

PREVENTION AND TREATMENT OF SWIMMER'S SHOULDER

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ABSTRACT

Swimmer's shoulder is a musculoskeletal condition that results in symptoms in the area of the anterior lateral aspect of the shoulder, sometimes confined to the subacromial region. The onset of symptoms may be associated with impaired posture, glenohumeral joint mobility, neuromuscular control, or muscle performance. Additionally, training errors such as overuse, misuse, or abuse may also contribute to this condition. In extreme cases, patients with swimmer's shoulder may have soft tissue pathology of the rotator cuff, long head of the biceps, or glenoid labrum. Physical therapists involved in the treatment of competitive swimmers should focus on prevention and early treatment, addressing the impairments associated with this condition, and analyzing training methods and stroke mechanics. The purpose of this clinical commentary is to provide an overview of the biomechanics of swimming, the etiology of the clinical entity referred to as swimmer's shoulder, and strategies for injury prevention and treatment.

Key words. Swimmer's shoulder, injury prevention, rotator cuff.

INTRODUCTION

The shoulder complex is designed to achieve the greatest range of motion (ROM) with the most degrees of freedom of any joint system in the body.¹ The excessive mobility of the shoulder at the glenohumeral and scapulothoracic joints is balanced by the stability of the acromioclavicular (AC) and sternoclavicular joints. At the glenohumeral joint, a complex ligamentous system contributes to primary stability and an elaborate musculotendinous system serves as secondary stabilizers. This support mechanism allows the shoulder to withstand large external forces, while providing enough mobility for the upper extremity to accomplish complex movement patterns.

Perhaps the greatest illustration of the balance between shoulder mobility and stability occurs during sports that require overhead motions. Many overhead sports such as throwing, racket sports, and volleyball require two or three overhead movement patterns. Conversely, swimming requires several overhead movement patterns, involving continuous humeral circumduction in clockwise and counter-clockwise directions.^{2,3} A competitive swimmer usually exceeds 4000 strokes for one shoulder in a single workout, making this sport a common source of shoulder pathology. Shoulder pain is the most common musculoskeletal complaint in swimming^{4,6} with reports of incidence of disabling shoulder pain in competitive swimmers ranging from 27% to 87%.^{4,12} The purpose of this clinical commentary is to provide an overview of the biomechanics of swimming, the etiology of the clinical entity referred to as swimmer's shoulder, and strategies for injury prevention and treatment.

SWIMMING BIOMECHANICS

Swimming requires several different shoulder motions, most being performed during circumduction in clockwise and counter-clockwise directions with varying degrees of internal and external rotation and scapular protraction and retraction.² Swimming is comprised of four different strokes of varying dis-

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tances, including freestyle (sometimes referred to as the crawl), butterfly, backstroke, and breaststroke. Most strokes are divided into two primary phases referred to as the pull-through and recovery. The pull-through is where propulsion is achieved and is further divided into different phases consisting of the hand entry, the catch, mid-pull, and finish or end pull-through. This section will provide an overview of swimming mechanics for each stroke related to the shoulder. For more detailed analysis of swimming biomechanics, the reader is referred to other sources.¹³

Freestyle requires a combined motion of scapular retraction and elevation, with humeral abduction and external rotation during the recovery.² During the pull-through phase, the scapula is protracted while the humerus is adducted, extended, and internally rotated. Stroke power is achieved through the shoulder adductors, extensors, and internal rotators with the serratus anterior and latissimus dorsi being the key propulsion muscles for swimmers.² Because the trunk is rotated away from the side that is beginning to pull, the shoulder avoids a true impingement position of forward flexion with internal rotation and horizontal adduction.

The *butterfly* has a similar motion at the shoulder as freestyle, but the stresses are different because both arms are moved through the same motion simultaneously rather than alternating. For this reason, no trunk rotation occurs so the demand of the medial scapular stabilizers and retractors during recovery is greater with butterfly than freestyle.² In addition, the humeral head moves into an impingement position of elevation, horizontal adduction, and internal rotation at hand entry. Much of the propulsion during the butterfly comes from the hips and trunk so inefficiency of these muscle groups can lead to increased stress on the shoulders.

The motion at the shoulder during the *backstroke* is opposite to the freestyle stroke with the shoulder in retraction, horizontal abduction, and external rotation at hand entry and the beginning of pull-through. This position places increased stress on the anterior capsule. The arm position during the recovery is different than freestyle because the elbow is extended (rather than flexed). Due to trunk rotation, the swimmer is rarely flat on the back during the movement, spending more time on the side.

Movement at the shoulder during *breaststroke* can vary, with more motion occurring below the surface of the water than any other stroke. Like the butterfly, the arms are moved simultaneously through a motion that

starts in full flexion with internal rotation. However, the elbows remain flexed during the pull-through until the humerus is fully adducted and brought into horizontal adduction with forearms touching each other. Unlike the other strokes, the hands never move below the hips so the tensile forces on the rotator cuff that occurs during the other strokes at the end of pull-through does not occur during breaststroke.²

ETIOLOGY OF SWIMMER'S SHOULDER

Most musculoskeletal conditions can be divided into macrotrauma and microtrauma based on the onset.¹⁴ A condition with sudden onset that occurs due to one specific incident usually is referred to as macrotrauma.¹⁴ Macrotrauma results from external forces and patients usually present with tissue pathology that causes associated impairments such as loss of motion, strength, and proprioception. Swimmer's shoulder is a condition with a gradual onset due to repetitive activity and can be classified as microtrauma. Unlike macrotrauma, the etiology of microtrauma is multifactorial and may be due to intrinsic factors or extrinsic factors.

Intrinsic Factors

Swimmer's shoulder usually presents as subacromial impingement involving the rotator cuff tendon, bicipital tendon, or subacromial bursa.¹⁵ Primary subacromial impingement involves compression of these structures between the acromion and greater tuberosity.¹⁶ The cause of primary impingement is usually a tight posterior capsule (causing the humeral head to migrate anteriorly) or abnormal acromial morphology. However, primary impingement syndrome is less common in competitive swimmers than secondary impingement.

The mechanism of secondary impingement occurs through a series of impairments, usually initiating in a swimmer with increased anterior glenohumeral laxity.^{10,15} Shoulder ROM in swimmers is similar to that of overhead athletes, with excessive external rotation and limited internal rotation. This shift in ROM towards increased external rotation is an adjustment to the demands on the glenohumeral joint which goes through approximately 4,000 strokes daily.¹⁵ The acquired anterior laxity permits excessive external rotation, but places greater demand on the rotator cuff and the long head of the biceps to reduce humeral head elevation and anterior translation.

Failure of the rotator cuff and the scapular stabilizers to maintain the humeral head in the glenoid fossa can lead to excessive humeral head migration and either increased

tensile stress on the tendons^{10,15} or compression of the tendons from abutment of the humeral head on the undersurface of the acromion.¹⁵ The proposed mechanism of failure initiates with muscle fatigue. For example, the serratus anterior in the healthy shoulder stabilizes the scapula in upward rotation and protraction, creating adequate subacromial space for the biceps tendon and rotator cuff and maintaining good approximation between the humeral head and the glenoid fossa. During the pulling motion of swimming, the serratus anterior effectively reverses origin and insertion to propel the body over the arm, while maintaining the subacromial space and glenohumeral joint congruency. When the serratus anterior becomes fatigued, the scapula fails to protract and upwardly rotate and the subacromial space may be compromised. Additionally, the space between the humeral head and glenoid increases, contributing to more laxity.

Symptoms that develop as a result of fatigue can also affect stroke mechanics. Research has documented changes in muscle activity that occurs in swimmers with painful shoulders compared to swimmers with healthy shoulders.⁶ Many swimmers will inherently adjust their stroke to avoid painful movement patterns.¹⁷ For example, during early pull-through, the hand usually enters the water close to the midline with the elbow above the surface of the water. The upper extremity then continues to “reach” forward below the surface of the water towards the midline of the body. In swimmers with painful shoulders, the hand enters further away from the midline with the elbow dropped closer to the surface of the water. This change is usually made to avoid an impingement position of full elevation with internal rotation and horizontal adduction. Another adjustment occurs at the end of the pull-through phase, when the hand should be close to the thigh with internal rotation of the shoulder. In swimmers with painful shoulders, the shoulder was externally rotated and the pull-through phase was shortened to avoid impingement.

Another proposed impingement mechanism involves the microvasculature of the rotator cuff. Studies indicate that when the shoulder is abducted, the vessels of the supraspinatus and long head of the biceps are filled.¹⁸ Conversely, when the arm is adducted and at the side, the vascular system to these tendons is compromised. This phenomenon is referred to as a “wringing out” of the tendon, causing a temporary avascular zone 1 cm proximal to the insertion on the humeral head. This response also occurs when the humerus is adducted and

flexed, a position that occurs with faulty mechanics or muscle fatigue.

Extrinsic Factors

In addition to identifying the impairments that may have contributed to swimmer's shoulder, the clinician must determine if the microtrauma is due to overuse, misuse, abuse, or disuse. *Overuse* in sports is performing a task with a frequency that does not allow the tissues to recover and symptoms may be due to lack of muscle strength or endurance. An example of overuse would be a swimmer increasing her yardage in a swim workout from 5000 yards to 10,000 yards per day. *Misuse* is using improper form or equipment, which may put abnormal stress on the tissue structures. An example of misuse is a swimmer using faulty stroke mechanics. One common error is inadequate or excessive body roll during freestyle. A swimmer with excessive body roll may cross the midline of the body during the pull through phase and this increased horizontal adduction can lead to impingement.² Lack of body roll will also cause the humerus to compensate by moving into further horizontal adduction for adequate propulsion. *Abuse* is having excessive force going through normal tissues. An example of abuse is a swimmer who trains excessively with hand paddles, increasing strain on the shoulder. *Disuse* occurs when a swimmer has taken a period of time off without training resulting in atrophy or altered neuromuscular control of the stabilizing shoulder girdle musculature. In all of these cases, the tissues cannot accommodate the repetitiveness, force, or stress that is encountered with a specific activity.

PRESEASON AND CLINICAL ASSESSMENT

Overview

This section will discuss key points when assessing a swimmer during a preseason physical or during the season when symptoms are present. Some individuals may be predisposed to swimmer's shoulder if they have musculoskeletal impairments or engage in improper training methods. A preseason evaluation should screen for these impairments in a similar manner as a physical evaluation used for a swimmer with symptoms. In both cases, the goal is to determine if impairments exist that could lead or have led to swimmer's shoulder. The reader is referred to other sources for a comprehensive orthopedic shoulder assessment.¹⁹

During a clinical examination, information is collected in the subjective and objective assessment to determine a

potential cause and effect relationship between the tissue pathology and presenting impairments. This information may be used to set up a preventative training program or guide treatment. The exact impairments that may predispose a swimmer to symptoms or tissue pathology are not fully understood as no research has studied impairments in asymptomatic swimmers to determine which impairments were most likely to lead to swimmer's shoulder. Most of the preventative programs are based on addressing impairments that occur as a result of developing swimmer's shoulder.

In swimmers who have already developed symptoms, the primary complaint is usually pain in the subacromial region. These symptoms may be associated with an inflammatory condition such as tendonitis, bursitis, capsulitis, or arthritis and may be labeled as impingement syndrome. While diagnosis of these symptoms and tissue pathology may guide medical treatment of either pharmacological intervention with oral medication or injections, this treatment may not address the causative factors. Physical therapists should focus on the impairments that are associated with the onset of symptoms including glenohumeral hypermobility or instability, impaired posture, impaired rotator cuff strength, altered scapulohumeral rhythm or poor neuromuscular control, or a tight posterior capsule. Like most microtraumatic conditions, swimmers can usually not single out a specific event so the physical therapist has to discern which of these impairments or training errors may have contributed to the condition or injury. The subjective assessment may help identify the contributing impairments while the physical examination can focus on specific tests and measures to confirm this information.

Subjective Assessment

The subjective examination also provides information about the area, symptom description, and behavior of the symptoms in patients with swimmer's shoulder. This information may help the clinician identify potential sources of the symptoms. For example, a patient who points with one finger to the anterior lateral aspect of the shoulder and describes a sharp pain with overhead movements may have involvement of the subacromial region or AC joint. The physical examination would need to focus on these areas. Conversely, a patient who presents with diffuse pain throughout the shoulder and upper extremity and describes burning, shooting pains may need to have a detailed evaluation of the cervical spine to rule out spinal pathology.

Other subjective information may help the physical therapist determine the appropriate amount of testing performed during the physical examination. The clinician should determine the level of irritability of a condition during the subjective examination. Irritability is characterized by three parameters: pain level, what it takes to provoke the symptoms, and the latency or time it takes the symptoms to resolve after provocation. A highly irritable condition is determined by all three factors. For example, a patient who reports symptoms with a 7/10 pain level that are brought on with lifting the arm above 90 degrees without a load and the symptoms last for several hours, has a highly irritable condition. Conversely, a patient who reports symptoms with a 5/10 pain level that comes on with lifting 200 lbs on a bench press, and last only for a few seconds has low irritability.

In swimmers, low-level shoulder pain that only occurs after heavy training and resolves quickly is low irritability. A swimmer who has high-level shoulder pain during swimming and following training for the remainder of the day has high irritability. The rehabilitation specialist must be cautious during the physical examination of a patient with high irritability because once the symptoms are provoked, results from the remaining tests and measures may be unclear.

One key element in the history is assessing the training program and methods of the swimmer. The physical therapist should determine the number of yards or meters performed in each workout, the number of workouts per week, the dry-land program, and any recent changes in training.

