when players were experiencing pain or injuries. In a study of psychological factors and overuse injuries in track and field athletes by Timpka et al. (2015), the authors concluded that the cause of overuse injuries was not the athletic load itself, but rather the load applied at situations when the athlete's body needed to rest.

In addition, this study found that coaches are focused on volleyball-specific training practice rather than injury prevention. In the absence of specialized staffing (example, physical trainer, and team physiotherapist) it is especially important for coaches to be aware of the importance of injury prevention , and also to allocate more time to physical preparation. However, another recent qualitative study of Irish field hockey coaches' attitudes to injury and injury prevention by Rees et al. (2021) found that despite having a generally positive attitude about injuries and potential injury prevention measures, field hockey coaches are unable to put these measures into practice due to a lack of resources, knowledge, and abilities. For instance, when it came to creating and implementing particular strengthening programs, which have been demonstrated to help reduce injuries,

coaches lacked confidence. The authors noted that coaches should have a fundamental understanding of training load and warm-ups, even though it is unrealistic to expect them to fill the duties of physiotherapists or sport scientists. Field hockey in Ireland shares similar contextual barriers as volleyball in Kuwait: it is an amateur sport, with a limited number of training sessions and sessions duration per week. Many teams only practice 1.5 to 2 hours twice a week, and few clubs have a fitness coach and physiotherapist. The coaches themselves are coaching voluntarily or on a semi-professional basis, having a career outside of coaching. Coaches in the study expressed some reluctance to devote some of their time to injury prevention strategies, instead of relying on athletes to undertake strength and conditioning sessions on their own time. This is very similar to the volleyball context in Kuwait.

Another aspect that came up in the semi-structured interviews was the importance of communication between the coach and the players. Coaches notice if a player is injured and provide advice on injury prevention and management, and players should also inform the coach about their symptoms and injuries. In another similar qualitative study of football players, communication with the coach and other staff was perceived by players to be an important component of injury prevention and management (Vella et al., 2021).

The coach also plays a role in referring players to the available medical resources available, but players noted that referral is often reserved for urgent cases. Other studies have shown that football teams with poor communication between the head coach/manager and the medical staff suffer from more injuries (Ekstrand et al., 2018). Therefore, more emphasis should be placed on strengthening the teamwork aspect of injury prevention.

The interviews also touched upon the role of the coach's leadership style in managing injuries. Some players noted that their coach was unsupportive and prioritized the player's performance over the player's well-being. Because of the demands imposed on players, a coach's leadership style may affect players' stress levels and injury risk (Ekstrand et al., 2018).

5.5.3 Club and Federation Levels

The interviews revealed that volleyball players in Kuwait lacked both experience and awareness about the role of the physiotherapist in injury prevention. Their experience with physiotherapists was limited to injury management and rehabilitation. However players believed physiotherapists do have a role to play in injury prevention as well as have the competence required. Players did have a theoretical awareness based on their comparison with the way

things are done abroad in places such as Europe (screening players for functional deficiencies before the start of the season, providing customized pre-rehabilitation exercises plans, following up with players to help with recovery after training and games). Other studies have found that despite good knowledge and perception of the role of physiotherapy, there is a need to educate players and technical staff on the role of physiotherapy in the prevention and management of sports injuries (Siba, Quartey & Kwakye, 2020). This suggests that the problem lies at the level of institutions in Kuwait whereby the club physiotherapist is not expected to prevent injuries. Clubs could start by expanding the role of physiotherapist. At the same time there is clearly a lack of staffing as there is usually one physiotherapist per club covering different teams and hundreds of athletes. Clubs should look into expanding the role of the physiotherapist to include injury prevention. Multidisciplinary team approaches to injury prevention in sports have been shown as effective at reducing the burden of injuries in professional rugby (Tee, Till & Jones, 2017).

Club administrations, in coordination with governmental authorities, should also address budget-related issues that may be leading to overuse injuries. As previously mentioned another study conducted in Kuwait by Marwan et al. (2012) noted that the lower prevalence of injuries for football players compared to

volleyball and other sports may be due to higher budgets allocated for football as it is the most popular sport in Kuwait. More attention, funding and resources are at football players disposal which might result in better preventive measures (high quality training programs, protective gear, athlete education about injury prevention). In the absence of funding and sufficient staffing, club administration may look towards successfully implementing injury prevention guidelines such as the Oslo Sports Trauma Research Center Volleyball Injury Prevention Exercises as an approach to dealing with injuries. This volleyball-specific injury prevention program consists of 18 exercises (including flexibility exercises, control exercises and muscle strength exercises) targeting different areas of the body. It includes three shoulder muscle strength exercises (muscle external rotation exercise, the Y exercise, and the push up exercise which targets shoulder stability), and one shoulder flexibility exercise (sleeper stretch exercise). A study by Al Attar et al. (2022) conducted in Gulf Cooperation Countries (GCC) including Kuwait examined the current implementation of these exercises amongst volleyball players. Only about half of participants from all GCC countries implemented these exercises. The most implemented shoulder-related strength exercise in Kuwait was the push up, but with only a little more than half of participants implementing it (51%). It is interesting to note that only 42.9% of participants from Kuwait implemented the

shoulder external rotation muscle strength exercise, the lowest rate of implementation of these injury prevention exercises for Kuwait. This may partly explain the ER muscle weakness found in study 2 (Chapter 4) of this thesis. The Y exercise was implemented by only 49% of participants. As for shoulder flexibility, only 49% of Kuwaiti participants implemented the sleeper stretch, which may be associated with the shoulder range of motion deficits found in Chapter 4. The authors attributed the low implementation of these exercises in the GCC to the fact that volleyball is practiced mainly in elite and semi-elite sports clubs; thus, the players may not have received as much awareness of exercises that prevent or reduce the likelihood of developing injuries as players that play on a professional level. The authors recommended more awareness campaigns and training to ensure more implementation.

The Kuwait Volleyball Federation‘s role was mainly limited to organizing games and tournaments, and their role in injury prevention was hardly mentioned by participants. The Federation potentially could also play a role in injury prevention by preparing information sessions or sharing documentation and training about common injuries in volleyball and how to prevent them. It could also help design injury prevention plans and recommend specific protocols to follow in case of injuries.

5.5.4 Government (policy maker) level

All players had a strong belief that professionalization would lead to positive changes in terms of their lifestyle, performance and injury prevention. This finding is comparable to those of a recent qualitative research study exploring the perceptions of women playing elite Australian football (Bruder et al., 2021). As part-time athletes that are employees or students, not much time can be allocated to physical preparation, or improvement of lifestyle for peak performance and injury prevention. However this belief might not necessarily be true as another study of rugby has shown more injuries post-professionalization (Garraway, Lee, Hutton, Russell & Macleod, 2000). Professionalization might lead to increased demands placed on players and pressure to perform. A culture and the right environment for injury prevention needs to be provided whether or not volleyball is being played at the amateur or professional level.

The lack of awareness about available government sports medicine facilities for players was notable. More information should be shared on how to access these facilities.

Due to the period during which this study was conducted, many interviewees mentioned the impact of lockdown and Covid-19 restrictions on players' physical

preparation as a factor for lack of physical preparation leading to their injuries. This context is similar to what happened during the 2011 NFL lockout that increased player injuries when players returned due to detraining (Myer, Faigenbaum, Cherny, Heidt & Hewett, 2011).

5.5.5 Study Strengths and Limitations

Our study has shown that as Bolling et al. (2018) have proposed, context does matter, especially in the case of athletes' perception of overuse shoulder injuries. The exploration of player perspectives using a qualitative approach and the application of a socioecological model helped gain a deeper understanding of the overuse injury problem and is a strength of the study. In particular, a qualitative approach has helped fill the gaps in the previous Chapter 3 findings on prevalence and severity and increased understanding of overuse shoulder injuries in the context of volleyball in Kuwait.

The primary researcher was familiar with the athletes and had communicated with them regularly during the course study season. Relationship was valuable in advising patients on the appropriateness of study participation (Xu, 2020). Currently the views of Australian researchers on this topic are relatively

unknown, including the role of a relationship between researcher and participant, and how the voluntary nature of a potential participant's decision is protected.

The researcher developed healthy and ethical relationship with participants since the primary study of the PhD project to ensure the quality of the research outcomes. The relationship between researcher and their research participants is integral to the quality of the research output (Algeo, 2013). Participants were centrally positioned to share experiences and perceptions, which was dependent on the relationships developed with the researcher. The relationship between researcher and participants were limited to their sport experiences during the study course season (2020/2021). Researcher enhanced the researcher-participants conversations for knowledge exchange. This opportunity of sharing knowledge leave the players with more information about the aim of the study and the researcher background. This approach established the researcher- participants trust and enhanced participants interest in the study. Moreover, it encouraged participants to be cognitively involved in the study. This create a safe-comfortable environment for talking and expression securely. Therefore, this encouraged participants to be willing and comfortable to share details freely about their experience (Wa-Mbaleka, Rosario, Zubkov & Saban, 2022). Moreover, this strengthen the players' awareness regarding his experience and how its valuable

inputs to this study. The researcher obtained more information about potential players' experience that developed the topic guide and assumptions of the study outcomes. Therefore, it influenced the findings to be more richer and authentic (Wa-Mbaleka, Rosario, Zubkov & Saban, 2022).

