DIFFERENCE OF RAW FUNCTIONAL MOVEMENT SCREEN™ SCORES OF MALE AND FEMALE COLLEGIATE CHEERLEADERS

By

ANDA MARIE UDRIS

Bachelor of Science Athletic Training

Missouri State University

Springfield, MO

2011

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 2013

DIFFERENCE OF RAW FUNCTIONAL MOVEMENT

SCREEN™ SCORES OF MALE AND FEMALE

COLLEGIATE CHEERLEADERS

Thesis Approved:

Jennifer Volberding

Thesis Adviser

Matthew O'Brien

Tyler Tapps

.

ACKNOWLEDGEMENTS

The greatest pleasure in gathering the data for this thesis was working with people who understood my intent, celebrated the concept, and supported the project from start to finish. Their generous spirits infuse this work. This study was made possible by subject participation support from the cheer squads of the University of Arkansas, Northwest Missouri State University, Missouri State University, and Oklahoma State University. The researcher wishes to thank the participants who offered their time to take part in it this study.

Name: ANDA MARIE UDRIS

Date of Degree: MAY, 2013

Title of Study: DIFFERENCE OF RAW FUNCTIONAL MOVEMENT SCREEN™ SCORES OF MALE AND FEMALE COLLEGIATE CHEERLEADERS

Major Field: ATHLETIC TRAINING

Abstract:

Context: Cheerleading is a sport that requires mobility, stability, and neuromuscular control. Many collegiate athletes perform pre-participation exams as proactive preventative measures prior to competition, which may include an evaluation called the Functional Movement Screen™. **Objective:** The purpose of this study was to assess the difference of FMS™ scores of cheerleaders at four different universities. **Setting:** Mid-west universities that had competitive cheerleading squads. **Participants:** One hundred and thirty-one healthy male and female athletes were recruited (Males= 51, Females=80). One female participant was removed due to a modified screening procedure. **Interventions:** Prior to participation, participants filled out pre-participation survey. After watching an explanatory video for each movement, a single researcher took each participant through the FMS™ patterns and clearing tests, in order. **Main Outcome:** There was statistical significance in FMS™ scores between genders and positions. However, the data found no significance in scores between universities, squads, competitive company, or years of general and collegiate experience. **Measures:** Each movement was scored on a summed numerical scale. When doubt was perceived regarding scoring, participants were scored low. **Results:** Data was successfully collected from four different universities and six different squads (n= 130). For all universities, the FMS™ scoring average was above the risk indicating score of 14 (15 ± 2.64). Data analysis indicated that there was no significant difference between scores of universities [F (3,126), p= .590], squad, total years cheerleading [F (15,114), p= .671], total collegiate years cheerleading [F (6,123), p= .426], amount of competitive teams participant currently cheers [F (1,128), p= .817], or designated competitive company [F (1,128), p= .980]. There was a significant difference in scores for gender [F (1,128) = 11.22, p = .001] and position [F (4,125) = 9.26, p = .000]. **Conclusions:** The findings of this study indicated that location, coaching, and training regimen did not create a significant difference in FMS™ scores amongst college cheerleaders. However, it did support the sport as an athletic activity that inherently requires significant stability and mobility. Increased understanding of functional movement patterns, mobility, stability, and injury prevention will aid in the development of rehabilitation and strengthening programs.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The field of healthcare integrates a wide variety of techniques that focus on immediate, long-term, and preventative care. Preventative care promotes movement, function, mobility and stability. However, there is no set standard on how to grade or measure risk factors related to whole movement patterns. Assumptions are usually made that motion implies movement. Motion is the possible range of flexibility attainable by a joint or body segment, whereas movement is the positional change of that body via the force and actions from surrounding muscles and structures[1]. This creates the naïve comfort that if a joint or muscle has normal range of motion and strength that it will also have normal movement patterns and neural muscular control. This is rarely the case. Therefore, a basic screening process helps identify risk factors that may promote injury or re-injury.

The Functional Movement Screen™ (FMS) was created to rate and rank movement patterns through seven specific tests and three clearing exercises[1-5]. It is an identification tool which is not meant to be utilized as a training tool or to diagnosis why dysfunction exists, but instead discover which movements are problematic[1]. Once dysfunction has been identified, other actions, such as rehabilitative exercises, can be utilized to resolve these problematic movements. The FMS is based on a 21 point scoring scale, three points per test. Those that score poorly, less than 14, usually use compensatory patterns to complete basic movements[1,6]. If these compensatory patterns continue, they will reinforce poor biomechanics. By correcting poor biomechanics, health care professionals can prevent future injuries.

PURPOSE

The purpose of this study is to examine the differences of raw Functional Movement Screening™ scores of male and female competitive collegiate cheerleaders between the ages of 18-30 years at four universities during the fall season.

RESEARCH QUESTIONS

1. Will raw Functional Movement Screening™ scores differ between college cheerleaders at different universities?

SUBQUESTIONS

1. Will there be a relationship in scores depending on positions on the squad?
2. Will there be a relationship in scores based on experience and/or training?
3. Will there be a relationship in scores based on the number of squads an individual competes on?
4. Will there be a relationship in scores due to gender?
5. Will there be similar mobility and stability dysfunctional implications between university squads that can be generalized to collegiate cheerleading?
6. Will there be a relationship in scores due to competition company choices?

