PERSISTENT OVERUSE INJURIES IN THE OVERHEAD ATHLETE

A THESIS

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THESIS APPROVAL

Graduate Athletic Training Education

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Constant overhead motion in an athlete can lead to many biomechanical errors, range of motion deficits and muscular imbalances; further predisposing an athlete to injury. Many overhead athletes injure their shoulder season after season, creating an unstable shoulder for the rest of their careers. It is possible that improper management of these injuries in their initial stages could have contributed to the long-term nature of conditions, such as rotator cuff tendonitis, bicipital tendonitis, shoulder instability and impingement syndrome.

The purpose of this study is to recognize the persistent overuse injuries occurring in the overhead athlete and examine the effective ways to treat and prevent these injuries. Specifically this study will examine the time of the initial onset of these overuse injuries and the initial treatment rendered.

In a study examining the incidence of shoulder injuries among collegiate overhead athletes, thirty-percent of intercollegiate overhead athletes experienced a shoulder injury at some point in their career.[1] Volleyball players experienced the highest incidence of injury, having a 43% incidence rate of shoulder injuries. When looking at specific injuries, subacromial impingement syndrome and rotator cuff tendonitis account for 27% and 24% of the total shoulder injuries. Significantly higher incidence rates were found for baseball players diagnosed with subacromial impingement, softball players diagnosed with subacromial impingement and rotator cuff tendonitis and swimmers diagnosed with subacromial impingement, rotator cuff tendonitis, and bicipital tendonitis. No significant differences were reported for the incidence rates of shoulder disorders among volleyball players. These results show that overhead athletes are suffering from a variety of overuse injuries based on the demands of the sport. Due to the high incidence of overuse shoulder injuries in the overhead athlete, it is important to understand the effective ways to prevent and treat these injuries.

For many years, several different stretching techniques have been used for preventative treatment before and after performing overhead motions in an attempt to lengthen the soft tissue,[2] allowing the shoulder complex to move through a full range of motion. Laudner et al[2] and Oyama et al[3] examined the effects of the sleeper stretch on shoulder range of motion. Laudner et al[2] found that the side-lying sleeper stretch produced a 2.3° increase in posterior shoulder motion and a 3.1° increase in internal rotation for the group containing baseball players. Oyama et al[3] found that the sleeper stretch at 45°, sleeper stretch at 90° and the horizontal cross-arm stretch produced a 4.3° increase in internal rotation and a 3.4° in horizontal adduction. The increase in range of motion produced through stretching will allow the athlete to participate in the sports specific movements required in their sport. If the athlete is not able to move freely throughout the full range of motion, it can lead to more force being placed on the shoulder throughout overhead movements.[2,3] Decreasing the amount of force being placed on the dynamic stabilizers of the shoulder can ultimately decrease the athletes risk of injury.

Van de Velde et al[4] examined the effects of a sports specific, twelve week training program on muscular strength, muscular endurance, side-to-side differences in strength and protractor/retractor ratio. The 18 swimmers were split into 2 groups based on which program they would complete; a muscular endurance or muscular strength training program. These programs consisted of exercises consisting of: scapular dynamic hug, scapular protraction, elbow push-ups and prone bilateral glenohumeral horizontal abduction with scapular retraction. The results showed that a 12-week swimming training program produced an increase in muscular strength, improved protractor/retractor ratio and improved side-to-side muscular strength. However, the program did not produce a change in muscular endurance.

Myers et al[5] also examined the effects of sports specific baseball program by studying the effects of 12 commonly used resistance tubing exercises on activating the shoulder muscles vital to throwing. The 15 participants randomly performed the 12 resisting tubing exercises while the muscle activation of the subscapularis, supraspinatus, teres minor, rhomboid major pectoralis major, anterior deltoid, middle deltoid, latissimus dorsi, serratus anterior, biceps brachii, triceps brachii, lower trapezius, and infraspinatus muscles were tested. The results showed that seven exercises; external rotation at 90°of abduction, throwing deceleration, humeral flexion, humeral extension, low scapular rows, throwing acceleration, and scapular punches, resulted in the highest level of muscle activation. Each of these seven exercises exhibited moderate activation in the rotator cuff, primary humeral movers and scapular stabilizers. The movements during overhead throwing requires the coordination of the rotator cuff, scapular stabilizers and humeral movers; making it important to perform exercises with high activity in these muscles.

It is also important to perform exercises with high activity of the rotator cuff, scapular muscles and deltoid throughout the rehabilitation process in order for the muscles to return to their original state before competition. Reinold et al[6] examined the electromyographic activity of the supraspinatus, middle deltoid and posterior deltoid during the "empty-can", "full-can" and "prone full can" exercises in 22 asymptomatic subjects. The results showed no statistical differences between the exercises for the supraspinatus. However, the middle deltoid showed significantly greater activity during the "empty-can" and "prone full-can" exercises. The "prone full-can" exercise produced the greatest amount of activity in the posterior deltoid. Even though each of these exercises were able to produce activity in the posterior deltoid, middle deltoid and supraspinatus, in certain injuries some of these exercises should not be used. In patients with impingement syndrome, the "empty-can" exercise decreases the subacromial space, predisposing the tendons underneath the coracoacromial ligament to impingement.[7,8] In the patient population with impingement syndrome, it would be more appropriate to use the "full-can" exercise.[8]

The purpose of this study is to examine and understand the persistent overuse injuries occurring in the overhead athlete. Many athletes participating in overhead sports throughout their childhood and into collegiate athletics are faced with numerous overhead injuries.

Many of the athletes are entering college already having shoulder instabilities and chronic injuries, ultimately persisting throughout their collegiate careers. Since these athletes have been playing with an injury season after season, it is difficult to correct the anatomical and functional adaptations. Instead, the athlete is often managed for pain, but is still playing with a shoulder that is not performing at the best of their ability. It is important as health care providers to understand the risk factors and preventative measures associated with common overuse injuries in order to understand ways to treat and prevent these injuries at a young age. It will also be useful to determine when the initial onset of these conditions occur as that may be the best time for intervention to prevent long term, chronic dysfunction.

METHODS

The primary purpose of this study was to examine the ways in which persistent overuse injuries in the overhead athlete are prevented and treated. This research sought to understand the risk factors, treatment protocols and preventative measures associated with these overuse injuries in hopes of reducing the number of injuries occurring throughout their careers. This section will include the following subsections: research design, participants, instruments, procedures, hypotheses, and data analysis.

Research Design

This research is a retrospective, descriptive study with the data collected using a survey. The independent variable was the athletes' injury group. This condition had three levels consisting of current history, previous history and no history. The current history group consisted of athletes currently suffering from impingement syndrome, bicipital tendonitis, rotator cuff tendonitis or shoulder instability and had the injury for more than two years. The previous history group was made up of athletes not currently suffering from an overuse shoulder injury but had previously suffered from impingement syndrome, bicipital tendonitis, rotator cuff tendonitis or shoulder instability for more than two years. The no history group consisted of athletes that are not currently injured and had no history of an overhead overuse injury. The dependent variables are the number of rehabilitation exercises performed and the number of training exercises performed.

Participants

The survey was mailed out electronically to 4 colleges, composed of approximately 250 Division II and Division III collegiate overhead athletes. The participants consisted of collegiate athletes that are members of the baseball, softball, volleyball or swim team. Informed consent was implied by completing and returning of the survey.

Preliminary Research

A review of the survey was be completed by a panel of experts consisting of three Certified Athletic Trainers. The panel made suggestions and improvements on the question clarity, grammar and validity of the survey.

Following Institutional Review Board (IRB) approval, a pilot study was conducted to confirm the reliability of the survey. The survey was administered to 15 members of the women's volleyball team at Washington and Jefferson College. After one week, these athletes were surveyed a second time and reliability coefficients were calculated for each question. Of the 15 athletes, 9 completed the survey both times and their data was used in the reliability analysis. The questions and overall survey displayed a relativity score of .30 or higher, indicating a moderate to strong correlation.

Instruments

The Overhead Overuse Injury Survey (Appendix C1) was used in this study and was distributed to the athletes using www.surveymonkey.com. This survey was developed to determine the current injury status of these athletes and how the treatment of previous injuries and preventative measures has affected their current injury status. The survey contained 129 questions regarding the type of overuse injuries encountered, sport in which the injury occurred, preseason-training programs, current injury status and treatment protocol associated with that injury.

Procedure

The researcher received approval by the California University of Pennsylvania's Institutional Review Board for Protection of Human Subjects (Appendix C2) before conducting research. Upon approval from the IRB, a direct link to the survey was created using www.surveymonkey.com. A cover letter (Appendix C3) was sent to the overhead athletes explaining the purpose of the study. The email containing the cover letter also contained a link giving the athlete direct access to the survey.

Before distributing the survey, the researcher contacted the Athletic Directors at the chosen Division II and Division III institutions, requesting that the survey be sent to the baseball, softball, volleyball and swimming teams at their institution. The researcher allowed ample time to complete the survey. The athletes received a second email 7-10 days after the initial email as a reminder to complete the survey.

Surveys were completed via the internet and upon closing of the survey, the researcher downloaded the data as a password protected spreadsheet file for manipulation and analysis.

Hypotheses

The following hypotheses were developed based previous research and the researcher's intuition after a review of the literature.

1. There will be a difference in the number of training exercises regularly performed between the current history, previous history and no history groups.
2. The previous history group will have performed more rehabilitation exercises when compared to the current history group.

Data Analysis

1. A one-way ANOVA test was used to test the difference in the number of training exercises performed in all three injury groups.

2. An independent T-test was used to compare the number of rehabilitation exercises performed in the current history and previous history groups.

RESULTS

Demographic Information

Subjects that voluntarily participated in this survey consisted of collegiate athletes on the baseball, softball, volleyball and swim team from Division II (n=3)and Division III (n=1)schools in Pennsylvania and Massachusetts. The survey was electronically sent out to 250 collegiate athletes. A total of 59 student athletes completed the survey, resulting in a return rate of 23%. Forty-eight participants were female (81.4%) and eleven were male (18.6%).

The largest percent of athletes (96.6%) reported to be within the 18-25 age group and the lowest percent of athletes (3.4%) reported to be 25 and older. Table 1 represents the athletes' sports participation previous to high school, throughout high school and their current participation in college. The majority of the participants in this survey are currently participating in softball (n=23) and swimming (n=21).

Table 1. Sports Participation

Sport	Previous to High School	High School	College
Baseball	8	5	4
Softball	25	24	23
Volleyball	22	20	9
Swimming	28	22	21
Football	5	1	0
Basketball	29	15	0
Soccer	37	8	0
Lacrosse	5	3	0
Field Hockey	5	2	1
Ice Hockey	0	2	0
Cross Country	3	1	0
Track	11	9	0
Tennis	3	0	0
Golf	3	2	0
Gymnastics	3	0	0
Water Polo	2	3	0

Hypothesis Testing

All hypotheses were tested at an alpha level of .05.

Hypothesis 1: There will be a difference in the number of training exercises regularly performed between the current history, previous history or no history injury groups.

The mean number of training exercises performed by the current history, previous history and no history group were compared using a one-way ANOVA. No significant difference was found ($F(2,39) = .259$, $p > .05$). The athletes from the three different injury groups did not differ significantly in the number of training exercises performed. Athletes in the current history group performed a mean of 23.1 (*sd*=7.99) exercises. Athletes in the previous history group performed a mean of 26.4 (*sd*=7.50) exercises. Athletes in the no history group performed a mean of 20.3 (*sd*=9.90) exercises.

Table 2. Injury Groups Mean Number of Training Exercises

Injury Status	**N**	**Mean**	**SD**
Current History	12	23.1	7.99
Previous History	8	26.4	7.50
No History	33	20.3	9.90

Hypothesis 2: The previous history group will have performed a higher number of rehabilitation exercises when compared to the current history group.

An independent-samples *t* test was calculated comparing the mean rehabilitation exercises performed by participants who currently have an injury to the mean exercises performed by participants who had a previous injury. No significant difference was found ($t(13) = .942$, $p > .05$). The mean number of exercises performed by the currently injured group (m=22.3, *sd* = 12.07) was not significantly different from the mean of the previously injured group (*m*= 16.8, *sd*= 6.46).

Table 3. Injury Groups Mean Number of Rehabilitation Exercises

Injury Status	N	Mean (SD)	t	p
Current History	10	22.3 (12.1)	.942	.363
Previous History	5	16.8 (6.5)		

Additional Findings

Due to the descriptive nature of this study, additional tests were performed using the data found in the preseason training, rehabilitation and injury status portion of the survey.

Since one of the major purposes of this study was to examine the major overhead overuse injuries and the initial onset of these injuries, further tests were conducted to examine these factors. The athletes were asked several questions regarding injury status, type of injury and length of injury. The number of athletes with a current injury, previous injury and those with no history of injury can be found in Table 4.

Table 4. Injury Status

Injury Status	Frequency	Percent
Current History	12	22.6
Previous History	8	15.1
No History	33	62.3

From these injury groups we were able to analyze the number of athletes who have previously or are currently suffering from bicipital tendonitis, rotator cuff tendonitis, impingement syndrome and shoulder instability. Table 5 represents the frequencies of these injuries. Of the 20 athletes that had reported having an injury at some point during their career, 60% suffered from rotator cuff tendonitis, 35% bicipital tendonitis, 35% shoulder instability and 25% impingement syndrome. Table 6 includes the initial onset of these injuries by looking at the length of injury. Totals equal over 100% as subjects were allowed to choose multiple injuries.

Table 5. Type of Injury

Injury	Frequency	Percent
Bicipital Tendonitis	7	35
Rotator Cuff Tendonitis	12	60
Impingement Syndrome	5	25
Shoulder Instability	7	35

Table 6. Length of Injury

Years	Frequency	Percent
1-2	5	40
3-5	5	35
5-7	3	15
7-10	1	5
10 or more	1	5

Table 7 represents the medical professionals that provided treatment to these athletes following their injuries. Totals equal over 100% as subjects were allowed to choose multiple providers.

Table 7. Medical Professionals Providing Treatment

Medical Professional	Frequency	Percent
Medical Doctor	10	71.4
Nurse Practitioner	0	0
Chiropractor	1	7.1
Athletic Trainer	8	57.1
Physical Therapist	13	92.9

Even though the hypothesis testing examined the mean number of training exercises performed between the current history, previous history and no history injury groups; further tests were performed examining at mean number of exercises performed for each individual training type. The specific type of training exercises performed as a part of preseason training, as well as the athletes' rehabilitation program are summarized in Table 8. Totals equal over 100% as subjects were allowed to choose multiple training types.

Table 8. Athlete's Participation in Training by Type

Training Program	N	Weight Training	Plyo.	Endur.	Speed	Agility	Core	Stretch
Preseason	47	45 (95.7%)	25 (53.2%)	29 (61.7%)	29 (61.7%)	28 (59.6%)	36 (76.6%)	44 (93.6%)
Rehab	17	12 (70.6%)	4 (23.5%)	4 (23.5%)	3 (17.6%)	4 (23.5%)	3 (17.6%)	17 (100%)

The specific type of exercises were reviewed further by analyzing the mean number of exercises performed in each category of training for the current history, previous history and no history group. Table 9 represents the mean number of preseason training exercises performed in each training category for the current history, previous history and no history groups. The mean number of rehabilitation exercises performed in each training category for the current history and previous history is presented in Table 10.