Common Findings on Physical Examination

A preseason physical or clinical examination of a swimmer with shoulder symptoms will screen for several impairments. Initial observation may reveal common postural impairments related to the shoulder girdle. A common postural deviation observed with swimmers is a forward head, rounded shoulder posture. This posture is a combination of upper quarter impairments including increased thoracic kyphosis, decreased cervical lordosis, protracted scapulae, and internally rotated/anterior humeral head.^{20,21} Soft tissue findings associated with this posture include restricted anterior shoulder musculature, lengthened and weak medial scapular stabilizers, tight glenohumeral posterior capsule, and weak anterior cervical flexors.²²

Physical examination of swimmer's shoulder will usually reveal alterations in active ROM of the shoulder, particularly at the midrange or end range of elevation. Swimmers with impingement may have a painful arc from 60-120 degrees if the head of the humerus is not maintained in the glenohumeral joint.^{4,11,15} Altered scapulohumeral rhythm may be observed with excessive elevation or upward rotation of the scapula. Kibler²³ has presented an assessment technique to measure lateral scapular slide, by measuring the distance between the medial border of the scapula and the spine during elevation. Assessment of passive ROM will usually show excessive external rotation and horizontal abduction due to hypermobility of the anterior glenohumeral joint capsule. These swimmers will usually have a sulcus sign, a positive load and shift, a positive relocation test, and may have a positive apprehension sign.^{5,7,10} However, hypermobility determined by these tests may be the result of ligamentous laxity.^{7,10} Hypermobility is not instability unless the secondary stabilizers do not function adequately and symptoms occur. In swimmers with instability, weakness of the rotator cuff and scapular stabilizers will be noted. If these structures are inflamed, impingement tests will be positive and resisted tests may be painful.

If these provocation tests are positive, the clinician must rule out sources of primary impingement such as abnormal acromial morphology (through x-ray) or a tight posterior capsule. In addition, if tissue pathology is suspected by the physical therapist based on the findings in the physical examination, the swimmer may need to be referred back to the physician for additional tests. Chronic swimmer's shoulder can result in pathology of the rotator cuff, glenoid labrum, and long head of the biceps.

PRINCIPLES OF PREVENTION AND TREATMENT

Introduction

The foundation for establishing a prevention or treatment plan for the swimmer's shoulder is having a clear understanding of the impairments, underlying tissue pathologies, and resultant functional limitations. Treatment and

prevention of swimmer's shoulder focuses on addressing impairments and the training errors of overuse, misuse, or abuse as described earlier in this chapter. Achieving functional goals also requires knowledge of swimming mechanics and training techniques, as well as the stress placed on the shoulder during swimming. This knowledge will guide the physical therapist to choose exercises that place demands on the shoulder similar to those encountered with a specific sport or position.

Address Impairments

The first step in treating swimmer's shoulder is to address any related impairments. Because the clinical presentation usually involves pain related to inflammation, initial treatments may use modalities and manual techniques, such as grade I or II mobilizations, to address pain. As pain resolves, the physical therapist should prioritize the problem list related to the symptoms. Potential common impairments that need to be addressed include postural deviations, tight anterior chest musculature, hypomobility of the thoracic spine, loss of joint mobility or excessive joint mobility, tight posterior capsule, and impaired strength and endurance of the rotator cuff and scapular stabilizers.

Posture

Postural impairments are managed through joint /soft tissue mobilization, flexibility, and strengthening/stabilization exercises of the scapular retractors and deep cervical flexors. Tight anterior shoulder musculature including the pectoralis minor can be self stretched or manually stretched. Care must be taken to avoid overstretching the anterior capsule. One method that allows the anterior chest to be stretched without overstressing the anterior capsule is to apply a low load on the anterior

aspects of the shoulder using cuff weights while the patient lies supine over a bolster (*Figure 1*). This position allows the scapulae to retract over the bolster so the stretch is concentrated on the anterior chest musculature.

Joint Mobility

In swimmer's shoulder, posterior capsule tightness may accompany anterior shoulder laxity and should be addressed by the physi-



Figure 1. Anterior capsule stretch using cuff weights; supine over bolster.

cal therapist. Posterior capsule mobilizations can be performed with the patient in supine and the shoulder blade supported in the scapular plane using a mobilization wedge or folded towel. The clinician holds the arm in mid range abduction, applies a gentle glenohumeral distraction while providing a posterior glide to the proximal humerus (Figure 2). A self stretch to the posterior capsule can also be applied by lying on the involved side with the shoulder flexed to 90 degrees. The patient applies a self stretch by applying a downward force to the distal forearm towards the plinth (Figure 3).

Scapular Stabilization

Scapular stability and proper scapulohumeral rhythm is an essential element of shoulder rehabilitation and prevention. Scapular position directly affects humeral head position and determines the length tension relationship for the rotator cuff as these muscles originate on the scapula.²³ An unstable scapula or faulty movement patterns can change the demands on the rotator cuff muscles, potentially leading to microtrauma injuries. The physical therapist should assess the muscles essential to scapular stability such as the middle and lower trapezius, serratus anterior, and rhomboids. Scapular position and improper movement patterns are treated with a combination of soft tissue release and neuromuscular re-education to inhibit overactive, dominant muscles and facilitate weak, inhibited muscles.

Rehabilitation and prevention of swimmer's shoulder should incorporate neuromuscular re-education and strengthening of the



Figure 2. Posterior glide to humerus (posterior bolster).



Figure 3. Self stretch of posterior capsule.



Figure 4. Rowing in prone.



Figure 5. Prone extension.



Figure 6. Prone horizontal abduction

scapular stabilizers. Research has documented the effectiveness of different prone exercises for recruiting the scapular stabilizers.²⁴ Prone scapular stability exercises are assessed by the ability to recruit targeted muscles in positions that simulate swimming. For prone exercises, the clinician should instruct the patient to maintain the scapula in retraction/depression while palpating the upper trapezius to ensure no compensation is occurring.

Figures 4-11 illustrate some common prone table exercises used for shoulder strengthening and scapular stabilization. The rowing motion is accomplished with humeral extension with elbow flexion (Figure 4). For prone extension, the patient extends the shoulder with the elbow extended and thumb facing away from the body (Figure 5). For prone horizontal abduction, the patient horizontally abducts the arm with the elbow extended and either neutral rotation or external humeral rotation (Figure 6). During these exercises, the clinician should instruct the patient to retract the scapula prior to and during the humeral motion. The patient should also know not to advance the humerus beyond the plane of the body, particularly if an injury or postoperative condition warrants protection of the anterior capsule. Figure 7 is an example of an exercise used in our clinic to recruit the lower trapezius. The patient lies prone with the humerus abducted to 150 degrees and the elbow is flexed to 90 degrees. The patient is instructed to lift the hand off the table by externally rotating the shoulder.



Figure 7. Recruitment of the lower trapezius. Lift the hand off the table by externally rotating the shoulder.



Figure 8. "Superman."



Figure 9. "TYI Exercises." T: Prone on mat. Retract scapulae with arms abducted to 90 degrees and humerus in horizontal abduction.



Figure 10. "TYI Exercises." Y: Shoulders externally rotate with elbow flexed to 90 degrees.



Figure 11. "TYI Exercises." I: Shoulders in full bilateral elevation with elbow extension.



Figure 12. Protraction of scapula.



Figure 13. Prone, supported on elbows.



Figure 14. Quadrupedal position.



Figure 15. Push up position.



Figure 16. Push up position; legs elevated in chair.

Figures 8 through 11 represent bilateral scapular stabilization exercises. “Supermans” are performed in prone with the elbows in full extension and the shoulders externally rotated at the sides of the body (Figure 8). The patient is instructed to retract the scapulae and lift the hands and arms off the table. Figure 9 is the first in a progressive sequence of three exercises that we refer to as TYI exercises because of the patterns formed. The patient retracts the scapulae with the arms abducted to 90 degrees and moves the humerus into horizontal abduction forming a “T”. As the patient advances, the shoulders are externally rotated with the elbows flexed to 90 degrees, forming a “Y” (Figure 10). The final exercise requires the patient to move into a position of full bilateral elevation with elbow extension, forming an “I” (Figure 11).

Scapular protraction and stabilization in the protracted position are trained through a series of exercises, starting with a supine punch. The patient is positioned supine with the arm held in 90 degrees flexion with full elbow extension and maintained in the scapular plane. During the movement, the patient is told to move the hand towards the ceiling, by protracting the scapula. Manual resistance or weights can be added to this motion as the patient advances (Figure 12). These exercises may also be used in conjunction with weight bearing exercises.

Weight bearing exercises for scapular stabilization are illustrated in figures 13-19. Exercises are advanced from prone on elbows (Figure 13) to quadruped (Figure 14) to a push up position (Figure 15). As the patient improves, the lower extremities can be elevated to increase resistance (Figure 16). A dynamic component can be added to higher level athletes who demonstrate good control with the preceding exercises. These patients can perform these exercises with the upper extremities on a wobble board (Figure 17), “walk-outs” with their upper extremities with the lower quarter on a gym ball (Figure 18), or “step-

overs” using the upper extremities to “walk” up and down over a foot stool (Figure 19). A slide board is also an excellent device to use for dynamic upper extremity stabilization. Patients can be progressed from performing horizontal abduction and adduction on their knees and eventually on their toes. For these exercises, patients are instructed to maintain scapular protraction during the activity to strengthen the serratus anterior.



Figure 17. Push up position; hands placed on wobble board.



Figure 18. “Walk-outs.”



Figure 19. “Step-overs.”

Rotator Cuff Strength

Strengthening exercises for the rotator cuff are progressed based on the presenting condition and the ability of the patient. The range of rotator cuff strengthening exercises may include isometric, concentric, eccentric, and plyometric activities. As healing allows, shoulder strengthening is initiated with isometric exercises including rhythmic stabilization drills, which are exercises to challenge a patient to maintain the upper extremity in a variety of positions while the rehabilitation specialist challenges the position with manual resistance. The exercise selection should be based on positions that do not overstress the healing tissues. This activity helps restore proprioceptive feedback to the central nervous system through mechanoreceptors of the shoulder girdle and prepares the shoulder for isotonic strengthening.

Isotonic strengthening of the rotator cuff can be accomplished with different types of resistance in different positions. Resistance can be applied manually, with resistive bands, or with weights. The advantage of using manual resistance is that the therapist can vary the resistance to accommodate the output from the patient. The advantage of using resistive bands is that the patient can perform functional movement patterns against resistance. However, these forms of resistance do not allow a clinician to quantify the amount of resistance, which is the advantage of using weights. When choosing a position for rotator cuff strengthening, the rehabilitation specialist should have a goal for the exercise. If the goal is to stabilize the scapula, exercising in supine may

be the best position because the scapula is fixed against the table. Patients can be progressed to a sidelying position to work against gravity or in standing position to simulate functional movement patterns. Patients should be encouraged to exercise in the scapular plane and the position of humeral abduction can advance to reproduce the position the arm is in during a specific sport.

Rotator cuff exercises are performed and advanced based on the available ROM. Due to the importance of the eccentric component of the rotator cuff in overhead sports, this mode of exercise should be integrated into the rehabilitation program, particularly for external rotation. The infraspinatus and teres minor contract to stabilize the humeral head by maintaining a posterior pull to counter any anterior translatory forces.

Address Training Errors

Overuse is a classic training error that occurs in swimming as athletes typically train 10-12 hours per week in the water in addition to dry-land training. Swimmers can average 10,000 yards per day of training. The high level of repetitions, estimated at 4,000 strokes per side, that occur during training sessions can cause fatigue, leading to the conditions discussed earlier. Modification of swim yardage may need to be emphasized if the swimmer wants to prevent progression of an injury.

Abuse is another training error that can occur in swimming, causing increased external stress on the shoulder. The use of hand paddles increases stress on the upper extremity by increasing surface area and resistance to movement. Kickboards put the arm in position of full elevation and internal rotation, leading to subacromial joint compression. Use of these devices should be omitted or limited for a swimmer returning from a shoulder injury.

Misuse in swimming occurs if an individual has faulty stroke mechanics. An example of improper technique is when the hand crosses the mid-line during the pull-through phases of the freestyle stroke. This motion is common in swimmers who have excessive body roll and can predispose them to impingement. Optimal body roll allows the arm to stay close to the plane of the scapula, thus reducing the stress of soft tissue structures in the anterior shoulder region.²⁵ Optimal body roll also allows greater lengthening of the abdominal oblique muscles, shoulder adductors/medial rotators, and scapular retractors so that at the beginning of the pull-through these

muscles have a mechanical advantage.² Conversely, a lack of adequate body roll forces the recovering arm into a greater range of shoulder extension, horizontal abduction, and medial rotation in order to clear the hand from the water, causing encroachment of the subacromial space.

An important issue to consider when working with swimmers is their reluctance to stay out of the water.²⁵ Although swimmers are involved in dry-land training, no suitable substitute exists for swimming. Modification of training schedules and techniques allow the patient to continue swimming, enabling the physical therapist to establish or maintain credibility with the swimmer.^{15, 25} In extreme cases, the swimmer may need a short dry-land period to allow for adequate soft tissue healing. In these cases, the rehabilitation specialist should educate the swimmer so that the reason for the lay-off is understood. Time spent out of the water should be kept as short as possible, even if the swimmer is doing primarily kicking activities. Although returning to the water may not be ideal for rehabilitation, keeping a swimmer out of the water for a lengthy period may result in a rehabilitation program that is ignored. Activity modification in swimming may consist of the following tasks:

- Temporarily reduce training distance and frequency.
- Alter training patterns so that different strokes are used more frequently throughout the practice. This alteration will reduce the repetitive pattern at the glenohumeral and allow the muscles to function differently.
- Avoid the use of hand paddles, kickboards, and surgical tubing.
- Use swim fins to enhance the propulsion from the legs and reduce the stress on the shoulder

SUMMARY

Swimmers shoulder is a condition that may be prevented with adequate preseason screening that can identify impairments and training errors that may lead to symptoms. If a swimmer does become symptomatic during the season, the physical therapist should identify the most likely impairments or training errors and rule out any significant tissue pathology that would warrant a referral to an orthopedic surgeon. A comprehensive rehabilitation program usually includes strengthening of the rotator cuff and scapular stabilizers, stretching anterior chest musculature that may be shortened, and implementing activity modification so the athlete can

still participate in the sport. Future research should focus on determining if addressing specific impairments prior to the season can reduce the incidence of swimmer's shoulder and assessing which impairments are the greatest risk factors.