HYPOTHESES

1. It is hypothesized that scores will differ between universities.

SIGNIFICANCE OF THE STUDY

Few studies are available that focus solely on cheerleading or the Functional Movement Screen™ system. By investigating the interaction of the two, we can further the field in various areas of rehabilitation and sports related injuries. Cheerleading is currently not recognized by the National Collegiate Athletic Association, but it is a sport that requires power, strength, balance, endurance, and neuromuscular control, especially at the collegiate level. FMS™ can help us focus on injury prevention and performance improvement in cheerleaders by recognizing compensation patterns and dysfunctional movements. These fields need further research and experimentation to improve rehabilitation techniques, injury prevention, and understanding of cheerleading as a sport.

DELIMITATIONS

1. Findings in this study apply to healthy male and female collegiate cheerleading athletes between the ages of 18-30 years.
2. The subjects were recruited from universities with competitive collegiate cheerleading programs.
3. Any subject that suffers from a physical disability that prohibits them from physical activity has been excluded from the study. This includes surgeries, current injuries, and previous medical conditions.
4. Testing will be performed at each university by a single tester.

LIMITATIONS

1. Participants may not be truly representative of the population.
2. The familiarization period may not be sufficient to ensure maximal performance.
3. All participants have not had similar backgrounds in cheerleading prior to college.
4. All participants were not exposed to same training regiments and requirements.
5. All participants have not been tested in identical environments.

ASSUMPTIONS

1. Participants will adhere to study procedures and give maximum effort when necessary.
2. All participants are healthy individuals.
3. All participants are capable of the same physical demands.
4. A single researcher evaluated each participant.

CHAPTER II

LITERATURE REVIEW

Movement is extremely important in activities of daily living. As infants, we roll our heads and bodies to observe the world around us. Our movements begin proximally and then increase distally as we progress and learn. We are able to crawl, squat, walk and eventually run. However, assumptions are usually made that motion implies movement, but they are distinctly different[1]. Motion is the possible range of flexibility attainable by a joint or body segment, whereas movement is the positional change of that body via the force and actions from surrounding muscles and structures. These assumptions create the naïve comfort that if a joint or muscle has normal range of motion and strength that it will also have normal movement patterns and neural muscular control. This is rarely the case.

In athletics, it is important that we are able to control these movements and use them efficiently and productively. However, compensations due to idleness or trauma can occur leading us to increased injury rates or pain. Healthcare providers should assess movement in pre-participation exams and screen for potential predisposed risks. There are many musculoskeletal screening processes but very few collaborative studies have been performed to examine each. The Functional Movement Screening™ test (FMS™) is just one test that can be used to determine functional movement and assess weaknesses in the kinetic chain.

The purpose of this current study is to observe the FMS™ screening scores among four competitive collegiate cheerleading athletic programs. This will show a consistence of specific inhibitions in mobility and stability among and between each university. This chapter will discuss the kinetic chain, functional movement in regards to mobility, stability and muscle imbalance, pre-participation screening, the FMS™ screening process, and previous studies performed using this screening technique.

General Information

According to Gray Cook[1], many healthcare professionals look at fundamental movement patterns and then specific movements. They believe in fundamentals first and then work on the basics, but fundamental movements are usually neglected in the rehabilitation process[1-4,6]. Generalized physical issues need to be addressed before muscle specific treatment protocols can be employed. One cannot fix the problem if they do not first look at the overall cause.

Fundamental movements are the precursor patterns to complex skills, such as body management, locomotor control, and object control skills[1-4,6-8]. These skills facilitate an individual's capability to perform athletically, as well as perform their usual activities of daily living. When watching a two-year-old pick up a ball, they bend at the knees, reach with both hands, and squat up, but even as early as their 20's individuals adapt a movement pattern of just bending at the waist to lift objects creating back pain over time. Fundamental movement patterns create such an impact on the way of life that the Australian Health and Physical Education curriculum is specifically directed to develop them in the early years of childhood[7]. It is easier to learn a new skill, which can take 9-10 hours, than correct a poorly developed movement, which can take roughly three months to re-define[7]. Therefore, when proper fundamental movements are developed and corrected early, individuals are better able to prevent injury due to the skills their bodies ascertained and perform more efficiently.

To understand this efficiency, each health profession studies the same anatomy, but there is no set baseline to the biomechanical activities of standard movement[1-3,5,6]. This lack of a baseline makes it difficult for clinicians to distinguish dysfunction and compensation from proper well-balanced performance. Athletes often utilize compensatory movements to perform high levels of achievement, and reinforcing compensation through blind treatment protocols will eventually lead to an increased risk of injury[4]. Health care providers should screen movement patterns before reinforcing poor quality movements, correct them with simple controlled exercises, and reinforce them with encouragement. This will not only make the individual more efficient but also proactive in injury prevention. For athletes, movement dysfunction should be addressed throughout the body's kinetic chain during pre-participation exams.