Table 9. Injury Groups Mean Number of Preseason Exercises Performed In Each Training Category

Injury Status	Theraband	Weight Training	Medicine Ball	Core	Stretching
Current History	5.7	5.1	2.8	6.9	2.7
Previous History	5.6	5.6	4.3	7.6	3.3
No History	4.9	4.1	2.9	6.0	1.9

Table 10. Injury Groups Mean Number of Rehabilitation Exercises Performed In Each Training Category

Injury Status	Theraband	Weight Training	Medicine Ball	Core	Stretching
Current History	8.6	4.4	1.5	3.4	3.4
Previous History	6.0	4.4	1.2	1.8	3.0

DISCUSSION

The discussion of findings will be broken up into the following three subsections: 1) Discussion of Results, 2) Conclusions and 3) Recommendations.

Discussion of Results

This study focused on the persistent overuse injuries occurring in the overhead athlete and the effective ways to prevent and treat these injuries. Specifically, the researcher examined the initial onset of these injuries and how they were initially managed. The researcher examined the athletes' preseason and rehabilitation training programs to see if their training regimen potentially affected their injury status.

The first hypothesis stated that there will be a difference in the number of training exercises performed between the current history, previous history and no history injury groups. As shown in Table 2, the previous history group performed the greatest number of exercises (26.4), followed by the current history group (23.1) and lastly the no history group (20.3). However, the statistical analysis for this study did not find a significant difference between the number of exercises performed between the current history, previous history and no history injury groups. This is due to the large variability of exercises.

The assumption that there will be a difference in the number of training exercises performed between each injury group was based on previous research supporting preseason training programs for athletes participating in baseball, softball, volleyball and swimming. Van de Velde et al[4] and Myers et al[5] found that the participation in a sports specific training program produced an increase in overall muscular strength[4], while resulting in moderate activation of the rotator cuff, humeral movers and scapular stabalizers[5]. Even though these studies were able to show an improvement in the muscular strength and activation in the muscles associated with overhead motion, research lacks on the effects of these exercises on an athlete’s injury status.

The second hypothesis examined the difference in the number of rehabilitation exercises performed between the current and previous history groups. Even though there was a difference in the mean number of rehabilitation exercises performed between the current history (22.3) and previous history (16.8) groups, the difference was not statistically significant.

Reinold et al[6] found that common rehabilitation exercises such as the “empty-can”, “full-can” and “prone full-can” were able to produce activation in the posterior deltoid, middle deltoid and supraspinatus. However, certain injuries are negatively affected by the use of these exercises due to the stresses placed upon the shoulder. For this reason, future research should examine the effective exercises for specific shoulder injuries.

In addition to the hypotheses, the researcher discovered additional findings by using supplementary training and injury status questions. An important component to this study was to examine the overuse injuries occurring in these athletes, along with the length of injury.

This study found that 38% of intercollegiate athletes participating in softball, baseball, volleyball and swimming have had an injury at some point during their career. Of the 20 athletes who had reported an injury at some point in their career, 60% had suffered from rotator cuff tendonitis, 35% from shoulder instability, 35% from bicipital tendonitis and 25% with shoulder impingement. These results were surprising in that over half of the injured athletes have experienced rotator cuff tendonitis and also that many of these athletes have suffered from multiple overuse shoulder injuries. The athlete's length of injury ranged from 1-2 years to 10 or more years, with a majority of them suffering from injury for 1-2 years (40%) and 3-5 years (35%). It was also important to note that 25% of these athletes suffered from their injury for 5 or more years. Since the majority of athletes fell within the 18-25 age group, these athletes that experienced their injury for 3-5 years had injured their shoulder during their high school careers. Those experiencing their injury for 5 or more years were likely to become injured early in their high school careers, some even middle school. Even though these athletes are performing in shoulder exercises both in the preseason and throughout their rehabilitation, the long term nature of these conditions can lead to anatomical and functional adaptations that are often difficult to treat. Many of these athletes are managed for pain, while still playing on a shoulder that is not performing at the best of its ability. Not correcting these injuries in their early stages can lead to further biomechanical alterations, further leading to injury.

The additional tests examining the injury status, injury type and injury length supported the findings of

Sipes et al[1] These researchers found that 30% of intercollegiate athletes had an injury at some point in their career, with shoulder impingement and rotator cuff tendonitis accounting for the largest number of injuries.

Even though the hypotheses examined the mean number of training exercises performed between the injury groups, further testing analyzed the mean number of exercises performed in each category of training. When comparing the categories of training performed in the athlete's preseason and rehabilitation programs, overall athletes performed in a greater variety of training during preseason when compared to their rehabilitation program. The majority of the athlete's rehabilitation program consisted of stretching and weight training. Only 17.6% of athletes participated in core exercises during their rehabilitation program while 76.6% participated in core exercises in their preseason training programs. These results were reproduced in Table 10, looking at the injury groups mean number of rehabilitation exercises performed in each training category. Out of 12 core exercises, the current history group performed a mean of 3.4 core exercises, while the previous history group performed a mean of 1.8 core exercises. Lust et al[9] found that a 6-week core training program resulted in significant gains in core stability, proprioception and throwing accuracy.

Another additional finding discovered that majority of the athletes received treatment from a physical therapist (92.9%), medical doctor (71.4%) and an athletic trainer (57.1%). This finding was surprising in that even though a majority of these athletes had received treatment from a health care professional, 12 out of the 20 athletes who had reported an injury are still currently injured.

Another interesting finding was the use of postural assessments. Before receiving treatment from these medical professionals, 79% of the athletes had stated that they had not received a postural assessment. Without a proper postural evaluation examining the postural concerns, muscular imbalances, overactive and underactive muscles, and biomechanical deficiencies; it is difficult to know if each athlete had performed the correct exercises.

The results of this study demonstrated that the athletes' injury status is not directly related to the number of rehabilitation and preseason training exercises performed. The findings differed from the expected results, in part due to the fact that the athletes were required to recall exercises and injuries dating back to their childhood. The athletes' number of preseason training exercises may not have differed between currently injured, previously injured and those with no history of injury due to more athletes participating in similar sports specific training programs rather than individualized training regimens. Similarly, rather than individualized rehabilitation programs, many rehabilitation programs are based on the injury rather than the client. For this reason, athletes with similar injuries would be participating in similar rehabilitation programs.

Conclusion

There were no significant differences found between the number of preseason exercises performed between the current history, previous history and no history groups or the number of rehabilitation exercises performed between the previous history and current history groups. Based on the results, we can conclude that the number of exercises performed does not have an effect on the injury status of the athlete. However, it can be concluded that overhead overuse injuries are still a problem that affect many baseball, softball, volleyball and swimming athletes, with a majority of them being affected by rotator cuff tendonitis.

While the results of this study were not as expected, it raises awareness on the incidence of overuse shoulder injuries. The results produced in this study open many doors for future research examining overuse overhead injuries in baseball, softball, volleyball and swimming athletes.

Recommendations

The results of this study demonstrate that, in general, overhead athletes are suffering from overuse injuries in which they are being treated for. In order to determine the overall effects of training exercises on shoulder injuries, future research should focus on the effects of specific training exercises on specific overuse shoulder injuries. Looking deeper into the effectiveness of individual exercises will raise awareness on specific ways to treat and prevent each injury.

Future research should also examine the effect of a postural assessment before preseason and rehabilitation training programs. This would give the medical professional a better outlook on the athletes individualized needs to effectively correct their postural concerns. In addition, a study containing a larger, more diverse population could produce different results.

Further research into this topic can facilitate the reduction of overuse injuries occurring in the overhead athlete.

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APPENDICES

APPENDIX A

Review of Literature

REVIEW OF LITERATURE

The prevalence of persistent overuse shoulder injuries in overhead athletes has become a major issue to the profession of athletic training. Repetitive overhead movements can lead to mechanical deficiencies, muscular imbalances, muscular weakness and changes in shoulder flexibility, ultimately leading to injury. Often these injuries have persisted in these athletes for years. It is possible that improper management of these injuries in their initial stages could have contributed to the long-term nature of these conditions.

The purpose of this literature review is to present information on the important risk factors, preventative measures and treatments that are associated with overhead overuse shoulder injuries in sports such as volleyball, baseball, softball and swimming.

This literature review will discuss: 1) Shoulder Anatomy 2) Risk Factors Associated with Overuse Injuries in the Overhead Athlete, 3) Prevention of Overuse Injuries and Management of Overhead Overuse Injuries.

Anatomy of the Shoulder

The shoulder girdle produces fluid shoulder movement through the interconnection of its parts including, bony anatomy, bony articulations and the static and dynamic stabilizers.[1] Each of the components working together as a unit allows the shoulder to move through three degrees of motion. The bony anatomy of the shoulder consists of the humerus, which is the longest and largest bone in the upper extremity, the triangular shaped scapula and the clavicle.[1] The shoulder complex consists of four different articulations including: the glenohumeral joint, sternoclavicular joint, acromioclavicular joint and the scapulothoracic articulation.[2]

The glenohumeral joint (GH joint) is the articulation between the large humeral head and comparatively small glenoid surface.[1] At any given time, only 25% to 30% of the humeral head is in contact with the glenoid surface, making it the most mobile joint in the body, allowing for 180°of total rotation.[1-3] The sternoclavicular joint (SC joint) consists of the articulation between the medial end of the clavicle and the upper portion of the sternum, denoting the only true articulation between the trunk and upper extremity.[1-2] This joint allows 30° to 35° of upward rotation, 35° of combined anterior and posterior movement, and 45° to 50° of rotation around its long axis.[1] The acromioclavicular joint (AC joint) is the connection between the acromion process of the scapula and the lateral border of the clavicle. The AC joint allows for 20° to 30° of motion in three planes of motion. Even though it is not considered a true joint, the scapulothoracic articulation is a space between the convex surface of the posterior thoracic cage and concave surface of the anterior scapula. The seventeen muscles that attach to the scapula help stabilize and produce motion at the scapula. The increased shoulder motion that is available at the scapulothoracic articulation allows for movement beyond the 120° offered solely by the glenohumeral joint.[1] Due to the large amounts of mobility present in the shoulder, the dynamic stabilizers play a crucial role in providing stability to the joint.[2]

The rotator cuff provides dynamic stability by compressing the humeral head within the glenoid fossa during overhead movements.[3] The rotator cuff muscles are include the supraspinatus, infraspinatus, teres minor and subscapularis. The supraspinatus, the most commonly affected rotator cuff muscle[3], originates from the supraspinous fossa of the scapula and inserts into the greater tuberosity of the humerus. The supraspinatus is responsible for the first 30° of shoulder abduction and provides stability to the humeral head between 60° to 90° of shoulder abduction.[1] After the first 30° of shoulder abduction, the middle deltoid becomes the primary shoulder abductor. The infraspinatus originates from the infraspinous fossa and goes to insert on the greater tuberosity of the humerus. The last of the posterior rotator cuff muscles, the teres minor originates from the mid to upper regions of the axillary portion of the scapula and also inserts on the greater tuberosity of the humerus. Along with the infraspinatus, the teres minor acts as an external rotator and also stabilizes the glenohumeral joint.[1] The anterior portion of the rotator cuff, the subscapularis, originates from the subscapular fossa and inserts on the lesser tuberosity of the humerus. The subscapularis functions as an internal rotator, especially during maximal internal rotation.[1] The movements produced by the rotator cuff muscles closely mimic the overhead movements seen in sports such as baseball, softball, volleyball and swimming; making them a crucial muscle group in overhead activities.

The increase in shoulder motion provided from the scapulothoracic articulation can be largely attributed to the scapulothoracic muscles. The scapulothoracic muscles consist of scapular retractors (trapezius, rhomboid major and rhomboid minor), scapular protractors (serratus anterior and pectoralis minor), scapular elevators (levator scapulae, trapezius, rhomboid major, rhomboid minor and deltoid) and scapular rotators (levator scapulae, serratus anterior, pectoralis minor and deltoid). The combination of bony articulations, ligaments and muscular forces allows for the shoulder to engage in many sports specific overhead activities.[1]

Risk Factors Associated with Overuse Injuries in Overhead Athlete

The constant "wear and tear" that occurs in the shoulder over time in sports such as baseball, softball, volleyball and swimming can lead to compensatory alterations in the shoulder, affecting overall performance. Much of the current research focuses on changes that occur in the shoulders of baseball players and how they affect overall performance. The movement that occurs in baseball players during throwing closely resembles that of the movements occurring in swimming, volleyball and softball, resulting in similar changes in shoulder positioning, flexibility and ability to perform.[2]

The alterations that occur in the shoulder are considered to be the major risk factors for overuse injuries in the shoulder. The constant overhead motion can lead to decreased glenohumeral internal rotation, increased glenohumeral external rotation, change in scapular positioning, muscle fatigue and muscular imbalances. These risk factors have been shown to lead to injuries such as rotator cuff pathology, SLAP lesion, impingement syndrome and bicipital tendonitis[2]. Many athletes have difficulty recognizing the adaptations until an injury has occurred. For this reason, many of these injuries are persisting into chronic conditions, making it difficult for athletic trainers to treat. Understanding and recognizing the risk factors and the specific overuse shoulder injuries that they occur can allow athletic trainers to create training protocols to hinder the alterations that occur in the shoulder.

Mechanical Errors

Sports that require the coordination of the kinetic chain throughout full shoulder range of motion can often lead to biomechanical issues. Biomechanics plays a huge role in throwing a baseball, spiking a volleyball or completing the butterfly stroke. If an overhead athlete continues to use improper mechanics, the shoulder is placed under stresses that can result in faulty adaptations, as well as injuries. The changes in motion that often result from improper biomechanics can affect normal function of the shoulder and often place tension on both the dynamic (muscular support) and static (glenoid labrum, capsule and ligaments) stabilizers of the shoulder.[4]

The tension being placed on the dynamic and static stabilizers of the shoulder can lead to a decrease in scapular movement, decrease in internal rotation and increase in external rotation.[4-7] Mechanical adaptations such as these can lead to a change in the way the shoulder complex is able to perform during the movements required in baseball, softball, volleyball and swimming. Much of the literature focuses on the adaptations that occur over the course of a season, as well as how these mechanical factors play a role on athletes of many different performance levels.

Swanik et al[4] looked to examine the changes in glenohumeral rotation and scapular position of 19 baseball players after the completion of a scholastic season. The changes were observed by measuring dominant and non-dominant glenohumeral internal and external rotation, as well as scapular positioning before and after the 12-week baseball season. The results showed that the baseball players' dominant arm had significantly less internal rotation and total motion when compared to their non-dominant arm. The results also showed that the dominant arm had significantly more external rotation.

In these athletes, scapular upward rotation at 0° abduction significantly increased over the course of the season and scapular upward rotation at 90° and 120° significantly decreased. Scapular protraction at 45° and 90° significantly decreased from preseason to postseason. In another study, Swanik et al[5] compared the glenohumeral internal-rotation deficits (GIRD), glenohumeral external rotation gain (ERG) and scapular positioning between collegiate and high school baseball players.