However, the study does have some limitations. This qualitative study took place at the end of the 2020/2021 season, so the quality of the data depends on the player's ability to recall the events of the previous months accurately. While the line chart may help the player recall his experience at different points during the season, there might still be an element of recall bias due to the retrospective nature of the study; however, the bias is likely minimal as the time frame of recall is less than 12 months and interviews were conducted right after the end of the season (Mukherjee, 2015).

Another possible limitation is that other stakeholders such as coaches, physiotherapists or club management were not included. A more holistic study including a wider range of perceptions from a variety of stakeholders would have produced a more comprehensive picture of the overuse shoulder injury problem, through data triangulation. For example, interviewing coaches and physiotherapists would have helped gain an understanding of their own beliefs,

knowledge and practices regarding the prevention and management of overuse shoulder injuries, and of the unique challenges that they face.

Also, while qualitative studies provide a more in-depth and contextualized understanding of a particular subject , they cannot be generalized. All interviewed players are from Kuwait, so cultural differences may play a role. The transferability of the findings to other contexts therefore has to be made with caution.

The Covid- 19 context during which the study happened also may have affected the study outcomes and the player's experiences.

5.5.6 Conclusion

The results provide valuable insights for understanding the context of overuse shoulder injuries in Kuwait and the complex relationships between the stakeholders found at different levels of the socioecological model.

Overuse shoulder injuries are perceived by volleyball athletes as impacting their performance, however pain was also considered a normal part of sport, leading to players often ignoring early signals of overuse injury and leading to little or no time loss. Lack of physical preparation, competing personal demands, personal ambitions, team spirit, and lifestyle-related factors were individual factors

perceived as contributing to injury occurrence. Coaches have little time to dedicate to injury prevention, and their focus is on volleyball-specific training; they have a role to play in managing the player training load when the player is injured, however some prioritize performance over the players' well-being. At the clubs level, there are budget issues and a lack of staff such as fitness trainers and physiotherapists. Club facilities such as gyms are often not available, and the role of club physiotherapist was limited to management and treatment of overuse injuries. The Volleyball Federation was perceived as scheduling too many games, contributing to high load and little time for recovery. At the policy level, the lack of professionalization of volleyball in Kuwait was perceived as a major barrier to effective injury prevention by all participants. All players perceived that professionalization would offer a safer environment to play and practice, with better care, equipment and facilities, complete world-class staffing and more time for physical preparation and injury prevention, as there would be no competing personal demands such as work or university studies.

Stakeholders have an important role to play in creating an environment that aims to minimize injury prevention. We suggest that future research studies include the perspectives of other stakeholders such as coaches and club physiotherapists.

This study supports strengthening the effectiveness of the key stakeholders involved, in particular by ensuring that they expand the role of the sport physiotherapists, coaches, organizers and administrators to include injury prevention.

This qualitative study makes an important contribution to understand the complexity of the overuse shoulder injuries phenomena. Moreover, the findings of this study make a unique contribution by generating an in-depth explanation and contextualized understanding of overuse shoulder injuries. For the first time, this qualitative study provide a good application self-confrontation approach to enhance the recalling of the participants' experiences cognitively. Up until now, self-confrontation was used in the context of sports performance, and not injury research.

Chapter 6.0: Synthesis

6.1 Achievement of thesis aims and objectives

Overuse shoulder injuries are multifactorial (Aicale et al. 2018). The development of injury prevention programs requires an understanding of risk factors and how they interact together (Seminati & Minetti, 2013). The sport of volleyball places the shoulder at high risk of injury due to the repetitive and complex nature of spiking and serving overhead movements, as well as the complexity and instability of the shoulder. In addition, performance-driven contexts and other contextual determinants contribute to the complexity of overuse shoulder injuries. However there are not enough studies addressing risk factors for overuse shoulder injuries in volleyball. This doctoral programme, therefore, establishes the extent of the overuse shoulder injury problem and identifies its risk factors in the context of competitive volleyball in Kuwait. Through the adoption of a revised 'Sequence of Prevention' framework that takes context into consideration (Bolling et al., 2018), and a pragmatic philosophical approach, the overarching aim of this thesis was to develop an evidence-based, and context-driven understanding of overuse shoulder injuries in a population of male sub-elite volleyball players. Specifically, to study overuse shoulder injury prevalence, incidence, severity and risk factors within the wider current context of the volleyball sport in Kuwait. This aim was achieved through a series of investigative

studies (including a one-season prospective cohort survey study, a cross-sectional experimental study, and a qualitative thematic analysis) that addresses the first two steps of the revised van Mechelen (1992) sequence of prevention theoretical framework. Table 4 demonstrate an overview of the applied context-driven 'Sequence of Prevention' model (Bolling et al., 2018) applied to this PhD study objectives and study outcomes.

Table 14. Overview of the applied context-driven 'Sequence of Prevention' model (Bolling et al., 2018) applied to PhD study objectives and study outcomes

Applied Sequence of prevention of overuse injuries	**PhD Study**	**Study Objectives**	**Study Outcomes**
Step1: Description of the Injury Problem and Context	Epidemiological perspective overuse shoulder injury surveillance (Chapter 3)	− Establish prevalence and incidence of overuse shoulder injuries in Kuwaiti volleyball sport. − Investigate the severity of overuse shoulder injuries among male competitive volleyball players in Kuwait.	- High prevalence of overuse shoulder injuries especially towards the first 2 to 3 weeks of the season - Significantly high severity measures
	Context-driven self-confrontation qualitative interviews (Chapter 5)	- To examine the perceptions and experiences of injured competitive volleyball players in Kuwait with overuse shoulder injuries, by using a social-ecological model as a guiding framework.	- Pain affects performance - Players continue to train despite pain or injury - Injuries have a psychological effect - Injuries impact the team
Step 2: Etiological Factors and Injury Mechanisms with Contextual Determinants	Epidemiological perspective overuse shoulder injury surveillance (Chapter 3)	− Identification of the overuse shoulder injury mechanism based self-report. − Investigate training related risk factors. − Investigate personal risk factors.	- No significant personal risk factors found - No significant training-related risk factors
	Cross-sectional physical risk factors of overuse shoulder injuries (Chapter 4)	Investigate physical risk factors of overuse shoulder injuries among male competitive volleyball players in Kuwait.	- Shoulder IIR and IER muscle weakness and shoulder ER and IR ROM are physical risk factors of overuse shoulder injuries - Although scapular dyskinesis had a practical significance effect, there are no statistically significant differences in the appearance of scapular dyskinesis between all shoulder groups.

	Context-driven self-confrontation qualitative interviews (Chapter 5)	- to examine the perceptions and experiences of injured competitive volleyball players in Kuwait with overuse shoulder injuries, by using a social--ecological model as a guiding framework.	- Individual factors: Lack of physical preparation, lifestyle issues (lack of sleep, poor nutrition), personal ambition, team spirit) - Limited club budget facilities (no on-site weight training facilities, only one physiotherapist/club, - Coach has limited time to integrate injury prevention in training - Unsupportive coaches - Lack of professionalization of volleyball - More focus on other sports such as football - Lack of awareness of medical facilities - Covid-19 context affected players' experiences with injuries.

To achieve the aim of this thesis, each study addressed specific objectives:

Objective 1. To establish the incidence/prevalence of overuse shoulder injuries among competitive male volleyball athletes in Kuwait and its impact

This objective was addressed via the administration of a weekly self-report questionnaire (study one), and established a high prevalence (39%) (95% CI 37.45% to 40.3%) and incidence (2.46/1000 hours) of overuse shoulder injuries in male volleyball players, with most injuries occurring early on in the season. Moreover, severe impacts on performance, participation, training volume, pain and task difficulty were found in injured players. Despite these significant severity measures, training-loss was not significant, with players continuing to play despite their

injuries, which is consistent with the nature of overuse injuries especially in competitive settings.

Objective 2. To define/identify the relationship of personal and training-related risk factors with overuse-shoulder injury incidence and the impact on severity measures.

Objective two was also achieved through study 1.

Personal risk factors (age, body mass, height, years of playing and playing level) and training-related risk factors (training session duration, volume and frequency) were investigated. However, the study found no significant personal or training-related risk factors for overuse shoulder injuries. Therefore, a more holistic understanding of other potential physical risk factors and the context in which these injuries occur is required to explain the high prevalence, incidence and severity of overuse shoulder injuries in male volleyball players in Kuwait.

Objective 3. To identify physical risk factors of overuse-shoulder injuries in a population of male volleyball athletes.

In study two, a reliable physical shoulder assessment model was used to establish physical risk factors for overuse shoulder injuries in volleyball players.