The body works as a unit, usually referred to as the kinetic chain[5]. In rehabilitation, clinicians use the concepts of an open- and closed-kinetic chain constantly. An open kinetic chain occurs if the distal end of the extremity is not fixed and a closed kinetic chain occurs if the distal end is fixed[9]. An open chain movement would be the hamstring curl, while a closed chain movement would be a squat. When one portion is negatively affected the whole unit is disturbed, especially when the chain is closed. This is demonstrated when an ankle sprain creates a compensation that can cause pain in the opposing shoulder from a possible weight shift. The ankle compensation creates a change in the knee moving to the hip, the spine, and ultimately the shoulder girdle and upper extremities.

Without screening an individual, a clinician may incorrectly presume that certain movements, mobilities, stabilities, and proprioceptions are considered normal in the kinetic chain when they are performed without pain[1]. This may not necessarily be the case. Numerous injuries are associated to previously acquired compensation patterns which left a portion of the body inadequately prepared for certain activities, especially in regards to sports specific movements[6]. Mobility, stability, and muscle imbalances are all areas focused on by healthcare providers to prevent these injuries.

Mobility, Stability, and Muscle Imbalances

Functional movement requires mobility, stability, and muscle balance. When these requirements are absent or excessive, they create an inequality which can predispose individuals to injury or create physical issues that cause pain[6,7,10-12].

Motion is the possible range of flexibility attainable by a joint or body segment which occurs in many planes in combination with linear and angular motion components [1,6]. Stability is closely related to equilibrium, but it is defined as the mechanical resistance to linear and angular acceleration[9,10,13]. It is also usually confused with balance, which is the ability to control equilibrium and inertia[13]. Mobility exercises are those that focus on joint range of motion, tissue length, and flexibility[1]. This would include stretching, joint mobilizations, and rehabilitation movement patterns. Whereas, stability exercises focus on basic sequencing movements, such as postural control[1]. Borsa et al, suggested that altered shoulder mobility developed secondary compensations which may compromise stability, putting an overhead athlete at increased risk of injury[10]. Therefore, both mobility and stability are needed for an individual to efficiently move and perform.

Without efficient movements, muscle imbalances are easily created and compensations will soon occur. Yeung et al, identified muscle imbalances between the quadriceps and hamstrings that were preseason risk factor determiners in competitive sprinters[12]. This study suggested that hamstring weakness, poor flexibility, shorter optimum angle for peak torque, fatigue, poor warm-up technique, and previous injury all left athletes susceptible to hamstring strains, and determined that a preseason hamstring: quadriceps muscle peak torque ratio at 180°/s of less than 0.6 increased the likelihood of injury by 17 times[12]. Peate et al used a core and trunk stabilization intervention on firefighters who had been assessed using FMS™, and saw reduced lost time due to injuries by 62% and reduced number of injuries by 42% over a twelve month period[11]. They linked a decrease in core strength with injuries to the back and extremities, and discovered a correlation based on linear regression between past musculoskeletal injuries with FMS™ scores[11].

Muscle balance throughout the body is important to prevent injury. According to the neurologist Janda, the body can create functional imbalances that can create structural changes. This is demonstrated in his concepts of upper and lower crossed syndromes[14]. Both concepts focus on the balance of muscular complexes around major joints to encourage proper arthrokinematics, which will prevent fatigue and injury[14,15]. Vera-Garcia et al noted that pelvic movement control created angular displacements of the spine which, compared to thorax movements, created a more stable activation of the abdominal musculature[16]. These concepts should be taken into consideration when establishing rehabilitation programs to ensure that the body can perform without risk of injury.

Pre-participation Screening

Traditionally pre-participation physicals consist of general medical information, body system checks, and disease screenings. They identify risk factors such as cardiac disease, previous head injury, and specific musculoskeletal problems[5,8,17-19]. Most sports physicians specifically look for anterior cruciate ligament and rotator cuff laxity, previous injury, or surgery. Usually the screenings are then followed by a brief performance tests that include sit-up and pushup endurance, strength measurements, endurance runs, sprints, agility activities and other quantitative measurements[1]. However traditionally, functional movement is not observed, which as indicated earlier can be proactive in injury prevention.

Movement screenings close the gap between activities of daily living and medical or biomechanical analysis[1,6]. Issues that can increase the likelihood of injury may be previous injury, body mass index, body composition, playing experience, femoral intercondylar notch width, equipment design, playing surface, muscle flexibility, ligamentous laxity, and foot biomechanics[6].

FMS™

Few studies have investigated the use of the FMS™ [8]. It is a predictive system to identify, rate and rank movement limitations and right-left asymmetries for individuals that are not currently experiencing pain or known injuries[1,6]. This is not to be confused with the Selective Functional Movement Assessment (SFMA), which is a movement-based diagnostic system for full-body movements[1].