The participants in this study[5] included 31 collegiate Division I baseball players and 21 male high school baseball players. The non-dominant and dominant arm were measured for glenohumeral internal and external rotation, scapular upward rotation at 0°, 60°, 90° and 120° of abduction and scapular protraction. The results showed that high school baseball players had less GIRD, greater ERG and less total motion deficit. It was also found that collegiate baseball players had a greater scapular upward rotation at rest when compared to high school baseball players. Many of these biomechanical adaptations that are occurring throughout years of throwing can help explain the widely seen shoulder injuries in collegiate baseball players.

Aguinaldo et al[6] also looked to determine the biomechanical differences that existed between different levels of competition to examine the effects throwing over many years has on the shoulder. The study that they conducted compared the biomechanical patterns of upper trunk rotation and shoulder joint torque during baseball pitching between professional, collegiate, high school and youth. The participants included 38 baseball pitchers; 6 professional, 11 collegiate, 12 high school and 9 youth pitchers. Each pitcher threw up to 15 fastballs, choosing their best one to be analyzed using Real-Time motion analysis, assessing trunk rotation, pelvic kinematics and shoulder torque. The only kinematic difference to appear between the groups was that professional pitchers started to rotate their hips much later in the pitching motion than the younger levels. Youth pitchers also exhibited the least amount of internal rotation torque compared to the higher levels of competition.

Gray et al[7] looked to understand the shoulder kinematics by comparing the mechanisms of coordination between skilled and unskilled arms of eight recreational baseball players. The researchers used a search-coil technique to look at the angular positions of five arm segments and their relationship to mean time of ball release and ball speed. Each of the participants were instructed to throw 30 balls at a slow speed, 30 at a medium speed and 30 fast pitches to understand how throwing kinematics adapt with speed. The results showed that the skilled arm had a larger angular deceleration of the upper arm in the forward horizontal direction, larger shoulder internal rotation velocity at ball release and an increase of wrist velocity with an increase of ball speed.

The research shows that biomechanical adaptations can occur to athletes at many different competition levels, transpiring over the course of many seasons or even a single season. Fatigue, muscular weakness and a decrease in flexibility can lead to a decrease in shoulder efficiency. The shoulder alters itself to try to perform at its maximum during these conditions, which can lead to biomechanical adaptations. In order to ensure that these biomechanical changes do not become permanent and lead to injury, it is important to understand the most effective treatment and prevention for overuse injuries in the overhead athlete.

Muscular Weakness and Imbalance

The instability of the glenohumeral joint places large emphasis on the dynamic stabilizers of the shoulder; including the rotator cuff, trapezius and scapulothoracic muscles.[8-9] It is essential for the muscles stabilizing the shoulder to have a balanced force production and balanced timing of muscle recruitment.[8] The accelerators and decelerators, as well as protractors and retractors[7] of the shoulder muscle maintain balance in order to produce coordinated shoulder movements. Muscular weakness or an imbalance of the muscles stabilizing the shoulder has been shown to increase the risk of overuse shoulder injuries.

Cools et al[8] sought to understand how muscular imbalances and weakness in the scapulothoracic[8] and trapezius[9] muscles played a role on shoulder injuries in the overhead athlete. In the first study, they compared the force output and muscle balance of the scapulothoracic muscles in thirty overhead athletes with impingement syndrome to a control group of thirty healthy overhead athletes. The experimental group had their uninjured side tested following their injured side, while the control group tested their non-dominant side followed by their dominant. The maximal protraction and retraction isokinetic tests were performed using a Biodex System at a linear speed of 12.2 cm/s and 36.6cm/s. The results showed that overhead athletes with impingement syndrome showed a decreased force output/body weight at both velocities for the protractor muscles compared to their uninjured side and the control group.

In another study, Cools et al[9] compared the intramuscular balance and trapezius activity between thirty-nine overhead athletes with chronic impingement syndrome and thirty non-injured overhead athletes. The intramuscular balance and trapezius activity was measured by examining the electromyographic activity of the upper, middle and lower trapezius during isokinetic abduction and external rotation. The EMG analysis provided data that showed a significant increase in upper trapezius activity on the injured side, as well as a significant decrease in lower trapezius on the injured side.

Both of these studies demonstrated the importance of maintaining the muscular strength and balance of the dynamic shoulder stabilizers. The group of participants diagnosed with impingement syndrome were able to produce findings that indicated a decrease in intramuscular balance, coordination and force output. Due to the crucial role that the trapezius and scapulothoracic muscles play in overhead athletics, the restoration of muscular strength and intramuscular balance is an important component of the rehabilitation and prevention of overhead injuries.

Flexibility

Overhead sports such as baseball, softball, volleyball and swimming not only involve the coordination of upper body movements, they all require coordination of full body movements. In order for the body to move freely through the full body movements required in these sports, it is important to maintain full range of motion. A decrease in range of motion can lead to a more force being placed on the shoulder in overhead activities.[10]

Over time many overhead athletes begin to develop an increase in glenohumeral external rotation and decrease in glenohumeral internal rotation. These changes have been shown to cause joint laxity[11] and posterior joint stiffness.[12] The motions that are produced due to changes in range of motion and increase in joint stiffness are believed to be major risk factors to the overuse shoulder injuries faced by many of these athletes.

Scher et al[10] studied the differences in hip and shoulder range of motion between professional baseball players with a history of shoulder injury and those with no history of injury, as well as assessing the relationship between hip and shoulder ROM in professional baseball players. A total of 57 baseball players participated in the study, 11 pitchers and 12 non-pitchers with a history of injury, as well as 18 pitchers and 16 non-pitchers with no history of injury. Each participant had hip internal rotation, external rotation and extension, as well as shoulder internal and external rotation measured on their dominant and non-dominant sides. The results showed no difference in shoulder external and internal rotation between pitchers with a history of shoulder injury and pitchers with no history of injury. Non-pitchers with a history of shoulder injuries had more shoulder external rotation and less shoulder internal rotation than pitchers without a history or injury. The non-pitchers with and without an injury produced a significant difference in non-dominant internal rotation. The differences that were produced in internal and external rotation could be attributed to the amount of joint stiffness and laxity present in the shoulder.

A study conducted by Crawford et al[11] examined the posterior glenohumeral joint laxity and stiffness in the throwing and non-throwing shoulders of 22 asymptomatic high school baseball pitchers. This study used the LigMaster to measure the joint laxity and stiffness of both the throwing and non-throwing shoulders of each participant. Anterior joint laxity and stiffness were measured with the shoulder in a neutral position and at 90° of external rotation. Posterior joint laxity was measured with the shoulder in 90° of abduction and neutral position. The findings in both shoulders was that glenohumeral joint laxity was less and glenohumeral joint stiffness was greater when tested in the functional throwing position, 90° of external rotation and 90° of abduction, when compared to neutral position.

In a similar study, Clambers et al[12] examined the effects of posterior capsule tightness on humeral head position of eight frozen shoulders in late cocking simulation. Each shoulder was placed into the late cocking phase of 90° abduction, 10° adduction and maximum external rotation. 3D measurements were taken of humeral head relationship in relation to the glenoid throughout the late cocking phase. The results showed that in a normal shoulder, there was a relative positive and inferior translation of the glenohumeral joint when the shoulder was in the late-cocking phase of throwing. The posterior and inferior translation of the humeral head can help to justify the large number of glenoid pathologies faced by baseball players of all ages.

Shoulder adaptations, such as an increase in glenohumeral internal rotation and increase in posterior tightness, have been shown to be major risk factors for overuse shoulder injuries such as rotator cuff pathologies and labral tears.[11-12] For this reason, it is important to address these changes at a young age, in hopes of decreasing the injuries faced by these athletes throughout their careers.

Prevention of Overuse Injuries

Repetitive overhead movements in baseball, softball, volleyball and swimming require coordinated overhead motion that results in high forces experienced at the upper extremity joints. The shoulder must maintain a combination of flexibility and stability in order to successfully move through the full range of motion (ROM) in both the acceleration and deceleration phase of the throwing motion. The coordination of the kinetic chain allows the athlete to move smoothly throughout the full range of overhead motion.

Fatigue to a component of the kinetic chain can lead compensation by the other components, resulting in an overload being placed on the shoulder and elbow.[13] The constant overload being placed on the shoulder results in an increased demand on the kinetic chain, ultimately leading to injury. Understanding the throwing mechanics, swimming strokes and volleyball motions along with the musculature associated with the kinetic chain will allow an individual to develop training programs to aid in strengthening and stretching the muscles related the functional movements related to each sport.

Preseason Programs

Baseball, softball, volleyball and swimming are sports that require multi-joint and multi-dimensional movements. In order to move fully through the full overhead motion, the body utilizes every component of the kinetic chain to produce maximum performance while decreasing the risk of injury. The kinetic chain is composed of the glenohumeral joint, upper arm, forearm, hand, hip, leg and trunk. [13-14] Training programs that are able to train each component of the kinetic chain separately, as well as a whole kinetic link[14] should be utilized before, during and after the athletic season.

Sports specific training is a crucial part of any training regimen. Understanding and incorporating specific movements related to a sport will allow the athlete to be more functional, while simultaneously preventing injuries. Training for overhead athletes should incorporate both open and closed kinetic chain exercises involving lower and upper body strength/power, torso rotational strength/power, endurance, agility training, resistance tubing training core stability and plyometrics.[13-14]

Since each of these sports requires numerous multi-dimensional and multi-joint movements, preseason programs should incorporate sport specific strength, power and endurance training. Szymanski et al[14] looked to determine if additional torso rotational strength through medicine ball training would provide additional improvements in torso rotational strength and power of fifty-five high school baseball players. Each player participated in a 12 week off-season training program in which they trained 3 days a week using medicine ball exercises such as; the standing side throw, the speed rotation, the hitter’s throw and the standing figure 8. Each athlete took measurements of height, body mass, body composition, 3RM dominant and non-dominant torso rotational strength, sequential hip-torso-arm rotational strength and 3RM parallel squat and bench press pre and post training. The group that took part in the medicine ball program made significantly greater increases in 3RM dominant and non-dominant torso rotational strength.

Lust et al[13] also looked to determine the effects of a preseason program on baseball players. The program consisted of 6-week training with open kinetic chain, closed kinetic chain and core-stability exercises and their effect on throwing accuracy, core stability and proprioception of 25 collegiate baseball players. The players were split up into 3 groups consisting of 12 players in the open kinetic/closed kinetic and 13 players in the open kinetic/closed kinetic/core stability group. The control group consisted of 15 college aged males that had some baseball experience. The pre and posttest measurements showed that the OKC/CKC group and the OKC/CKC/CS group produced significantly greater posttest scores than the control group. There was no significant difference between the two experimental groups throughout the pre and posttest.

Myers et al[15] also examined the effects of baseball specific exercises. The researchers studied the effects of 12 commonly used resistance tubing exercises by baseball players on activating the shoulder muscles vital to throwing. The 15 participants randomly performed the 12 resisting tubing exercises while the muscle activation of the of the subscapularis, supraspinatus, teres minor, rhomboid major pectoralis major, anterior deltoid, middle deltoid, latissimus dorsi, serratus anterior, biceps brachii, triceps brachii, lower trapezius, and infraspinatus muscles was tested. The results showed that seven exercises; external rotation at 90°of abduction, throwing deceleration, humeral flexion, humeral extension, low scapular rows, throwing acceleration, and scapular punches, resulted in the highest level of muscle activation. Each of these seven exercises exhibited moderate activation in the rotator cuff, primary humeral movers and scapular stabilizers. The movements during overhead throwing requires the coordination of the rotator cuff, scapular stabilizers and humeral movers; making it important to perform exercises with high activity in these muscles.

Swimming is also a sport that requires the coordination of the scapular muscles in order to reduce the athletes' risk of injury.[16] Van de Velde et al[16] examined the effects of a 12-week training program on muscular strength, muscular endurance, side-to-side differences in strength and protractor/retractor ratio. The 18 swimmers were split up into a muscular endurance or muscular strength training program that consisted of exercises such as; scapular dynamic hug, scapular protraction, elbow push-ups and prone bilateral glenohumeral horizontal abduction with scapular retraction. The results showed that a 12-week swimming training program produced an increase in muscular strength, improved protractor/retractor ratio and improved side-to-side muscular strength. However, the program did not produce a change in muscular endurance.

Preseason training programs that incorporate sports specific exercises including strength training, power, plyometrics, core stability and endurance can lead to improvements throughout the season. [13-14] These training programs can vary in length but even a short program, lasting six weeks, was able to produce pre and post test improvements. Understanding the specific movements and functional needs in each sport will allow an athlete to participate in specific exercises to increase torso strength, core stability and the accuracy and strength of overhead motions, while reducing the athletes risk for injury.

Improving Muscular Imbalances and Flexibility

Constant overhead motion can lead to many shoulder adaptations that can predispose an individual to injury and chronic shoulder pain.[17-19] It has been researched that many range of motion deficits can result from the soft tissue adaptations including; increased shoulder external rotation, decreased shoulder internal rotation and horizontal adduction and increased posterior shoulder tightness.[17- 18] Alterations in range of motion and posterior tightness resulting from the deceleration phase[17] can lead to impingement syndrome, rotator cuff pathologies, muscular strains, SLAP lesions, bicipital tendonitis and ulnar collateral ligament insufficiency.[18] Miyashita et al.[20] examined the correlation of maximum external rotation/ external rotation measurements to elbow injuries in forty high school baseball players with and without a history of medial elbow pain. The results showed that the non-throwing shoulders of the injured group produced significantly smaller external rotation measurements than the control group. Since there is a correlation between the mechanics in baseball and maximum external rotation and external rotation, it is important to understand the preventative measures in order to improve overall mechanics, in hopes of decreasing the athlete’s risk of injury.

Many different stretching techniques have been used for preventative treatment before and after performing overhead motions in an attempt to lengthen the soft tissue,[17] allowing the shoulder complex to move through a full range of motion. Many individuals that participate in overhead activities use stretching techniques such as the sleeper stretch,[17-18] PNF techniques,[21] Fauls stretching[19] and horizontal cross-arm stretching. There have been many studies that looked at the evidence associated with posterior shoulder stretching and its effect on the overall ROM in external rotation, internal rotation and horizontal adduction.

The constant overhead motion produced by overhead athletes that often leads to an increase in external rotation and decrease in internal rotation can also lead to posterior shoulder tightness. Many athletes decrease posterior shoulder tightness by using a technique known as the sleeper stretch. The sleeper stretch looks to stabilize the scapula to restrict movement while moving the shoulder into internal rotation.[17-18] Laudner et al[17] examined the effects of a side-lying sleeper stretch on the shoulder range of motion of 33 Division I pitchers and 18 position players. The control group consisted of 33 physically active male college students who did not participate in any stretching routine throughout the study. The measurements completed before and after completing the 3 sets of 30-second passive sleeper stretches produced a 2.3° increase in posterior shoulder motion and a 3.1° increase in internal rotation for the baseball group. Oyama et al[18] also found that the sleeper stretch at 45°, sleeper stretch at 90° and the horizontal cross-arm stretch produced a 4.3° increase in internal rotation and 3.4° in horizontal adduction. Even though the sleeper stretch showed a small increase in internal rotation, athletes that maintain stretching protocols throughout the season can maintain flexibility and decrease the risk of injury.

