KINEMATIC AND FUNCTIONAL ANALYSIS OF ROTATOR CUFF EXERCISE AMONG DIYALA UNIVERSITY VOLLEYBALL PLAYERS WITH SHOULDER PAIN

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SULTAN IDRIS EDUCATION UNIVERSITY

2024

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05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

FACULTY OF SPORT SCIENCE AND COACHING
SULTAN IDRIS EDUCATION UNIVERSITY

2024

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ACKNOWLEDGEMENT

I thank Allah Almighty for His blessing during all my life and during the study time. I would like to dedicate this thesis to the beloved Prophet Muhammad, may blessings and peace be upon him.

I'd like to thank “Universiti Pendidikan Sultan Idris” for allowing me to complete my thesis with the numerous resources offered, including facilities and online resources.

Special gratitude for my supervisor “TS. Dr. Mohd Yusof bin Baharuddin” who was the best supporter throughout my studies. He gave me up important time to patiently guide me and offer me helpful recommendations when I was having difficulties. His counsel and support have aided me in keeping my research on track and completing my thesis. I would also like to thank all my professors who supported me in my studies.

Finally, I would like to dedicate this thesis to my late father Muhammad Abbas Al-Taie (May Allah rest his soul), my mother, may God prolong her life and to my brothers and sisters, my support in this life and for their advices, and encouragements along the way. I also want to express my gratitude to my family who emotionally supported me during my research and thesis writing and for displaying their understanding of any event during the research.

ABSTRACT

This study aims to examine the effect of rotator cuff exercise (RCE) based on the kinematic analysis, functionality, and pain among Diyala University volleyball players who are experiencing shoulder pain. This study was conducted on 30 volleyball players and divided randomly into two groups: i) the control group who performed general exercise, and ii) the experimental group who conducted the RCE for six weeks. The RCE consists of the serratus anterior strengthening exercises, trapezius strengthening exercises, and glenohumeral strengthening exercises. This study applied three questionnaires to measure the effect of the intervention program: i) visual analogue scale (VAS), ii) Disabilities of the Arm, Shoulder and Hand (DASH) score, and iii) Western Ontario Rotator Cuff (WORC) index. One-way MANCOVA demonstrated that there was a statistically significant difference between the control and experimental group for DASH and VAS, $F(2, 25) = 174.9$, $p < 0.0005$, Wilks' $\Lambda = 0.067$, partial $\eta 2 = .933$. There was also statistically significant difference for WORC, $F(7, 15) = 10.13$, $p = 0.00$, Wilks' $\Lambda = 0.175$, partial $\eta 2 = .902$. All kinematic parameters demonstrated statistically significant differences ($p \leq 0.05$) except for the wrist angle ($p=0.59$), jump height ($p=0.58$), and range of motion ($p=0.59$). In conclusion, this study demonstrated that RCE lessens the volleyball player's shoulder pain and enhances functionality and movement during spikes. As implications, RCE intervention improved the player's spiking performance and aided practitioners in managing shoulder pain, which frequently occurs in volleyball players.

ANALISIS KINEMATIK DAN FUNGSI LATIHAN ROTATOR CUFF DI KALANGAN PEMAIN BOLA JARING IRAK DI UNIVERSITI DIYALA YANG MENGALAMI SAKIT BAHU

ABSTRAK

Kajian ini bertujuan mengkaji kesan program senaman *rotator cuff* (RCE) menggunakan analisis kinematik, kefungsian, dan, kesakitan di kalangan pemain bola tampar Universiti Diyala yang mengalami sakit bahu. Kajian ini dijalankan ke atas 30 pemain bola tampar yang telah dibahagikan secara rawak kepada dua kumpulan: i) kumpulan kawalan yang melakukan senaman am, dan ii) kumpulan eksperimen yang menjalankan RCE selama enam minggu. RCE terdiri daripada senaman pengukuhan *serratus* hadapan, senaman pengukuhan *trapezius*, dan senaman pengukuhan *glenohumeral*. Kajian ini menggunakan tiga soal selidik untuk mengukur kesan program intervensi: i) *visual analogue scale* (VAS), ii) skor *Disabilities of the Arm, Shoulder and Hand* (DASH), dan iii) indeks *Western Ontario Rotator Cuff* (WORC).. Analisis MANCOVA sehala menunjukkan bahawa terdapat perbezaaan statistik yang signifikan di antara kumpulan kawalan dan kumpulan eksperimen bagi DASH dan VAS, $F(2, 25) = 174.9$, $p < 0.0005$, Wilks' $\Lambda = 0.067$, partial $\eta 2 = .933$. Terdapat juga perbezaaan statistik yang signifikan bagi WORC, $F(7, 15) = 10.13$, $p = 0.00$, Wilks' $\Lambda = 0.175$, partial $\eta 2 = .902$. Kesemua parameter kinematic menunjukkan terdapat perbezaan statistik yang signifikan ($p \leq 0.05$) kecuali bagi sudut pergelangan tangan ($p=0.59$), tinggi lompatan ($p=0.58$) dan julat pergerakan ($p=0.59$). Kesimpulannya, kajian ini menunjukkan bahawa RCE dapat mengurangkan kesakitan bahu pemain bola tampar, meningkatkan kefungsian dan pergerakan ketika rejaman. Implikasi RCE adalah dalam penambahbaikan prestasi rejaman pemain dan membantu pengamal mengurus kesakitan bahu yang seringkali berlaku kepada pemain bola tampar.