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PHYSIOTHERAPIST DELIVERED PREPARTICIPATION EXAMINATION: RATIONALE AND EVIDENCE

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ABSTRACT

Preparticipation examinations are often performed based on the assumption that the exam contributes to the identification of risk factors for injury and, therefore, lead to the implementation of appropriate injury prevention strategies for athletes. Research evidence supporting the components, benefits, and limitations of the preparticipation examination performed by a physiotherapist is the focus of this paper. Evidence exists that some specific preparticipation examination components will identify known risk factors which may be addressed in the context of injury prevention strategies for that athlete. Examinations should use existing evidence-based practice to identify valid and appropriate tests examining known risk factors. Physiotherapists are encouraged to continue development, implementation, and evaluation of appropriate training techniques for the athletes to minimize their risk of injury. Physiotherapists need to be aware of athlete confidentiality issues as well as the importance of cost effectiveness of preparticipation examinations. The future of physiotherapist delivered preparticipation examinations may lie in the utilization of an evidence-based approach to risk factor identification, development and evaluation of prevention strategies, and development and evaluation of performance enhancement strategies for the athlete.

Key words. Preparticipation exam, screening, prevention.

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INTRODUCTION

A preparticipation examination, also called a pre-season examination or a screening examination was original described in 1978.¹ The intent of this examination was that it would (i) fulfill the athlete's institution legal and insurance requirements, (ii) assure the coaches that team members would start the season with some common level of health and fitness, (iii) provide the medical team with the opportunity to discover treatable conditions that might interfere with or be worsened by athletic participation, (iv) potentially aid in predicting/preventing future injuries, and (v) be appropriate for all sports. A musculoskeletal version of the original preparticipation examination is often performed annually by physiotherapists working with athletic teams to anticipate and preclude physiological and biomechanical problems for athletes prior to the commencement of a sport season. As such, the ultimate goal of such a preparticipation examination is injury prevention. Additional and parallel objectives to injury prevention include assurance of optimal musculoskeletal health, to optimize performance (physiological and biomechanical), to develop a professional relationship with the athlete and to educate the athlete.^{2,9} Ideally, a preparticipation examination should also make it possible to identify the factors common to athletes with great performances which would facilitate the identification of such factors in other athletes.^{2,3,10,11}

Research evidence supporting the preparticipation examination performed by a physiotherapist is the focus of this paper. This paper will not discuss the medical screening or preparticipation evaluation of athletes that is often performed by physicians to ensure optimal medical health for sport participation despite underlying medical conditions (i.e. asthma, diabetes, menstrual dysfunction, depres-

sion), to review medications and vaccinations, and to prevent sudden death of the athlete.¹²

Definition and Role of the Preparticipation Examination

Preparticipation examinations are performed based on the assumption that they can enhance performance of the athlete and identify potentially modifiable risk factors for injury. Modifiable risk factors are those that can potentially reduce injury rates through the implementation of injury prevention strategies.^{11,13} Evidence exists that modifiable risks, such as, decreased levels of sport specific training in the off season, endurance, strength, and balance do increase the risk of injury in sport.¹⁴⁻²² Non-modifiable risk factors are those factors that can not be altered to reduce injury rates through the implementation of injury prevention strategies.^{11,13} Examples of a non-modifiable risk factor would be age, gender, and previous injury. An ideal preparticipation examination system applicable to all sports does not exist, although there are examples of sport-specific preparticipation examinations. A comprehensive examination should identify the sport-specific biomechanical and physiological requirements for training and competition, as well as when these requirements exceed the athlete's ability to perform.^{2-4,10,11} Additionally, the examination should be capable of detecting possible biomechanical and physiological deficits that might be a precursor to injury.^{2-4, 10,11} Upon recognition of potentially modifiable risk factors by the physiotherapist, sport-specific injury prevention strategies can be implemented to reduce such risks.^{2-4, 10,11}

Identifying Risk Factors for Injury

The injury prevention model developed by vanMechelen et al^{123,24} suggests that the incidence and severity of sport injury need to be established prior to identifying risk factors for injury. Sport injury prevention strategies may be developed and evaluated if a good understanding exists of injury rates, the participant population at risk, and the risk factors associated with injury for this population.^{11,18,25} Sport injury risk factors are defined as those entities which contribute to the occurrence of athletic injury.^{11,13} Both intrinsic (i.e. decreased strength, previous injury) and extrinsic factors (i.e. shoes, equipment) that may increase susceptibility to injury should be identified prior to the occurrence of an injury-inciting event.¹³ Further, Bahr and Krosshaug²⁶ identified the importance of recognizing that one or more factors (i.e. biomechanics, playing situation, player/opponent behaviour) may generate an injury-inciting event. An understanding of sport-specific

mechanisms of injury will facilitate the identification of potential risk factors during the preparticipation examination and subsequent delivery of appropriate and sport-specific injury prevention strategies.

The use of validated sport-specific injury surveillance will assist the therapist in identifying risk factors and their component biomechanical and physiological aspects contributing to injury in that sport.²⁷ Given the limited evidence that exists identifying sport-specific risk factors for injury using adequate sport-specific injury surveillance, the support for injury prevention strategies is often based on anecdotal evidence.²⁸ In a systematic review of the literature regarding prevention strategies for injury in sport at any age, MacKay et al²⁹ concluded that very few well designed prospective studies exist. In order for the physiotherapist to provide the most appropriate, evidence-based preparticipation examination, they must stay current with the research identifying sport-specific risk factors and injury prevention strategies pertinent to their athletes. Desirable features of the preparticipation examination include valid and reliable measurement of these risk factors in order to assess the athlete's risk of injury as well as to compare the athlete's test results within a sport in a given year, across years, and with other sports.

Who is Using Preparticipation Examinations?

Judging from informal discussions with coaches, athletes, and support personnel (in various sports communities around the world) as well as reports in the literature, it would appear that most elite teams and many university and high school based teams are using some form of preparticipation examination.^{12,30,31} Examples of the use of physiotherapist delivered preparticipation examinations include football and triathlon teams in the United Kingdom.³ In these examples, teams had a complete physiotherapy assessment of every player that included flexibility, range of motion, balance, and core stability tests. These tests provided a baseline measurement of the musculoskeletal status of the athletes and enabled the physiotherapist to plan specific training and injury prevention programs tailored for individual players. In addition, a preparticipation evaluation by a physician is critical but beyond the scope of this paper.¹²

Components of the Preparticipation Examination

Although no standard examination has been identified across sports, certain consistencies exist among these examinations. Based on the literature and informal discussions with health care professionals monitoring other

sport teams, preparticipation examinations consistently include athlete questionnaires, standard neuro-musculoskeletal examinations, and some form of functional testing. A good preparticipation examination should be accurate, practical in order to apply to a large number of subjects, and testing procedures must be safe and acceptable to most individuals.³² A preparticipation examination should be performed in a 45 minute time frame, similar to the time allotted for a physiotherapy assessment in the sport medicine setting. An example of a format used for preparticipation assessment for elite athletes can be found in Appendix A.

Despite the limited consistency among preparticipation examinations, the importance of musculoskeletal screening is evident in the fact that athletes frequently resume full athletic participation following a significant injury with considerable deficits in strength, range of movement and proprioception.³³⁻³⁵ Consistent evidence exists that one of the most likely predictors of injury is a previous injury.^{16,36-39} Therefore, any post injury deficits should be fully assessed with a goal of designing a rehabilitation program to restore full function. Such an assessment should include an athlete questionnaire that identifies the nature and date of any previous injury; lists any residual problems; describes the nature, date, and symptoms of any current injury; as well as any past or current treatment received for these injuries.^{5,40,41} For example, identification of previous injury (i.e. ankle sprain) and providing appropriate prevention strategies (i.e. wobble board training) will reduce the risk of recurrent injury.⁴²

There is evidence that muscle strength ratios^{33,38,43-48} are an individual risk factor for a particular injury in athletes. The standard neuro-musculoskeletal examination which tests for strength in the form of isometric, concentric, or eccentric testing contribute to the identification of such strength ratios. The standard neuro-musculoskeletal examination should also include a neurological examination, active and passive range of motion testing, articular testing in the form of joint glides, muscle recruitment testing (especially around the torso and pelvis), static and dynamic postural and balance investigations, and appropriate functional tests. For example, Gabbe et al⁴⁹ provide evidence that Australian Football players with increased quadriceps flexibility (as measured by the modified Thomas test) were less likely to sustain a hamstring injury. Evidence also exists to support investigation of torso and core strength with regard to lower quadrant injury prevention as well as injury reoccurrence.⁵⁰⁻⁵⁵ Improving balance has been shown to be important in

injury prevention in sports such as soccer.^{56,57} Additionally, Trojian et al⁵⁸ demonstrated the ability to predict ankle sprain injury with a positive single leg balance test in high school and varsity athletes. Validated testing methods for the preparticipation examination should always be used. For torso strength, for example, two validated testing methods exist: a) modified double straight leg lowering test⁵⁹⁻⁶² and b) flexor endurance test.⁶³ It is strongly suggested that neuro-musculoskeletal screening assessments be particular to the sport the athletes are involved in. For example, sports with high risk of specific joint or muscle injuries (i.e. swimmers' shoulder, pitchers' elbows) should have specific assessments performed on these areas.⁵ Many validated orthopaedic tests for various regions of the body can be found in medical and physiotherapy textbooks and should be used for the preparticipation examination (i.e. Patrick's test for examining hip range of motion).⁶⁴⁻⁶⁶

Many functional performance tests exist and are commonly recommended for inclusion in a preparticipation examination (i.e. sit-ups, push-ups, endurance runs, sprints, and agility activities).^{67,68} For example, Hewitt et al⁶⁹ demonstrate the identification of high-risk landing force profiles in youth athletes using a functional box drop vertical jump test. It is suggested that not only the clinical test outcome be scored (i.e. sit-up repetitions) but also the form and efficiency of the underlying functional movement involved in the test.⁷⁰ For example, taking note of the weight that an athlete can hold during a lunge test and how the athlete's body was aligned during the test. Scoring such function can be challenging as few validated systems exist. The examiner is advised to develop scoring methodologies and submit this scoring method to future research scrutiny.

Additional Benefits of the Preparticipation Examination

In addition to potential injury prevention and performance enhancement, the preparticipation examination allows the physiotherapist additional opportunities. This examination provides an opportunity for the physiotherapist to commence their professional relationship with the athlete. This relationship allows the physiotherapist to educate the athlete on issues such as injury prevention (i.e. importance of core strength, stretching, warm-up), immediate injury management (i.e. RICE management for acute inflammation), and appropriate equipment use (i.e. helmets, mouth guards, shin pads). The examination enables the physiotherapist to become fully aware of the athlete's past history and gives them insight into the

athlete's physical, mental, and emotional state. Additionally, the athletes are typically given the opportunity to discuss any pertinent issues with the physiotherapist.

Limitations with the Preparticipation Examination

Many limitations exist with the current state of the physiotherapist delivered preparticipation examination.³ As with any preparticipation examination performed by health care professionals, often no uniformity of protocols is used.¹² As a result, concrete recommendations concerning the findings from a preparticipation examination are lacking and are often attributed to "(i) the lack of consensus regarding the threshold for abnormality, (ii) the unavailability of data indicating the predictive value of specific physical 'abnormalities' for injury, and (iii) the lack of definitive proof that corrective interventions alter outcome."⁷¹ Extensive examinations are often performed with various resultant recommendations, but frequently no follow-up occurs. Literature and clinical experience suggest follow up at 6 weeks to ensure that the recommended actions have been taken.³

The extent of the examination is limited by financial and time constraints. The examinations are time consuming for both the athlete and the examiner leading to potential compliance issues from the athlete. The time consuming nature of the preparticipation examination can potentially interfere with the time available to treat athletes. As such, the physiotherapist may have to prioritize the most essential components of the examination based on the sport-specific requirements for each athlete. Overall, if the process is to be cost-effective then it has been suggested that it needs to be regularly audited and evaluated.³

Reliability issues are of primary concern with multiple examinations performed by health care professionals from different disciplines (i.e. athletic therapist, physiotherapist, chiropractor, medical doctor) or other support team members (i.e. strength trainer, physiologist) on the same athlete or by different examiners on different athletes within a team. Smith and Laskowski⁷¹ recognize that in order to integrate the history and physical examination components of a preparticipation examination, one requires a substantially higher level of knowledge and skill on the part of the examiner. Therefore, the task may be impractical, especially at the high school and youth sports levels that are utilizing non-medical trained personal.

Confidentiality is a very important issue to consider. Individuals within the specific sport organization (i.e. athlete, coach, physician) and outside the sport organization (i.e. National Olympic Committee) who have access to the data from the preparticipation examination must be clearly identified. Some health care professionals suggest that the traveling athlete should have a medical passport (i.e. hard copy or electronic record) containing all relevant information to ensure complete communication of the athlete's medical information to all involved in their care.^{3,72,73}

CONCLUSION

Preparticipation examinations are often performed based on the assumption that they contribute to the identification of risk factors for injury, and therefore, lead to the implementation of appropriate injury prevention strategies for athletes. However, despite evidence identifying some specific risk factors for injury that may be identified in a preparticipation examination, little global evidence exists supporting the use of preparticipation examinations to reduce injury rates among athletes. Identification of previous injury (such as ankle sprains) and providing appropriate prevention strategies (such as balance training) has been shown to reduce the risk of recurrent injury. There is also evidence that some specific preparticipation examination components will identify known risk factors (i.e. specific strength, flexibility, balance tests) which may be addressed in the context of injury prevention strategies for that athlete. However, much needed research to further validate specific components of the preparticipation exam and provide further evidence for identification of sport-specific risk factors is needed. Currently, physiotherapists rely on the examples supported in the literature for injury prevention in conjunction with their clinical expertise and judgment within their own team practices. The future of physiotherapist delivered preparticipation examinations may lie in the utilization of an evidence-based approach to risk factor identification, development and evaluation of prevention strategies, and development and evaluation of performance enhancement strategies for the athlete.