Another stretching technique that has been used since the 1980's to decrease posterior shoulder tightness and increase shoulder ROM in baseball players is known as Fauls stretching routine. This routine consists of twelve passive stretches that combine stretches and circular motions. Each of the stretches is maintained for seven seconds and the circular motions consists of ten repetitions.[19] Sauers et al[19] examined the effects of the Fauls stretching routine on shoulder ROM in 30 collegiate baseball players. The pre and post-stretch measurements consisted of shoulder complex external rotation, glenohumeral external rotation, shoulder complex internal rotation, glenohumeral internal rotation and posterior shoulder tightness (using Tyler's test). The results showed a decrease in posterior shoulder tightness, 9.2° increase in shoulder complex internal rotation and 6.4° increase in glenohumeral internal rotation. There was no significant difference in external rotation. Overall, the Fauls stretching routine played a major role in increasing shoulder complex internal rotation as well as decreasing posterior shoulder tightness.

Proprioceptive neuromuscular facilitation (PNF) is a stretching routine that combines stretching and contraction of a particular muscle group in order to improve flexibility.[21] The PNF patterns consist of hold-relax, contract-relax and slow-reversal-hold-relax. The contract-relax pattern is performed by an isotonic contraction of the antagonist muscle followed by passive stretch. The hold-relax pattern is performed is an isometric contraction of the agonist followed by a passive stretch. Decicco et al[21] looked at the effects of contract-relax and hold-relax proprioceptive neuromuscular facilitation patterns on the effects of increasing external rotation of the shoulder. The 30 participants consisted of male and female overhead athletes that were randomly assigned to 1 of 3 groups; contract-relax, hold-relax and control group. The subjects performed PNF stretches two times a week for 6 weeks to test the pre and post ROM differences. The contract-relax produced a 14.6° increase in external rotation, compared to a 13.5° increase produced by the hold-relax group. The control group was not able to produce any difference in measurements. Overall, proprioceptive neuromuscular facilitation has been proven to be an effective form of stretching by combining stretching and muscular contractions, hoping to further increase overall range of motion.

This section examined the effects of different stretching techniques on ROM in overhead athletes demonstrates evidence towards the use of stretching programs to increase the overall motion produced at the shoulder joint. All of the studies were able to show an increase in total internal rotation, even though some did not produce statistically significant data.[17] Only one of the studies was able to show an increase in the total external rotation.[21] The studies were not able to show any significant differences between the measurements of the different stretches. However, a combination of stretching and circular motions was able to produce the greatest change in ROM measurements.[19] Based on the results produced in the studies, overhead athletes can benefit from participating in stretching programs before and after practice sessions.

Stretching before and after overhead activities result in improvements in flexibility, allowing an athlete to move through a full range of motion. A decrease in ROM has led to many biomechanical issues, soft-tissue adaptations and overuse injuries. The published research has been able to show an increase in shoulder ROM after a stretching regimen.

Treatment of Overuse Shoulder Injuries

Approximately thirty-percent of intercollegiate overhead athletes have experienced a shoulder injury at some point during their career.[22] Many of these injuries have persisted from the time they were playing youth sports up until their intercollegiate careers. It is possible that the chronic effects of these injuries could be a result of the improper management of these injuries in their initial stages.

Shoulder pain is the third most common musculoskeletal complaint, affecting 7%-34% of the general population. [23-25] Due to the fact that the glenohumeral joint exhibits the greatest amount of motion of any joint in the body[3], the shoulder is placed under large amounts of stress during overhead movements. The shoulder joint relies heavily on the dynamic stabilizers to provide stability, allowing for fluid overhead motion. However, athletes often overstress the dynamic stabilizers during sports specific overhead movements, ultimately leading overuse shoulder injuries.

Due to the large importance of the dynamic stabilizers during overhead movements, rehabilitation of shoulder should focus on exercises that stress the rotator cuff, scapular muscles and deltoid. When performing rehabilitation exercises it is important to perform those exercises that exhibit the highest amount of activity from these muscle groups.[3,26] Those exercises that have shown the greatest amount of activity from the rotator cuff, deltoid and scapular muscles consist of prone horizontal abduction at 100° abduction with external rotation, flexion and abduction with external rotation, "full can", "empty can", D1 and D2 flexion and extension diagonal patterns, external rotation at 0° and 90° abduction, internal rotation at 0° and 90° abduction, push-ups, dynamic scapular hug, scapular punches and row-type exercises.[26]

Impingement syndrome and rotator cuff tendinopathy are among the most common overuse shoulder conditions seen throughout athletics and general medical practice.[3,27] For this reason, it is important to understand the key exercises used to manage these conditions. Reinold et al[3] examined the electromyographic activity of the supraspinatus, middle deltoid and posterior deltoid during the “empty-can”, “full-can” and “prone full can” exercises in 22 asymptomatic subjects. The results showed no statistical differences between the exercises for the supraspinatus. However, the middle deltoid showed significantly greater activity during the “empty-can” and “prone full-can” exercises. The “prone full-can” exercise produced the greatest amount of activity in the posterior deltoid. Even though each of these exercises were able to produce activity in the posterior deltoid, middle deltoid and supraspinatus, in certain injuries some of these exercises should not be used. In patients with impingement syndrome, the “empty-can” exercise decreases the subacromial space, predisposing the tendons underneath the coracoacromial ligament to impingement.[26,28] In the patient population with impingement syndrome, it would be more appropriate to use the “full-can” exercise.[28]

Bernhardsson et al[24] also looked at the effects of an exercise protocol on subacromial impingement syndrome. These researchers evaluated the effect on pain intensity and function of an exercise program including specific eccentric strength training with progressive loading of the supraspinatus and infraspinatus tendons in ten patients with subacromial impingement syndrome. Each of the subjects completed baseline testing of pain intensity using a visual analogue scale, function using the Patient-Specific Functional Scale, shoulder function evaluated with the Constant score, and shoulder-related quality of life evaluated with the Western Ontario Rotator Cuff Index. The 12-week exercise program consisted of eccentric strengthening exercises for the supraspinatus and infraspinatus muscles, shoulder shrugs, scapular retraction and stretching of the lower trapezius. The before and after measurements showed a pain intensity in eight of the ten patients, increase in function in all ten subjects, the Constant score increased in nine subjects and the Western Ontario Rotator Cuff Index increased in seven subjects. Due to the significant changes in baseline and treatment scores, eccentric strengthening should be an important part of rehabilitation protocols.

Araújo et al[23] also wanted to look at the effects of common rehabilitation exercises on shoulder function. The researchers examined the effects of performing isometric 3-point kneeling exercises on a Swiss ball on the EMG activity of the posterior deltoid, pectoralis major, biceps brachii, triceps brachii, upper trapezius and serratus anterior when compared to performing the same exercise on a stable surface. Each of the 12 volunteers randomly performed 3 six-second contractions in different isometric 3-point kneeling exercises with the dominant limb placed either on a stable surface or on a Swiss ball. The results showed that isometric 3-point kneeling exercises on an unstable base influenced the load values produced and the muscle activation levels when compared with performing the same exercise on a stable surface. A significant increase was seen in the activation of the glenohumeral muscles, but no difference was observed for the scapulothoracic muscles.

Improper management of shoulder injuries in their initial stages can contribute to the long-term effects faced by many overhead athletes. For this reason, it is important to incorporate rehabilitation exercises that stress the dynamic stabilizers of the shoulder. Exercises such as the “full-can”, prone “full-can”, “empty-can”, dynamic scapular hug, scapular punches, eccentric-strengthening of the infraspinatus and supraspinatus and push-ups. Completing a variety shoulder exercises throughout rehabilitation can ensure the activation of the rotator cuff, scapular muscles and deltoid; providing dynamic stability to the shoulder.

Summary

Shoulder pain is the third most common musculoskeletal complaint, affecting 7%-34% of the general population. [23-25] The shoulder is constantly placed underneath stress because the glenohumeral joint is the most mobile joint in the body.[3] The excessive mobility of the shoulder relies on the dynamic and static stabilizers to provide stability to the joint.[2] If the dynamic stabilizers are put under too much stress and not able to provide stability to the joint, many biomechanical adaptations can occur.

The constant "wear and tear" that occurs in the shoulder over time in sports such as baseball, softball, swimming and volleyball can lead to decreased glenohumeral internal rotation, increased glenohumeral external rotation, muscular imbalances, muscle fatigue and change in scapular positioning.[4-7] These adaptations that can occur due to the constant overhead motion can lead to injuries such as; rotator cuff tendinopathy, impingement syndrome, SLAP lesion, bicipital tendonitis and shoulder instability. The adaptations that occur in the shoulder overtime can be prevented by taking part in preseason programs that stress the dynamic and static stabilizers of the shoulder joint, as well as torso rotational strength[14] to decrease the load placed on the shoulder.

An athlete that performs in a sports specific training program, such as resistance tubing for baseball players[15] and or a scapular strengthening program for swimmers[16], can help to activate the dynamic stabilizers needed to produce coordinated overhead motion. When creating a preseason program, it is important to understand the specific motions required throughout each sport. A crucial component to every preseason program is the addition of a stretching protocol to increase flexibility in the dynamic stabilizers, ultimately reducing the risk of injury. Stretching has been shown to increase the range of motion in the shoulder, allowing for more fluid motion throughout overhead movements. If the athlete does not properly manage these adaptations by performing in proper exercises and stretching protocols, the stresses placed on the shoulder can predispose an athlete to an overhead overuse injury.

It is possible that many of the chronic effects of overhead overuse injuries can be due to the improper management of these injuries in their acute phase. Exercises should focus on stressing the rotator cuff, scapular muscles and deltoid in order to activate the dynamic stabilizers. Those exercises that have shown the greatest amount of activity from the rotator cuff, deltoid and scapular muscles consist of prone horizontal abduction at 100° abduction with external rotation, flexion and abduction with external rotation, “full can”, “empty can”, D1 and D2 flexion and extension diagonal patterns, external rotation at 0° and 90° abduction, internal rotation at 0° and 90° abduction, push-ups, dynamic scapular hug, scapular punches and row-type exercises.[26] Properly managing injuries with the use of effective rehabilitation exercises can help stop these injuries in their acute stages, decreasing the amount of athletes with persisting overhead overuse injuries.

APPENDIX B

The Problem

STATEMENT OF THE PROBLEM

Constant overhead motion in the overhead athlete can lead to many biomechanical errors, range of motion deficits and muscular imbalances; further predisposing an athlete to injury. Many throwing athletes injure their shoulder season after season, creating an unstable shoulder for the rest of their careers. In a study looking at the incidence of shoulder injuries among collegiate overhead athletes, thirty-percent of intercollegiate overhead athletes had a shoulder injury at some point in their career.[22] The purpose of this study is to recognize the persistent overuse injuries occurring in the overhead athlete and examine the effective ways to treat and prevent these injuries.

Definition of Terms

The following definitions of terms will be defined for this study:

1) Kinematics: Branch of mechanics studying the motion of the body. [4,6-7]
2) Flexibility: The normal extensibility of all soft tissues that allows full range of motion of a join and optimal neuromuscular efficiency throughout all functional movements.[29]

3) Concentric Contraction: Developing tension while a muscle is shortening; when developed tension overcomes resistive force.[29]

4) Eccentric Contraction: Developing tension while a muscle is lengthening; when resistive force overcomes developed tension.[29]

5) Isometric Contraction: Generating force in the muscle without changing length.[29]

6) Current History Group: An athlete currently suffering from impingement syndrome, bicipital tendonitis, rotator cuff tendonitis or shoulder instability and has had the injury for more than two years.

7) Previous History Group: An athlete not currently suffering from an overuse shoulder injury but has previously suffered from impingement syndrome, bicipital tendonitis, rotator cuff tendonitis or shoulder instability for more than two years.

8) No History Group: An athlete not currently suffering and no previous history of impingement syndrome, bicipital tendonitis, rotator cuff tendonitis or shoulder instability.

Basic Assumptions

The following are basic assumptions of this study:

1) The participants are representative of baseball, softball, volleyball and swimming athletes at the collegiate level.
2) The participants will give their best effort when participating in the survey.
3) The participants will put time into completing the survey.

Limitations of the Study

The following are possible limitations of the study:

1) Only surveying select Division II and Division III colleges

Significance of the Study

The purpose of this study is to examine and understand the persistent overuse injuries in the throwing athlete. Many athletes that participate in overhead sports throughout their childhood and into collegiate athletics are faced with numerous overhead injuries.

Many of these athletes are entering their collegiate careers already having shoulder instabilities, ultimately leading to injuries throughout the season. Since these athletes have been playing with biomechanically unsound shoulders season after season, it is difficult to correct the adaptations. Instead, the athlete is often managed for pain, but is still playing with shoulders that are not performing at the best of their ability. It is important as health care providers to understand the risk factors and preventative measures associated with common overuse injuries in order to understand ways to treat and prevent these injuries at a young age.

APPENDIX C

Additional Methods

APPENDIX C1

Overhead Overuse Injury Survey

Cover Letter

Dear Participants:

My name is Kellie Sullivan and I am currently a graduate student at California University of Pennsylvania pursing a Master of Science in Athletic Training. Part of the graduate study curriculum is to complete a research thesis through conducting research. I am conducting survey research to recognize the persistent overuse injuries occurring in the overhead athlete and examine the effective ways to treat and prevent these injuries. Specifically this study will examine the time of the initial onset of these overuse injuries and the initial treatment rendered. Understanding the effective ways to prevent and treat these injuries at a young age can prevent the chronic effects associated with overhead overuse injuries.

Overhead athletes participating in baseball, softball, volleyball and swimming at the chosen institutions are being asked to participate in this survey; however, your participation is voluntary and you do have the right to choose not to participate. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania Institutional Review Board has reviewed and approved this project. The approval is effective 01/31/12 and expires 01/31/13 .

All survey responses are anonymous and will be kept confidential, and informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Participants must be 18 years or older in order to participate in this study. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience as it will take approximately 20 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Kellie Sullivan at SUL8358@calu.edu. You can also contact the faculty advisor for this research Thomas F. West, PhD, ATC by email west_t@calu.edu or phone 724-938-5933. Thanks in advance for your participation. Please click the following link to access the survey (INSERT LINK HERE).

Thank you for taking the time to take part in my thesis research. I greatly appreciate your time and effort put into this task.