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LIST OF ABBREVIATIONS

ACL	Anterior Cruciate Ligament
AHD	Acromiohumeral Distance
ANOVA	Analysis of variance
AT	Alternative Spike Technique
BMI	Body mass index
CMS	Constant-Murley score
DASH	Disabilities of the Arm, Shoulder, and Hand questionnaire
DHC	Dynamic humeral centring
DLT	Direct Linear Transformation
EMG	Electromyography
ER	External rotation
ES	Effect size
GIRD	Glenohumeral internal rotation deficit
HAQ	Health Assessment Questionnaire
HRQOL	Health-related quality of life
ICF	International Classification of Functionality
IR	Internal rotation
IRD	Internal rotation deficit
NBA	National Basketball Association
NSAID	Non-steroidal anti-inflammatory drugs

PRMD	Playing-related musculoskeletal diseases
PROM	Patient-reported outcome measure
QOL	Quality of life
RC	Rotator cuff
RCE	Rotator cuff exercise
RCSP	Rotator cuff-related shoulder pain
RCT	Randomised clinical trials
ROM	Range of motion
RPS	Revolutions per second
SAIS	Subacromial Impingement Syndrome
SEM	Structural equation model
SIS	Shoulder impingement syndrome
SFA	Scapula-focused methods
SPADI	Shoulder Pain, and Disability Index
SPS	Subacromial pain syndrome
SPSS	Statistical Package for Social Sciences
SRM	Standard Arabic response mean
TR	Total Rotation
TRM	Total rotation motion
TT	Traditional Spike Technique
UK	United Kingdom
VAS	Visual Analog Scale
WORC	Western Ontario Rotator Cuff Index

APPENDIX LIST

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter discusses the background study of the volleyball spike and injuries related to the shoulder. Then, the problem statement explains the prevalence of volleyball player-acquired shoulder injuries. The research objectives were discussed, followed by the research questions and hypotheses. Finally, the limitations and significance of the study are explained.

1.2 Background of Study

Volleyball, a popular team sport played worldwide and an Olympic staple involves two teams of six players, each competing to bring the ball to the opponent's floor. Common mistakes include touching the ground outside one's court, double hits, and net violations like foot faults. Serving, spiking, and blocking are crucial elements of volleyball performance, with spikes being fundamental offensive skills that require a wide range of motion and high vertical leaps to achieve a steeper ball trajectory and effective field

size. Research has shown that jumping performance is essential for success in volleyball, with higher competition levels correlating with increased jumping abilities. Successful spikes are directed strategically, with studies analysing ball trajectory variations in three dimensions to optimize performance (Fuchs et al., 2021; Obara et al., 2022).

Volleyball, an Olympic sport requiring a diverse skill set, emphasizes the importance of a strong spike as a key offensive strategy for scoring goals. Players strive for height in their leaps during spikes to enhance their range of motion, control the ball's trajectory, and increase the court's effective size. However, the high-intensity demands of volleyball, including sprinting and leaping at top speed, make players susceptible to both traumatic and overuse injuries (Qi, 2021). Despite the sport's popularity and the increasing number of participants, volleyball-related injuries have been on the rise. The spike, a fundamental assault action in volleyball, significantly impact the final score, with attack tempo playing a crucial role in the spiker's performance (Chojęta et al., 2020). Success in executing a spike relies on various physical and psychological factors captured by kinematic variables and ball speed after the hit.