The system is based on a 0-3 point scale. A score of zero is acquired when pain is obtained with any movement. A score of one is given if the person is unable to complete the movement pattern or is unable to assume the initial required position. A score of two is given if the person is able to perform the movement but does so with compensations. A score of three is given if the person performs the movement correctly without any compensation. Notes should be taken bilaterally and should reflect why a score of three was not obtained [1,2,3]. The movements assessed are: 1) the deep squat, 2) the hurdle step, 3) the in-line lunge, 4) shoulder mobility, 5) active straight leg raise, 6) trunk stability push-up, and 7) the rotary stability test[1,6,8]. The total score is out of 21, but most studies use a score of 14 or less to predict serious injuries based on information from the ROC[1,6,5 , 4, 8]. The ROC, or Receiver Operator Characteristic curve, maximizes the sensitivity and specificity of the test using a number derived from professional football players by Kiesel et al[6,5, 4, 8]. According to Schneiders et al, there are significant differences apparent between male and females in FMS™ testing where strength and flexibility are the tested factors[5].

Unfortunately, there is a limitation to FMS™ studies based on lack of stratification of individual sports and exercise participation. This decreases its ability to be generalized to specific athletic events. However, it is useful for data collection when screenings are being administered to large groups due to inter-rater reliability[5,20-22]. Shultz et al noted that clinicians should avoid cross referencing among multiple testers, and the process can be more efficient if a video capture is utilized[21,22]. Future research needs to be performed to further refine and validate the FMS™.

Summary

As mentioned earlier, more research needs to be done on the FMS™ program to determine the differences between sports in regards to mobility and stability and if there are consistencies within sports that may help with injury prevention. Also further investigation should be done examining the overall effect of focusing on functional movement training methods instead of stagnant, isolated movements.

CHAPTER III

METHODOLOGY

The purpose of this study was to examine the differences of raw Functional Movement Screening™ scores of collegiate cheerleaders between the ages of 18-30 years at four universities. This chapter will explain the details of the research study including subjects, instrumentation, procedures, and data analysis.

SUBJECTS

One hundred and thirty-one healthy, collegiate competitive male and female cheerleading athletes volunteered to participate during the fall season. They were recruited by e-mail and text message. Each subject was grouped according to university. Each group consisted of approximately 20 individuals. Subjects had physician clearance and were excluded from the study if they presented with any current injuries, surgeries, or pain that prevented them from physical activity. All participants signed a consent form and filled out a health questionnaire after being informed of the risks and benefits of the study by the researcher.

INSTRUMENTS

Instrumentation consisted of the Functional Movement Screen™ kit[1]. The kit consisted of a four-foot dowel rod, two smaller dowel rods, a small-capped piece, an elastic band, and a two-by-six board (2x6). A laptop was used to play a video to explain each movement prior to participant data collection. This was done to ensure that instruction was identical for all participants.

RESEARCH DESIGN

The experimental design for this study was cross-sectional design using a 1x4 design. The dependent variables were the Functional Movement Screen™ raw scores. The independent variable was the differences of scores between university cheerleading squads.

PROCEDURES

A single researcher performed all of the scoring. The researcher was instructed by a certified FMS™ practitioner and has three years of experience.

Prior to participation, each individual was instructed to wear appropriate athletic attire and proper footwear. Each participant was tested individually in one session lasting approximately 20 minutes. Participants were taken through seven movement patterns and three clearing tests. The movement patterns were scored on a scale of 0-3. A score of zero, which nullifies all other scores, was assigned to any movement where pain was reported. Pain criteria was met when the movement was familiar and created discomfort, was produced by common movements, and demonstrated signs of concern or stress[1]. Discomfort criterion was differentiated if the movement was unfamiliar, was produced with awkward movements, and showed no signs of concern or stress[1]. Screening continued if discomfort was displayed, but was discontinued if the pain criterion was met. A score of one was established if the participant was unable to perform or complete a movement pattern. A score of two was established if the movement was performed, but there was some form of compensation noted. Finally, a score of three was established when the participant was able to complete the functional movement with undisputed capability[1-4,6,23,24]. The clearing tests were not graded on a 0-3 scale, but instead were reported with a positive as painful or negative as non-painful. Each movement was attempted three times. If the participant could not meet any of the criterions to receive a three, they were given score of a two. If the participant could not meet any of the criterions to receive a two, they were given a score of one. When doubt was perceived regarding scoring of a participant, they were scored low.

For the study, the following movements were performed in this order after watching a descriptive video:

1) Deep Squat Movement Pattern

Description[1]

To begin, the participant's feet were placed shoulder width apart in the sagittal plane. A dowel rod was provided and rested on top of the head to adjust hand position to 90°elbow flexion. The rod was then pressed overhead with shoulders flexed and abducted with elbows fully extended. Next, participants were instructed to descend slowly into the squat position. Heels were firmly placed on the floor with head and chest facing forward while the rod was fully extended overhead. The knees should not have proceeded over the toes and no valgus or varus deviations should have occurred. If any of the previous criteria were not met, the participant was asked to perform the motion with a board under their heels.

Testing

All positions should have remained unchanged throughout the entire motion when the heels were elevated.

Verbal Instruction[1]

- Stand tall with your feet approximately shoulder width apart with toes pointing forward.
- Grasp the dowel in both hands and place it horizontally on top of your head so your shoulders and elbows are at 90°.
- Press the dowel so that it is directly above your head.
- While maintain an upright torso, and keeping your heels and the dowel in position, descend as deep as possible.
- Hold the descended position for a count of one, then return to the starting position.
- Do you understand the instructions?