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APPENDIX A
PRE-PARTICIPATION PHYSIOTHERAPY ASSESSMENT

Athlete to please fill out the following: Date: _____

Name: _____ Address: _____

Phone No: _____ Age: _____ Physician: _____ Physician Phone No: _____

Sport: _____ Level of Completion: _____

Distance: _____ Number of Years Completing: _____

Coach(s) Name : _____ Coach(s) Phone No: _____

Past Medical History: (list injury, date and percentage of recovery)

Fractures: _____

Surgery(s): _____

Sprains/Strains: _____

Car Accidents: _____

Illness / Hospitalization: _____

Other: _____

Past Treatment: (list injury, date treated, name of practitioner & also indicate if treatment ongoing)

Physiotherapy: _____

Chiropractor: _____

Acupuncture: _____

Athletic Therapy: _____

Massage: _____

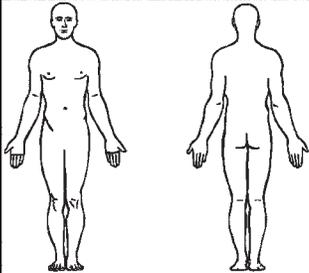
Other (medical tests such as blood work, x-rays, ect): _____

Present Injury(s) & Present Treatment:

Medications / Supplements:

Braces / Orthotics / Splints Usage:

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Map of Symptoms (grade pain 0-10/10)

///=pain
xxx=paraesthesia

PT Initial: _____ Page 1/4

Physical Examination

Posture:

Functional Tests:

Sit-stand-sit:	Stairs: Step Up: Step Down:
Sit-lie-sit:	Heel raise: double: single:
¼ squat: double: single:	Vert. jumping: double: single:
full squat: double: single:	Tuck jumping: single:
Walk:	Lift Floor to Waist:
Run:	Lift Waist to Overhead:
Balance Test:	Lunge: right fwd left fwd
Other Sport Specific Test:	

Range of Motion

TMJ

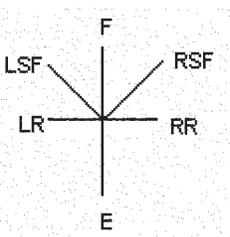
PPM:

PAM:
Compression:
Stress Tests:
Inferior:
Posterior:
Anterior:

Ribs

AROM:
PAM:
CTJ Stress Tests:
Anterior:
Inferior:
Other:

Csp



PPIVM:
PAIVM:
Stress Tests:
Passive / Dynamic
Ant:
Post:
Lat:
Rot:
Comp:
Traction:
Alar:

VA tests:

MRecruit: (rep's/qual/dur/measurement)
DNF Supine:
Other:

Neuro Meningeal:

ULTT 1:
2:
3:

Slump: ___ ° R CV flex: DF: Other:
Slump: ___ ° L CV flex: DF: Other:
SLR: ___ ° R CV flex: DF: Other:
SLR: ___ ° L CV flex: DF: Other:
Mod PKB: ___ ° R CV flex: DF: Other:
Mod PKB: ___ ° L CV flex: DF: Other:
Other:

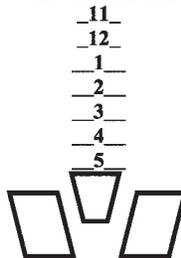
Pulses:

Name: _____

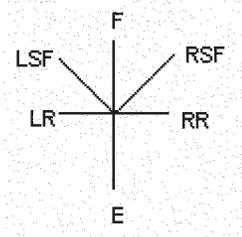
Palpation Findings:

- _1_
- _2_
- _3_
- _4_
- _5_
- _6_
- _7_
- _o_1_o_
- _o_2_o_
- _o_3_o_
- _o_4_o_
- _o_5_o_
- _o_6_o_
- _o_7_o_
- _o_8_o_
- _o_9_o_
- _o_10_o_

Tender ○
Painful ●
Stiff X
Spasm
Tightness III



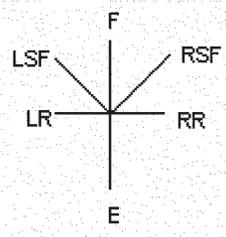
Tsp



PPIVM:
PAIVM:
Stress Tests:
Passive / Dynamic
Ant:
Post:
Lat:
Rot:
Comp:
Traction:

MRecruit:
Scapular Control:
Other:

Lsp



PPIVM:
PAIVM:
Stress Tests:
Passive / Dynamic
Ant:
Post:
Lat:
Rot:
Comp:
Distract:
Traction:

MRecruit:
Crookly hip flex:
Prone hip exten:
Sidely hip exten:

Neuro Conductivity: upper / lower quadrant

Dermatomes: Light Touch
Sharp / Dull
Temperature:

Myotomes:
LMN Reflexes:

Clonus: **Babinski:** **Cranial Nerves:**

SIJ

Gillet's:
Stance leg:
Nonstance leg:
Hip Ext: Standing: Prone:
Fwd / Bwd Bend:
ASLR:
Form closure:
Force Closure --TA
- Mult
- Lat
- Glut

PPM/PAM:
Stress Tests:
Passive / Dynamic
Ant:
Posterior Gap SIJ:
Anterior Gap SIJ:
Ant Shear:
Post Shear:
Vertical Shear: Sup:
Inf:

PT Initial: _____ Page 2/4

Peripheral Joints

Name: _____

Shoulder:

AROM:	PROM:	Resisted:
F:		
E:		
Ab:		
Ad:		
IR: 0°:		
90°:		
ER: 0°:		
90°:		
Combined:		
Quadrants:		
HBB:		
HBH:		
Horz Add:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

Elbow:

AROM:	PROM:	Resisted:
F:		
E:		
Pron:		
Sup:		
Combined:		
Quadrants:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

Wrist/Fingers:

AROM:	PROM:	Resisted:
Wrist F:		
Wrist E:		
Wrist Rad Dev:		
Wrist Ulnar Dev:		
Wrist Combined:		
Finger F:		
Finger E:		
Finger Rad Dev:		
Finger Ulnar Dev:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

Hip:

AROM:	PROM:	Resisted:
F:		
E:		
Ab:		
Ad:		
IR: 0°:		
90°:		
ER: 0°:		
90°:		
Quadrants:	Right:	Left:
FADIR's		
Patrick's		
Other:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

Thomas Test:

Ham's Tripod:

Knee:

AROM:	PROM:	Resisted:
F:		
E:		
IR:		
ER:		
Combined:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

Ankle & Foot:

AROM:	PROM:	Resisted:
DF:		
PF:		
Pro:		
Sup:		
Combined:		
Toe F:		
Toe E:		
Toe Abd*:		
Toe Add*:		

Observation and Palpation:

Stress Tests:

PAM:

Special Tests:

Muscle Recruitment:
(rep's/quality/duration/measurement)

PT Initial: _____

Name: _____
Date: _____

Digital and Video Analysis / Comments:

Clinical Impression / Key Points Identified:

Suggestions for Coach / Strength Trainer:

Contraindications to treatment:

- Rationale for possible pathology given to patient
- Rationale for treatment given to patient
- Patient gave consent for assessment, future assessment and treatment

Treatment Given:

Treatment Plan:

Consent for sharing information with coaches, trainers, team medical personnel on file: Yes___ No___

Therapist_____

CARDIOVASCULAR PREVENTION IN A HIGH RISK SPORT, ICE HOCKEY: APPLICATIONS IN WIDER SPORTS PHYSICAL THERAPY PRACTICE

Diana H. Hopkins-Rosseel, DEC, BSc, MSc^a

ABSTRACT

Although acute myocardial infarction and sudden cardiac death are relatively rare occurrences in athletics, cardiovascular accidents do occur. This manuscript presents information on the cardiovascular risks in athletics. In addition, information is provided on screening for cardiovascular risk – including history taking, chart review, physical examination – and the appropriate guidelines on the treatment of athletes found to be at risk. For the purpose of this article, the sport of ice hockey is used to illustrate the subject matter and highlight the behaviors in sport that carry cardiovascular risk. Physical therapists have ethical and legal responsibility to undertake the necessary screening procedures to recognize and respond to any signs of cardiovascular risk in their clients.

BACKGROUND

The debate regarding the cardiovascular (CV) risks and benefits of vigorous exercise and physical competition has appeared in the literature since ancient times.¹ The benefits of exercise in decreasing all-cause morbidity and mortality in adolescents and older adults hypothesized centuries ago are now well known and well documented.²⁻⁶ The questions for the physical therapist (PT) are: 'What are the CV risks in athletes?', 'Can those risks be mitigated?', and 'Should those risks be mitigated?' As with all clinical research, the need exists for more prospective, large, randomized control trials to solidify the answers to these questions. The current state of the literature and the consensus of leading researchers, clinicians, and organizations across the world is sufficient to provide strong answers and to make sound recommendations to

physical therapists regarding their practices with athletes. For the purposes of this article, the sport of ice hockey is used to illustrate the subject matter and highlight some of the behaviors in sport that carry CV risk.

EPIDEMIOLOGY OF CARDIOVASCULAR RISK IN ATHLETES

A competitive athlete has been defined as "one who participates in an organized team or individual sport that requires competition against others as a central component, places a high premium on excellence and achievement, and requires some form of systematic training."⁷ Given this definition, the primary negative CV events precipitated by exertion reported in the literature are acute myocardial infarction (AMI) and sudden cardiac death (SCD).⁸ Thompson and his colleagues⁹ reported in 1982 that SCD was seven times more likely during jogging than at rest with one death annually for every 15,240 healthy joggers. Similarly, in 1984 Siscovick et al¹⁰ documented one cardiac arrest each year for every 18,000 healthy men and that the risk was greatest for the habitually least active subjects. In 1993, Mittleman et al¹¹ and Willich et al¹² provided supporting evidence of the increased risk of AMI with vigorous exercise and that the risk was greatest for the least active individuals. Finally, Van Camp et al,¹³ in 1995, estimated the risk of SCD among young athletes as one in every 133,000 males and 770,000 females annually. They cited the US National Center for Catastrophic Sports Injury Research which reported 160 nontraumatic athlete deaths in high school and college organized sports between July 1983 and June 1993, of which 88% were of cardiac etiology. The estimated incidence of sudden death in this group was 7.47:1,000,000 per year in males and 1.33:1,000,000 in females. In athletes over 35, McGrew¹⁴ summarizes estimates of the frequency of SCD as 1:15,000 to 1:50,000 annually. Of note is

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that these data are likely underestimates of the true prevalence of sports-related AMI and SCD because many of the retrospective studies have relied on institutionally reported rates. Unlike the relative risk these authors have reported, the absolute risk that an acute CV event will occur during vigorous exercise in a healthy population has been estimated to be between 1 in 500,000 and 1 in 2,600,000 hours of exercise.^{8,11}

PATHOGENESIS OF EXERTION-RELATED CV EVENTS

The cause of exertion-related cardiovascular complications correlates with the athlete's age, with coronary atherosclerosis being the most frequent finding in individuals over the age of 35 to 40 after SCD.⁸ Conversely, inherited structural CV abnormalities are the major cause of SCD during exercise in younger athletes.^{1,7,10-17} These silent CV diseases predominantly consist of cardiomyopathies, premature coronary artery disease, and congenital coronary anomalies including anomalous coronary artery anatomy, arrhythmogenic right ventricular cardiomyopathy, myocarditis, conduction system abnormalities, and Marfan Syndrome.¹⁶ In the majority of United States reports, hypertrophic cardiomyopathy is documented as being the primary congenital or inherited CV disease linked to SCD in sporting activities accounting for more than one third of deaths.^{16,17} It is not the CV abnormality that causes the event but the combination of the physiological changes occurring during exercise and the abnormality. Although the mechanisms of exercise-related AMI and SCD are beyond the scope of this paper, suggested sequelae of these physiological alterations are decreased coronary perfusion, increased myocardial irritability, and altered myocardial conduction.⁸

CARDIOVASCULAR RESPONSES IN ICE HOCKEY

Game Characteristics of Ice Hockey

Hockey originated in Ireland as a field game using a ball and stick called Hurley. In Canada, when the winter arrived, the game moved to the ice and the ball was replaced by the puck. The word "hockey" is probably derived from the French *hoquet* ("shepherd's crook"), referring to the shape of the stick.¹⁸ Hockey is now Canada's national game and played seriously, at recreational and elite levels, in 20 countries. The game involves five active skaters on each team covering a 200' by 85' ice rink surface. Most elite competitive games are played in climate controlled arenas whereas, recreational games may be indoors or, alternatively, on outdoor rinks in a wide variety of weather conditions. For protection,

players in all venues wear substantial gear with full body coverage. Game play is for 3 periods of 20 minutes each. The nature of the game of hockey is to have the players take 1.5-3 minute shifts of high intensity skating on the ice and 2.0-5.0 minutes off the ice throughout the 60 minutes of play. Each period is also separated from the next with a 15 minute break in play. These bouts of intermittent exercise followed by stationary rest periods have been studied specifically in ice hockey by a handful of published researchers to determine the physiological and morphological myocardial adaptations as well as the demands on the CV systems of the athletes.¹⁹⁻²⁴

The Elite Hockey Player

Elite ice hockey players present with an increase in left ventricular (LV) cavity size, wall thickness, and mass, as well as a reduction in resting heart rate (HR) and blood pressure (BP). These findings are typical of a combination of sports requiring predominantly sprint work (wall thickness) and endurance work (cavity size).^{19,25} Physiologically, using the Fick Equation [$VO_{2\max} = Q \times a-vO_{2\text{ difference}}$], where endurance capacity ($VO_{2\max}$) is the result of cardiac output ($CO=Q$) and the ability to extract oxygen ($a-vO_{2\text{ difference}}$) and where CO is the result of left ventricular stroke volume (SV) times HR , in the hockey player it appears that an increase in SV is the method for increasing CO for play. Conversely, in control groups of healthy age matched peers, the increased CO is primarily derived from an increase in HR .¹⁹ In both groups an increase in $a-vO_{2\text{ difference}}$ occurs but the increase is greater in the elite hockey players.^{19,21} In addition, ice hockey is often described as an anaerobic sport, a fact supported by Bossone et al¹⁹ in their study of elite college ice hockey players who noted their requirement to tolerate anaerobic debt.