Three-dimensional kinematic studies have provided valuable insights into spike performance, highlighting differences related to sex, experience level, technique, and injury prevention(Serrien et al., 2016). While there is no consensus on technique variances between male and female players, male athletes demonstrate a deeper understanding of technical and coordination distinctions contributing to spike jump success. Factors such as step length, maximum angular velocity of the dominant knee extension, dynamic arm swing, countermovement, range of motion in lower limbs, and

angular velocities in ankles and knees are crucial for achieving optimal jump height in volleyball spikes (Xu et al., 2021).

Volleyball players must possess a combination of technical proficiency and physical prowess to excel in the sport. The ability to spike, block, or serve from a leap necessitates exceptional jumping skills. While similarities exist between the volleyball spike jump (SPJ) and the vertical leap (VJ) from a standing position, the SPJ stands out due to features like converting horizontal energy gained from stepping into vertical energy during take off, enabling players to achieve significant leaping height. The relationship between the height of the standing vertical jump (SPJ), horizontal leaping ability, and lower joint kinetic values in vertical and horizontal leaps remains a topic of interest.

Factors such as take-off vertical velocity, third-step horizontal velocity, and the deceleration of horizontal velocity during takeoff have been linked to SPJ height in female volleyball players. Coaches can leverage these insights to design effective technical and strength training programs tailored to enhance SPJ performance in female collegiate volleyball players. Additionally, understanding the positive correlations between hip and ankle power in the standing long jump (SLJ), knee power in the vertical jump (VJ), and the vertical and horizontal velocities of SPJ can further inform training strategies aimed at improving overall performance (Gupta et al., 2021; Ikeda et al., 2018; Slovák et al., 2022).

Volleyball, with the second-highest participation rate globally, poses a significant risk of injuries to players, particularly in the lower extremities, due to the sport's emphasis on high-intensity jumping. Overuse injuries to the shoulder are prevalent among volleyball athletes, attributed to the repetitive overhead actions

involved in spiking and blocking. Common volleyball-related injuries include shoulder injuries, rotator cuff tendinitis, finger injuries, ankle sprains, patellar tendinitis, ACL injuries, and low-back pain. Subacromial Impingement Syndrome (SAIS) accounts for up to 65% of shoulder pain complaints, making it the most common shoulder condition. Studies have shown a high incidence of rotator cuff tendonitis, with a significant proportion of individuals seeking treatment for shoulder discomfort, particularly those engaged in sports like volleyball, swimming, and handball, as well as occupations requiring prolonged overhead arm positioning (Fatahi et al., 2019; Lin et al., 2018; May & Garmel, 2019; Rincón-Hurtado et al., 2018; Roy et al., 2017; Tooth et al., 2020).

Glenohumeral Internal Rotation Deficit (GIRD) is a common condition not exclusive to volleyball players, characterized by decreased internal rotation and increased external rotation of the shoulder. Changes in eccentric external-rotator strength decreased concentric internal-rotator strength, and alterations in the ER: IR ratio are associated with GIRD onset. Repetitive actions involving 90 degrees of shoulder abduction and ER less than 90 degrees can lead to excessive posterior capsular tightening, causing anterior and superior humeral head displacement during throwing actions.

The pathophysiology of Subacromial Impingement Syndrome (SAIS) remains unclear, with ongoing debate on whether impingement causes intrinsic damage to rotator cuff tendons or if impingement itself is the primary source of tendon damage. The intrinsic mechanism hypothesis, focusing on inadequate blood supply to the supraspinatus tendon insertion, has gained traction in recent years. Rotator cuff-related pain encompasses various structural diagnoses like subacromial pain, rotator cuff tendinopathy, and degenerative cuff ruptures, presenting as pain and disability during

shoulder movements, particularly flexion and outward rotation. Diagnostic tests such as isometric outward rotation, painful arc signs, and the Hawkins-Kennedy test demonstrate good reliability and specificity in identifying rotator cuff-related pain (Moradi et al., 2020; Saccol et al., 2021; G. Singh, 2019; Telles et al., 2021).

Shoulder injuries are prevalent in volleyball, accounting for 8 to 20 per cent of all volleyball-related injuries. Overhead sports like volleyball place high demands on the shoulder joint due to its mobility and lack of stability, making it prone to injury. Shoulder discomfort and dysfunction are common, with spiking and serving being identified as primary causes of harm. The unique overhead abilities in volleyball, such as spiking and serving, generate significant power and torque in the upper body, increasing the risk of shoulder injuries. Overuse is a leading cause of shoulder pain in volleyball players, with varying types of serves and spikes exerting different kinetics on the shoulder. Proper strength is crucial for optimal performance and reducing vulnerability to shoulder injuries in athletes engaging in overhead sports like volleyball (Chaconas et al., 2017; Flores Santy et al., 2022; Leong et al., 2019; Littlewood et al., 2019; Spargoli, 2018).