A preliminary study confirmed the reliability of clinical measurement tools (goniometer, handheld dynamometer and dynamic scapular dyskinesis test) and was used to establish a reliable physical shoulder assessment model. Then, a cross-sectional study was conducted with two groups: injured and uninjured players (identified through the study 1 prospective study). Measurements were taken for both shoulders of injured players and dominant of non-injured players. The study found that shoulder eccentric external rotation, isometric internal rotation and isometric external rotation muscle weakness and external rotation and internal rotation ROM deficiencies may be physical risk factors of overuse shoulder injuries in competitive volleyball players in Kuwait. More specifically, players with overuse shoulder injuries have significant isometric internal rotation and isometric external rotation muscle weakness and external rotation and internal rotation ROM deficiencies compared to the shoulders of players with no overuse shoulder injury. Also, injured players had a significantly lower EER muscle strength in their shoulders compared to the shoulders of players with no overuse shoulder injury. However, there are no significant differences in the EER muscle strength between the affected and unaffected shoulders of players with overuse shoulder injuries. As for scapular dyskinesis, it was not identified as a significant risk factor. These potential modifiable risk factors may be a good starting point for injury prevention

strategies. However, due to the timing of the measurements conducted towards the end of the season, it was not possible to confirm a causal relationship for the identified risk factors. Therefore, for future studies of overuse shoulder injuries in volleyball players, a prospective study design is suggested with baseline measurements taken prior to the start of the season to be able to establish a relationship.

Objective 4. To explore the sport-specific and national context in which volleyball overuse shoulder injuries occur.

This objective was achieved through a reflexive thematic analysis using semi-structured interviews with injured volleyball players (study three). The interviews were analysed through the lens of a socio-ecological framework. Contextual determinants of injury were found at multiple stakeholder levels: individual (lack of physical preparation, lifestyle, personal ambition, team spirit, unhealthy lifestyle), interpersonal (lack of injury prevention, unsupportive coaches), organizational (club limited financial and human resources, too many games scheduled), and at the policymaker level (lack of professionalization, lack of awareness about medical facilities for sports players).

6.2 General Discussion

According to the van Mechelen (1992) sequence of prevention model, the first step in developing effective injury prevention strategies is establishing the extent of the problem, by assessing injury prevalence and impact. In line with this vital first step, study one found that overuse shoulder injuries are a significant issue for volleyball players in Kuwait, with a seasonal prevalence of 39% (95% CI 37.45% to 40.3%). The high prevalence reflects the mechanism-based, “gradual-onset" definition of overuse injury used in the self-report questionnaire, that has gone beyond the “time-loss” definitions used in traditional surveillance systems, as recommended by Bahr (2009). The use of a time-loss definition may have resulted in a much lower prevalence. In addition, the epidemiological investigation has supported the previous evidence in the literature of a significantly high presence of overuse shoulder injuries among male volleyball players in the beginning of the competitive sport season (Clarsen, 2015). This finding has practical implications in the implementation of injury prevention interventions prior to the start of the season. By adopting questions from the OSTRC-O self-report questionnaire, Study one was able to assess the self-reported impact of overuse shoulder injuries on performance and pain, resulting in high severity measures, but with no significant time loss. This is consistent with what is already known about overuse injury, as it

is highly typical for athletes to practice and compete despite suffering from pain and impaired function as a result of an overuse injury. In a study of overuse and acute injuries among competitive collegiate athletes, overuse injuries caused no time off from sports in more than half of cases (50.8%) (Yang et al., 2012). The frequency and level of activity might also affect the symptoms of an overuse injury (Smoljanovic et al., 2009; Gam et al., 2005). Although athletes with acute, traumatic injuries frequently have specific rehabilitation protocols to follow and are observed throughout recovery, athletes with overuse injuries often modify their training depending on the degree of pain they are feeling (Gam et al., 2005).

This high prevalence and severity may also be explained by the injury context. In this thesis, we applied Bolling et al. (2018) revised sequence of prevention that takes injury context into consideration. Study three confirmed that despite the high severity measures found in the first study, overuse injury occurrence did not usually stop the player from participating; if it did it was usually for a limited time. Pain was normalized by the participants and due to the gradual onset it may be difficult to differentiate between normal soreness and injury. The normalization of pain contributes to overuse injuries (Cavallerio et al., 2016), as well as ignoring warning signals (Tranaeus, Martin & Ivarsson., 2022). This can contribute to the symptoms and injuries worsening later on. High prevalence and

severity justify the need for injury prevention interventions in this population, and in order to do that the study of risk factors is essential (step 2 of the sequence of prevention). The qualitative study revealed other effects of overuse injuries such as psychological effects and the impact of the injuries on other team members and coach plans and logistics. Therefore the benefits of managing and preventing these injuries not only helps with loss of participation and impaired function but also boosts overall mental and emotional wellbeing. Injury prevention will contribute to the individual athlete's health but also the health and success of the team and volleyball community as a whole.

An understanding of modifiable risk factors is essential for delivering the best care for overuse injuries, and it may also help future efforts to prevent shoulder injuries in volleyball players (Reeser et al., 2010). Chapter 4.0 (Study 2) was focused on modifiable intrinsic risk factors and found that shoulder eccentric external rotation, isometric internal rotation and isometric external rotation muscle weakness, and shoulder external rotation and internal rotation ROM may be physical risk factors of overuse shoulder injuries (similar to findings by Clarsen et al. 2014 for handball players). Therefore, range of motion, muscle strength and scapular dyskinesis are modifiable intrinsic risk factors that can provide a starting point for volleyball-specific overuse shoulder injury prevention strategies.

On the other hand, this thesis examined training-related risk factors which are modifiable extrinsic factors in study one (training session duration, frequency and volume) and found these to be non-significant predictors of overuse shoulder injury. This was surprising given systematic reviews that have shown training load to be a significant risk factor in different overhead sports (Tooth et al., 2020), but it is possible that the selected approach to measure the training load was not sensitive enough to quantify the actual intensity of the athlete workload. More insights around this were gained in the qualitative study (study 3). During the semi-structured interviews, players spoke about intense training and match schedules (too many matches scheduled, and spikes in training intensity followed by periods of inactivity due to the Covid-19 context). In addition, players have full-time jobs or are students and are playing competitively on a part-time basis so may be experiencing fatigue due to managing the demands of training and matches along with other personal demands. The effect of player position (another modifiable training-related extrinsic factor) on overuse shoulder injuries was not included in Chapter 3.0 (study 1), a possible study limitation. Other studies have shown front row volleyball players experience more shoulder injuries due to repetitive spiking activity. Reeser et al. (2010) found that attackers (outside hitters, opposites, and middles) in collegiate volleyball players reported more shoulder pain than setters

and liberos (64% versus 49%). In another more recent study by Skazalski et al. (2021), the development of shoulder issues was significantly higher in opposites and outside hitters than in other position groups. However, this risk factor did come up later during the Chapter 5.0 qualitative study (study 3) semi-structured interviews, and some of the injured players shared that they temporarily change position to manage their injury to avoid the explosive overhead movements and be able to continue to play or practice with little or no time-loss. When asked, these players revealed their usual position is a front row position. This known risk factor can be taken into consideration when designing volleyball-specific injury prevention programs by targeting exercises to these groups of players. Chapter 5.0 identified a number of perceived contextual determinants for overuse injury thanks to topic 2 of the interview guide " Factors influencing injury": individual factors (lack of physical preparation, lack of sleep, poor nutrition, personal ambition, team spirit), lack of time to integrate injury prevention exercises, unsupportive coaches, club budget and staffing issues, lack of weight training facilities. Lack of professionalization of volleyball in Kuwait was also a major factor cited. All players perceived that professionalization would offer a safer environment to play and practice, with better care, equipment and facilities, complete world-class staffing and more time for physical preparation and injury prevention, as there would be

no competing personal demands such as work or university studies. A study of amateur field hockey athletes in Ireland found that they face similar challenges (Rees et al., 2022). The authors noted that club financial constraints and the ensuing underinvestment in resources for athletes, such as physiotherapy and strength and conditioning, will probably make it more difficult for them to avoid and treat injuries. Despite the fact that field hockey in Ireland is an amateur sport, the absence of essential amenities like a club gym or access to a dedicated team physiotherapist was startling. The authors recommended that the wellbeing of athletes should be prioritized in any future funding for the sport, and funding for essential amenities like gyms and nutritional assistance should be made possible. Due to limitations at the club level, it is necessary to involve the level of the national governing body (Rees et al., 2022). Therefore more research and future injury prevention interventions need to take these contextual determinants into consideration as the identified risk factors in this study are insufficient to explain the high prevalence of these injuries. As for non-modifiable , personal risk factors (age, body mass, height, years of playing, and playing level) studied in study one, these were found to be non-significant. However, non-modifiable factors are more useful for identifying target populations for injury prevention rather than the injury prevention measures themselves. Tooth et al. (2020) systematic review of risk

factors for shoulder injuries in overhead athletes also found that personal factors have a modest influence on overuse shoulder injury occurrence in overhead athletes, compared to other modifiable risk factors (which they identified to be range of motion, rotator cuff muscle weakness, and training load).

We have synthesized the findings of this thesis that relate to the first two steps of sequence of prevention in table 15; injury prevention strategies should therefore focus on the modifiable risk factors and the contextual determinants identified in study one and study three.