An analysis of the CV demands involved in playing ice hockey, and similar intermittent exercise sports, is performed by measuring the intensity of the CV workload at any given time during play, rest, and into recovery. Exercise at moderate intensities of 50 to 70% of oxygen uptake reserve ($VO_{2\max} - VO_{2\text{rest}}$), 60 to 80% heart rate reserve ($HRR = HR_{\max} - HR_{\text{rest}}$) or 70 to 85% of age-predicted maximum HR (HR_{\max}) have been widely demonstrated to be safe and beneficial.^{20,26} The American College of Sports Medicine (ACSM) estimates maximum predicted HR in a healthy population as $HR_{\max} = 220 - \text{age in years in beats per minute (bpm)}$.²⁶ The ACSM and Canadian Association of Sports Sciences both advocate target heart rate zones for training that do not exceed 85%

of predicted HR_{max} in healthy populations.²⁶ Yet, authors report that these hockey players frequently exceed 85% of both measured and predicted HR_{max} during bouts of play on the ice for between 10-30% of on-ice time, with their HRs returning to below 60% HR_{max} during rest.²¹⁻²³ Perhaps as interesting, a finding in a study of elite women hockey players by Spiering et al²³ indicated that these players experienced significantly greater CV load during game play than during practice (mean working HR during the game 90 +/- 2%, during practice 76 +/- 3%; mean percent session time >90% HR_{max} during the game 10.5% +/- 4%, during practice 5.6 +/- 3.5%).²⁵ Further, Paterson's²¹ literature search suggested a reduced efficiency of the thermoregulatory system in intermittent exercise, placing added demand on the CV system.

Adult Recreational Hockey

The most widely cited study of adult recreational ice hockey is the 2002 *Hockey Heart Study* conducted as a descriptive, cross-sectional study of male players in Sydney, Nova Scotia (n = 113; average age 42.7 +/- 6.9).²⁴ All subjects were over 35 years of age and were without known CV diseases or abnormalities. Atwal et al²⁴ assessed participant symptoms, HR, heart rhythm, and electrocardiogram (ECG) changes. In 100% of subjects, HR_{max} during play was greater than target exercise HR, calculated as 55-85% age-predicted HR_{max} (mean 184 +/- 11). The mean duration of these elevated HRs was 30 +/- 13 SD minutes. In addition, for 70.1% of data sets, HR recovery was poor, dropping as little as 4 bpm in the first minute of recovery when a drop of >12 bpm is correlated with lower CV risk.^{24,26} Also of concern were the recordings of non-sustained ventricular tachycardia from two monitoring sessions and ST-segment depression indicating myocardial ischaemia in data from 15 sessions. Symptoms reported while playing hockey included one report each of shortness of breath, palpitations, and chest pain or heaviness. No incidents of AMI or SCD were reported. Another finding of these particular recreational hockey players was that, although the authors reported a few risk factors present in adult recreational hockey players, no association existed with ischaemic heart disease and sudden death.²⁴ In his published commentary of the study and recreational hockey, Mittleman²⁷ stated that the participants had not received adequate primary prevention. Yet, despite elevated cholesterol levels (52.8%) and strong family histories of CV disease (41%), over 60% of the participants did exercise ≥ 3 times per week (excluding hockey) and were not considered sedentary. This exercise history appeared to have a substantial protective effect

considering the risk of an AMI or SCD triggered by vigorous exertion is approximately 50 times higher among sedentary people.¹¹

RATIONAL FOR CLIENT PRE-SCREENING FOR CARDIOVASCULAR RISK

Cardiovascular Risk Levels

Ice hockey is a sport requiring high intensity CV workloads for short bouts of intermittent exercise with maximum HRs exceeding current guidelines of $\leq 85\%$ of HR_{max} for a large percentage of the time spent on-ice. This intensity translates into an elevated relative risk level of 2-2.5 fold. In absolute terms, though, the risk is extremely low.¹⁰⁻¹² Despite this fact, clinicians must recognize that one CV event or one death is a result that must be avoided if at all possible. The risk in individuals under the age of 35 correlates with undiagnosed cardiovascular abnormalities such as hypertrophic cardiomyopathy or premature atherosclerosis. In individuals over the age of 35 the strongest correlations with risk are the incidence and degree of CV risk factors such as hypertension, smoking, dyslipidemias, sedentary lifestyle, diabetes, central obesity, and elevated body mass index (BMI).^{17,26,28} In both age groups, these indicators can be screened for. In the case of the younger athletes and CV pathology, a referral to a medical physician for elite athletes has been recommended.^{14,16,17,29-31} Alternatively, although prescreening is recommended for all individuals 35 years of age and older, the initial screening can be performed by all clinicians trained in CV risk and risk prevention.^{3-5,8,20,26,28,32}

Physical Therapist's Legal And Ethical Liability

Physical therapists across North America are now primary care practitioners in many jurisdictions giving the public direct access to our services. With this right comes an ethical and legal responsibility to screen for any risks associated with the initiation of, or return to, sport. This responsibility becomes especially true when the possible outcome is as extreme as a CV event or death. Further, the principle of beneficence held by the PT as a primary ethical foundation suggests that the access to athletes and the knowledge base and scope of practice allow the PT to determine their CV risk and take that information to mitigate that risk through education, training and rehabilitation.

CARDIOVASCULAR EVENT PREVENTION

Screening for Cardiovascular Risk

Recognizing and mitigating CV risk by physical therapists takes two forms: (1) the assessment and (2) training

regimes, including coaching and athlete education. A screening process should have target outcomes that have a significant impact on morbidity and mortality and should be accurate, practical to apply, and relatively low in cost.³⁰ A PT history taking and physical assessment of athletes of every level can meet all of these goals (Figure 1).

Physical Therapy Assessment: History Taking and Chart Review

The components of a PT history taking that are key to documenting increased CV risk related to both (i) discov-

ering the non-modifiable and modifiable known CV risk factors (Table 1) and (ii) getting an accurate symptom and event history. The modifiable CV risk factors include: hypertension, smoking, dyslipidemias {low high density lipoprotein (HDL) levels or elevated cholesterol, total cholesterol/HDL ratio, triglycerides, and low density lipoprotein (LDL) levels}, sedentary lifestyle, diabetes mellitus (DM), depression, central obesity, and elevated body mass index (BMI).^{26,33} Although international guidelines may vary somewhat in target values of some of the risk factors, strong consensus exists on healthy ranges. Of note is that individuals of a lower socioeconomic bracket are

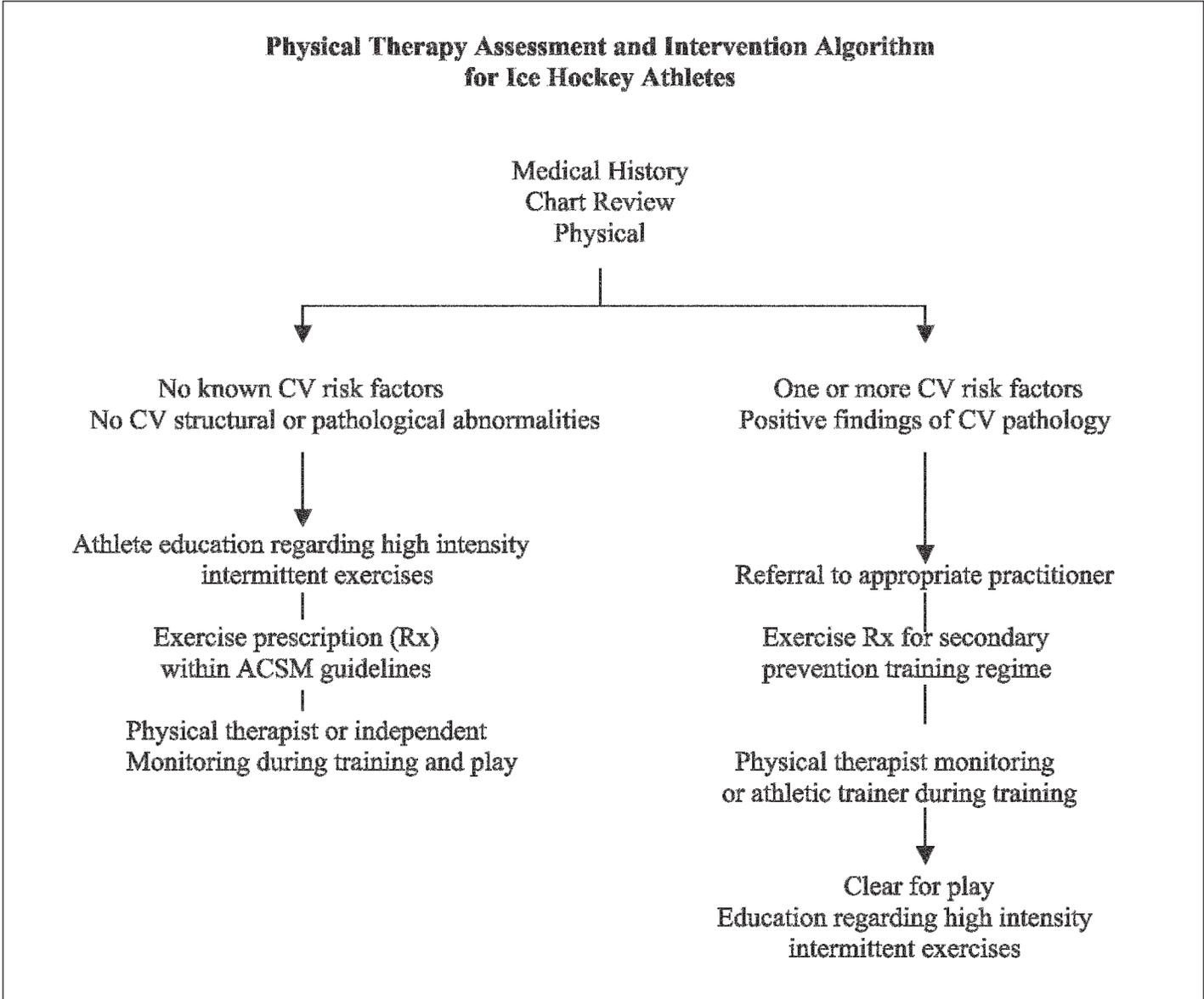


Figure 1: Physical Therapy Assessment and Intervention Algorithm for Ice Hockey Athletes and athletes of similar intermittent exercise sports.

also known to have a greater incidence of atherosclerosis, CV, and cerebrovascular events. If any single modifiable risk factor is borderline or exceeds recommended levels, the PT should communicate the findings to the client's family physician. The PT may also make direct referrals to clinicians whose scope of practice addresses any one or more key risk factor.

heart beat, dizziness, nausea, lightheadedness, and diaphoresis (heavy perspiration). Individuals may not initially report these symptoms but when they reveal that they are not as active as they were five years earlier, the clinician may be able to probe more specifically to determine if the reason is the avoidance of one or more of these symptoms. The clinician should also note if the

CV Risk Factors for the Development of Atherosclerosis (Target Definitions)
<p>Non-modifiable:</p> <ol style="list-style-type: none"> 1. advancing age ($VO_{2\max}$ decreases ~ 10% per decade) 2. male sex 3. ethnicity (Canadian First Nations, South Asian, African American, African Caribbean, Mexican American)^{32,34,35} 4. family history (premature deaths, vascular disease in surviving relatives) 5. genetic factors
<p>Modifiable:</p> <ol style="list-style-type: none"> 1. tobacco smoking (any exposure) 2. physical inactivity (< 30 to 60 minutes moderate exertion most days of the week;²⁶ < 1.5 kcal/kg body weight/day³²) 3. over-weight (> 25 BMI); obesity (>30 BMI)* 4. increased waist circumference- central obesity (_ >90 cm; _ >100 cm)* 5. excessive alcohol consumption (< 2/day; _ <9/week, _ <14/week) 6. hypertension (<140/90 mmHg in the absence of co-morbidities)* 7. dyslipidemia (total cholesterol > 5.0 mmol/L; LDL >2.5 mmol/L; HDL _ < 1.3 mmol/L, _ < 1.0 mmol/L) ; total cholesterol HDL ratio < 4.0; triglycerides < 1.7 mmol/L)* 8. diabetes mellitus (fasting blood glucose 6.0 mmol/L; 2-hour post-prandial < 7.8 mmol/L)* 9. depression <p>* Metabolic Syndrome is a cluster of three or more specific risk factors that increases overall CV risk</p>
<p>Emerging Risk Factors / Markers of Vascular Disease:</p> <ol style="list-style-type: none"> 1. C-reactive protein (high sensitivity) – inflammatory marker (>1.0 mg/L) 2. lipoprotein(a) – lipid related factor 3. fibrinogen – haemostasis thrombosis marker 4. homocysteine - other 5. erectile dysfunction

The symptoms (Table 2) most closely related to atherosclerosis are angina (chest discomfort or heaviness; aching in the chest, neck or jaw; radiation into the shoulder or arm), shortness of breath, palpitations or irregular

client has a history of calf discomfort with exertion that resolves with rest possibly suggesting peripheral arterial disease or claudication.

Primary Symptoms of Myocardial Ischaemia
1. chest discomfort or heaviness (angina)
2. aching in the neck or jaw, radiation into the shoulder or arm
3. shortness of breath (dyspnea)
4. irregular heart beat (palpitations)
5. dizziness, lightheadedness
6. nausea
7. diaphoresis (heavy perspiration)

Table 2: The symptoms most closely linked to a decreased myocardial oxygen supply due to atherosclerosis.

Although the ordering of tests such as echocardiograms, electrocardiograms, graded exercise tolerance tests (GXT), Holter monitor, or blood work is within the scope of the physician, the PT must make sure that any relevant test results are sourced, recorded, and then taken into account when undertaking an exercise prescription. For athletes under 35 years of age, particular attention is given to determining if there is any known inherited structural CV abnormalities. Similarly, the client's current medications should be recorded. If these tests have been performed, it may be a red flag and the PT should follow up with the family physician to enquire about the client's CV health. Males over 40 and females over 50 years of age should undergo a GXT every two years if healthy or annually if they have known CV disease.^{26,28} If the client has not undergone a GXT as recommended, the PT should discuss this with their client and refer them to their physician for follow up.