Overuse injuries in volleyball players, particularly related to the shoulder, are prevalent due to the high workload and repetitive motions involved in the sport. Shoulder pain in overhead athletes is often attributed to impingement, glenohumeral instability, and musculoskeletal immaturity. Risk factor identification and appropriate therapy are crucial for the recovery of these athletes (Mendez-Rebolledo et al., 2018). Seminati et al. (2015) conducted a study on overuse injuries in volleyball spikes, comparing traditional and alternative spike techniques. The findings suggested that the alternative technique may help prevent chronic shoulder diseases by reducing shoulder

flexion during spiking, thus emphasizing the importance of proper technique to mitigate shoulder injuries in volleyball players. Muscle imbalances, altered force ratios, and overload are identified as primary risk factors for rotator cuff-related pain, highlighting the significance of maintaining proper strength ratios and monitoring training loads to reduce the risk of injury (Asker et al., 2018; Colbert et al., 2022; Karabay et al., 2020). Shoulder overuse injuries manifest as discomfort, weakness, and reduced range of motion, often stemming from eccentric overload and repetitive stresses on the rotator cuff muscles and capsule (Fritz et al., 2020; Sakata et al., 2018; Telles et al., 2021).

In overhead throwers, including baseball pitchers and athletes in sports like volleyball, cricket, and handball, overuse can significantly increase the risk of shoulder injuries. Factors such as pitching frequency, intensity, and mechanical stress from repetitive motions contribute to morphological changes in the shoulder, predisposing athletes to injuries. Pitchers who continue throwing despite discomfort face a higher risk of damage, emphasizing the importance of recognizing and addressing pain promptly. Volleyball players, in particular, are prone to shoulder injuries due to the repetitive nature of serves and smashes, highlighting the need for injury prevention strategies tailored to the demands of the sport. Overall, identifying risk factors and implementing preventive measures based on these factors is crucial in reducing the prevalence of shoulder disorders in athletes across various sports) (Castagna et al., 2021; Hanrahan & Luigi, 2018; Marshall, 2018).

Overuse injuries in volleyball players, particularly related to the shoulder, are prevalent due to the repetitive nature of spiking and serving motions. The high volume and intensity of training, along with the forceful overhead movements executed during matches, contribute to the development of shoulder pathologies such as anterior

instability and impingement syndrome. The biomechanics of the volleyball spiking motion, which involves contacting the ball while in mid-air using the upper arm and torso, further increases the risk of shoulder injuries. Factors like subacromial impingement, glenohumeral instability, scapular dyskinesia, mobility limitations, and muscle imbalances are common in volleyball players, highlighting the need for preventive measures and proper training techniques to maintain shoulder health and performance (Eisner & Bajaj, 2020; Lin et al., 2018; Oliver et al., 2020).

In volleyball, spikes play a crucial role in determining match outcomes, requiring high coordination and involving various phases such as a run, countermovement jump, powerful overhead moves, and landing. Understanding the kinematic features of the volleyball spike can aid coaches, athletes, and researchers in designing more effective training sessions and improving tactical aspects. Early detection of discomfort and dysfunction is vital in preventing injuries in overhead throwers, with a focus on addressing the "thrower's conundrum" related to shoulder stability during throwing motions. Non-operative rehabilitation methods are essential for managing shoulder injuries in athletes, emphasizing long-term shoulder health and function post-retirement.

Rehabilitation treatment after a shoulder injury aims to restore range of motion, strength, stability, and neuromuscular control through specific therapy areas and progressive rehabilitation stages. Conservative treatments, including exercise therapy and subacromial injections, are effective for managing shoulder impingement syndrome. Sports injuries in volleyball often result from poor training techniques, structural issues, muscle weaknesses, and overuse, with rotator cuff tendinitis being a

common and challenging injury to treat in volleyball players (Chojęta et al., 2020; Contemori & Biscarini, 2018; Pereira et al., 2019; Shih & Wang, 2019).