Table 15. Findings applied to Bolling et al. (2018) context-driven 'Sequence of Prevention'

Step 1: Extent of the problem	Step 2: Aetiology and Risk Factors
Overuse shoulder injuries are a significant issue in volleyball players (identified in Chapter 3.0): • Prevalence: 39% • Incidence: 2.46/ 1000 hours • High severity measures: task difficulty, quality of performance, pain, training volume and overall severity • No significant time-loss (players continue to play despite their injuries). *Context based injury definition (based on volleyball player's perspectives in Chapter 5.0):* • Pain affects performance • Players continue to train despite pain or injury (normalization of pain) • Injuries have a psychological effect • Injuries impact the team.	*Modifiable Physical Risk Factors (identified in Chapter 4.0):* • Shoulder IIR and IER muscle weakness • Shoulder ER and IR ROM • Scapular dyskinesis was not identified as a significant risk factor but has practical significance. *Contextual Determinants (identified in Chapter 5.0 based on volleyball players perspectives)* • Individual factors: Lack of physical preparation, lifestyle issues (lack of sleep, poor nutrition), personal ambition, team spirit) • Limited club budget, staffing and facilities (no on-site weight training facilities, only one physiotherapist/club • Coach has limited time to integrate injury prevention in training • Unsupportive coaches • Lack of professionalization of volleyball • Poor or lack of facilities • Covid-19 context affected players' experiences with injuries.

With a high prevalence, yet few modifiable risk factors found in this thesis, the multifactorial models of injury causation that came after van Mechelen (1992)

sequence of prevention appear not to explain the high injury occurrence in the case of competitive volleyball in Kuwait. In particular, the “workload—injury aetiology” model proposed by Windt & Gabbett (2016) which builds on models such as Meeuwisse et al. (2007); & Bahr & Krosshaug (2005), and takes into consideration training and workload variables, does not seem to fully apply to the case of competitive volleyball in Kuwait as no significant training-related risk factors were identified. However, this may actually be due to the selected approach to estimating training load during the weekly self-report by measuring only session duration, training volume and training frequency and failing to fully account for the external and internal workloads. Well-known and popular measures of internal workload that also rely on participants' perception such as the Rating of Perceived exertion (RPE) (Gabbett, 2015) could have been another more accurate approach to quantify the load. Athletes rate the intensity of each training session on a scale of one to ten at the end of each session. It is recommended that athletes wait 30 minutes before scoring the session to get a more accurate assessment (Foster, 1998). The training load is calculated by multiplying the session's intensity by the length of the session. The use of such a measure might have been more accurate but would have been more difficult to implement within this study design especially due to the large number of participants.

However the higher injury prevalence at the beginning of the season may be related to a sudden spike in the participant workload. A spike in training for which athletes are unprepared (i.e., a high acute:chronic workload ratio) is likely to result in more maladaptations, altering a number of internal risk factors, and increasing their predisposition for injury in the future (Windt & Gabbett, 2016). This was confirmed by participants in the qualitative study as they described their experience of the injury over the season. There is a need to address these spikes and also focus on participants' preparation before the season. To some extent, some of the other aspects of their model were also reflected in the qualitative study; for instance in the semi-structured interviews, participants consistently mentioned “lack of preparation”. Training sessions in Kuwait are focused on training with the ball, with little time allocated to physical fitness (for example, clubs consider players should work on weight training in their own free time due to lack of facilities and time). Players have little free time to work on their fitness before their training sessions (due to competing work and personal demands). Therefore the mechanism through which workloads cause "fitness," or positive physiological changes (which minimize the chance of future injuries by positively impacting internal risk factors) is not adequately utilized in this population of players. The induction of beneficial physiological adaptations, many of which are

linked to decreased injury risk (including high aerobic capacity, ideal body composition, and strength) is dependent on adequate workloads (Windt & Gabbett, 2017). These adaptations are also crucial for good performance. Therefore, workloads that are too low could lead to reduced levels of fitness and preparedness, which would increase the risk of injury in addition to lowering performance (Windt & Gabbett, 2017). In the case of fast bowlers in cricket, a "dual threshold" has been demonstrated in which injury risk was increased by both high workloads and short recovery times as well as by low total deliveries (<123, relative risk=1.4) and long recovery times (>5 days, relative risk=1.8) (Orchard et al., 2009).

However the authors of this model admit its limitations. Some variables such as lack of sleep are not explicitly incorporated (Windt & Gabbett, 2016). In addition they state that workloads may have an impact on some psychological factors (such as commitment to training, self-blame, perceived stress/fatigue, etc.), which may then modify how people behave during matches and training sessions and modify their risk of injury (Windt & Gabbett, 2016). Thus having a qualitative study in this thesis helped to clarify some of the possible psychological and other factors such as lack of sleep. Therefore this thesis supports the need to move towards more complex and dynamic systems approaches to injury causation, such as the one proposed by Bittencourt et al. (2016,) with their “web of determinants’ (the stable

and sometime complex relationships between injury determinants that contribute to the emergence of injuries in sports), and Bolling et al. (2018) context-driven approach to injury prevention used in this thesis, are a more useful lens through which to view overuse injuries and their prevention in real world conditions.

The mixed-methods approach adopted in this thesis was primarily centered around the athlete's experience of his injury. Different research methodologies can complement one another in mixed-methods studies; the field of sports medicine can benefit from a variety of research techniques, which can also provide insights and new perspectives for research questions (Bolling et al., 2019). On one hand, the first study was prospective and relied on athlete's self-reporting of overuse shoulder injuries and their impacts; results of this self-assessment of symptoms then were used to categorize participants into injured vs non-injured for the cross-sectional study one of physical risk factors. On the other hand, the study three semi-structured interviews were carried out following the end of the season and therefore had a retrospective element. By applying the course of action framework using a modified self-confrontation interview methodology (visualising the player's experience of injury severity and his performance over the course of the season with a line chart), "resituated' the injured player in his lived experience and context that surrounded his performance, his pain and his injury during the sport season.

The athlete's perspective is therefore reflected through this entire PhD programme. While giving a voice to these injured athletes is a strength of the study, a more holistic approach would have been to include other perspectives and attitudes towards injuries and their prevention, such as those of the coaches. Based on the insights gained in the interviews, most of the burden of injury management and prevention currently falls on the athletes and coaches, with many contextual factors that are perceived to contribute to injury or hinder their prevention (such as club financials and government policy issues) out of their control. This is very similar to the findings from other qualitative studies about the contextual factors related to sport injuries that are experienced by amateur field hockey athletes and coaches in Ireland (Rees et al., 2021; Rees et al., 2022).

While this thesis was designed to mainly cover the first two steps of the revised van Mechelen et al. (1992) sequence of prevention, the qualitative study did help to gain insight on other stakeholders that should be included in future injury research and strategies. This can inform step three and four of the sequence of prevention model by identifying what kind of interventions are needed at each level of the socioecological framework, knowing that different levels interact with each other. In the third qualitative study, athletes perceived themselves to be the primary responsible for preventing their injuries. However, guidance on pre-

rehabilitation programmes should be provided by the club or federation. Other important stakeholders and levels of the socioecological model were identified: coaches, trainers and team-mates (interpersonal level); clubs including club administration and club physiotherapists (organization level); the Volleyball Federation (community level); and Kuwait and its government (policy level). The importance of effective communication and collaboration between these different stakeholders is important to the success of any injury prevention. In other similar studies, communication with the coach and other staff was perceived by players to be an important component of injury prevention and management (Vella et al. 2021). Moreover, other studies have shown that football teams with poor communication between the head coach/manager and the medical team suffer more injuries (Ekstrand et al. 2019). The authors also found that players were less likely to show up for practice on teams where there was poor communication between the fitness coaches and the medical personnel. Therefore, more emphasis should be placed on strengthening the teamwork aspect of injury prevention.

6.3 Contribution to the knowledge

This thesis has made significant contributions to the existing body of knowledge in several aspects. It addresses gaps in volleyball-specific research

regarding prevalence and risk factors, which have typically been explored in other overhead sports such as baseball. It emphasizes the common occurrence of overuse shoulder injuries in volleyball (Asker et al., 2018; Clarsen et al., 2014).

A notable aspect of this thesis is its pioneering adoption of Bolling et al.'s (2018) revised "Sequence of Prevention" model. This model was utilized to comprehend the prevalence and risk factors associated with overuse shoulder injuries among male competitive volleyball players, considering the specific context in which these injuries occur. Additionally, it established a robust definition of overuse shoulder injuries, enabling efficient investigation. The thesis advocates for future epidemiological studies to employ precise definitions, prospective cohort designs, and reliable measurement tools tailored for volleyball players with overuse shoulder injuries, thereby enhancing the overall quality of research design (Kilic et al., 2017).

Notably, this is the inaugural prospective cohort study in Kuwait's sports medicine domain. Moreover, it stands as one of the few studies applying Bolling et al.'s (2018) contextual approach within the socioecological framework. By exploring the extent, magnitude, and identifying personal and training-related risk factors, this study successfully navigated the context-driven "sequence of

prevention" model to prevent overuse shoulder injuries among competitive male volleyball players in Kuwait (Bolling et al., 2018).