Sincerely,

Kellie Sullivan, ATC
Primary Researcher
California University of Pennsylvania
250 University Ave
California, PA 15419
774-249-4856
SUL8358@calu.edu

Demographics

***1. Gender:**

- ◯ Male
- ◯ Female

***2. Choose your following age group:**

- ◯ 17 and Under
- ◯ 18 to 25
- ◯ 25 and Older

Sports Participation

***3. Which of the following varsity sports are you currently participating in?**

- [ ] Baseball
- [ ] Softball
- [ ] Volleyball
- [ ] Swimming

Other (please specify)

4. Which NCAA division do you compete in?

- ◯ Division I
- ◯ Division II
- ◯ Division III

5. Choose all of the sports you participated in during your high school career:

- [ ] Football
- [ ] Baseball
- [ ] Basketball
- [ ] Softball
- [ ] Volleyball
- [ ] Swimming
- [ ] Soccer
- [ ] Lacrosse
- [ ] Wrestling
- [ ] Field Hockey
- [ ] Track and Field
- [ ] Cross Country
- [ ] Tennis

Other (please specify)

6. Choose all of the sports you participated previous to high school:

- [ ] Football
- [ ] Baseball
- [ ] Basketball
- [ ] Softball
- [ ] Volleyball
- [ ] Swimming
- [ ] Soccer
- [ ] Lacrosse
- [ ] Wrestling
- [ ] Field Hockey
- [ ] Track and Field
- [ ] Cross Country
- [ ] Tennis

Other (please specify)

***7. Prior to college, did you regularly participate in any sports specific training outside of practice?**

- ○ Yes
- ○ No

8. Choose all of the following types of training you performed:

- [ ] Weight Training
- [ ] Plyometric Training
- [ ] Endurance Training
- [ ] Speed Training
- [ ] Agility Training
- [ ] Core Training
- [ ] Stretching

***9. Prior to participation in a sports specific training program, did you ever receive a postural assessment? (refer to the pictures provided below)**

- ○ Yes
- ○ No

Overhead Squat Test

Postural Assessment

Theraband Exercises

Theraband exercises are exercises that are completed using a resistance band or resistance tube. These bands come in 8 different colors(based on amount of resistance)and help provide resistance to common shoulder exercises. Theraband exercises are commonly used to improve strength and range of motion.

As you read through the next set of questions regarding theraband exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***10. In your training program prior to college, did you regularly perform in Theraband (elastic tubing) exercises, like those shown below?**

◯ Yes

◯ No

11. If you answered yes to the previous question, How long have they been a part of your training program?

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ 5 years or more

***12. Prior to participation in Theraband exercises, did you receive instructions on how to properly perform each exercise?**

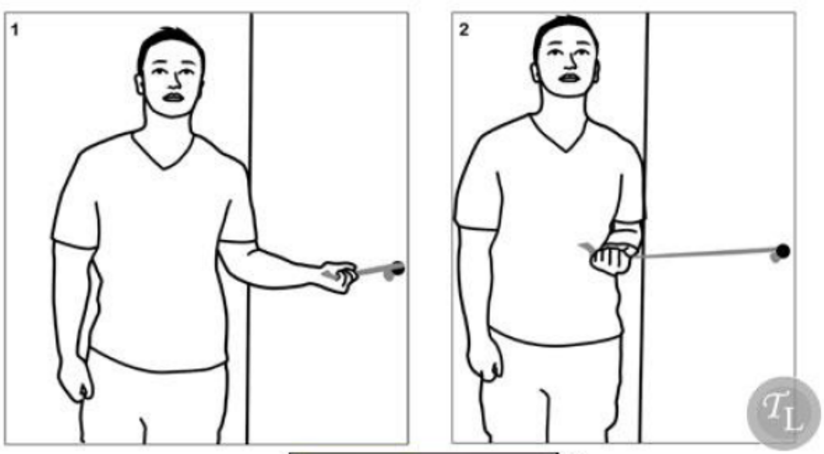
- ◯ Yes
- ◯ No

***13. As part of your Theraband exercises, did you perform in shoulder internal rotation at 0° of shoulder abduction ? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Shoulder Internal Rotation at 0° of Shoulder Abduction

Theraband Exercise: Internal Rotation



TherapyLibrary SM

***14. As part of your Theraband exercises, did you perform in shoulder internal rotation at 90° of shoulder abduction ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Internal Rotation at 90° Shoulder Abduction

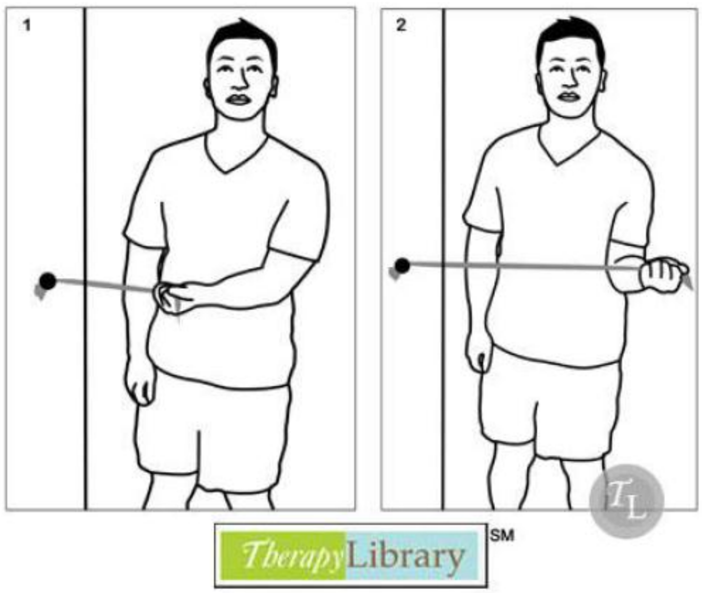
***15. As part of your Theraband exercises, did you perform in shoulder external rotation at 0° of shoulder abduction ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder External Rotation at 0° of Shoulder Abduction

Theraband Exercise: Shoulder External Rotation



*16. As part of your Theraband exercises, did you perform in shoulder external rotation at 90° of shoulder abduction ? (refer to the picture provided below)

◯ Yes

◯ No

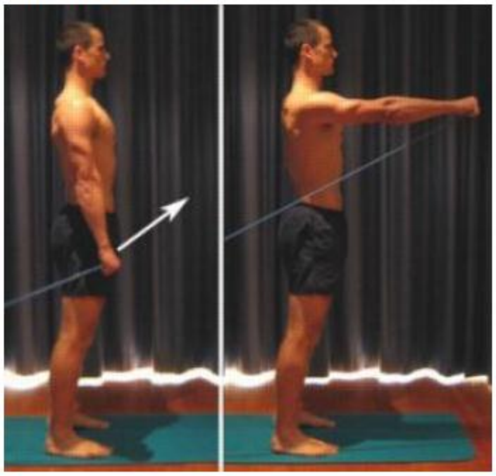
Shoulder External Rotation at 90° of Shoulder Abduction

***17. As part of your Theraband exercises, did you perform shoulder flexion exercises ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Flexion

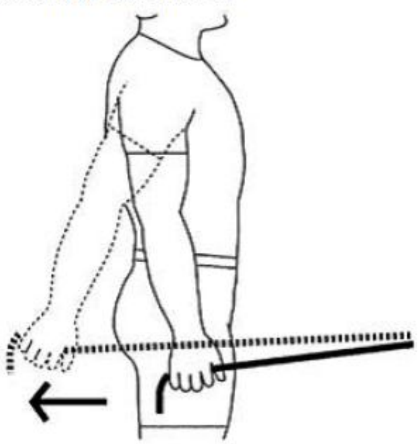


***18. As part of your Theraband exercises, did you perform shoulder extension exercises ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Extension

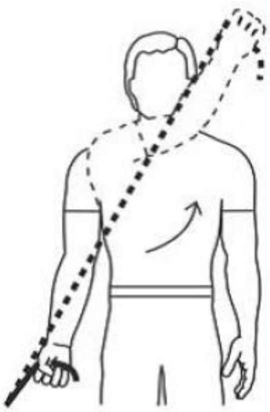


***19. As part of your Theraband exercises, did you perform a D1 flexion pattern (Lifting arm upward and across the body to the opposite shoulder, bending elbow and ending with palm inward)?**
(refer to the picture provided below)

◯ Yes

◯ No

D1 Flexion Pattern



***20. As part of your Theraband exercises, did you perform a D1 Extension pattern (Pulling arm down and across body,ending with the palm outward)? (refer to the picture provided below)**

◯ Yes

◯ No

D1 Extension Pattern

***21. As part of your Theraband exercises, did you perform a D2 Flexion pattern (Begins with arm crossed over trunk and palm turned inward, at opposite hip. Raise arm up and diagonally across, ending with palm facing forward)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

D2 Flexion Pattern

***22. As part of your Theraband exercises, did you perform a D2 Extension pattern (Beginning with arm raised and palm turned outward pull arm down and diagonally across, ending at the opposite hip with palm facing inward)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

D2 Extension Pattern

***23. As part of your Theraband exercises, did you perform a dynamic scapular hug (Beginning with the band wrapped around upper back, holding each end in hands. Keeping the shoulders elevated and pushing arms forward and inward in a hugging motion)? (refer to the picture provided below)**

◯ Yes

◯ No

Dynamic Scapular Hug

***24. As part of your Theraband exercises, did you perform scapular punches? (refer to the picture provided below)**

◯ Yes

◯ No

Scapular punch

Weight Training Exercises

Weight training is a form of strength training that is used to increase the size and strength of the desired muscle group. This type of training utilizes equipment such as weighted bars, dumbbells or barbells. Other types of weight training can utilize body weight (push-ups) to increase strength.

As you read through the next set of questions regarding weight training exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***25. In your training program prior to college, did you regularly perform in weight training exercises, like those shown below?**

- ◯ Yes
- ◯ No

26. If you answered yes to the previous question, How long have they been a part of your training program?

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ 5 years or more

***27. Prior to participation in weight training exercises, did you receive instructions on how to properly perform each exercise?**

- ◯ Yes
- ◯ No

***28. As part of your weight training, did you perform in the empty can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed down)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Empty Can

***29. As part of your weight training, did you perform in the full can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed up)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Full Can Exercise

***30. As part of your weight training, did you perform in a prone full can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed up while lying prone)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

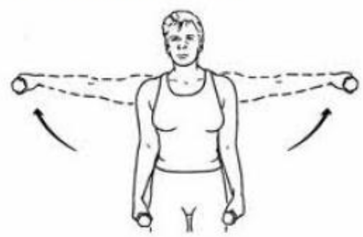
Prone Full Can Exercise

***31. As part of your weight training, did you perform in shoulder abduction exercises? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Abduction



***32. As part of your weight training, did you perform upright rows? (refer to the picture provided below)**

◯ Yes

◯ No

Upright Row

***33. As part of your weight training, did you perform prone rows? (refer to the picture provided below)**

◯ Yes

◯ No

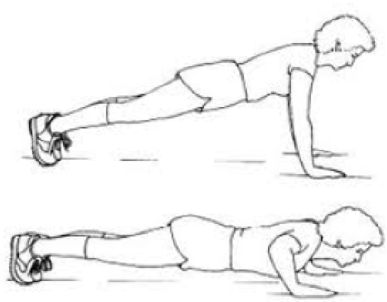
Prone Row

***34. As part of your weight training, did you perform push-ups? (refer to the picture provided below)**

◯ Yes

◯ No

Push Up



***35. As part of your weight training, did you perform push-ups with a plus (After doing a regular push up, pushing the back towards the ceiling, allowing to raise a couple more inches? (refer to the picture provided below)**

◯ Yes

◯ No

Push-Up Plus

***36. As part of your weight training, did you perform push-ups on an unstable surface? (refer to the picture provided below)**

◯ Yes

◯ No

Push-Ups on Unstable Surface

Medicine Ball Exercises

Medicine ball exercises use a weighted ball to improve overall performance. This type of training is commonly used to improve core strength, speed, power and upper and lower body strength.

As you read through the next set of questions regarding medicine ball exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***37. In your training program prior to college, did you regularly perform in Medicine Ball exercises, like those shown below?**

- ◯ Yes
- ◯ No

38. If you answered yes to the previous question, how long have they been a part of your training program?

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ 5 years or more

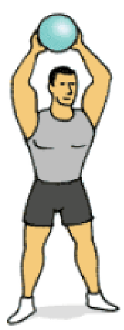
***39. Prior to participation in medicine ball exercises, did you receive instructions on how to properly perform each exercise?**

- ◯ Yes
- ◯ No

***40. As part of your medicine ball training, did you perform medicine ball slams? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Medicine Ball Slam

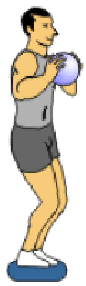


*41. As part of your medicine ball training, did you perform medicine ball chest passes? (refer to the picture provided below)

◯ Yes

◯ No

Medicine Ball Chest Pass

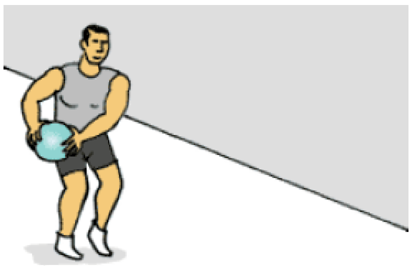


*42. As part of your medicine ball training, did you perform medicine ball rotational throws? (refer to the picture provided below)

◯ Yes

◯ No

Medicine Ball Rotational Throws

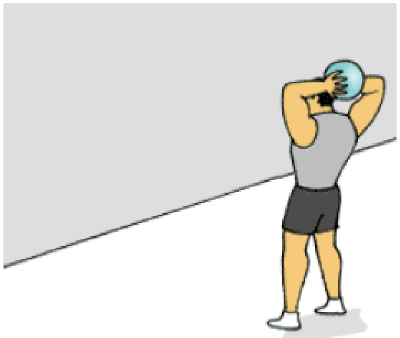


*43. As part of your medicine ball training, did you perform medicine ball overhead throws? (refer to the picture provided below)

◯ Yes

◯ No

Medicine Ball Overhead Throws

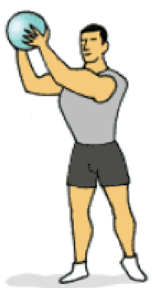


*44. **As part of your medicine ball training, did you perform medicine ball figure 8 exercises? (refer to the picture provided below)**

◯ Yes

◯ No

Medicine Ball Figure 8



Core Exercises

The core is defined as the center of the body and the beginning point of body movements. The core is made up of the muscles that stabilize the trunk, the spine and the pelvis. The core consists of muscles that make up the abdominals, lower back and hip. Core exercises are described as those that target one or more of the muscles making up the core.