1.3 Problem Statement

Shoulder pain is a common problem in sports and a common cause of missed training time or missed matches. In sports, there are studies in volleyball where shoulder problems came up third and fourth place among the most common injuries and where the incidence of acute or chronic shoulder pain is reported to be between 30-45% of the population and is one common cause of missed training time and missed matches (Fritz et al., 2020). Among volleyball players, shoulder pain is its most common problem, with an incidence of between 40-91% (Wunder, 2020), but large differences occur depending on age, competition level, amount of training, time of the season and depending on the definition of shoulder pain (Creech & Silver, 2021).

Eight per cent to twenty per cent of volleyball-related injuries are connected to the shoulder (Blankenship et al., 2019). With an injury incidence of 0.65 per 1000 athlete exposures, the National College Athletic Association's Injury Surveillance System data show that shoulder difficulties rank third overall as a cause of time-loss injuries in women's collegiate volleyball (Baugh et al., 2018). The repercussions of shoulder injuries that cause significant time off work are not insignificant. Shoulder injuries are the most detrimental to a volleyball player's career, with Reddy & Reddy (2020) reporting a mean time loss of 6.2 weeks. During the 2-year research period, Eshghi et al. (2022) found that almost 40% of English first-division male volleyball players missed practice or competition due to shoulder injuries.

Volleyball has significant potential for shoulder injury due to its repetitive nature, especially spiking, which is the most explosive, with speeds reported up to 28 m/s in elite players (Fuchs et al., 2019). Despite the high incidence of shoulder injuries to volleyball players in Iraq, which is reported to be nearly 30 per cent annually, there are still not enough preventive programs initiated (Giatsis et al., 2022). Thus, intervention programs to minimize the prevalence of shoulder injuries are vital in volleyball. The exercise regimen is used in various studies to reduce the shoulder pain caused by rotator cuff injuries. Exercise is a more favourable treatment option compared to surgery in shoulder pain-related cases (Desmeules, Boudreault, Dionne, et al., 2016; Littlewood et al., 2012; Mulligan et al., 2016; Roy et al., 2017). Hence, this study proposes a rotator cuff exercise program that focuses on several major muscles in the shoulder joint, such as the trapezius, serratus anterior, and glenohumeral.

The proposed intervention programs involve a six-week exercise program strengthening the muscles in the shoulder joint, which is crucial in improving function and reducing symptoms of shoulder pain that occur to volleyball players, especially during spiking. Moreover, the kinematic analysis helps determine the correct position of the spiking technique, which assists the coaches in analysing and correcting the volleyball player's movement. The information, such as the velocity of the ball and the angle of the shoulder, provides accurate information and feedback to the player during training. The effect of the exercise was evaluated based on the Western Ontario Rotator Cuff (WORC) index, and Disability Arm, Shoulder, and Hand (DASH) score and pain using Visual Analogue Scale (VAS) during volleyball spiking were measured at Week 0 3 and 6.

1.4 Research Objectives

The aim of this study is:

1. To analyze the effect of the rotator cuff exercise among Diyala university volleyball players.
2. To investigate how the rotator cuff exercise impacts the kinematic characteristics of spiking in Diyala university volleyball players.
3. To analyze the effect of the rotator cuff exercise program on shoulder pain among Diyala university volleyball players.
4. To investigate the effect of the rotator cuff exercise program on functionality among Diyala university volleyball.

1.5 Research Questions

The research aims to answer the following questions:

1. What is the effect of the rotator cuff exercise program on volleyball players experiencing shoulder pain?
2. How does the rotator cuff exercise program affect the kinematic features of the volleyball spike among Diyala university volleyball players?
3. How does the rotator cuff exercise program affect the functionality among Diyala university volleyball players?

1.6 Research Hypotheses

This section outlines the research hypotheses that guide the study. Research hypotheses are essential as they provide a clear and testable statement regarding the expected relationship between variables. These hypotheses are formulated based on the theoretical framework and literature review, serving as a foundation for the research design and methodology. By establishing specific hypotheses, the study aims to explore and validate the anticipated outcomes, thereby contributing to the broader understanding of the research topic.

H1: The rotator cuff intervention exercise program has a significant effect on disability/symptoms among Diyala university volleyball players.

H2: The rotator cuff intervention exercise program has a significant effect on functional status among Diyala university volleyball players.

H2a: The rotator cuff intervention exercise program has a significant effect on physical symptoms among Diyala university volleyball players.

H2b: The rotator cuff intervention exercise program has a significant effect on sports-related activity among Diyala university volleyball players.

H2c: The rotator cuff intervention exercise program has a significant effect on work-related activities among Diyala university volleyball players.