Furthermore, the instruments employed in the physical shoulder examination during the cross-sectional study could potentially be integrated into volleyball sports physical therapy practices. This integration could aid in identifying volleyball players prone to overuse shoulder injuries before the competitive season begins, facilitating the implementation of appropriate preventive strategies.

Moreover, Study Three marks a milestone as the first qualitative study utilizing self-confrontation interviews in injury prevention research. Traditionally used in the context of sports performance rather than injury research, this qualitative study contributes significantly to understanding the complexity of overuse shoulder injuries. Its findings offer an in-depth explanation and a contextualized understanding of these injuries, making a unique contribution to the field.

6.4 Strengths and Limitations

The series of studies presented in this thesis has contributed to advancing the understanding of overuse shoulder injuries in volleyball players. The selected

approach was a strength of the work. By adopting a mixed-methods approach to addressing step one and two of the revised model , we were able to achieve each study's objective. The inclusion of a qualitative study helped to gain more in-depth insights and showed that context does matter as Bolling et al. (2018) proposed.

Study 1 (Chapter 3.0)

This study is the first to examine interrelationships among overuse shoulder injuries, training-related risk factors and sport participation. This can establish and develop effective preventive and severity measures of volleyball-related overuse shoulder injuries. The current study has strong contextual study design features to highlight the key issues. The longitudinal cohort study design used in this study provides good evidence to support the development of overuse shoulder injury prevention programs that address training strategies. Other prospective studies have successfully used weekly questionnaires such as Clarsen et al. (2013) and Clarsen et al. (2015).

Weekly monitoring in this study raised the quality of evidence and limited the errors in the findings such as recall bias. Although the current findings may offer a good start for future guidance, it is important to be aware of the present study's limitations.

Firstly, this study relies on self-reporting to identify overuse injury based on the mechanism of injury that has a good approval from a systematic review (Roos & Marshall, 2014). Self-reporting of injuries using gradual onset definition was clearly able to capture more overuse injuries. However, athletes may sometimes be unable to distinguish pain from normal soreness resulting from practice. Not all "pain" in sports is due to injury. Pink et al. (2011) refer to soreness as a "generalized feeling in the muscles", while pain is "a deeper, and sometimes sharper, more localized feeling". Pink and Tibone (2000) advise educating athletes and coaches about the difference between pain and soreness, as well as discouraging the "no pain, no gain" mentality. This can minimize damage from injury and accelerate return to play. Therefore, it is possible some participants may actually be reporting soreness instead of true injury, while others may not report an injury thinking it is normal soreness from practice. When it comes to evaluating pain according to a scale, true accuracy is obtained by including the observations of the athlete, of the coaches, and of the medical staff (Pink et al., 2011).

Also, the self-report survey cannot provide a diagnosis of the specific type of overuse shoulder injury, as the amount of details that can be collected from athletes directly through the questionnaire is limited. The only information gathered by the questionnaire is related to the anatomical location, not the type of

injury or specific diagnosis, which should ideally be made through a clinical examination (Clarsen et al., 2013). This can have implications for effectively managing, treating, and preventing these injuries. However, Owoeye et al. (2018) evaluated the diagnostic accuracy of an OSTRC-P questionnaire (OSTRC-patellar tendinopathy questionnaire, which is the adapted OSTRC Overuse Injury Questionnaire for patellar tendinopathy) in detecting patellar tendinopathy (jumper's knee) in youth basketball players, when compared to clinical evaluation by a physical therapist. They found that that the OSTRC-P questionnaire's diagnostic accuracy for self-reporting patellar tendinopathy and patellar tendinopathy severity had an acceptably high level, and that it offers a low-cost alternative to clinical evaluation for identifying patellar tendinopathy and rating its severity in large-scale surveillance studies and athlete care (Owoeye et al., 2018).

This current study can be an initiation to encourage further studies to establish a gold standard measurement tool to identify and manage overuse injuries. Combining self-reporting, medical evaluations, and clinical imaging (MRI) can help create more specific preventive and management strategies based on the type of injuries. For example, Serner et al. (2021) conducted a one year prospective case study with 16 competitive male athletes who had an adductor longus tendon avulsion injury and received an exercise-based treatment. The completion of a

supervised, structured, criterion-based rehabilitation regimen was advised to all athletes. A standardized clinical examination, a modified Copenhagen Hip and Groin Outcome Score (HAGOS), the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O), and a detailed magnetic resonance imaging (MRI) assessment were carried out at three points during the year: after inclusion in the study, on the day of the treatment protocol's completion (return to sport), and at the 1-year follow-up after injury. The authors found that athletes had high self-reported function, minimal performance restrictions, normal adductor strength and range of motion, and evidence of partial or complete tendon continuity as indicated on MRI at the 1-year follow-up after injury. Similar comprehensive protocols that include both clinical examinations and imaging measures with self-report questionnaires could be designed to monitor the progress of injured volleyball players with overuse shoulder injury.

In addition, with regards to severity, measures such as pain, performance and task difficulty are also subjective concepts that may depend on other psychological factors such as the participants' stress levels, and personal ambition and motivation.

Secondly, the quantitative survey approach used in this study provides limited insights into other contextual factors that may be contributing to the risk of injury and severity measures. This led the author to conduct qualitative interviews with players with overuse shoulder injuries to address the gaps identified in this quantitative study (Chapter 5).

Thirdly, this cohort study included a large number of participants that self-reported weekly about overuse shoulder injuries and training load, which affected the consistent and successful follow-up of the participants by the researcher. This led to some missing data that required data management by the author. All variables have been counted according to the injury status group. Non-injured variables data of all 30 weeks have been averaged. However, injured variables data have been counted according to each aspect of the overuse shoulder injury risk factors/impacts model (Perera et al., 2019).

Finally, the exceptional situation due to the COVID-19 pandemic and its consequences on the sport season have affected the standardization of the findings and how these might be reflected onto the regular sport season situation. However, the author took this into consideration earlier while designing the methodology of this study by addressing the effect of this pandemic in the sport

season, then excluding it to have more reliable findings that reflect the usual sport season experience.

Study 2 (Chapter 4.0)

This is the first cross-sectional study on physical risk factors for overuse shoulder injuries among sub-elite male volleyball players. Good reliability for clinical measurements is necessary to give confidence that differences are real and not due to measurement errors. Therefore the instruments used in investigating the physical risk factors of overuse shoulder injuries were assessed for their reliability in conducting this study and were found to be reliable. However, the same method has some limitations due to the small sample size that might limit the statistical analysis and the variety in players' experiences that already have been treated through specification in exclusion and inclusion criteria.

Although the current study was not designed prospectively to address the aetiology and risk factors of shoulder injuries, it provides good findings about the possible aetiology of overuse shoulder injuries in volleyball players and associated adaptations in all shoulder physical components. However, the categorization of injured vs. non-injured players was completely dependent on the athlete's self-reporting of the gradual-onset definition of overuse injury symptoms and was not

backed up by a diagnostic definition with clinical assessment and imaging. Ideally a study or practical application would combine self-reporting of overuse symptoms with a gold standard diagnostic method to confirm overuse shoulder injury and diagnose the type of injury. Therefore, not knowing if injured vs non-injured player categories are accurate is a limitation.

Another limitation might be related to the timing of the assessment post-injury and towards the end of the season. It is unclear whether or not proximity or distance from when the injury was first identified may be influencing the results. For example, could the injury be causing these deficiencies or are the deficiencies causing the injury? Was the assessment conducted when pain had decreased since injury occurred? Therefore, a preseason physical assessment of all participants of the first study (Chapter 3) might have been more adequate to confirm a causal relationship.

Instruments used in the physical shoulder examination demonstrated the ability to identify potential physical risk factors of overuse shoulder injuries. Therefore, they could be utilized in the volleyball sport physical therapy practice to identify volleyball players who are prone to overuse shoulder injuries prior to the start of the sport competitive season and implement appropriate preventive

strategies. However, overuse shoulder injury prevention strategies incorporating the addressed risk factors should be tested using randomized controlled trials.

Study 3 (Chapter 5.0)

Our study has shown that as Bolling et al. (2018) have proposed, context does matter, especially in the case of athletes' perception of overuse shoulder injuries. The exploration of player perspectives using a qualitative approach and the application of a socioecological model helped gain a deeper understanding of the overuse injury problem and is a strength of the study. In particular, a qualitative approach has helped fill the gaps in the previous Chapter 3 findings on prevalence and severity and increased understanding of overuse shoulder injuries in the context of volleyball in Kuwait.

However, the study does have some limitations. This qualitative study took place at the end of the 2020/2021 season, so the quality of the data depends on the player's ability to recall the events of the previous months accurately. While the line chart may help the player recall his experience at different points during the season, there might still be an element of recall bias due to the retrospective nature of the study; however, the bias is likely minimal as the time frame of recall

is less than 12 months and interviews were conducted right after the end of the season (Mukherjee, 2015).

Another possible limitation is that other stakeholders such as coaches, physiotherapists or club management were not included. A more holistic study including a wider range of perceptions from a variety of stakeholders would have produced a more comprehensive picture of the overuse shoulder injury problem, through data triangulation. For example, interviewing coaches and physiotherapists would have helped gain an understanding of their own beliefs, knowledge and practices regarding the prevention and management of overuse shoulder injuries, and of the unique challenges that they face.