Physical Therapy Assessment: Physical Examination

In addition to the usual PT musculoskeletal and neuromuscular scans and assessment procedures, any client who is going to be prescribed exercise at moderate or high intensities must have basic vital signs and any symptoms recorded including their HR and rhythm, blood pressure, and ventilatory rate both at rest *and with exercise*. Vital signs should be taken on more than one occasion to verify them. The Borg Rating of Perceived Exertion (RPE) is also highly correlated with exertion and should be used to assess and monitor athletes.²⁶

Player Guidelines

Mitigation of Risk

Several components exist for minimizing CV risk when undertaking any sport, but this reduction in risk is especially true of sports, such as ice hockey, involving high intensity bouts of intermittent exercise, including the following:

Training. Training regimes must include aerobic training at moderate to high intensities 3 to 5 times per week to optimize VO_{2max} . In addition, practices must incorporate periods of high intensity exercise of similar duration to those encountered in game play. Athletes should be charged with self-monitoring shifts on and off the ice. Athletes should also spend 2-3 sessions on resistance training for the primary muscles used on the ice.

Pre-game preparation. Athletes should take a dietician's advice on nutritional needs for play but should recognize the risk of any significant intake of solid foods within one hour of a practice or game due to the high oxygen cost of digestion. To decrease cardiac workload from vascular resistance through vasodilation and to promote increased CO, athletes should warm-up by performing continuous aerobic exercise for 8 to 20 minutes prior to play. Pre-game hydration is also important in preparation for myocardial and skeletal muscle cell elevated metabolism during play. Dehydration can cause a significant increase in workload on the heart causing elevated heart rates and body temperature, lowered BP, and up to a 50% loss in performance. To avoid over-heating, players must consider their clothing and gear from the perspective of the temperature of the arena on the day of play.

During the practice or game. Players must avoid an abrupt drop in HR and BP when coming off the ice to avoid situations where myocardial oxygen supply does not meet demand, as well as to ensure they are ready for the next bout on-ice. To do this the player can remain standing and perform intermittent static or dynamic muscle contractions of the large muscle groups of the body. Hydration remains vital. Any signs or symptoms of CV deficit must be noted and reported. Players must also recognize any signs of over-heating and take action to cool themselves down (cold applied to the neck or wrists, removing gloves).

Immediately following the game. Players need to allow 12 to 20 minutes to let their HR and BP to decrease gradually, ensuring again that oxygen supply continues to meet the elevated metabolic rate anticipated for an extended period after exercise. This "cool down" is very difficult given

current practices of heading immediately for the locker room to debrief and change. Marching on the spot, walking, or any type of movement during this period can help to pace the drop in CO.

Education

Players and coaches in sports involving high intensity bouts of intermittent exercise should be approached and informed of the CV risks and how to mitigate those risks. Training should be laid out for the athletes and, in the case of recreational athletes, monitored for sufficient frequency, duration, and intensity. Although elite ice hockey is unlikely to change its format of play, recreational hockey groups can revise warm-up and cool-down routines to optimize CV health.

CONCLUSIONS

The benefits of recreational or elite ice hockey participation well outweigh the risks of AMI and SCD during play. As Mittleman²⁷ describes it, the risk of AMI in an hour of vigorous exertion is doubled compared to rest but their risk of CV events in the other 23 hours of the day is 50% lower than a sedentary individual.

The risks of ice hockey are sufficient to warrant pre-screening and targeted interventions to mitigate that risk. Physical therapists have an ethical and legal imperative to undertake the necessary assessment procedures to recognize and respond to any signs or findings of elevated CV risk in their clients. The basic parameters for assessing and mitigating CV risk for ice hockey players should apply equally to other sports with bouts of high intensity intermittent exercise.

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CURRENT KNOWLEDGE, PERCEPTIONS, AND INTERVENTIONS USED BY COLLEGIATE COACHES IN THE U.S. REGARDING THE PREVENTION AND TREATMENT OF THE FEMALE ATHLETE TRIAD

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ABSTRACT

Background. Coaches play an important role in the prevention of female athlete triad, but their current knowledge level, perceptions, and practice behaviors are not known.

Objectives. The purpose of this study was to describe the knowledge, perceptions, and behaviors college coaches have about the female athlete triad. This study's purpose was to describe the relationships between these variables, and to compare coaches having high levels of general knowledge about the triad with coaches having low levels of general knowledge with their perceptions, behaviors, and more specific knowledge about the triad.

Methods. A questionnaire was sent to 300 Division I collegiate coaches in the United States. Descriptive statistics, the Pearson product-moment correlation, and independent t-tests were used to describe the participants, relationships between variables, and compare groups of coaches with high and low levels of knowledge about the triad.

Results. Forty-three percent of the 91 college coaches responding to the survey (30% return rate) were able to correctly list the specific components of the disorder. Coaches with high levels of general knowledge about the triad had statistically significant differences in their perceptions, behaviors, and more specific knowledge of the triad than coaches with low levels of general knowledge about the triad.

Conclusion. The best intervention for the female athlete triad is prevention. Future education about the triad should focus on treatment and prevention

as well as specific factors related to the syndrome, such as nutritional requirements, methods of assessing menstrual irregularities, and screening techniques.

Keywords: female athlete, disordered eating, menstrual dysfunction, osteoporosis

INTRODUCTION

Greater participation of women in sports has increased competition among female athletes. The desire to succeed in athletics, combined with the pressure to maintain a lean appearance may cause female athletes to intentionally or inadvertently restrict their dietary intake and train excessively. This desire may be particularly true for athletes who participate in sports having a competitive or aesthetic value on maintaining a lean appearance (cross-country, gymnastics, figure skating, and ballet).^{1,2} Female athletes may engage in disordered eating patterns to achieve a low body weight believing that it will improve their sports performance.³ The internal desire to achieve an "ideal appearance" may be intensified by external stresses, such as societal pressure to be thin and demands placed upon the athlete by coaches or parents to excel in their sport. Women who chose disordered eating patterns to attain a desired body weight and athletic performance may be at risk for developing a condition known as the female athlete triad.^{4,5} The female athlete triad includes three interrelated components that are often expressed on a continuum: disordered eating, menstrual dysfunction, and osteoporosis.

Disordered eating is a continuum of abnormal patterns of eating ranging from mild or occasional abnormal eating behaviors (restriction of high fat foods or episodic fasting) to the more extreme conditions of anorexia (voluntary starvation) and

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bulimia (binging, followed by purging). Nutritional deficiencies resulting from caloric restriction or over-exercising may cause an irregularity or disruption of the menstrual cycle, known as oligomenorrhea (less than 8 menstrual cycles per year) or amenorrhea (a complete cessation of the menstrual cycle).⁶ Eventually, this condition can lead to osteoporosis (a loss of bone mineral density that is 2.5 standard deviation or more below the average bone mineral density (BMD) of young adult women) or osteopenia (a loss of BMD that is between 1.0 and 2.5 standard deviation below the average BMD of a young adult women) at an early age. The premature onset of osteoporosis in the young female athlete occurs at a time when peak bone mass is normally reached. In time, if not treated appropriately, the effects of this syndrome may be irreversible and eventually detrimental to the health of the athlete later in life.

The athlete who engages in inappropriate eating patterns or excessive behaviors to improve athletic performance may become nutritionally deficient if their energy intake (the amount of calories taken in) is less than the energy they have expended through intense training and exercise.⁷ A lack of energy or nutritional availability can have an effect on hormones responsible for the normal function of the menstrual cycle.⁸ Normal concentrations of the lutenizing hormone (LH) in the blood can become disrupted, limiting the secretion of estrogen by the ovaries.⁹ Lutenizing hormone is secreted from the pituitary gland when triggered by the release of the gonadotropin-releasing hormone (Gn-RH) from the hypothalamus.⁷ Suppression of the Gn-RH, thought to be initiated by a deficiency in energy availability or caloric restriction^{7,9}, can inhibit the release of LH. Low serum LH levels can result in oligomenorrhea or amenorrhea, the second condition of the triad.¹⁰ A subsequent loss of estrogen, combined with calcium and vitamin deficiencies, can lead to osteoporosis (a loss of bone mineral density), or osteopenia, a more common, less severe form of osteoporosis. Recent findings indicate, however, that the disruption in LH secretion resulting in amenorrhea can be prevented by proper nutrition.⁷

In children, bone mass increases until it generally reaches peak by about age 20.¹¹ Nutritional and hormonal deficiencies can impede this process and result in low bone mineral density. Although not entirely understood, failure to reach peak bone mass is thought to occur when the amount of bone reabsorbed by the body exceeds new bone formation. Low bone mineral density has been associated with the presence of stress fractures in the female

athlete¹² and may be one of the first clinical signs of an irreversible osteoporotic state. Failure for young women to reach peak bone mass at the appropriate time could result in accelerated rates of bone loss with aging and a greater risk of osteoporotic fracture in adulthood.⁶ To date, it is not known if large bone density losses can be reversed even when a woman's menstrual cycle returns when nutrition is improved. Preliminary evidence suggests that opportunity may exist for skeletal development to "catch-up" in bone mineral density, when interrupted in adolescence, even into the third decade of life.¹³ But this evidence was based on a single case study about an elite female athlete and other studies are needed to support this conclusion. One way of ensuring that peak bone mass is achieved during teen-age years is to make sure that the female athlete is receiving adequate nutrition per day. For example, a diet that includes an adequate amount of total calories, as well as a sufficient amount of micronutrients (such as calcium), is needed to meet the needs of the athlete's training program. Adequate nutrition is imperative for the prevention of osteoporosis, the final and most deleterious condition of the female athlete triad.

Coaches play an important role in the prevention of the female athlete triad. They have the ability to positively impact the female athlete by educating and encouraging them to adopt healthy patterns of behavior. Proper nutritional advice, training programs, screening tools, and referral to appropriate sources are essential to the prevention and treatment of the female athlete triad, but knowledge and understanding of the condition is required. The extent to which coaches know how to recognize, treat, and prevent the female athlete triad is not known. Determining where gaps in knowledge exist gives direction as to where education about the female athlete triad should be focused. Determining specific strategies that are effective is important in the treatment and prevention of the syndrome so that other coaches, health professionals, and parents involved in the care of the athlete can adopt these methods, as well.

The purpose of this study was to: 1) describe levels of knowledge, perceptions (attitude), and skills (behavior) collegiate coaches have about the female athlete triad; 2) describe the relationships between coach's knowledge of the female athlete triad and demographic/general practice information; 3) compare coach's general knowledge of the components of the female athlete triad with their perceptions (attitude), skills (behavior), and more specific knowledge of the syndrome; and 4) describe current

strategies used by college coaches for the prevention and treatment of the female athlete triad.

METHODS

A questionnaire was developed to gather data for this study consisting of a 5-page questionnaire divided into two parts. The first two pages of the survey were to be completed by all respondents. This first part consisted of 31 questions, including demographic and general practice information about the survey participants and an assessment of the coach's knowledge and perceptions about the female athlete triad. The coaches' response to this first part of the survey was converted into scales that were used for subsequent data analysis. For example, one question asked was: "Do you ask your female athletes about their menstrual cycle?" The response of the question ranged from the highest score of 5 (yes, 100% of the time) to the lowest score of 1 (no, never).

The second part of the survey (the remaining two pages of the questionnaire) was to be completed only by those participants who had in the last 24 months coached female athletes suspected of having the female athlete triad (for example, through observation or discussion with other health care professionals) or athletes who were medically diagnosed with the condition. Coaches who did not fit the criteria for continuation of the survey were finished with the survey and thanked for their participation in the study.

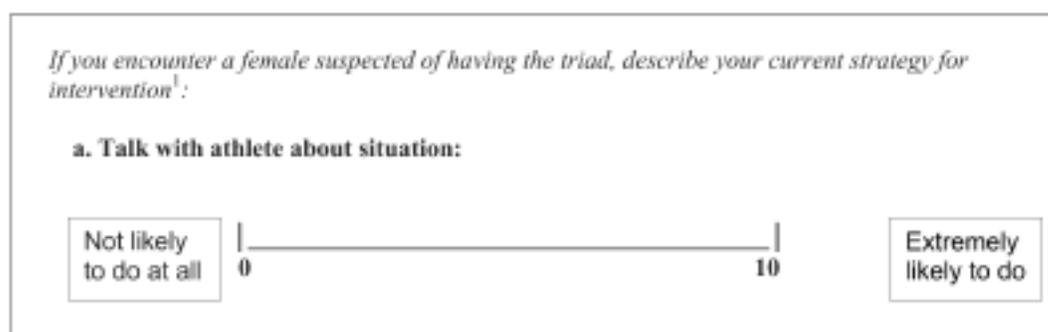
This second portion of the survey was designed to assess current strategies for treatment and prevention of the female athlete triad. Coaches were asked to describe the

likelihood they would use particular intervention strategies using 10-point Likert scales (0 indicating a behavior they were *not likely to do at all* and 10 indicating a behavior they were *extremely likely to do* (Figure 1). Finally, coaches were also asked if they currently screen or employ prevention strategies for the female athlete triad and were given an opportunity to describe in narrative form the specific strategies that they were using.

A prototype questionnaire was sent to a panel of 20 experts (90% response rate) who reviewed the survey for construct and content validity. Revisions were made to the survey based on recommendations made by the expert panel by consensus. The resulting 5-page survey consisted of a total of 36 questions, containing two parts.

The survey was sent to a systematic random sample of 300 Division I collegiate coaches involved in women's sports in the United States (U.S.), following approval by the Institutional Review Board at Drexel University. In the systematic random sampling process, subjects were selected from a database of coaches (a random selection of coaches in the U.S.) in a systematic fashion in that every third coach in the database was chosen for participation in the study. A cover letter and a self-addressed stamped envelope accompanied the survey. To increase the survey response rate, coaches who did not respond to the survey after one month of the first mailing were sent a letter of reminder and a second survey to complete. Survey questionnaires were returned anonymously. Completion of the questionnaire indicated informed consent to participate in the study.

FIGURE 1. An illustration of the 10-point scale used to determine the likelihood in which coaches incorporated intervention strategies for athletes suspected of having the female athlete triad. The results are listed in Table 7.