H2d: The rotator cuff intervention exercise program has a significant effect on lifestyle-related activities among Diyala university volleyball players.

H2e: The rotator cuff intervention exercise program has a significant effect on emotions-related functions among Diyala university volleyball players.

H3: The rotator cuff intervention exercise program has a significant effect on shoulder pain among Diyala university volleyball players.

H4: The rotator cuff intervention exercise program has a significant effect on kinematic parameters among Diyala university volleyball players.

H4a: The rotator cuff intervention exercise program has a significant effect on shoulder angle among Diyala university volleyball players.

H4b: The rotator cuff intervention exercise program has a significant effect on elbow angle among Diyala university volleyball players.

H4c: The rotator cuff intervention exercise program has a significant effect on wrist angle among Diyala university volleyball players..

H4d: The rotator cuff intervention exercise program has a significant effect on jump height among Diyala university volleyball players.

H4e: The rotator cuff intervention exercise program has a significant effect on hand velocity among Diyala university volleyball players.

H4f: The rotator cuff intervention exercise program has a significant effect on ball velocity among Diyala university volleyball players.

H4g: The rotator cuff intervention exercise program has a significant effect on the range of motion among Diyala university volleyball players.

1.7 Conceptual Framework

The conceptual framework enables the researcher to demonstrate the relation between the studied concepts and constructs as it links the concepts, empirical research and theoretical background used in systemizing the information adopted by the researcher (Adom et al., 2016). The conceptual framework is also used to demonstrate how the research problem would be explored as it offers an integrated means through which the under-study problem is viewed (Liehr & Smith, 2017). The conceptual framework provides a description of the association among the main notions of the research. It provides a visual display of the relation of the study variables (Osanloo & Grant, 2016).

The concept is believed to add various benefits to study. It enables the researcher to demonstrate and construct the view of the variables to be investigated (Osanloo & Grant, 2016). It is considered the most straightforward method through which the variables are linked together. It emphasizes the motives of studying the research topic (Evans, 2007).