3

- Torso was parallel with tibia or vertical
- Femur below horizontal
- Knees were aligned over feet
- Dowel aligned over feet

2

- Torso was parallel with tibia or vertical
- Femur below horizontal
- Knees were aligned over feet
- Dowel aligned over feet
- Heels lifted off ground

1

- Tibia and torso were not parallel
- Femur was not below horizontal
- Knees were not aligned over feet
- Lumbar flexion occurred

2) Hurdle Step Movement Pattern

Description[1]

The height of the participant's tibial tuberosity was measured and used to adjust hurdle height. The participant stood next to the hurdle, in line with one of the uprights and the marking cord was slid up to the necessary height position. Both sides were level and displayed accurate tibial tuberosity height bilaterally.

The participant then placed their feet together and touched to meet the center of the hurdle base. Toes were aligned perpendicular to the hurdle base.

The dowel rod was held across the shoulders under the neck. The participant was asked to step over the hurdle and touch their heel to the floor. The lead leg then returned to the starting position in a slow, controlled manner.

Testing

The cord was ensured to be in proper alignment. The participant was instructed to get as tall as possible during testing to ensure clearance. Also, toes were observed to stay in contact with the hurdle base.

Verbal Instruction[1]

- Stand tall with your feet together and toes touching the test kit.
- Grasp the dowel with both hands and place it behind your neck and across the shoulders.
- While maintaining an upright posture, raise the right leg and step over the hurdle, making sure to raise the foot towards the shin and maintaining foot alignment with the ankle, knee and hip.
- Touch the floor with the heel and return to the starting position while maintaining foot alignment with the ankle, knee and hip.
- Do you understand the instructions?

3

- Hips, knees and ankles remained aligned in the sagittal plane
- Minimal to no movement in lumbar spine
- Dowel and hurdle remained parallel

2

- Alignment was lost between hips, knees and ankles
- Lumbar spine movement was present
- Dowel and hurdle did not remain parallel

1

- Contact between foot and hurdle occurred
- Loss of balance occurred

3) Inline Lunge Movement Pattern

Description[1]

The participant's back foot's toes lined up at the start line on the kit. Using the tibial height measurement attained from the previous movement, the participant was instructed to place the heel of their front foot at the same measurement on the 2x6 board.

The dowel was placed behind the back in contact with the head, spine, and sacrum. The participant's hand opposite of the lead leg grasped the dowel at the cervical spine, while the other hand grasped at the lumbar spine.

Movement began by instructing the participant to lower the back knee to touch the board behind the heel of the front foot. The participant was then to return to the starting position in a slow, controlled manner.

Testing

The dowel remained at all three contact points throughout the upward and downward position.

Verbal Instruction[1]

- Place the dowel along the spine so it touches the back of your head, your upper back and the middle of the buttocks.
- While grasping the dowel, your right hand should be against the back of your neck, and the left hand should be against your lower back.
- Step onto the 2x6 with a flat right foot and your toe on the zero mark.
- The left heel should be placed at the tibial measurement mark.
- Both toes must be pointing forward, with feet flat.
- Maintaining an upright posture so the dowel stays in contact with your head, upper back and top of buttocks descend into a lunge position so the right knee touches the 2x6 behind your left heel.
- Return to the starting position.
- Do you understand?

3

- ➢ Dowel contact was maintained throughout the entire motion
- ➢ Dowel remained vertical
- ➢ No torso movement was noticed
- ➢ Dowel and feet remained in sagittal plane

2

- Knee touched board behind heel of front foot
- Dowel contact was maintained throughout the entire motion
- Dowel remained vertical
- No torso movement was noticed
- Dowel and feet remained in sagittal plane
- Knee touched board behind heel of front foot
-

1

- Loss of balance was noticed

4) Shoulder Mobility Movement Pattern

Description[1]

Initially, the participant's hand length was determined by measuring the distance from the distal wrist crease to the tip of the longest digit. The participant was instructed to stand with their feet together and make fists containing their thumbs. The participant then simultaneously moved one fist overhead behind the neck and the other behind and up the back in one smooth motion. Distance between the two fists was measured and then this process was repeated bilaterally to determine symmetry.

Testing

Fists remained closed throughout the entire process, and participants did not attempt to creep fists closer together.

Verbal Instruction[1]

- Stand tall with your feet together and arms hanging comfortably.
- Make a fist so your fingers are around your thumbs.
- In one motion, place the right fist overhead and down your back as far as possible while simultaneously taking your left fist up your back as far as possible.
- Do not "creep" your hands closer after their initial placement.
- Do you understand the instructions?

3

- Fists were within one hand length

2

- Fists were within one-and-a-half hand lengths

1

- Fists were not within one-and-a-half hand lengths

a) Impingement Clearing Test

Description[1]

The participant was asked to place their palm on their opposing shoulder and lift their elbow and high as possible, while keeping the hand in place. This was repeated bilaterally.

Testing

Hand-to-shoulder contact remained throughout the test.

Verbal Instruction[1]

- Stand tall with your feet together and arms hanging comfortably.
- Place your right palm on the front of your left shoulder.
- While maintaining palm placement, raise your right elbow as high as possible.
- Do you feel any pain?