¹Survey participants were asked to describe their current strategy for intervention by marking the scale (the horizontal line) with a vertical line or slash-mark that corresponded most closely with what they do (between not likely to do and extremely likely to do). The scale was measured in 10ths of a centimeter and entered into a database for subsequent statistical analysis.

Data analysis

Descriptive statistics were used to summarize demographic and general practice information supplied by the survey respondents. Participant responses to survey questions regarding general and specific knowledge about the female athlete triad were described as percentages. The Pearson product-moment correlation was used to describe the relationships between the coach's knowledge of the female athlete triad and demographic/general practice information (age, gender, years of practice, and the percentage of female athletes coached).

To allow the statistical comparison of general knowledge about the triad with perceptions (attitude) and behavior (skill) and more specific knowledge about the triad, coaches were divided into two groups: those who were "high" in their

general knowledge of the components of the female athlete triad and those who were "low" in their general knowledge about the triad. The classification of groups was based on the responses made to the

question which asked coaches to "list the 3 conditions of the female athlete triad". Respondents who were able to correctly identify all three components of the triad: disordered eating, menstrual dysfunction (amenorrhea, oligomenorrhea, or menstrual irregularity) and osteoporosis (osteopenia) scored the highest score of "3" for their responses. Participants who could not identify any of the components of the triad received a score of "0". Two-tailed independent sample t-tests were used to compare coaches who were "high" or "low" in their general knowledge of the components of the female athlete triad with their perceptions (attitude), behavior (skill), and more specific knowledge level about the prevention and treatment of the disorder. A correction for multiple comparisons using t-tests was made by adjusting the alpha level to $p < .002$ ($.05/25 = .002$). Qualitative information

about current strategies for treatment and prevention was analyzed, divided into themes, and summarized in narrative form.

RESULTS

Ninety-one U.S. collegiate coaches responded to the mailed survey (30% return rate). Demographic and general practice information about the survey respondents are summarized in Table 1 and Figure 2. The largest percentage of survey respondents were female (54.9%), between 25-35 years old (38.5%), and had 16 or more years of experience as a coach (45%). The primary sports that survey participants reportedly coached were basketball, track and field, gymnastics, cross-country, swimming, crew, rowing and diving. The sports coached by the respondents included many of the sports in which the

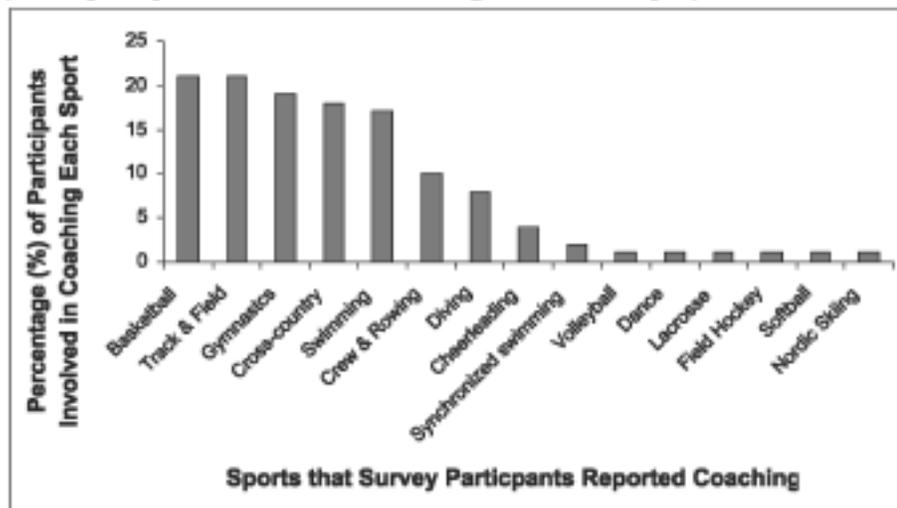
female athlete triad is considered to be most prevalent.¹⁵

Fifty-eight (64%) of the responding coaches reported having "heard of the female athlete triad" (Table 2). Forty-four of the 91 survey participants (48%) responded

"yes" when asked if they could identify the three distinct conditions of the female athlete triad, and approximately 39 coaches (43%) were able to correctly list the specific components of the triad (Table 2). A description of the coach's responses to questions reflecting specific knowledge, perceptions (attitudes), and behaviors (skills) about each of the three components of the triad are listed in Table 3.

A very low correlation was found between knowledge of the female athlete triad and gender of the coach ($r = .07$, $p = .52$). A coach's knowledge of the female athlete triad was also not related to the age of the coach ($r = -.035$, $p = .74$), years of experience as a coach ($r = -.06$, $p = .59$), and the number of female athletes coached ($r = -.13$, $p = .20$), respectively.

FIGURE 2: A description of the particular sports that the survey participant's reported coaching (several participants were involved in coaching more than one sport).



College coaches with a high level of general knowledge about the components of the female athlete triad (n = 52) had statistically significant differences in their perceptions (attitudes), behaviors (skills), and more specific knowledge of factors related to the female athlete triad than college coaches with low levels of general knowledge about the triad (n = 39). The results of these are detailed in Table 4 (a 3-point ordinal scale), Table 5 (a 5-point ordinal scale), and Table 6 (a 10-point ordinal scale). Specific strategies that coaches reported using for the treatment and prevention of the female athlete triad are described in Table 7.

DISCUSSION

The intent of this study was to determine the extent to which collegiate coaches in the U.S. know about the female athlete triad, the perceptions (attitudes) they have about the syndrome, and the behaviors (skills) that are currently being practiced. Understanding what coaches know about the female athlete triad and where information may be lacking helps direct where education needs to be focused. Based on the sample of collegiate coaches that responded to the survey, this study found that gaps in knowledge and misconceptions about the triad continue to exist. Although approximately 64% of the coaches participating in this study reported having heard of the female athlete triad, less than half (48%) thought

TABLE 1. Demographic and general practice information about the population of survey respondents

Demographic Variable	Frequency of Response (#)	Percentage (%) of Response
Gender: Female	50	54.9
Male	41	45.1
Age (years):		
< 25 years old	2	2.2
25-35 years old	35	38.5
36-45 years old	25	27.5
46-55 years old	24	26.4
56 years old or older	5	5.5
Years of Practice:		
Less than 1 year	2	2.2
1-5 years	11	12.1
6-10 years	18	19.8
11-15 years	19	20.9
16 or higher years	41	45.1
Estimated % of female athletes coached in last 12 months:		
0-5%	2	2.2
6-50%	4	4.4
51-75%	20	22.2
76-100%	65	71.1
How coach first came to know about the triad: (includes respondents who reported "knowing about the triad")		
Personal experience	11	12.1
Professional contact working with athletes	25	27.5
Research/literature	29	31.9
School/educational seminar	37	40.7
Other*	10	11.0

*From athletic trainers, athletes, teammates (college experience as an athlete), teaching, personal experience with daughter, HBO television special, internet, seminar at Princeton.

they could identify its components, and only 43% were actually able to correctly list all of the three components of the triad (Table 3). This finding suggests that although the majority of the survey respondents were familiar with the term "female athlete triad", many did not know what the specific components of the triad were and may have overestimated their knowledge level.

TABLE 2. Coach's responses to general and specific knowledge questions about the female athlete triad (n = 91).

Survey Question	Survey Response	Percentage (%) of Response
"Have you ever heard of the Female Athlete Triad?"	"Yes"	63.7
	"No"	33.0
	"Not sure"	3.3
"Can you identify the 3 distinct conditions associated with the Female Athlete Triad?"	"Yes"	48.3
	"No"	41.7
	"Not sure"	10.0
"Please list each of the specific components of the Triad"	Disordered eating	43.9
	Menstrual dysfunction	56.0
	Osteoporosis	52.7
	All three components	42.9

*The percentages represent the total number of respondents able to correctly list the component(s) of the female athlete triad.

It was interesting to note that for the group of collegiate coaches studied, no relationship existed between knowledge of the female athlete triad and gender, years of experience as a coach, and the number of female

TABLE 3. Coach's responses to survey questions about the three components of the female athlete triad, reflecting specific knowledge, perceptions and skills used (n = 91).

Survey Question	Survey Response	Percentage (%) of Response
DISORDERED EATING		
"When coaching female athletes, have you noticed any disordered eating behaviors?"	Yes	87.9
	No	12.1
"Do you ask female athletes questions to try to expose any type of abnormal eating pattern?"	Yes, > 50% of the time	38.5
	Yes, 25-49% of the time	7.7
	Yes, < 25% of the time	35.2
	No	17.6
	Missing	1.0
"Are you comfortable discussing disordered eating with female athletes?"	Yes	86.8
	No	13.2
"Do you think emotions affect how a female athlete may eat or exercise?"	Yes	99.0
	I don't know	1.0
"Do you assess or have body fat assessed on your athletes?"	Yes	27.5
	No	57.1
	Sometimes	15.4
MENSTRUAL DYSFUNCTION		
"Do you believe that irregular menstruation or absent menstruation is a normal consequence of exercise in female athletes?"	Yes	24.2
	No	71.4
	Not sure	3.3
	Do not know	1.1
"Do you ask your female athletes about their menstrual cycle?"	Yes, 100% of the time	8.8
	Yes, @ 50-99% of the time	17.6
	Yes, @ 25-49% of the time	8.6
	Yes, < 25% of the time	28.6
	No, never	36.3
"Do you assess menstrual history in your female athletes if you are suspicious of irregular menstruation?"	Yes, 100% of the time	34.5
	Yes, @ 50-99% of the time	13.8
	Yes, @ 25-49% of the time	5.2
	Yes, < 25% of the time	24.1
	No, never 100% of time	22.4
"Are you comfortable discussing menstrual irregularity with female athletes?"	Yes	81.3
	No	18.7
"A loss or irregularity of the menstrual cycle may result in the following (mark all that apply):" *	Improved bone growth	1.0
	Improved athletic performance	8.0
	Hot flashes	11.0
	Stress fractures	69.3
	Do not know	28.4
OSTEOPOROSIS		
"What is the suggested intake of calcium for females, ages 11-24 years according to the NIH?"	401-800 mg	8.8
	801-1200mg	13.2
	1201-1500 mg	15.4
	Not sure	28.6
	Do not know	34.1
"Please indicate the age range in which peak bone mineral density in women is reached."	11-14 years	3.3
	15-18 years	26.4
	19-22 years	33.0
	Not sure	20.9
	Do not know	16.5
"How often have you encountered or treated a female athlete with a stress fracture?"	Never	11.0
	1-5 times	52.7
	6-10 times	19.8
	11 or more times	16.5
"Do you believe that bone mineral density needs to be measured in female athletes when they have abnormal or absent menstruation?"	Yes	72.5
	No	0.0
	Not sure	27.5
"Indicate when it might be appropriate for women to be screened for osteopenia or osteoporosis if they had a history of the female athlete triad in high school?"	Immediately when diagnosed	52.7
	Within 1 year	11.0
	Not sure	18.7
	Do not know	17.6
	Never	0.0
*Percent values represent those responding "yes" to each of the answers provided.		

TABLE 4: t-test results showing the items that were statistically significant when comparing coach's "knowledge score" (ability to correctly list each of the three components of the female athlete triad) with perceptions, behaviors, and more specific knowledge factors related to components of the triad, by the survey respondents. The responses to the questions in this table were rated on a 3-point ordinal scale ($p < .05$) ($n=91$).

	Mean Values		t-value	p-value
	General Knowledge Level "LOW" Knows none of components of the triad. (n = 39)	"HIGH" Knows all three components of the triad. (n = 52)		
ATTITUDE, BEHAVIORS & SPECIFIC KNOWLEDGE				
<i>Do you believe that a loss/irregularity of the menstrual cycle may result in stress fractures?</i>	.36	.90	-6.60	.0001
<i>Have you encountered a female athlete with a stress fracture?</i>	2.05	2.69	-3.59	.001
<i>Indicate when it might be appropriate for women to be screened for osteopenia/osteoporosis if had a history of the triad in high school.</i>	.21	.77	-6.36	.0001
<i>Would you know how to recognize the signs and symptoms of the triad?</i>	1.31	1.93	-4.68	.0001
<i>Would you know how to treat a female athlete with signs and symptoms of the triad?</i>	1.15	1.62	-4.93	.0001
<i>Do you currently screen for any of the conditions associated with the triad during sport pre-participation evaluations?</i>	1.03	1.39	-4.17	.0001
<i>Do you currently use prevention strategies?</i>	1.13	1.87	-4.29	.0001

athletes coached. One might have predicted that since the triad occurs in female athletes; female coaches, coaches more exposed to female athletes, and those with more coaching experience may have been more knowledgeable about the syndrome, but this was not the case. The results suggest that knowledge about the female athlete triad is neither gender specific or based on the amount or type of coaching experience. The fact that knowledge about the triad was not influenced by certain demographics may be useful information to consider when educating coaches about the condition. It is the author's opinion that all coaches, regardless of sex, years of experience and proportion of females athletes coached, should have an awareness and understanding about the female athlete triad.

Specific Knowledge

When comparing more specific knowledge items on the survey, coaches who had a high level of knowledge of the components of the triad, compared to those with low levels of knowledge, were more likely to recognize the signs and symptoms of the triad, understand that absent or irregular menstruation could lead to stress fractures, and knew when it was most appropriate for women, with a history of the female athlete triad in high school to be screened for osteoporosis (Table 5). The findings suggest that coaches with a more general

understanding of the components of the triad had better awareness of specific information related to the female athlete triad.

Behavior (skill)

Although knowledge and awareness about the female athlete triad is essential in the treatment and prevention of the condition, certain skills or behaviors need to be implemented to make this happen. The results of this survey indicate that the likelihood of asking female athletes about their menstrual cycle, assessing menstrual history with their female athletes, and encountering female athletes with stress fractures was significantly higher in coaches that had more knowledge about the triad than

TABLE 5: t-test results showing the items that were statistically significant when comparing coach's "knowledge score" (ability to correctly list each of the three components of the female athlete triad) with behaviors by the survey respondents, related to questions asked of female athletes about their menstrual cycle. The responses to the questions in this table were rated on a 5-point ordinal scale ($p < .05$) ($n=91$).