As you read through the next set of questions regarding core exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***45. In your training program prior to college, did you regularly perform in core exercises, like those shown below?**

- ◯ Yes
- ◯ No

46. If you answered yes to the previous question, How long have they been a part of your training program?

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ 5 years or more

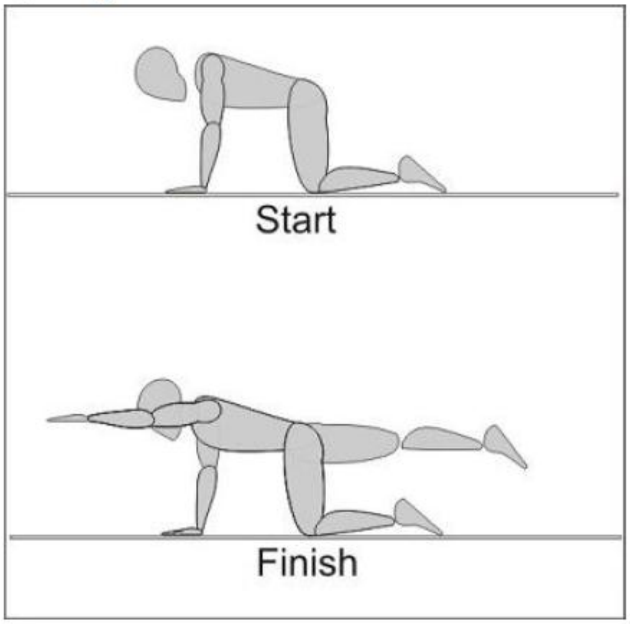
***47. Prior to participation in core exercises, did you receive instructions on how to properly perform each exercise?**

- ◯ Yes
- ◯ No

***48. As part of your core exercises, did you perform the quadruped exercise? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

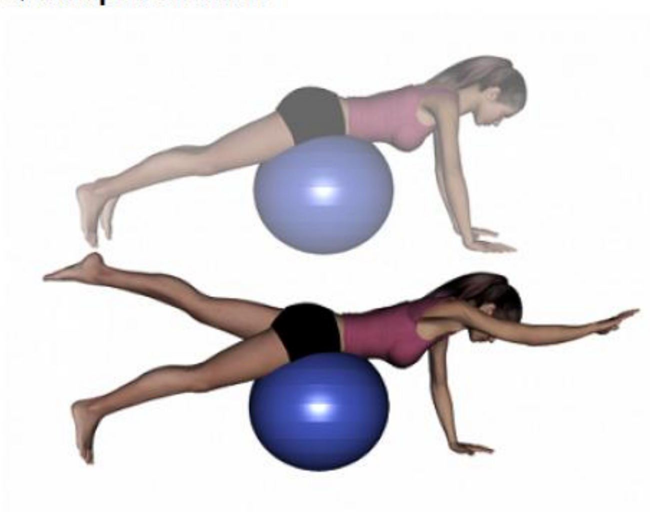
Quadruped Exercise



*49. Did you perform the quadruped exercise on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)
(refer to the picture provided below)**

- ◯ Yes
- ◯ No

Quadruped Unstable



***50. As part of your core exercises, did you perform the dead bug exercise? (refer to the picture provided below)**

◯ Yes

◯ No

Dead Bug Exercise

***51. Did you perform the dead bug exercise on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

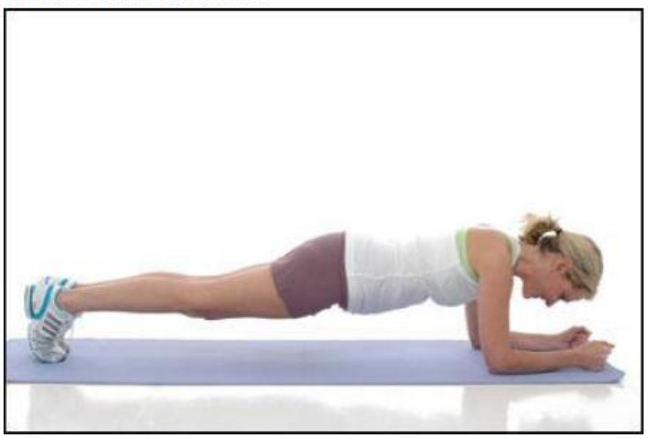
Dead Bug Unstable

***52. As part of your core exercises, did you perform a front plank? (refer to the picture provided below)**

◯ Yes

◯ No

Front Plank Exercise



***53. Did you perform the front plank on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

Front Plank Unstable

***54. As part of your core exercises, did you perform a side plank? (refer to the picture provided below)**

◯ Yes

◯ No

Side Plank Exercise

***55. Did you perform the side plank on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

Side Plank Unstable

***56. As part of your core exercises, did you perform a curl up? (refer to the picture provided below)**

◯ Yes

◯ No

Curl Up Exercise

***57. Did you perform the curl up on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)
(refer to the picture provided below)**

◯ Yes

◯ No

Curl Up Unstable

***58. As part of your core exercises, did you perform a single leg squat? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Single Leg Squat

***59. As part of your core exercises, did you perform a lunge with a twist? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Lunge with a twist

Stretching Program

As you read through the next set of questions regarding stretching exercises, refer to the picture below each question for a visual representation of each stretch. Each question requires a yes or no answer before advancing to the next one.

***60. In your training program prior to college, did you regularly perform in a shoulder stretching protocol, like those shown below?**

◯ Yes

◯ No

61. If you answered yes to the previous question, how long have they been a part of your training program?

◯ 1-2 years

◯ 3-5 years

◯ 5 years or more

***62. Prior to participation in a stretching program, did you receive instructions on how to properly perform each stretching technique?**

◯ Yes

◯ No

***63. As part of your stretching program, did you perform an internal rotation stretch? (refer to the picture provided below)**

◯ Yes

◯ No

Internal Rotation Stretch

***64. As part of your stretching program, did you perform an external rotation stretch? (refer to the picture provided below)**

○ Yes

○ No

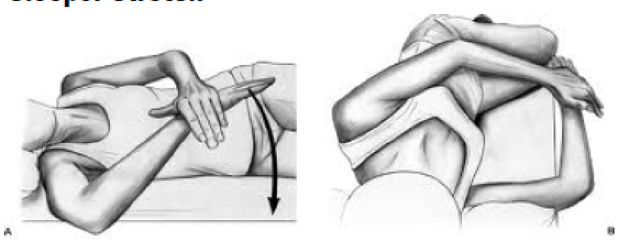
Shoulder External Rotation

***65. As part of your stretching program, did you perform the Sleeper Stretch? (refer to the picture provided below)**

○ Yes

○ No

Sleeper Stretch



***66. As part of your stretching program, did you perform the horizontal cross arm stretch? (refer to the picture provided below)**

○ Yes

○ No

Horizontal Cross Arm Stretch

Injury Status

***67. In the MOST RECENT COMPETITIVE SEASON, did you suffer from any of the following Injuries: Bicipital Tendonitis, Rotator Cuff Tendonitis, Shoulder Instability or Impingement Syndrome?**

◯ Yes

◯ No

***68. How long have you suffered from this injury?**

- ◯ 1-2 years
- ◯ 3-5 years
- ◯ 5-7 years
- ◯ 7-10 years
- ◯ 10 or more years

***69. Choose all of the following injuries that you have suffered from in the most recent competitive season:**

- ☐ Bicipital Tendonitis
- ☐ Rotator Cuff Tendonitis
- ☐ Shoulder Instability
- ☐ Impingement Syndrome

***70. In your ENTIRE PLAYING CAREER, have you ever suffered from any of the following Injuries: Bicipital Tendonitis, Rotator Cuff Tendonitis, Shoulder Instability or Impingement Syndrome?**

- ◯ Yes
- ◯ No

***71. How long have you suffered from this injury?**

- ◯ 0-2 years
- ◯ 3-5 years
- ◯ 5-7 years
- ◯ 7-10 years
- ◯ 10 or more years

***72. Choose all of the following injuries that you have suffered from throughout your competitive career:**

- ☐ Bicipital Tendonitis
- ☐ Rotator Cuff Tendonitis
- ☐ Shoulder Instability
- ☐ Impingement Syndrome

***73. Did you receive any treatment for the following injuries: Bicipital Tendonitis, Rotator Cuff Tendonitis, Shoulder Instability, Impingement Syndrome?**

- ◯ Yes
- ◯ No

74. Choose all of the following individuals that provided treatment throughout your injury:

- ☐ Medical Doctor
- ☐ Nurse Practitioner
- ☐ Chiropractor
- ☐ Athletic Trainer
- ☐ Physical Therapist

Other (please specify)

***75. Did you participate in rehabilitation exercises for your injury?**

- ◯ Yes
- ◯ No

76. Choose all of the following types of exercises you performed:

☐ Weight Training

☐ Plyometric Training

☐ Endurance Training

☐ Speed Training

☐ Agility Training

☐ Core Training

☐ Stretching

***77. Prior to participation in a rehabilitation program, did you receive a postural assessment? (refer to the pictures provided below)**

◯ Yes

◯ No

Overhead Squat Test

Postural Assessment

Theraband Rehabilitation

Theraband exercises are exercises that are completed using a resistance band or resistance tube. These bands come in 8 different colors(based on amount of resistance)and help provide resistance to common shoulder exercises. Theraband exercises are commonly used to improve strength and range of motion.

As you read through the next set of questions regarding theraband exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***78. In your rehabilitation program, did you perform in Theraband(elastic tubing) exercises, like those shown below?**

○ Yes

○ No

***79. Prior to participation in Theraband rehabilitation exercises, did you receive instructions on how to properly perform each exercise?**

○ Yes

○ No

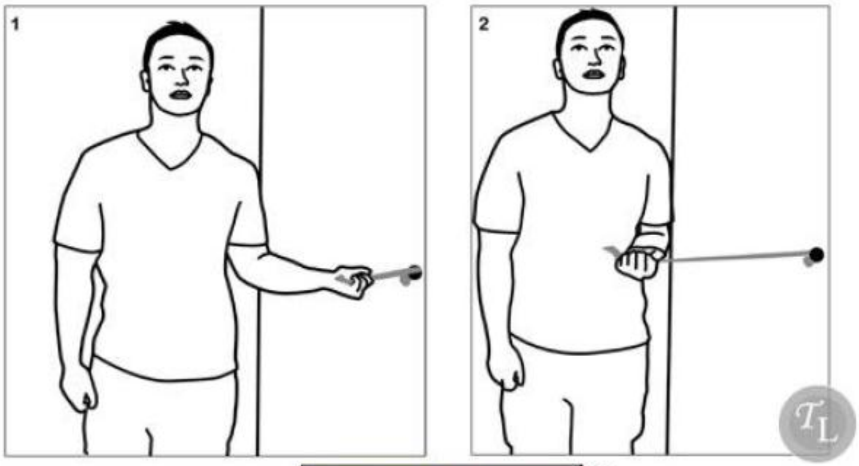
***80. As part of your Theraband exercises, did you perform in shoulder internal rotation at 0° of shoulder abduction ? (refer to the picture provided below)**

○ Yes

○ No

Shoulder Internal Rotation at 0° of Shoulder Abduction

Theraband Exercise: Internal Rotation



TherapyLibrary SM

***81. As part of your Theraband exercises, did you perform in shoulder internal rotation at 90° of shoulder abduction ? (refer to the picture provided above)**

- ◯ Yes
- ◯ No

Shoulder Internal Rotation at 90° Shoulder Abduction

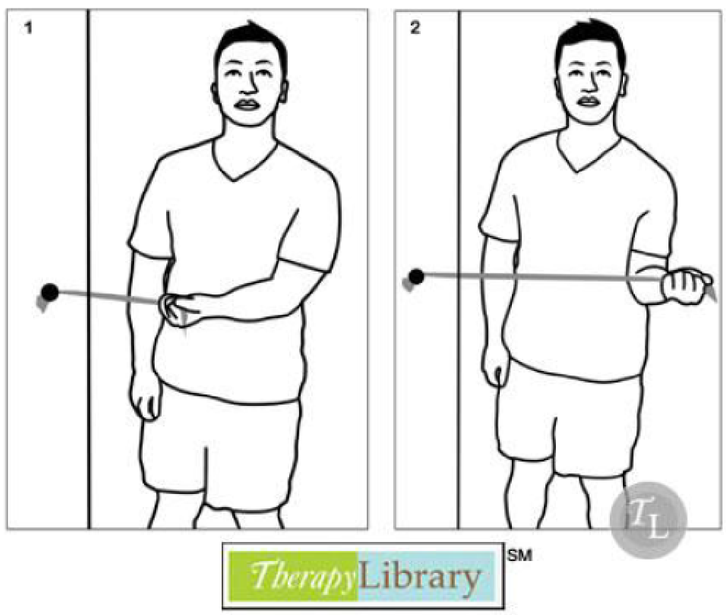
***82. As part of your Theraband exercises, did you perform in shoulder external rotation at 0° of shoulder abduction ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder External Rotation at 0° of Shoulder Abduction

Theraband Exercise: Shoulder External Rotation



***83. As part of your Theraband exercises, did you perform in shoulder external rotation at 90° of shoulder abduction ? (refer to the picture provided below)**

◯ Yes

◯ No

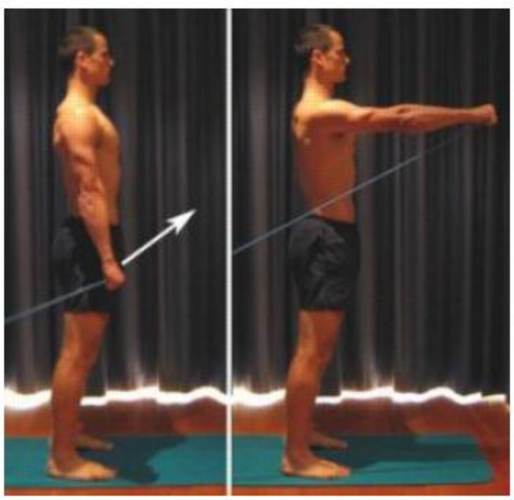
Shoulder External Rotation at 90° of Shoulder Abduction

***84. As part of your Theraband exercises, did you perform shoulder flexion exercises ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Flexion

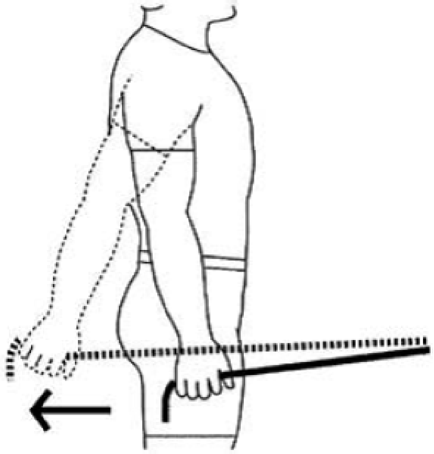


***85. As part of your Theraband exercises, did you perform shoulder extension exercises ? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Extension

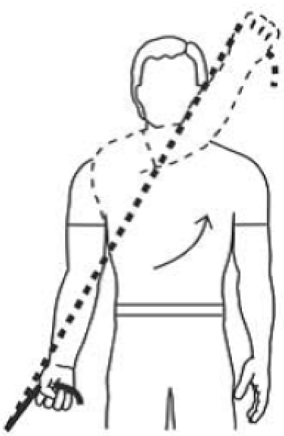


***86. As part of your Theraband exercises, did you perform a D1 flexion pattern (Lifting arm upward and across the body to the opposite shoulder, bending elbow and ending with palm inward)?**
(refer to the picture provided below)