Also, while qualitative studies provide a more in-depth and contextualized understanding of a particular subject, they cannot be generalized. All interviewed players are from Kuwait, so cultural differences may play a role. The transferability of the findings to other contexts therefore has to be made with caution.

The Covid- 19 context during which the study happened also may have affected the study outcomes and the player's experiences.

6.5 Future research and practice

The findings in this thesis have a few practical and research implications. Chapter 3.0 established the extent of the overuse shoulder injury problem in volleyball players in Kuwait. The high prevalence of overuse shoulder injury highlighted the need to prioritise the development of effective volleyball-specific prevention strategies for overuse shoulder injuries that particularly address severity measures in volleyball sport in Kuwait. With most injuries happening early on in the season, the early implementation of preventive measures and strategies prior to the start of the season is necessary to limit overuse shoulder injuries experienced throughout the competitive sport season. This can include exercises programs targeting both shoulder strength and flexibility. Shoulder external rotator strengthening exercises combined with a controlled stretching programme are recommended for volleyball players to prevent injury. However, it should be noted that stretching exercises should be given with care to prevent further injuries or hyperlaxity as these can often be caused by unsupervised or aimless stretch programmes (Wang & Cochrane, 2001).

Chapter 4.0 identified potential modifiable physical risk factors (shoulder EER, IIR and IER muscle weakness, shoulder ER and IR ROM) that could be taken

into consideration in the design of injury prevention interventions. Although the results demonstrated that scapular dyskinesis is not considered as a physical risk factor for overuse shoulder injury in volleyball in Kuwait, it could be included in the prevention strategies as a supplementary intervention through an exercise program focused on scapular stability.

One overuse shoulder injury prevention programme worth looking into and that may inform future prevention strategies is the application of Oslo Sports Trauma Research Center (OSTRC) Shoulder Injury Prevention Programme. A randomized controlled trial showed that this programme was successful in reducing the prevalence and risk of reporting shoulder issues in elite handball players and that may be applied to other throwing athletes (Andersson et al., 2017). This comprehensive 10-minute exercise program reduced the risk of shoulder injury by 28%. It includes five exercises that have been shown to improve kinetic chain, thoracic mobility, as well as glenohumeral IR, ER, and scapular muscle strength, and the study authors recommended for it to be included as part of the warm-up in throwing sports. Coaches, team captains, and medical staff (including physiotherapists) were trained on the content and execution of the exercise programme. Posters with the exercises were distributed to the teams. The authors recommended its implementation three times a week, but the study found that the

programme could be implemented once or twice a week to achieve the reported effect (Andersson et al., 2017). However, another more recent randomised control trial conducted on handball players by Fredriksen, Cools, Bahr & Myklebust (2020) specifically studied the effect of this program on ER strength and IR ROM and found that these risk factors were not affected. Therefore, the preventive effect of the program and reduced injury incidence reported by Andersson et al. (2017) may be due to other factors. In addition, player compliance to the program has been reported as an issue due to players' perception that the program is too time consuming (Friedriksen et al., 2020).

Another randomized controlled trial by Moradi, Hadadnezhad, Letafatkar, Khosrokiani & Baker (2020) investigated the efficacy of a throwing exercise with TheraBand in male volleyball players with shoulder internal rotation deficit. The study found improved neuromuscular control, strength, joint position sense and functional rotator cuff ER-IR ratio in asymptomatic volleyball players with GIRD after an 8-week exercise-based intervention. Such an intervention could therefore be implemented to both prevent injuries and rehabilitate injured players with GIRD.

Optimization of spiking technique or instruction of alternative spiking techniques are a preventive strategy that can be considered to reduce overuse shoulder injuries. Many authors suggest that coaches work with players to create techniques that reduce stress on the shoulder joint and keep the glenohumeral joint far from articular limits (Seminati & Minetti, 2013). A study of shoulder 3D range of motion and humerus rotation in two volleyball spike techniques (traditional and alternative) found that the alternative spiking technique can potentially reduce shoulder overuse injuries. The alternative technique may lower the risk of shoulder impingement while maintaining or even improving performance, not just in elite athletes but also in recreational and school/collegiate players (both males and females) by allowing the rotator cuff to function within a range of motion that is deemed less dangerous (Seminati et al., 2015).

The Chapter 5.0 qualitative study of volleyball players' perceptions helped clarify the context, perception of injuries and causal factors, and the different socioecological levels involved in injury management. It is likely that the context is contributing to injuries. It highlighted the need to strengthen the effectiveness of the key stakeholders involved, in particular by ensuring that they expand the role of the sport physiotherapists, coaches, organizers and administrators to include

injury prevention. Stakeholders have an important role to play in creating an environment that aims to minimize injury prevention.

Effective communication between all the stakeholders is important to prevent injuries. Multidisciplinary team approaches to injury prevention in sports have been shown as effective at reducing the burden of injuries in professional rugby (Tee et al., 2017). The authors collected epidemiological injury data for 5 consecutive seasons. At the end of each season, this information was used to inform injury prevention strategies by a multidisciplinary team. Thus they applied an iterative approach to the sequence of prevention, constantly refining and reassessing the strategies based on real world conditions to improve injury prevention efforts. It is important to note that the injuries only started to get reduced during the fourth season, indicating the importance of consistency, patience, collaboration and a long term vision in sports injury prevention.

Coach knowledge and awareness level about injuries training-related risk factors which are addressed earlier in Chapter 3, should be elevated. Physiotherapists should provide pre-season prevention strategies according to the individual physical injury risk factors which are addressed earlier in Chapter 4. Organizers and administrators should encourage the clubs and federation to

promote players awareness, health and wellbeing. We suggest that future research studies include the perspectives of other stakeholders such as coaches and club physiotherapists in order to design more effective injury prevention interventions.

6.6 Summary and conclusions

Through a mixed-methods approach and revised sequence of prevention model, we have determined that overuse shoulder injuries in male volleyball players in Kuwait are a complex and significant problem with a high prevalence and severity. Our study has demonstrated the physical factors and contextual determinants that may be involved in the injury mechanism. The findings are a call to action for translating this research into injury prevention programs that take into consideration the context and levels of the socioecological framework (step 3 and 4 of the sequence of prevention model). It is clear that policy makers have an important role in creating a safe and healthy environment. Guidelines and recommendations may be produced for the different stakeholders to help prevent these injuries in volleyball players.

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Chapter 8.0: Appendices

8.1 Appendix A

Information Sheet and Consent

Introduction and Demographic questionnaire

INTRODUCTION:

You are invited to be a participant in a doctoral research program. This study aims to record the prevalence rate of overuse shoulder injuries among volleyball players in Kuwait. The study will monitor the overuse shoulder injuries incidence, training load, recovery status, severity as well as monitoring several physical characteristics among volleyball players. We are looking for male volunteers who currently play volleyball, are over 18 years of age and playing for first-degree volleyball teams in Kuwait.

Participation in this study requires from you to complete this initial questionnaire one time and to respond to a quick questionnaire at the end of each week for the forthcoming competitive season. The initial questionnaire is to obtain your personal details as well as some key background information. All information provided will be treated confidentially and nobody except the researcher will explore it. It will be used only for this research purpose and to help the researcher to monitor your weekly status. You may also be asked to take part in the arm of the study that records clinical measures every two weeks. This would require you to commit to a 15 minute slot at your club training session every two weeks. The researcher would regularly conduct some basic tests on you and ask you some questionnaires.

If you are interested in taking part, please follow the instructions below and answer the following questions. By submitting this questionnaire, you indicate that you agree to participate. Participation is entirely voluntary, and you may stop participating at any time while filling this questionnaire. Once you have agreed to take part, you will be sent an electronic link weekly to be responded to. It is shorter and easier than this current questionnaire. There is an instruction before each

question to guide you for the required way of answering and you need to answer all required questions to complete the survey.

You will be asked to provide your name and contact details so we can keep a record of your participation in the study, however, this information will be kept confidential and will not be disclosed publicly.

All data from the study will be stored, processed, and reported using an anonymous user ID and as a part of an aggregate dataset collected from multiple participants.

If you have a query about how your data is used by the University or you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) or you would like to complain about how the University has used your personal data, you can contact the Data Protection Officer.

Taking part in this study will contribute to the development of sport injuries database in Kuwait sport. This will add a beneficial consideration for the organization to improve the health care system in the sport field. Your participation will add an interesting value to sport participants. It will contribute by preventing shoulder injuries among those who are interested in sport. Participants can be up-to-date regarding the outcome of the research. There are no health risks to taking part in this study. It might affect the players mentally and direct him out of his comfort zone when he is recalling his experience and complaints. However, this can be managed by encouraging the participants to not hesitate on contacting the researcher for clarifying the difficulties.

Participant can discuss anything with researcher anytime using the provided contact details.

The results of this study will contribute towards PhD research and scientific publications. If you would like to receive a result report at the end of the study, please contact the named researcher.

You will receive an electronic link demonstrating the questionnaire in your device.

This project has been subject to ethical review, according to the procedures specified by the Sheffield Hallam University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

If you have concerns with how the research was undertaken or how you were treated, you can contact the Head of Research Ethics.