	Mean Values		t-value	p-value
	General Knowledge Level			
	"LOW" Knows none of components of the triad. (n = 39)	"HIGH" Knows all three components of the triad. (n = 52)		
ATTITUDE, BEHAVIORS & SPECIFIC KNOWLEDGE				
<i>Do you ask female athletes about their menstrual cycle?</i>	3.27	4.18	3.33	.001
<i>Do you assess menstrual history in your female athletes if you are suspicious of irregular menstruation?</i>	2.05 3.13	4.31	3.53	.0001

TABLE 6: t-test results showing the items that were statistically significant when comparing coach's "knowledge score" (ability to correctly list each of the three components of the female athlete triad) with current strategies used by survey respondents for intervention. The responses to the questions in this table were rated on a 10-point ordinal scale (refer to figure 1 for illustration). ($p < .05$) ($n=91$).

	Mean Values		t-value	p-value
	General Knowledge Level			
	"LOW" Knows none of components of the triad. (n = 39)	"HIGH" Knows all three components of the triad. (n = 52)		
<i>If you encounter a female athlete suspected of having the triad describe your current strategy for intervention:</i>				
Talk with athlete	1.17	5.10	4.69	.0001
Talk with athlete's parents, if a minor.	.68	3.28	3.94	.0001
Contact team or athlete's physician	1.36	5.05	4.16	.0001
<i>If you encounter a female athlete suspected of having the triad describe your likelihood in coordinating multi-disciplinary involvement with a:</i>				
Nutritionist	1.26	4.72	3.93	.0001
Athletic trainer	1.30	4.58	3.74	.0001
Physical therapist	.76	1.34	1.13	.243*
Mental/Behavioral health practitioner.	1.06	4.35	3.96	.0001

*This item was not statistically significant, but was included in this report to illustrate all the health professionals that coaches were asked to rate in this question.

those who had less knowledge about the triad (*Table 5*). Collegiate coaches who were more knowledgeable about the triad appeared to be more likely to apply skills that exposed components of the triad and were coaches who had more exposure to athletes with stress fractures. These findings suggest that knowledge influenced the coach's actions in discussing the menstrual cycle with female athletes. In addition, experience in dealing with an athlete with a stress fracture may have influenced the coach's knowledge of the triad.

Perceptions (attitudes)

One of the more interesting findings of this study was the fact that some coaches (24%) believe that irregular or absent menstruation is a "normal" consequence of exercise. Another 4% of the responding coaches stated they were "not sure" or "did not know" if this fact was true (*Table 4*). Some female athletes, as well as coaches, may erroneously believe that absent menstruation is a normal response in exercising women. The coaches may recognize amenorrhea as a sign of a dedicated, hard-working athlete who trains intensively, rather than as a warning sign that the athlete may be nutritionally deficient. Increasing knowledge and recognition of the female athlete triad among college coaches requires proper education about the syndrome, so that certain myths such as these can be discarded.

Treatment/Intervention

Coaches with higher levels of knowledge about the female athlete triad were more likely to know how to treat a female athlete with the signs and symptoms of the triad, employ preventative strategies, and screen for the triad during sports pre-participation physical evaluations than those with lower levels of knowledge (*Table 5*). The findings were not surprising given that the ability to treat and use preventative strategies and screening tools would be factors that knowledge would impact.

Because of the complex nature of the syndrome, intervention strategies are most likely to be successful when they include a multidisciplinary team approach. Coaches need to encourage and communicate healthy nutrition and training but must call on the support of other health care professionals when appropriate and necessary. Collegiate coaches having a high level of knowledge of the components of the triad, who encountered a female suspected of having the triad, were more likely to talk with the athlete about it, talk with the athlete's parents, if a minor, and contact a team or personal

physician about the athlete's condition, (*Table 5*) than those with a low knowledge level. Coaches with higher levels of knowledge about the triad were also more likely to coordinate a multidisciplinary assessment with a nutritionist, an athletic trainer, and a mental health practitioner, but not a physical therapist (*Table 5*). It was encouraging to note that coaches who had knowledge about the triad were employing a team approach that addressed important, but differing issues of the triad: dietary/nutritional, psychological, physical training, and general medical concerns. The methods in which coaches applied this approach are useful in that they can serve as a model for those who are not currently utilizing a specific plan for intervention.

It was interesting to note that physical therapists were not included in this multi-disciplinary team. This finding may be explained by the fact that coaches may work more closely with an athletic trainer than a physical therapist, and that the athletic trainer may fulfill the coach's need for advice about physical training and conditioning. It is also quite possible that coaches may not perceive physical therapists as having a role in the treatment of the female athlete triad. Perhaps this opinion is due to the limited extent that physical therapists may have in nutritional education or due to the thought that physical therapists may not become involved in the care of an athlete until an injury, such as a stress fracture, occurs. This time might be when the athlete may undergo a more formal rehabilitation program that is provided by a physical therapist before returning to sports participation. It is important for coaches to understand that physical therapists may also play a role in the treatment and prevention of this disorder, particularly when an athletic trainer may not be available. The physical therapist can give suggestions for maximizing bone health in young females, educate athletes in preventing future stress fractures by alternating impact training with weight training, and participate in school activities and educational programs for the athlete and the athlete's parents.¹⁴

Lastly, collegiate coaches using prevention strategies for the female athlete triad were given an opportunity to describe the methods they currently use in narrative form. These suggestions were compiled in *Table 6*. Strategies included educating individual and team members on healthy living and healthy eating, open communication between the coach and athlete, and referring to other health care professionals when necessary. More specific strategies included those that emphasized a

TABLE 7. A description of specific treatment and prevention strategies used by a sample of college coaches in the United States for the female athlete triad.

Specific Strategies Used by a Sample of Coaches in the U.S. for the Prevention of the Female Athlete Triad
<p>I. Direct Intervention by Coaches</p> <p><i>With athlete:</i></p> <ul style="list-style-type: none"> • Educate individual athlete and team on healthy living and healthy eating. • Have open communication between the athlete and coach. • Provide handouts on recent literature. • Engage individual/team in preseason discussions about triad. • Immediately address the emotional needs of the athlete. • May need to determine if athlete is in appropriate weight class for the sport and restrict supervised weigh-ins to lightweight rowing only. • Avoid “undersizing” uniforms; they encourage the athlete to lose weight. • A food journal or a menstrual cycle journal are required. • All athletes, men and women, are educated on the importance of nutrition. We provide packets of suggested meals and snacks that are easy to prepare on a college budget and talk openly about drug and alcohol abuse. • Eliminate athlete from competition, if diagnosed as anorexic or bulimic. • Weight lifting, impact sports are encouraged to increase bone mass. <p><i>With other health care professionals:</i></p> <ul style="list-style-type: none"> • Nutritionists consult athlete on a regular basis to discuss calcium, vitamin D, and nutritional needs. • Coaches, team physicians, athletic trainers, and nutritionists work together to discuss warning signs or symptoms that may be observed in the athlete and devise a comprehensive nutritional plan and training program for the athlete. • Mandatory meetings are held with nutritionists and sports psychologists who specialize in eating disorders. • Team physician monitors for the presence of amenorrhea during physicals. • Intervention starts with the team physician. As coaches, we never try to solve the problem ourselves; we involve a multidisciplinary team of medical professionals. • A comprehensive screening, assessment and educational program in place, which is supported by college staff and resources. • Behavioral contracts are used to assure that the athlete is compliant in behavioral changes, for example, if athletes do not keep appointments with health professionals, they cannot practice or compete.
<p><i>Referrals sources most frequently used and rationale:</i></p> <p>Nutritionist/Dietitian</p> <ul style="list-style-type: none"> • Educate individuals/team on healthy eating strategies • Educate about the components of the triad • Set realistic body image/goals for athlete

degree of accountability for the athletes’ actions, such as keeping a food journal, a menstrual cycle journal, and devising behavioral contracts that enforced exclusion from sports practice or participation if the contract was not kept. Information provided by the responding coaches included roles that other health professionals play in the treatment of the disorder and the support that they receive within their individual programs. This informa-

tion provides a glimpse of what collegiate coaches are currently doing for the prevention and treatment of the female athlete triad and is a valuable resource for others to draw from. For example, this information may educate other coaches and health care professionals on how to initiate a prevention and treatment program if they were previously unsure about how to proceed.

Clinical Relevance and Future Direction

Since the American College of Sports Medicine (ACSM) published its first position paper about the female athlete triad in 1992,⁵ an extensive amount of information about the female athlete triad has been published and made available to the general public. Despite efforts to increase exposure about the devastating effects that the female athlete triad may have on women, the condition may often go unnoticed. This lack of understanding can be attributed to the complexity of each of the conditions or due to the fact that each of the components is expressed on a continuum rather than as separate or discrete disorders. The different types of disordered eating patterns or the underlying psychological reasons an athlete may decide to practice inappropriate eating patterns may not be easily recognized or understood. Recognition and prevention of the female athlete triad by coaches and other health care professionals requires knowledge and close attention to the athlete's nutrition and training habits. Preventative measures can begin by screening athletes for the disorder and educating or guiding athletes to adopt healthy nutritional and training habits. Coaches should know when it is appropriate to refer the athlete to another health professional for treatment. When recognized early, treatment can avoid progression of the stages and the most severe effect, the development of osteoporosis.¹⁵⁻¹⁸

Coaches are involved first-hand in the care of the female athlete and may be the first ones to notice abnormal or inappropriate eating or training behaviors. It is therefore important that the coaches understand the female athlete triad and its complexities. This study was relevant in that it provided a base-line understanding of knowledge collegiate coaches had about the female athlete triad. This study was also important to describe how levels of knowl-

edge influenced the coach's perceptions and behaviors about the triad. While significant differences in attitude and behavior were found between groups of coaches with high levels of knowledge and those with low levels of knowledge about the triad, it is important to mention that 40% (21/52) of coaches who had a high level of knowledge did not report incorporating strategies for intervention. As evidenced by the low mean values for the high knowledge group when current strategies for intervention were assessed (Table 5). Using a scale of 0-10 (Table 1) the highest mean values for *current strategies for intervention* were "talking with the athlete" (5.1) and "contacting the team or athlete's physician" (5.05). This finding indicates that recognizing what the three components of the triad are does not necessarily mean there is an understanding of how the condition should be treated or prevented. Given the results of this study, it is likely that educating collegiate coaches about the female athlete triad needs to be focused towards how the triad should be treated and prevented, as well as to increase specific knowledge about the condition.

Education of college coaches about the specifics of the condition should include nutritional requirements for the female athlete, recognizing behaviors or conditions that may signal a "red-flag" for medical intervention, recognizing individual coach's comfort levels with addressing the conditions of the triad with the athlete, and determining when medical screening and intervention is necessary. Future directions could include assessing levels of knowledge about the female athlete triad in high school coaches and educating them about prevention and treatment of the syndrome as necessary. High school coaches can instill and promote healthy habits in female athletes early on, so that by the time the athlete competes on a collegiate level, positive behaviors are already well established.

<p>Athletic Trainer</p> <ul style="list-style-type: none"> • Educate individual/team; monitors athlete with signs and symptoms. • Educate on triad and where to seek help (from other health professionals)
<p>Team Physician/MD/Nurse Practitioner</p> <ul style="list-style-type: none"> • Prescribes bone density tests; prescribes birth control pills, if amenorrheic. • Blood testing • Calcium/Vitamin D supplements • Medication or estrogen supplements; sometimes administer fosamax. • Monitor athlete on a regular basis • Use of physicals to screen athlete for triad; for example, questioning athletes about their menstrual cycle during preseason physical exams. • Educate individual and/or team about the triad.
<p>Health Centers</p> <ul style="list-style-type: none"> • Educate team on health center services. • Follow University protocol for treatment of athlete. • Collaborate athlete's plan of care with athletic trainer, team physician, nutritionist

Education of college coaches about the specifics of the condition should include nutritional requirements for the female athlete, recognizing behaviors or conditions that may signal a "red-flag" for medical intervention, recognizing individual coach's comfort levels with addressing the conditions of the triad with the athlete, and determining when medical screening and intervention is necessary. Future directions could include assessing levels of knowledge about the female athlete triad in high school coaches and educating them about prevention and treatment of the syndrome as necessary. High school coaches can instill and promote healthy habits in female athletes early on, so that by the time the athlete competes on a collegiate level, positive behaviors are already well established.

The information that collegiate coaches in the U.S. provided as to specific strategies for prevention and treatment of the female athlete triad was interesting and insightful. The suggestions provided can help others formulate decisions as to how they might implement these strategies in their athletic programs. While this study focused on collegiate coaches and collegiate female athletes, it is important to be aware that the conditions of the triad are also present in normal active females, who are not necessarily involved in college sports. Education and preventative measures regarding disordered eating, menstrual dysfunction, and the development of osteoporosis should then extend to include all physically active girls and young women.¹⁵

Lastly, a limitation of this study was the small sample of coaches that responded to the mailed questionnaire (30%). It is possible that the responses from the participating coaches did not accurately represent levels of knowledge, perceptions, and behaviors practiced by the majority of population of collegiate coaches in the U.S. Non-respondents to the survey may have had differing levels of knowledge, perceptions, and behaviors that may have not been reflected in the observed results. Another limitation of this study was the possibility that survey respondents may have consulted different resources to find answers to the survey questions prior to returning the survey, which may have inflated the reported results on knowledge about the female athlete triad. In addition, by classifying survey respondents into "high" and "low" knowledge levels by their ability to correctly list the components of the triad may not have necessarily tested their depth of understanding of the syndrome, including their ability to treat and prevent the condition.

CONCLUSION

Women's participation in sports will likely continue to increase, as might their risk of developing the female athlete triad, unless preventative strategies are put into practice. Coaches play an important role in the prevention of the female athlete triad by encouraging healthy patterns of behavior and recognizing when warning signs are present, but adequate knowledge of the condition is necessary. This study suggests that educating collegiate coaches about the female athlete triad should focus more on specific factors related to the syndrome, such as nutritional requirements, methods of assessing menstrual irregularities, and proper screening techniques. Prevention may include the use of comprehensive sports pre-participation examinations and carrying out some of

the methods of intervention suggested by the participating collegiate coaches surveyed in this study.

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