◯ Yes

◯ No

D1 Flexion Pattern

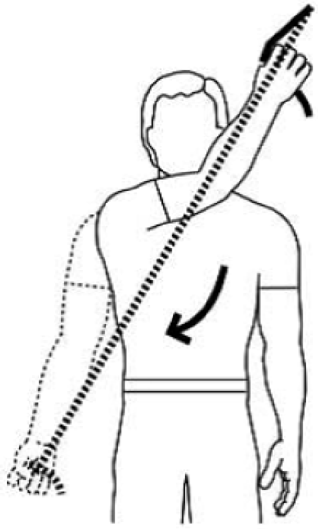


***87. As part of your Theraband exercises, did you perform a D1 Extension pattern (Pulling arm down and across body,ending with the palm outward)? (refer to the picture provided below)**

◯ Yes

◯ No

D1 Extension Pattern

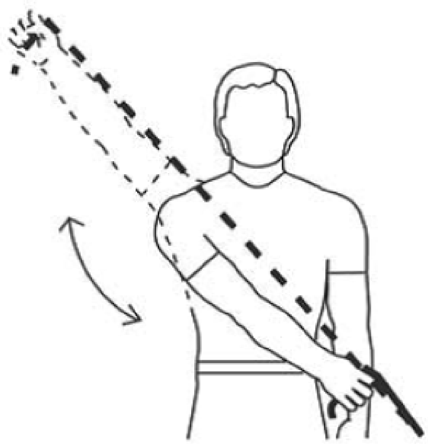


***88. As part of your Theraband exercises, did you perform a D2 Flexion pattern (Begins with arm crossed over trunk and palm turned inward, at opposite hip. Raise arm up and diagonally across, ending with palm facing forward)? (refer to the picture provided below)**

◯ Yes

◯ No

D2 Flexion Pattern

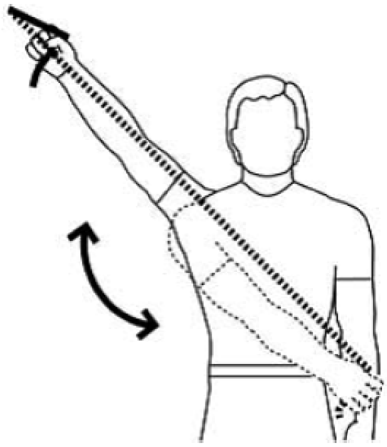


***89. As part of your Theraband exercises, did you perform a D2 Extension pattern (Beginning with arm raised and palm turned outward pull arm down and diagonally across, ending at the opposite hip with palm facing inward)? (refer to the picture provided below)**

◯ Yes

◯ No

D2 Extension Pattern



***90. As part of your Theraband exercises, did you perform a dynamic scapular hug (Beginning with the band wrapped around upper back, holding each end in hands. Keeping the shoulders elevated and pushing arms forward and inward in a hugging motion)? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Dynamic Scapular Hug

***91. As part of your Theraband exercises, did you perform scapular punches? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Scapular punch

Weight Training Rehabilitation

Weight training is a form of strength training that is used to increase the size and strength of the desired muscle group. This type of training utilizes equipment such as weighted bars, dumbbells or body weight barbells. Other types of weight training can utilize body weight (push-ups) to increase strength.

As you read through the next set of questions regarding weight training exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***92. In your rehabilitation program, did you perform in weight training exercises, like those shown below?**

◯ Yes

◯ No

***93. Prior to participation in weight training rehabilitation exercises, did you receive instructions on how to properly perform each exercise?**

◯ Yes

◯ No

***94. As part of your weight training, did you perform in the empty can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed down)? (refer to the picture provided below)**

◯ Yes

◯ No

Empty Can

***95. As part of your weight training, did you perform in the full can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed up)? (refer to the picture provided below)**

◯ Yes

◯ No

Full Can Exercise

***96. As part of your weight training, did you perform in a prone full can exercise (Exercise is performed with the shoulder out at 45° and thumb pointed up while lying prone)? (refer to the picture provided below)**

◯ Yes

◯ No

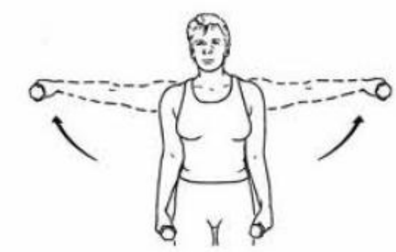
Prone Full Can Exercise

***97. As part of your weight training, did you perform in shoulder abduction exercises? (refer to the picture provided below)**

◯ Yes

◯ No

Shoulder Abduction



***98. As part of your weight training, did you perform upright rows? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Upright Row

***99. As part of your weight training, did you perform prone rows? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

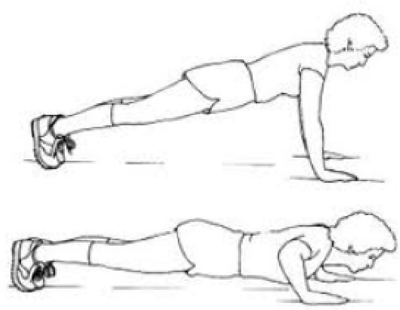
Prone Row

***100. As part of your weight training, did you perform push-ups? (refer to the picture provided below)**

◯ Yes

◯ No

Push Up



***101. As part of your weight training, did you perform push-ups with a plus (After doing a regular push up, pushing the back towards the ceiling, allowing to raise a couple more inches? (refer to the picture provided below)**

◯ Yes

◯ No

Push-Up Plus

*102. As part of your weight training, did you perform push-ups on an unstable surface? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Push-Ups on Unstable Surface

Medicine Ball Rehabilitation

Medicine ball exercises use a weighted ball to improve overall performance. This type of training is commonly used to improve core strength, speed, power and upper and lower body strength.

As you read through the next set of questions regarding medicine ball exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***103. In your rehabilitation program, did you perform in medicine ball exercises, like those shown below?**

○ Yes

○ No

***104. Prior to participation in medicine ball rehabilitation exercises, did you receive instructions on how to properly perform each exercise?**

○ Yes

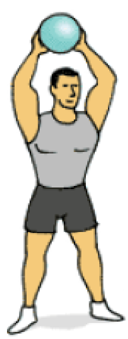
○ No

***105. As part of your medicine ball training, did you perform medicine ball slams? (refer to the picture provided below)**

○ Yes

○ No

Medicine Ball Slam

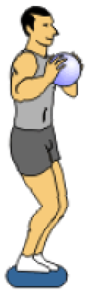


***106. As part of your medicine ball training, did you perform medicine ball chest passes? (refer to the picture provided below)**

○ Yes

○ No

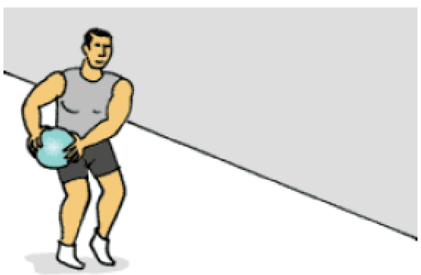
Medicine Ball Chest Pass



*107. As part of your medicine ball training, did you perform medicine ball rotational throws? (refer to the picture provided below)

- ◯ Yes
- ◯ No

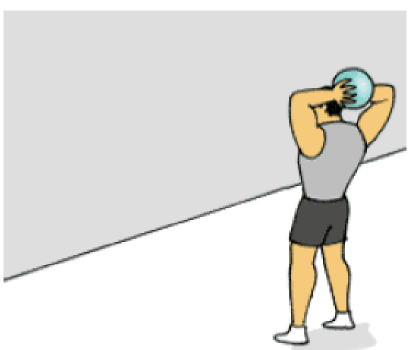
Medicine Ball Rotational Throws



*108. As part of your medicine ball training, did you perform medicine ball overhead throws? (refer to the picture provided below)

- ◯ Yes
- ◯ No

Medicine Ball Overhead Throws

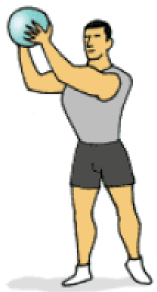


***109. As part of your medicine ball training, did you perform medicine ball figure 8 exercises? (refer to the picture provided below)**

◯ Yes

◯ No

Medicine Ball Figure 8



Core Rehabilitation

The core is defined as the center of the body and the beginning point of body movements. The core is made up of the muscles that stabilize the trunk, the spine and the pelvis. The core consists of muscles that make up the abdominals, lower back and hip. Core exercises are described as those that target one or more of the muscles making up the core.

As you read through the next set of questions regarding core exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***110. In your rehabilitation program, did you perform in core exercises, like those shown below?**

- ◯ Yes
- ◯ No

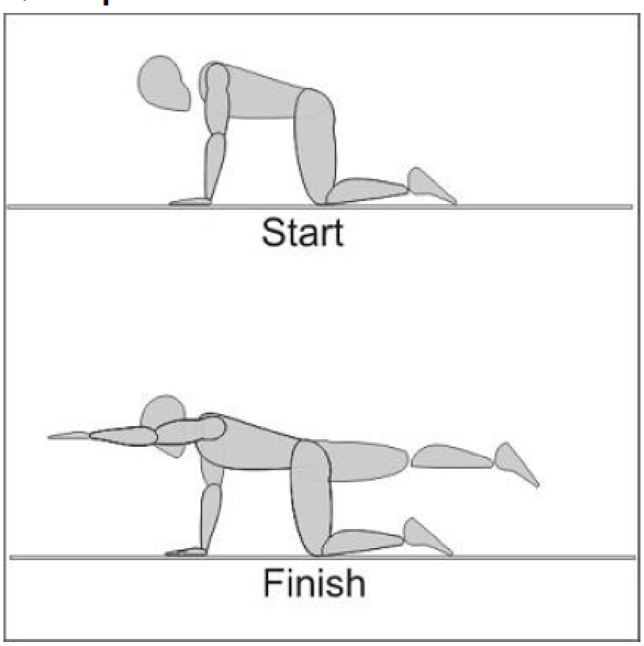
***111. Prior to participation in core rehabilitation exercises, did you receive instructions on how to properly perform each exercise?**

- ◯ Yes
- ◯ No

***112. As part of your core exercises, did you perform the quadruped exercise? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Quadruped Exercise

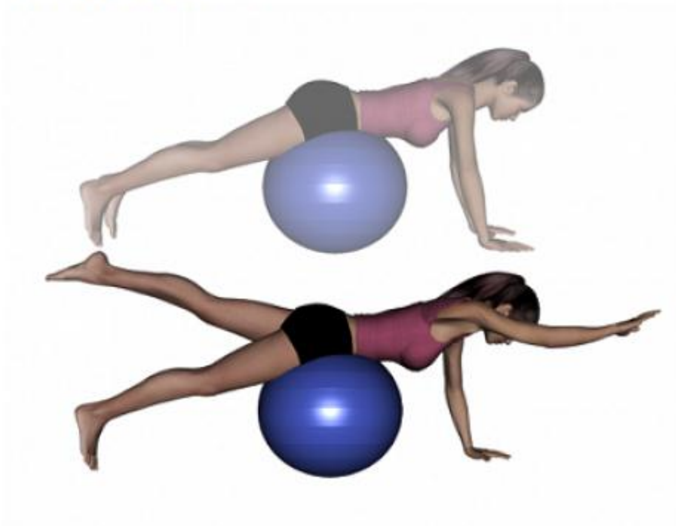


*113. Did you perform the quadruped exercise on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)
(refer to the picture provided below)

◯ Yes

◯ No

Quadruped Unstable



*114. As part of your core exercises, did you perform the dead bug exercise? (refer to the picture provided below)

◯ Yes

◯ No

Dead Bug Exercise

***115. Did you perform the dead bug exercise on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

Dead Bug Unstable

***116. As part of your core exercises, did you perform a front plank? (refer to the picture provided below)**

◯ Yes

◯ No

Front Plank Exercise

***117. Did you perform the front plank on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

Front Plank Unstable

***118. As part of your core exercises, did you perform a side plank? (refer to the picture provided below)**

◯ Yes

◯ No

Side Plank Exercise

***119. Did you perform the side plank on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)**
(refer to the picture provided below)

◯ Yes

◯ No

Side Plank Unstable

*120. As part of your core exercises, did you perform a curl up? (refer to the picture provided below)

◯ Yes

◯ No

Curl Up Exercise

*121. Did you perform the curl up on an unstable surface? (ex. physioball, exercise ball, swiss ball or bosu ball)
(refer to the picture provided below)

◯ Yes

◯ No

Curl Up Unstable

*122. As part of your core exercises, did you perform a single leg squat? (refer to the picture provided below)

◯ Yes

◯ No

Single Leg Squat

***123. As part of your core exercises, did you perform a lunge with a twist? (refer to the picture provided below)**

○ Yes

○ No

Lunge with a twist

Stretching Rehabilitation

As you read through the next set of questions regarding stretching exercises, refer to the picture below each question for a visual representation of the exercise. Each question requires a yes or no answer before advancing to the next one.

***124. In your rehabilitation program, did you perform in a shoulder stretching protocol, like those shown below?**

- ◯ Yes
- ◯ No

***125. Prior to participation in a rehabilitation stretching program, did you receive instructions on how to properly perform each stretching technique?**

- ◯ Yes
- ◯ No

***126. As part of your stretching program, did you perform an internal rotation stretch? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Internal Rotation Stretch

***127. As part of your stretching program, did you perform an external rotation stretch? (refer to the picture provided below)**

- ◯ Yes
- ◯ No

Shoulder External Rotation

***128. As part of your stretching program, did you perform the Sleeper Stretch? (refer to the picture provided below)**

○ Yes

○ No

Sleeper Stretch

***129. As part of your stretching program, did you perform the horizontal cross arm stretch? (refer to the picture provided below)**

○ Yes

○ No

Horizontal Cross Arm Stretch

Thank You

Thank you for your participation in this survey. Your time and effort is greatly appreciated. If you have any questions, feel free to contact the primary researcher:

Kellie Sullivan, ATC
California University of Pennsylvania
250 University Ave.
SUL8358@calu.edu

APPENDIX C2

Institutional Review Board –

California University of Pennsylvania

Proposal Number

____

Date Received

____

California University of Pennsylvania

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title ***Persistent Overuse Injuries in the Overhead Athlete***

Researcher/Project Director ***Kellie Sullivan***

Phone # ***774-249-4856*** ***E-mail Address*** ***sul8358@calu.edu***

Faculty Sponsor (if required) ***Tom West***

Department ***Health Science***

Project Dates ***January 1, 2012*** ***to*** ***December 31, 2012***

Sponsoring Agent (if applicable) ***NA***

Project to be Conducted at *California University of Athletic Training "via online survey"*

Project Purpose: ☒ ***Thesis*** ☐ ***Research*** ☐ ***Class Project*** ☐ ***Other***

Keep a copy of this form for your records.

<u>Please attach a typed, detailed summary of your project AND complete items 2 through 6.</u>

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(ses)or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.*

   This proposal is a retrospective, descriptive study that will examine the effective preventative and rehabilitation exercises of overhead overuse injuries in Division II and Division III baseball, softball, volleyball and swimming athletes through the use of a survey. The survey will be finalized after review from a panel of experts. Upon approval from the California University of Pennysylvania's Institutional Review Board, the researcher will create a direct link to the survey using www.surveymonkey.com. A cover letter (Appendix C3) will be sent to the overhead athletes explaining the purpose of the study. The email containing the cover letter will also contain a link that will give the athlete direct access to the survey. The researcher will contact the Athletic Directors at the chosen Division II and Division III institutions, requesting that the survey be sent to the baseball, softball, volleyball and swimming teams at their institition.