The University undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of public tasks that are in the public interest.

A full statement of your rights can be found at https://www.shu.ac.uk/about-this-website/privacy-policy/privacy-notices/privacy-notice-for-research.

However, all University research is reviewed to ensure that participants are treated appropriately, and their rights respected. This study was approved by UREC with Converis number. Further information at https://www.shu.ac.uk/research/ethics-integrity-and-practice.

You should contact the Data Protection Officer if:

- You have a query about how your data is used by the university
- You would like to report a data security breach (eg if you think your personal data has been lost or disclosed inappropriately)
- You would like to complain about how the university has used your personal data

You should contact the Head of Research Ethics if:

- you have concerns with how the research was undertaken or how you were treated

By submitting this questionnaire, you indicate that you agree to participate.

○ Agree (1)

8.2 Appendix B

Weekly Training and Injury Questionnaire

Dear Participant

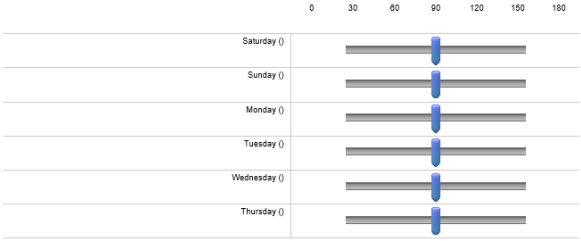
Welcome to the weekly follow-up questionnaire.

This less than 5 minutes quick-questionnaire will monitor your training load and the incidence of injuries.

Please follow the instructions below and try to give an appropriate answer as much as you can anyway.

This following section is to measure your training duration in the past week.

Q1 Rate your duration of training in minutes for each day of the past week: (you will find specific box for each day in the past week, please drag the pointer to the appropriate number of minutes for each day. In case there is no experience for specific day or match day, please drag the pointer to the Zero for this specific day box, If there is match between match day and one of weekday, please repeat the same value for both days)



Q2 Have you experienced shoulder Problem? The term ''shoulder problems'' refers to pain, aching, stiffness looseness or other complaints in one or both of your shoulders in the past week.

1) Yes
2) No

Q3 What is the most appropriate statement can describe your injury?

1) Gradual onset without a single, identifiable event responsible for the injury
2) Sudden onset (non-contact trauma) resulting from a specific and identifiable event
3) Recurrence of previous injury
4) Sudden onset (contact trauma) resulting from a specific and identifiable event
5) Other, please Specify _____

Please answer all questions regardless of whether or not you have problems in your shoulders. Select the alternative that is most appropriate for you, and in the case that you are unsure, try to give an answer as best you can anyway.

The term ''shoulder problems'' refers to pain, aching, stiffness looseness or other complaints in one or both of your shoulders.

Q4 Have you had any difficulties participating in normal training and competition due to shoulder problems during the past week?

1) Full participation without shoulder problems.
2) Full participation, but with shoulder problems.
3) Reduced participation due to shoulder problems.
4) Cannot participate due to shoulder problems.

Q5 To what extent have you reduced you training volume due to shoulder problems during the past week?

1) No reduction
2) To a minor extent
3) To a moderate extent
4) To a major extent
5) Cannot participate

Q6 To what extent have shoulder problems affected your performance during the past week?

1) No effect
2) To a minor extent
3) To a major extent
4) Cannot participate

Q7 To what extent have you experienced shoulder pain related to your sport during the past week?

1) No pain
2) Mild pain
3) Moderate pain
4) Severe pain

Q8 How many days you missed the training session only because of shoulder discomforts/injuries?

Weekly_Training_and_Injury_Questionnaire

8.3 Appendix C

INFORMATION SHEET

Project Title: Perceptions of Overuse Shoulder Injuries in Competitive Male Volleyball Players in Kuwait.

What is the purpose of the study?

The purpose of this study is to explore Male volleyball players experiences of overuse shoulder injuries in Kuwait.

Who is eligible to participate in the study?

You are eligible to Participate as you have been taking part in the injury surveillance study and have been identified as a player with a recurrent shoulder problem.

please contact the author regarding your willingness to take part.

Participation is entirely voluntary, and you are free to withdraw at any time without giving a reason. The principle researcher is essential at this stage of the research to answer the questions raised by participants.

What will be involved if you take part?

The researcher will contact you to arrange a face to face in- depth semi structured interview according to your preference time and place. Interview lasted between 30 and 60 min. The outcome of the injury observational study applied by the player will be demonstrated during the demonstration session. This will influence the players' talk by reflecting on the provided report. Although the interviews will be semi structured, the participants will be encouraged to talk freely. Follow-up

questions will be only asked by the interviewer when indicated by the interview guide. Participants who are eligible and happy to discuss their point of views, will be requested to provide written informed consent of their participation before the interview process starts at the time and place arranged with them for interview at their convenience. The interviews will be recorded and written up after the meeting. The audio recordings will also be saved on the university storage. The interview will be transcribed by a third party company that has institutional approval. A copy of the transcribed data will be sent to you via email for checking and verifying approval of quotations to use in the final results.

Confidentiality, storage and disposal of information

Players' data and their names will be coded and anonymous in order to achieve anonymity throughout the study and to keep the identity and privacy of the participants confidential. This information will be kept confidential and will not be disclosed up publicly. All data from the study will be stored, processed, and reported using an anonymous user ID and as a part of an aggregate dataset collected from multiple participants. The data will be stored in Research Store (Q drive) particularly in researcher space. This area is password protected and aligns with SHU data protection regulations. These Data will be disposed when the PhD programme is finished December 2022. If you have a query about how your data is used by the University or you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) or you would like to complain about how the University has used your personal data, you can contact the Data Protection Officer.

Are there any benefits/ risks to taking part [e.g. health]?

There are no health risks to taking part in this study. It might affect the players mentally and direct them out of his comfort zone when he is recalling his experience and complaints. However, this can be managed by encouraging the participants to not hesitate in contacting the researcher for clarifying the difficulties.

When will I have the opportunity to discuss my participation?

Participant can discuss anything with researcher anytime.

What will the results of the study be used for?

The results of this study will contribute towards PhD research and scientific publications. If you would like information on the results at the end of the study, please contact the named researcher.

Where will the studies take place?

Interviews took place face to face at a location of the participant's choice. The researcher will contact you to arrange a face to face in- depth semi structured interview according to your preference time and place. The interview process starts at the time and place arranged with you for the interview at their convenience.

Who has reviewed the study?

This project has been subject to ethical review, according to the procedures specified by the Sheffield Hallam University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

Contact details for further questions:

In the event of a complaint

If you have concerns with how the research was undertaken or how you were treated, you can contact the Head of Research Ethics.

The University undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of public tasks that are in the public interest.

A full statement of your rights can be found at https://www.shu.ac.uk/about-this-website/privacy-policy/privacy-notices/privacy-notice-for-research. However, all University research is reviewed to ensure that participants are treated appropriately, and their rights respected. This study was approved by UREC with Converis number. Further information at https://www.shu.ac.uk/research/ethics-integrity-and-practice.

You should contact the Data Protection Officer if:

- you have a query about how your data is used by the University
- you would like to report a data security breach (eg if you think your personal data has been lost or disclosed inappropriately)
- you would like to complain about how the University has used your personal data

You should contact the Head of Research Ethics if:

- you have concerns with how the research was undertaken or how you were treated

8.4 Appendix D

Participant Consent Form

TITLE OF RESEARCH STUDY: Perceptions of Overuse Shoulder Injuries in Competitive Male Volleyball Players in Kuwait.

the response that applies

	YES	NO
1. I have read the Information Sheet for this study and have had details of the study explained to me.		
2. My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any point.		
3. I understand that I am free to withdraw from the study within the time limits outlined in the Information Sheet, without giving a reason for my withdrawal or to decline to answer any particular questions in the study without any consequences to my future treatment by the researcher.		
4. I agree to provide information to the researchers under the conditions of confidentiality set out in the Information Sheet.		
5. I wish to participate in the study under the conditions set out in the Information Sheet.		

6. I consent to the information collected for the purposes of this research study, once anonymised (so that I cannot be identified), to be used for any other research purposes.

Participant's Signature: _____ Date: _____

Participant's Name (Printed): _____

Contact details: _____

Researcher's Name (Printed): _____

Researcher's Signature: _____

Researcher's contact details:

(Name, address, contact number of investigator)

Please keep your copy of the consent form and the information sheet together.