5) Active Straight-Leg Raise Movement Pattern

Description[1]

The participant lied supine with their arms by their sides, palms up, and head flat on the floor. The 2x6 was placed behind the participant's knees with their feet in a neutral position, soles of the feet perpendicular to the floor. Next, the dowel was placed perpendicular to the floor between the anterior superior iliac spine and the joint line of the knee. The participant was instructed to lift the straight, test leg while maintaining a dorsiflexed foot. The opposing knee's posterior aspect remained in contact with the board at all times. Once reaching end-range, scoring occurred based on the position of the test leg's malleolus.

Testing

The moving limb indicated the side being scored, the non-moving leg maintained the neutral position, and verbal encouragement did not occur.

Verbal Instruction[1]

- Lay flat with the back of your knees against the 2x6 with your toes pointing up.
- Place both arms next to your body with the palms facing up.
- Pull the toes of your right foot toward your shin.
- With the right leg remaining straight and the back of your left knee maintaining contact with the 2x6, raise your right foot as high as possible.
- Do you understand these instructions?

3

- Vertical line of malleolus was between mid-thigh and ASIS
- Non-moving limb remained in original position

2

- Vertical line of malleolus was between mid-thigh and joint line
- Non-moving limb remained in original position

1

- Vertical line of malleolus was below the joint line
- Non-moving limb remained in original position

6) Trunk Stability Pushup Movement Pattern

Description[1]

Participants lied face down with arms extended overhead and knees fully extended with soles of their feet perpendicular to the ground. Male participants began with their thumbs at the top of the forehead, and then lowered to chin if necessary. Female participants began with their thumbs at chin level, and then lowered to clavicle if necessary. Participants performed one push-up in this position in one fluid motion, keeping the body rigid. If participants could not perform the movement, their thumbs were lowered to the second position offered.

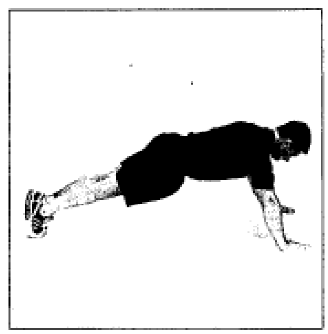
Testing

The body was lifted as a unit in one smooth motion while hands remained in original positions. There was no sway in the spine.

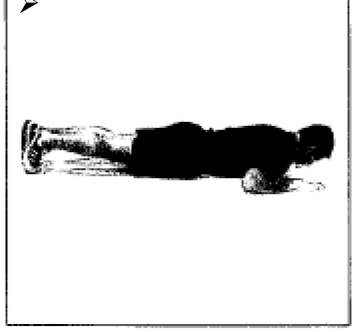
Verbal Instruction[1]

- Lie face down with your arms extended overhead and your hands shoulder width apart.
- Pull your thumbs down in line with the ____ (forehead for men, chin for women).
- With your legs together, pull your toes toward the shins and lift your knees and elbows off the ground.
- While maintain a rigid torso, push your body as one unit into a pushup position.
- Do you understand these instructions?

3



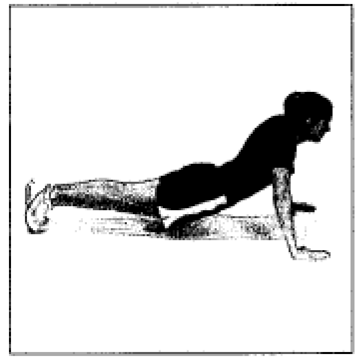
➢ Body lifted as one unit with no lag in spine
➢ Men- Thumbs at top of head
➢ Women- Thumbs at chin
➢
➢



2

➢ Body lifted as one unit with no lag in spine
➢ Men- Thumbs at chin
➢ Women- Thumbs at clavicle

1



- Men- Unable to perform movement with hands at chin
- Women- Unable to perform movement with hands at clavicle

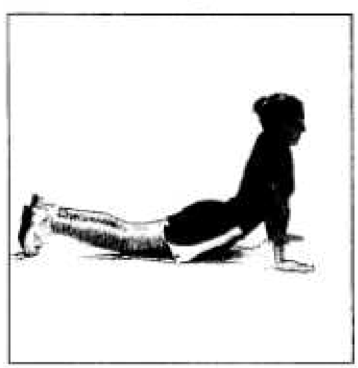
a) Press-Up Clearing Test

<u>Description[1]</u>

Participant assumed the “cobra” yoga pose by pushing up from a face down position while keeping hips in contact with the floor.

<u>Verbal Instruction[1]</u>

- While lying on your stomach, place your hands, palms down, under your shoulders.
- With no lower body movement, press your chest off the surface as much as possible by straightening your elbows.
- Do you understand these instructions?
- Do you feel any pain?



7) Rotary Stability Movement Pattern

Description[1]

The participant started in a quadruped position with the 2x6 between their hands and knees. The board was parallel to the spine and hips and shoulders were at 90° flexion. Soles of the feet were perpendicular to the ground. The hands were open with thumbs, knees, and feet touching the board. The participant was instructed to extend their arm while extending the same-side hip and knee. Without touching down, the participant then brought the elbow to knee remaining in line with the board and then returned them to the starting position. This was then performed bilaterally.