   Hypotheses:

   1:There will be a difference in the number of training exercises regularly performed between the current history, previous history or no history injury groups.

   2.The previous history group will have performed a higher number of rehabilitation exercises when compared to the current history group

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*

   a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

      There is a risk that the participants personal information and/or answers to the survey could become public. In order to minimize these risks, the participants name will not be asked in the survey. The surveys will be completed online and without a name. Once the surveys are returned, they will be downloaded and password protected.

      The participants are at minimal risk while completing the survey, considering the rewards gained upon completion of the survey. Determining the effective preventative and rehabilitation exercises for overhead overuse injuries can help decrease the chronic effects associated with these injuries by treating these athletes at a young age.

   b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable* *populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

The survey will be sent to the members of the baseball, softball, volleyball and swimming teams of the chosen Division II and Division III institutions. The demogrpahic section at the beginning of the survey will require the participant to provide their age. If the athlete is not 18 or older, they will not have access to the survey and will be sent to a page thanking them for their participation. The participation of the survey may also be discontinued at any time without penalty and all data disregarded.

c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

Informed consent will be implied upon completing and returning the survey. As stated in the cover letter provided to the participants, the participants have the right to not participate in the survey.

d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

This is an anonymous survey that does not contain the participants name or email upon completion. Once the surveys are returned, they will be downloaded and password protected. The electronic surveys will be stored on university servers, where only the researcher and thesis chair have access.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

☒ *Adult volunteers*	☐ *Mentally Disabled People*
☒ *CAL University Students*	☐ *Economically Disadvantaged People*
☒ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☐ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

4. *Is remuneration involved in your project?* ☐ *Yes or* ☒ *No. If yes, Explain here.*

5. *Is this project part of a grant?* ☐ *Yes or* ☒ *No If yes, provide the following information:*

Title of the Grant Proposal _____

Name of the Funding Agency _____

Dates of the Project Period _____

6. *Does your project involve the debriefing of those who participated?* ☐ *Yes or* ☒ *No*

   If Yes, explain the debriefing process here.

7. *If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix___in the Policies and Procedures Manual.*

California University of Pennsylvania Institutional Review Board
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview or questionnaire?

☒ **YES**—Complete this form

☐ **NO**—You MUST complete the "Informed Consent Checklist"—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:

☒ (1) Statement about the general nature of the survey and how the data will be used?

☒ (2) Statement as to who the primary researcher is, including name, phone, and email address?

☒ (3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

☒ (4) Statement that participation is voluntary?

☒ (5) Statement that participation may be discontinued at any time without penalty and all data discarded?

☒ (6) Statement that the results are confidential?

☒ (7) Statement that results are anonymous?

☒ (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)

☒ (9) Statement that returning the survey is an indication of consent to use the data?

☒ (10) Who to contact regarding the project and how to contact this person?

☒ (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)

☒ (12) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)?

☒ (13) FOR ELECTRONIC/WEBSITE SURVEYS: Does the text of the cover letter or
explanatory statement appear before any data is requested from the participant?

☒ (14) FOR ELECTONIC/WEBSITE SURVEYS: Can the participant discontinue participation at any point in the process and all data is immediately discarded?

California University of Pennsylvania Institutional Review Board
Informed Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview, or questionnaire?
☒ **YES**—DO NOT complete this form. You MUST complete the "Survey/Interview/Questionnaire Consent Checklist" instead.
☐ **NO**—Complete the remainder of this form.

1. Introduction (check each)
☐ (1.1) Is there a statement that the study involves research?
☐ (1.2) Is there an explanation of the purpose of the research?

2. Is the participant. (check each)
☐ (2.1) Given an invitation to participate?
☐ (2.2) Told why he/she was selected.
☐ (2.3) Told the expected duration of the participation.
☐ (2.4) Informed that participation is voluntary?
☐ (2.5) Informed that all records are confidential?
☐ (2.6) Told that he/she may withdraw from the research at any time without penalty or loss of benefits?
☐ (2.7) 18 years of age or older? (if not, see Section #9, Special Considerations below)

3. Procedures (check each).
☐ (3.1) Are the procedures identified and explained?
☐ (3.2) Are the procedures that are being investigated clearly identified?
☐ (3.3) Are treatment conditions identified?

4. Risks and discomforts. (check each)
☐ (4.1) Are foreseeable risks or discomforts identified?
☐ (4.2) Is the likelihood of any risks or discomforts identified?
☐ (4.3) Is there a description of the steps that will be taken to minimize any risks or discomforts?
☐ (4.4) Is there an acknowledgement of potentially unforeseeable risks?
☐ (4.5) Is the participant informed about what treatment or follow up courses of action are available should there be some physical, emotional, or psychological harm?
☐ (4.6) Is there a description of the benefits, if any, to the participant or to others that may be reasonably expected from the research and an estimate of the likelihood of these benefits?
☐ (4.7) Is there a disclosure of any appropriate alternative procedures or courses of treatment that might be advantageous to the participant?

5. Records and documentation. (check each)

☐ (5.1) Is there a statement describing how records will be kept confidential?

☐ (5.2) Is there a statement as to where the records will be kept and that this is a secure location?

☐ (5.3) Is there a statement as to who will have access to the records?

6. For research involving more than minimal risk (check each),

☐ (6.1) Is there an explanation and description of any compensation and other medical or counseling treatments that are available if the participants are injured through participation?

☐ (6.2) Is there a statement where further information can be obtained regarding the treatments?

☐ (6.3) Is there information regarding who to contact in the event of research-related injury?

7. Contacts.(check each)

☐ (7.1) Is the participant given a list of contacts for answers to questions about the research and the participant's rights?

☐ (7.2) Is the principal researcher identified with name and phone number and email address?

☐ (7.3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

8. General Considerations (check each)

☐ (8.1) Is there a statement indicating that the participant is making a decision whether or not to participate, and that his/her signature indicates that he/she has decided to participate having read and discussed the information in the informed consent?

☐ (8.2) Are all technical terms fully explained to the participant?

☐ (8.3) Is the informed consent written at a level that the participant can understand?

☐ (8.4) Is there text equivalent to: "Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm"? (the actual dates will be specified in the approval notice from the IRB)

9. Specific Considerations (check as appropriate)

☐ (9.1) If the participant is or may become pregnant is there a statement that the particular treatment or procedure may involve risks, foreseeable or currently unforeseeable, to the participant or to the embryo or fetus?

☐ (9.2) Is there a statement specifying the circumstances in which the participation may be terminated by the investigator without the participant's consent?

☐ (9.3) Are any costs to the participant clearly spelled out?

☐ (9.4) If the participant desires to withdraw from the research, are procedures for orderly termination spelled out?

☐ (9.5) Is there a statement that the Principal Investigator will inform the participant or any significant new findings developed during the research that may affect them and influence their willingness to continue participation?
☐ (9.6) Is the participant is less than 18 years of age? If so, a parent or guardian must sign the consent form and assent must be obtained from the child

- ☐Is the consent form written in such a manner that it is clear that the parent/guardian is giving permission for their child to participate?
- ☐Is a child assent form being used?
- ☐ Does the assent form (if used) clearly indicate that the child can freely refuse to participate or discontinue participation at any time without penalty or coercion?

☐ (9.7) Are all consent and assent forms written at a level that the intended participant can understand? (generally, 8^{th} grade level for adults, age-appropriate for children)

California University of Pennsylvania Institutional Review Board
Review Request Checklist (v021209)

This form MUST accompany all IRB review requests.
Unless otherwise specified, ALL items must be present in your review request.

Have you:

☒ (1.0) FOR ALL STUDIES: Completed ALL items on the Review Request Form? Pay particular attention to:

- ☒ (1.1) Names and email addresses of all investigators
  - ☒ (1.1.1) FOR ALL STUDENTS: use only your CalU email address)
  - ☒ (1.1.2) FOR ALL STUDENTS: Name and email address of your faculty research advisor
- ☒ (1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—NO EXCEPTIONS)
- ☒ (1.3) Answered completely and in detail, the questions in items 2a through 2d?
  - ☒2a: NOTE: No studies can have zero risk, the lowest risk is "minimal risk". If more than minimal risk is involved you MUST:
    - ☐ i. Delineate all anticipated risks in detail;
    - ☐ ii. Explain in detail how these risks will be minimized;
    - ☐ iii. Detail the procedures for dealing with adverse outcomes due to these risks.
    - ☐ iv. Cite peer reviewed references in support of your explanation.
  - ☒ 2b. Complete all items.
  - ☒ 2c. Describe informed consent procedures in detail.
  - ☒ 2d. NOTE: to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location ON UNIVERSITY PREMISES. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.
- ☐ (1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you MUST:
  - ☐ (1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.
  - ☐ (1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate ("assent").

☐ (1.5) Included all grant information in section 5?
☐ (1.6) Included ALL signatures?

☐ (2.0) FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:
☐ (2.1) Attached a copy of all consent form(s)?
☐ (2.2) FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE: attached a copy of all assent forms (if such a form is used)?
☐ (2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)
☒ (3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:
☒ (3.1) Attached a copy of the cover letter/information sheet?
☒ (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)
☒ (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

☒ (4.0) FOR ALL STUDENTS: Has your faculty research advisor:
☒ (4.1) Thoroughly reviewed and approved your study?
☒ (4.2) Thoroughly reviewed and approved your IRB paperwork? including:
☒ (4.2.1) Review request form,
☒ (4.2.2) All consent forms, (if used)
☒ (4.2.3) All assent forms (if used)
☒ (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)
☒ (4.2.5) All checklists
☒ (4.3) IMPORTANT NOTE: Your advisor's signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.
☒ (5.0) Have you retained a copy of all submitted documentation for your records?

Project Director's Certification

Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature | Department Chairperson's Signature

Student or Class Research

Student Researcher's Signature

Supervising Faculty Member's Signature if required | Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved[ ] ☐ Disapproved

Chairperson, Institutional Review Board | Date

Approved, September 12, 2005 / (updated 02-09-09)

<u>ACTION OF REVIEW BOARD</u> (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☐ Approved[________________________________] ☐ Disapproved

____ _________________________

Chairperson, Institutional Review Board Date

Institutional Review Board
California University of Pennsylvania
Morgan Hall, Room 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP,Chair

Dear Kellie Sullivan:

Please consider this email as official notification that your proposal titled "Persistent overuse injuries in the overhead athlete" (Proposal #11-047) has been approved by the California University of Pennsylvania Institutional Review Board as submitted, with the following stipulation:

--:The consent/cover information must specify that only individuals 18 years of age or older may participate in the study.

Once you have updated the consent form, you may immediately begin data collection. You do not need to wait for further IRB approval. At your earliest convenience, you must forward a copy of the updated consent form for the Board's records.

The effective date of the approval is 1-31-2012 and the expiration date is 1-30-2013. These dates must appear on the consent form .
Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 1-30-2013 you must file additional information to be considered for continuing review. Please contact instreviewboard@cup.edu

Please notify the Board when data collection is complete.

Regards,

Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

Appendix C3

Cover Letter

California University of Pennsylvania

Date

Dear Participants:

My name is Kellie Sullivan and I am currently a graduate student at California University of Pennsylvania pursing a Master of Science in Athletic Training. Part of the graduate study curriculum is to complete a research thesis through conducting research. I am conducting survey research to recognize the persistent overuse injuries occurring in the overhead athlete and examine the effective ways to treat and prevent these injuries. Specifically this study will examine the time of the initial onset of these overuse injuries and the initial treatment rendered. Understanding the effective ways to prevent and treat these injuries at a young age can prevent the chronic effects associated with overhead overuse injuries.

Overhead athletes participating in baseball, softball, volleyball and swimming at the chosen Division II and Division III institutions are being asked to participate in this survey; however, your participation is voluntary and you do have the right to choose not to participate. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania Institutional Review Board has reviewed and approved this project. The approval is effective 01/31/12 and expires 01/30/13 .

All survey responses are anonymous and will be kept confidential, and informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Participants must be 18 years or older in order to participate in this study. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience as it will take approximately 20 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Kellie Sullivan at SUL8358@calu.edu. You can also contact the faculty advisor for this research Thomas F. West, PhD, ATC by email west_t@calu.edu or phone 724-938-5933. Thanks in advance for your participation. Please click the following link to access the survey (INSERT LINK HERE).

Thank you for taking the time to take part in my thesis research. I greatly appreciate your time and effort put into this task.

Sincerely,

Kellie Sullivan, ATC
Primary Researcher
California University of Pennsylvania
250 University Ave
California, PA 15419
774-249-4856
SUL8358@calu.edu

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ABSTRACT

Title: PERSITENT OVERUSE INJURIES IN THE OVERHEAD ATHLETE

Researcher: Kellie A. Sullivan, ATC

Advisor: Dr. Thomas F. West

Context: Many overhead athletes are faced with numerous overhead injuries throughout their entire career. Many of the athletes are entering college already having shoulder instabilities and chronic injuries, ultimately persisting throughout their collegiate careers

Objective: The purpose of this study was to recognize the persistent overuse injuries occurring in the overhead athlete and examine the ways these athletes have attempted to treat and prevent these injuries. Specifically this study examined the initial onset of these overuse injuries and exercises performed.

Design: Descriptive Study

Setting: Population-Based Online Survey

Participants: A total of 59 collegiate athletes on the baseball, softball, volleyball and swim team from Division II (n=3)and Division III (n=1)schools in Pennsylvania and Massachusetts completed the survey. Forty-eight participants were female (81.4%) and eleven were male (18.6%).

Interventions: A pilot study was conducted to determine the reliability of the Overhead Overuse Injury Survey. The questions and overall survey displayed a reliability score of .30 or higher, indicating a moderate to strong correlation.

Main Outcome Measures:
The independent variable was the athletes' injury group. This condition had three

levels consisting of current history, previous history and no history. The dependent variables included the number of rehabilitation exercises performed and the number of training exercises performed. The first hypothesis stated that there will be a difference in the number of training exercises regularly performed between the current history, previous history or no history injury groups. The second hypothesis stated that the previous history group will have performed a higher number of rehabilitation exercises when compared to the current history group.

Results: The mean number of training exercises performed by the current history, previous history and no history group were compared using a one-way ANOVA. No significant difference was found ($F(2,39) = .259$, $p > .05$). The current history group performed a mean of 23.1 exercises, compared to the previous history group who performed a mean of 26.4 exercises and the no history group who performed a mean of 20.3 exercises. An independent t-test was calculated comparing the mean rehabilitation exercises performed by participants who currently have an injury to the mean exercises performed by participants who had a previous injury. No significant difference was found ($t(13) = .942$, $p > .05$). The mean number of exercises performed by the currently injured group ($m=22.3$) was not significantly different from the mean of the previously injured group ($m= 16.8$).

Conclusion: There were no significant differences found between the number of exercises performed and the athletes' injury status. Based on the results, we can conclude that the number of exercises performed does not have an effect on the injury status of the athlete.

Word Count: 457