8.5 Appendix E

Sport Training Exposure and Injury Severity

Player	1	2	3	4	5	6	Excellent	Mean (SD)
Sport Training Exposure								
Training session duration, min	70	69	88	57	120	14	115	76 (36)
Training session volume, min	422	415	529	340	720	83	690	76 (218)
Training session frequency, n	4	6	6	4	6	6	6	5 (1)
Injury Severity								
Week of injury	2	6	3	10	5	9	11	
Task Difficulty	0	0	0	8	8	0	8	3 (4)
Quality of Performance	0	6	6	6	6	0	6	4 (3)
Pain	8	8	8	8	17	8	8	9 (3)
Training Volume	13	6	6	6	0	0	6	5 (4)
Severity	21	20	20	28	31	8	28	22 (8)
Training-loss	0	2	0	2	0	0	0	1 (1)

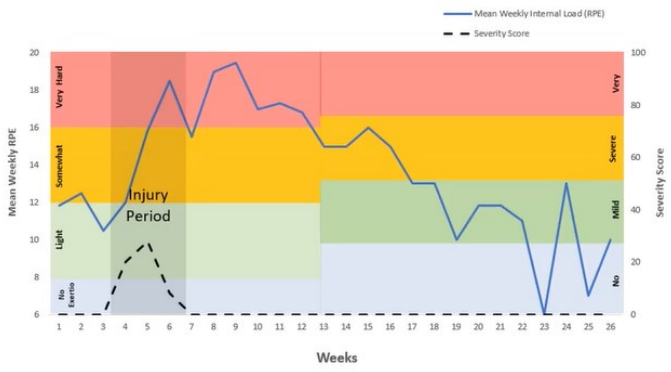
8.6 Appendix F

Interview guide

Interview Guide

a. Thank the player for agreeing to take part in this study and for agreeing to discuss experiences.
b. Explain purpose of the study
c. Show the colourful line chart demonstrating individual player self-report study course recording collected during the volleyball sport season (2020/2021) followed by a self-confrontation interview in which the player, while viewing the chart image, is urged to recall and explain what he was personally experiencing during the season (Examples below)

Mean Weekly Internal Load (RPE)	Severity Score	Weeks
12	0	2
13	0	3
11	0	5
12	20	6
16	28	8
19	8	9
16	0	10
19	0	11
20	0	12
17	0	13
17	0	14
17	0	15
15	0	16
15	0	17
16	0	18
15	0	19
13	0	20
13	0	21
10	0	22
12	0	23
12	0	24
11	0	25
6	0	26
13	0	27
7	0	28
10	0	29
10	0	30



d. Self-confrontation interview guide:

Interview Topic Guide	
Topic	**Questions**
Injury perception	**a. How would you describe your overuse shoulder injury? (Pain, range of motion…)** **b. How did it affect you? (Performance, effort, absence from training, psychological effect…)** **c. How did you deal with this injury?** **d. How did your injury affect your team?** **e. How did the coach deal with your injury? Did he refer you to a physiotherapist or medical specialist?** **f. How did the club and/or Federation deal with your injury?** **g. Was a physiotherapist involved in your recovery process?**
Factors influencing injury	**What are the factors that contributed to this injury?**
Injury prevention	**a. Who is responsible for injury prevention?** **b. Do you believe physiotherapy can help prevent injuries?** **c. What do you think is required for sports injury prevention in Kuwait?**

e. Conclude the interview by asking the player if he would like to add anything.

8.7 Appendix G

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	(a) 82
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	(b) N/A It is not a published paper and it is a part of thesis.
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	83-85
Objectives	3	State specific objectives, including any prespecified hypotheses	85
Methods			
Study design	4	Present key elements of study design early in the paper	86
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	86-94
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	87-88, 94-95
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	89-93, 95-99
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	89-93

Bias	9	Describe any efforts to address potential sources of bias	119-124
Study size	10	Explain how the study size was arrived at	86-87
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	95-99
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	99-101
		(*b*) Describe any methods used to examine subgroups and interactions	99-101
		(*c*) Explain how missing data were addressed	96-98
		(*d*) If applicable, explain how loss to follow-up was addressed	96-98
		(*e*) Describe any sensitivity analyses	99
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	94-95
		(b) Give reasons for non-participation at each stage	94-95
		(c) Consider use of a flow diagram	94-95 clearly described in text
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	101-102
		(b) Indicate number of participants with missing data for each variable of interest	96-98
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	102-107

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	102-107
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	99
Discussion			
Key results	18	Summarise key results with reference to study objectives	108-118
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	119-124
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	124-126
Generalisability	21	Discuss the generalisability (external validity) of the study results	118-119
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

g.

h. *Give information separately for exposed and unexposed groups.

i.

j. **Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

8.8 Appendix H

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	127
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	N/A It is not a published paper and it is a part of thesis.
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	128-129
Objectives	3	State specific objectives, including any prespecified hypotheses	130
Methods			
Study design	4	Present key elements of study design early in the paper	162-163
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	164-165
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	163
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	166-168
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	164
Bias	9	Describe any efforts to address potential sources of bias	178
Study size	10	Explain how the study size was arrived at	164
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	166-167
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	167-169

		(*b*) Describe any methods used to examine subgroups and interactions	166
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	163
		(*e*) Describe any sensitivity analyses	168
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	166
		(b) Give reasons for non-participation at each stage	166
		(c) Consider use of a flow diagram	166-167 clearly described in text
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	166
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	167
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	168
Discussion			
Key results	18	Summarise key results with reference to study objectives	169-171
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	178
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	172-176
Generalisability	21	Discuss the generalisability (external validity) of the study results	179

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

8.9 Appendix I

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

No	Item	Guide questions/description	Response
Domain 1: Research team and reflexivity			
Personal Characteristics			
1.	Interviewer/facilitator	Which author/s conducted the interview or focus group?	Tasneem Alnaser, PhD candidate (Physiotherapist) conducted all interviews.
2.	Credentials	What were the researcher's credentials? E.g. PhD, MD	Tasneem hold Bachelors (Kuwait University) and Master of Science (Sheffield Hallam University, UK) degree in Physiotherapy, and are certified orthopedic manual therapy via Curtin university (Perth)
3.	Occupation	What was their occupation at the time of the study?	Tasneem was full-time PhD student sponsored by Kuwaiti government while she is holding her occupation as physiotherapist in Kuwaiti hospital.
4.	Gender	Was the researcher male or female?	Female
5.	Experience and training	What experience or training did the researcher have?	Tasneem PhD training regimes included plentiful instruction in qualitative data collection and analysis, and she have variety of seminars holded in the university and different conferences.
Relationship with participants			
6.	Relationship established	Was a relationship established prior to study commencement?	A relationship was established with a contact person at each participating case company. The contact person then facilitated the recruitment of interview participants.
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? *e.g. personal goals, reasons for doing the research*	All participants were introduced at the beginning of the interview to the goals and procedure of the research project, both in writing and from an intro script read at the beginning of each interview. A professional introduction to the interviewer was provided to participants.
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? *e.g. Bias, assumptions, reasons and interests in the research topic*	Tasneem has good communication with participants previously since the preliminary study. She conducted two quantitative studies before interviewing. This established some assumptions and questions required to be clarified via qualitative study.
Domain 2: study design			
Theoretical framework			
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? *e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis*	Thematic Analysis according to the 6-phase model described by Braun and Clarke (2019).
Participant selection			
10.	Sampling	How were participants selected? *e.g. purposive, convenience, consecutive, snowball*	Purposive sampling was used in the beginning of the sampling process to enable the researcher to recruit participants.

11.	Method of approach	How were participants approached? *e.g. face-to-face, telephone, mail, email*	An invitation letter and participant information sheet were sent to potential participants by text messages. The participants were interviewed via the ZOOM meeting.
12.	Sample size	How many participants were in the study?	Seven
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	Fifteen participants declined to take part for different reasons (e.g., not prefer to continue in study or don't want to be video recorded). Some of the participants (n=4) after the interview appointment was scheduled, they didn't attend the appointment or replied to the researcher reminder messages.
Setting			
14.	Setting of data collection	Where was the data collected? *e.g. home, clinic, workplace*	The participants interviewed via ZOOM Application.
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	No
16.	Description of sample	What are the important characteristics of the sample? *e.g. demographic data, date*	Age range (yrs.) = 27 (6) Body mass range (Kg) = 77 (13) Height range (cm) = 183 (8) Practicing years range = 16 (7) Interview period: April-May 2021
Data collection			
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	The interview questions have been added as an appendix to reports and some publications, when space allows. Yes, the questions to male competitive volleyball players were pilot tested.
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes, visual (video) recordings were made of all interviews
20.	Field notes	Were field notes made during and/or after the interview or focus group?	Yes, but only for supportive purposes and to cover attribute or organizational information for each interviewee. The researchers relied mainly on transcribing the recordings.
21.	Duration	What was the duration of the interviews or focus group?	36 minutes on average (23-48 minutes).
22.	Data saturation	Was data saturation discussed?	This is discussed in the project report (thesis).
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No; this was deemed unfeasible due to long time delays.
Domain 3: analysis and findings			
Data analysis			
24.	Number of data coders	How many data coders coded the data?	1-2 people (TA, LA)
25.	Description of the coding tree	Did authors provide a description of the coding tree?	Yes
26.	Derivation of themes	Were themes identified in advance or derived from the data?	The codes were organized into potential themes, using the study aims as a guide. The themes were then defined and named according to the socioecological framework.

27.	Software	What software, if applicable, was used to manage the data?	Microsoft Word Document
28.	Participant checking	Did participants provide feedback on the findings?	No (mainly due to time delays)
Reporting			
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? *e.g. participant number*	Yes (to both)
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31.	Clarity of major themes	Were major themes clearly presented in the findings?	Yes
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	No diverse cases were identified, however minor themes were discussed.