Testing

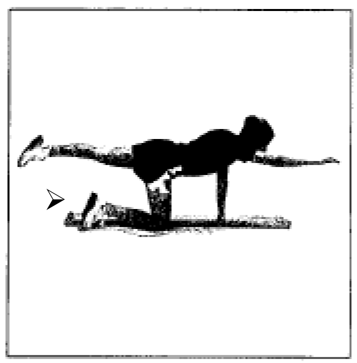
Spinal flexion was allowed as participant brought elbow to knee. If the ispilateral movement was unattainable, then the participant attempted a diagonal pattern using opposite shoulder and hip in the same manner. However, they received a score of two at best.

Verbal Instruction[1]

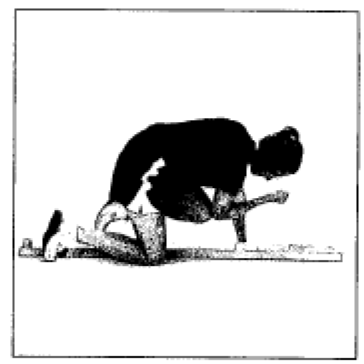
- Get on your hands and knees over the 2x6 so your hands are under your shoulders and your knees are under your hips.
- The thumbs, knees and toes must contact the sides of the 2x6, and the toes must be pulled toward the shins.
- At the same time, reach your right hand forward and right leg backward, like you are flying.
- Then without touching down, touch your right elbow to your right knee directly over the 2x6.
- Return to the extended position.
- Return to the start position.
- Do you understand these instructions?

3

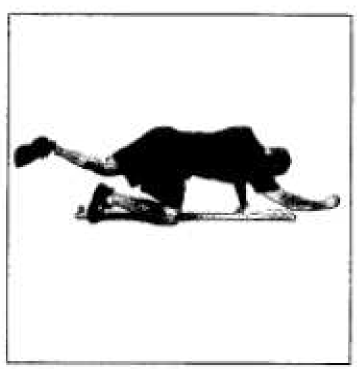
- Performed a proper unilateral repetition



2



- Performed a proper contralateral repetition



1

- Inability to perform a proper contralateral repetition

a) Posterior Rocking Clearing Test

Description[1]

Participant assumed a quadruped position and rocked back onto their heels until they were in the “child’s pose” yoga position. The buttocks were in contact with the heels. Hands remained in front of the body, reaching as far forward as possible.

Verbal Instruction[1]

- Get on all fours, and rock your hips toward your knees.
- Lower your chest to your knees, and reach your hands in front of your body as far as possible.
- Do you understand these instructions?
- Do you feel any pain?

Scores were then summed together to obtain the final score. Participants were able to see their scores at the end of the testing session for their group. This prevented competitive nature between participants.

The descriptions, photos, and verbal commands are courtesy of *Movement: Functional Movement Systems* by Gray Cook et al in order to follow specific FMS™ protocol[1].

DATA ANALYSIS

Microsoft Office Excel™ 2012 for Windows and IBM SPSS Version 19.0 were used to analyze all data. An analysis of variance (ANOVA) was used to see if there were any statistical differences between groups. The alpha level will be set at 0.05.

CHAPTER IV

RESULTS

Data was successfully collected from four different universities and six different squads (n= 130). One subject scored an 18 on a modified scale due to an above the knee amputation and due to the modification was removed from the overall data comparison.

For all universities, the Functional Movement Screen™ scoring average was above the score of 14 indicating increased risk of injury (15 ± 2.64); Table 1[1-3,5,6,20,24]. Analysis of the four universities indicated that there was no significant difference between scores of universities [F (3,126), p= .590], squad (Table 2), total years cheerleading [F (15,114), p= .671], total collegiate years cheerleading [F (6,123), p= .426], amount of competitive teams participant currently cheers [F (1,128), p= .817], or designated competitive company [F (1,128), p= .980]. There was a significant difference in scores for gender [F (1,128) = 11.22, p = .001] and position [F (4,125) = 9.26, p = .000]; Table 3 and 4. These factors can be related due to gender specific positions. Males are usually bases, while females are usually flyers; both genders tumble.

Table 1. University Scoring Averages

University	Deep Squat	Hurdle Step	Inline Lunge	Shoulder Mobility	ASLR	Push-up	Trunk Stability	SCORE AVG	SD
1	2.19	2.19	2.74	2.37	2.33	2.48	1.85	16.15	2.27
2	1.77	1.91	2.45	2.14	2.23	2.68	1.95	15.14	2.51
3	2.10	2.05	2.45	1.95	2.55	2.75	1.90	15.75	3.39
4	2.02	2.11	2.70	2.08	2.67	2.33	1.80	15.87	2.40
							TOTAL	15.73	2.64