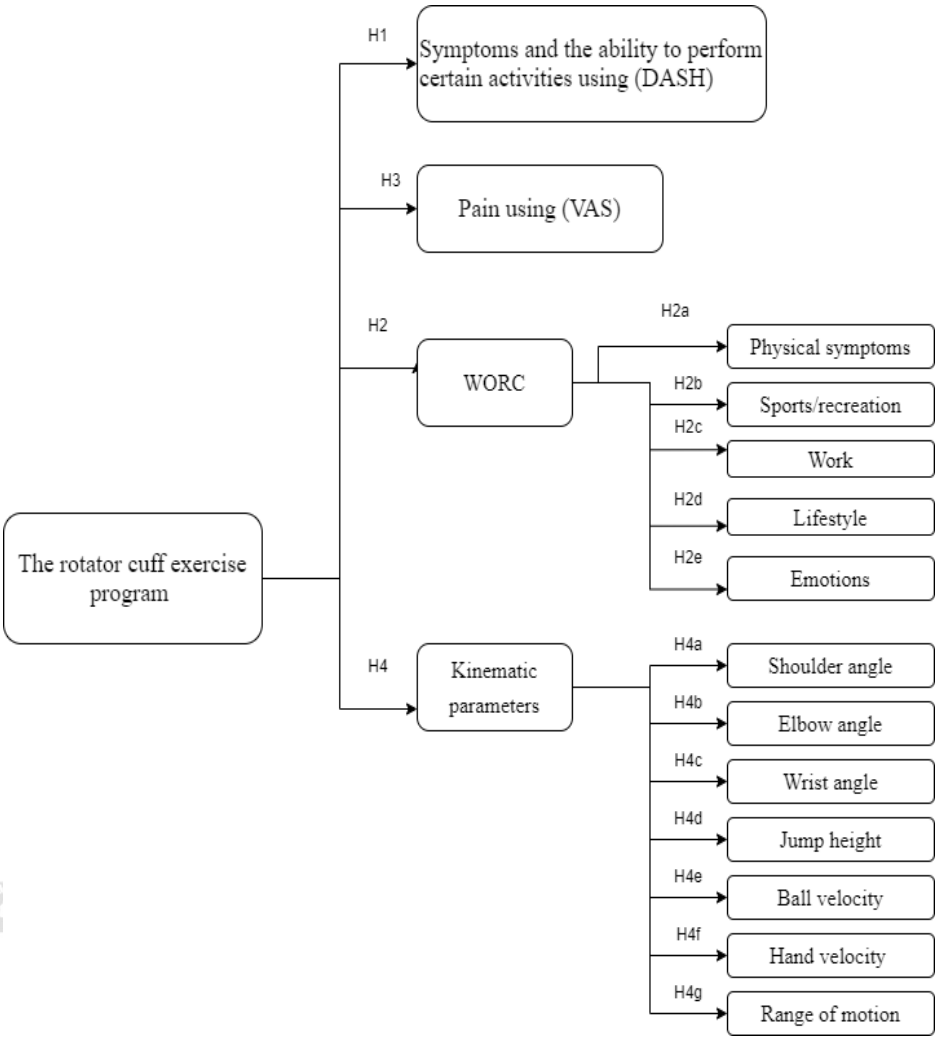

Figure 1.1. The conceptual framework

1.8 Operational Definitions

Biomechanical Analysis

Biomechanics is the science that analyses not only human movements based on the physical description (kinematics) but also identifies the causes of mathematical movement (Kinetics) in order to ensure economy and efficiency in the effort (Dutton et al., 2020).

Kinematic

Kinematics is the form pattern or sequencing of movement with respect to time (Dowling et al., 2020).

Shoulder

The shoulder joint is one of the greatest anatomical and structural structures in the human body. Its natural place is on the shoulder blade, so there are muscles, tendons, and ligaments that cover it, which is the only joint that allows 360 ° rotation. The rotator cuff is a group of muscles and tendons surrounding the shoulder joint (Burkart & Debski, 2002).

Shoulder pain

Shoulder pain, as defined in the research, refers to the discomfort, soreness, or sensation of pain experienced in the shoulder region by volleyball players, particularly those suffering from rotator cuff tendinopathy. This pain may be associated with movement, overhead activities, sports performance, or daily tasks (Jakobsen et al., 2018).

Rotator cuff

Rotator cuff injuries cause shoulder pain, which worsens when sleeping on the affected side. Shoulder joint injury is a frequent and frequent occurrence in athletes in most activities Sports, especially volleyball players, occur as a result of injury and are also common among players to Poor attention to warm-up exercises, especially warming up the upper limbs for being the key element in the performance of volleyball skills, or as a result of the large and wrong use of force, which is often accompanied by mistakes are the mechanical technical performance of the skill (Burkart & Debski, 2002).

Spiking

Spiking is one of the most frequently used scoring techniques in volleyball games, and around 80% of shoulder pain in volleyball players is linked to the spiking movement (Shih & Wang, 2019).

Functional analysis

Functional analysis involves the assessment and evaluation of the impact of the rotator cuff exercise program on volleyball players experiencing shoulder pain. This analysis focuses on measuring the effectiveness of the intervention in improving functional outcomes related to pain levels, symptoms, and the ability to perform various activities. It includes the evaluation of shoulder kinematic parameters such as shoulder angle, elbow angle, wrist angle, jump height, ball velocity, hand velocity, and range of motion to determine the functional changes resulting from the intervention program. The functional analysis aims to provide insights into the benefits of the rotator cuff exercise program in enhancing shoulder function and performance among volleyball players with shoulder pain.

Rotator cuff exercise

Rotator cuff exercise refers to a specific program or regimen designed to strengthen the muscles and improve the function of the rotator cuff in the shoulder joint. This exercise program is proposed as a targeted intervention to address shoulder pain and dysfunction experienced by volleyball players, particularly those with rotator cuff tendinopathy. The rotator cuff exercises included in the program aim to enhance muscle strength, stability, and coordination in the shoulder region, ultimately improving the overall shoulder function, reducing pain, and optimizing performance during volleyball.

1.9 Limitation of Study

This study involves the volleyball university players of Diyala University who play in the university league in Iraq. The limited duration while conducting this research is one of the limitations faced by the researchers. Furthermore, the lifestyle or activities performed by subjects outside the intervention program cannot be controlled. This study only focused on one type of volleyball spike, which is the straight spike jump, and the motion was analyzed using two-dimensional kinematic analysis.

1.10 Research Significance

This study contributes to the studies about the effect of the rotator cuff exercise program on volleyball players experiencing shoulder pain. The study will also be significant in similar contexts in overhead-throwing athletes in other sports such as baseball, softball, and tennis. The rotator cuff exercise aims to minimize shoulder pain by encompassing the strengthening exercise program of the rotator cuff and preventing shoulder injuries from occurring later. This study focuses on major shoulder muscles such as the trapezius, serratus and glenohumeral, which are crucial to strengthening a volleyball player's shoulder. Given the importance of shoulder pain and injuries in general or rotator cuff injuries in specific, as it relates to the quality of life continuation of the athletic career of volleyball players, the examination of the effect of the rotator cuff exercise program on the kinematic features of the volleyball spike among Diyala University volleyball players will provide a better understanding of how can the rotator cuff exercises enhance spike kinematic parameters such as shoulder angle, elbow angle, wrist angle, jump height, ball velocity, hand velocity and range of motion as the literature review found only very few studies have been done on the effect of rotator

cuff exercises on volleyball spike kinematic parameters. The support information of kinematic analysis during volleyball spikes is vital to look upon the correct position of spiking and to determine the shoulder range of motion if the players acquired shoulder pain. The couch would correct the player's position while performing a spike using the kinematic analysis, which could improve the possibility of getting points and prevent injuries due to malposition while performing a spike.

Contribution to studies examining the effect of exercise on the pain and functionality of volleyball athletes. The study uses the 30 items (DASH), 21- items WORC and (VAS). The study contributes to the WORC sub-dimensions, including Physical symptoms, Sports/recreation, Work, Lifestyle and Emotions, as it provides insights into how the rotator cuff exercise affects each sub-dimension of the WORC questionnaire. The study gives an idea to practitioners on the progress of the exercise program by monitoring the effect of the rotator cuff exercise on three weeks and six weeks of the proposed intervention. The proposed exercise intervention could initiate the intervention program to prevent this problem from prolonging, which could affect the volleyball team's performance.

This research adds value for volleyball players, coaches, trainers, and physical therapists by providing in depth view of the effect of the rotator cuff exercise on various kinematic parameters and functionality. This will help practitioners understand how to deal with shoulder pain caused by rotator cuff injury among volleyball players, as it's a common problem. The recommendations made by the research will help in providing better management of shoulder pain in overhead athletes.

1.11 Thesis Outline

There are five chapters in this thesis:

The first chapter gives an overview of the study's subject, the effect of the rotator cuff exercise program on Iraqi volleyball players experiencing shoulder pain. This chapter provides background information on shoulder injuries, their prevalence among overhead-thrown athletes, the risk factors associated with shoulder injuries and the machoism of shoulder overuse injury. This chapter also provides a formulation of the problem. The chapter also provides the research questions, objectives, hypotheses, and limitations and operational definitions.

The second chapter, which is the literature review, provides an in-depth review of the anatomy of the shoulder joint. The Shoulder biomechanics and kinematics are examined in this chapter. Sections of the review deal with the effect of a shoulder injury on individuals and the physical symptoms associated with shoulder injuries. The chapter goes to great length about the effect of shoulder injuries on emotions, work, and lifestyle, as well as its common measures in literature, including WORC and DASH. Studies on the kinematic analysis in volleyball are included in the reviewed literature in an attempt to provide a comprehensive overview of the biomechanical parameters of spike serve. There are investigations on exercise or physical therapy in the treatment of rotator cuff tendinopathy. Studies were separated into subcategories based on their topic related to the effect of shoulder injuries on emotions, work and lifestyle, kinematic analysis in volleyball and exercise or physical therapy in the treatment of rotator cuff tendinopathy. A research gap is identified by analysing the studies that have been evaluated.

The third chapter is the methodology. This chapter will cover the data-gathering processes, tactics, and methodologies employed in this study, an explanation of the study's methodology, as well as the research instrument employed. Also covered in detail is the analysing process itself. Analytical studies foundations are created in this chapter by reflecting on the methodological framework, as well as operational problems. A brief introduction to the research's main strategy, including explicit explanations for the usage of various testing methodologies, is presented initially. Then, clearly defined data-collecting methods and research designs are presented secondly. Data planning and interpretation are presented in the preparatory phase of the study to prepare for data assessment and consideration of study findings in later stages.

The fourth chapter, which is the data analysis and results in this chapter's goal, is to provide an evaluation of the pertinent data gathered during the Iraq field study. The findings of the questionnaire survey, as well as the results of the hypothesis testing MANCOVA, are presented in this chapter.

The fifth chapter is the conclusion and recommendations. This summarises the results and debates in light of the previous studies, study goals and questions. The practical and theoretical contributions of this study are also highlighted in this chapter. It also includes practical suggestions. The fifth chapter also includes the researcher's recommendations for future study.