Table 2. Squad Scoring Averages

Squad	Deep Squat	Hurdle Step	Inline Lunge	Shoulder Mobility	ASLR	Push-up	Trunk Stability	SCORE AVG	SD
Large Coed 1	2.19	2.19	2.74	2.37	2.33	2.48	1.85	16.15	2.27
Large Coed 2	1.77	1.91	2.45	2.14	2.23	2.68	1.95	15.14	2.51
Large Coed 3	2.10	2.05	2.45	1.95	2.55	2.75	1.90	15.75	3.39
Large Coed 4	2.08	2.19	2.73	1.88	2.58	2.42	1.77	15.65	2.64
Small Coed 5	1.93	2.00	2.71	2.50	2.86	2.29	1.79	16.07	1.90
All-girl 6	1.94	2.00	2.67	1.94	2.61	2.11	1.83	15.11	2.27
							TOTAL	15.65	2.50

Table 3. Gender Differences

Gender	Deep Squat	Hurdle Step	Inline Lunge	Shoulder Mobility	ASLR	Push-up	Trunk Stability	TOTOAL	Minimum	Maximum
Male	2.00	1.92	2.46	1.77	2.08	2.88	1.77	14.82	8	20
Male SD	0.89	0.48	0.71	0.86	0.80	0.59	0.43	2.80		
Female	2.00	2.08	2.69	2.19	2.69	2.08	1.88	16.29	10	20
Female SD	0.63	0.63	0.47	0.94	0.55	1.26	0.33	2.17		

Table 4. Position Differences

Position	Mean	SD	Minimum	Maximum
Flyer	19.00	1.41	18	20
Base	13.52	2.88	8	18
Flyer/tumbler	16.48	2.02	10	20
Base/tumbler	15.72	2.15	11	20
Flyer/base/tumbler	18.00	2.65	15	20
Total	15.72	2.53	8	20

CHAPTER V

DISCUSSION

In this study, we investigated the difference of raw Functional Movement Screening™ scores amongst four mid-western universities. To the knowledge of the researchers, this is the first study to focus on cheerleading and Functional Movement Screening™ scores. The findings of this study indicated that location, coaching, and training regimen did not create a significant difference in FMS™ scores amongst college cheerleaders. However, it did support the sport as an athletic activity that inherently requires significant stability and mobility.

Mobility, Stability, and Muscle Imbalance

Mobility and stability are necessary for pain-free, functional movement. When these requirements are absent or excessive, they create an inequality which can predispose individuals to injury or create physical issues that cause pain[6,7,10-12]. Muscle imbalances caused by this inequality can also create conditions, such as upper- and lower cross syndrome, which place individuals at greater risk of injury by altering the biomechanical kinetic chain[13,14].

Amongst the cheerleaders studied, there was a distinct difference in mobility and stability between genders. Males demonstrated lower scores in inline lunge, active straight leg raise, and trunk stability, while females had lower push-up scores compared to their counterpart. In general, male cheerleaders in this study appeared to have poor core stabilization, compromised scapular and hip stability, and limited knee, hip, spine, and shoulder mobility and flexibility[1]. Female cheerleaders tended to be more flexible than their counterparts, while the males tended to, have more chest strength. The female cheerleaders in this study appeared to lack some core and hip stability, experience inadequate scapular mobility and stability, and exhibit decreased upper body strength. Clinicians should look at each patient as an individual and cannot guarantee a correlation of exact cause without looking at the sport and its participants. This also means clinicians need to recognize an athlete's position and the required movements of that position, such as male cheerleaders needing to shrug through their shoulders and females needing to pull heel stretches while balancing on one leg. Therefore, there are many individual implications as to the cause of decreased scores, such as those listed in Table 5. However, through the scores

Table 5. Implications for Faulty Movement Patterns[1]

Movement	Implication
Deep Squat	Limited upper torso mobility: poor glenohumeral or thoracic spine mobility, or both.
	Limited lower extremity mobility: poor closed chain dorsiflexion of ankles, knees, or hips.
	Poor stabilization and weight shift control.
Hurdle Step	Poor stability of stance leg.
	Poor mobility of step leg.
Inline Lunge	Limited ankle, knee, or hip mobility of front or rear leg.
	Poor dynamic stability.
	Limited thoracic spine mobility.
Shoulder Mobility	Decreased internal rotation.
	Thoracic mobility related scapular stability.
	Excessive development or shortening of anterior thoracic muscles: pectoralis minor, latissimus dorsi, rectus abdominus. Rounded shoulders.
	Scapulothoracic dysfunction: decreased glenohumeral mobility secondary to poor scapulothoracic mobility or stability.
	Poor postural control or core stability.
Straight Leg Raise	Poor pelvic control.
	Poor mobility of opposite hip.
	Poor hamstring flexibility.
Push Up	Poor core stability.
	Compromised upper body strength or scapular stability, or both.
	Limited hip and thoracic spine mobility.
Rotary Stability	Poor reflex stabilization of core.
	Compromised scapular and hip stability.
	Limited knee, hip, spine, and shoulder mobility.

acquired by a FMS™ session, its implications, and an understanding of the sport, healthcare providers can adjust rehabilitation programs for optimal effectiveness and efficiency.

Despite differences between genders, the scores of the athletes that participated in this study rivaled the scores of professional football players. Forty-six professional football players were scored using the same system averaged 14.3, if on injury reserve list or lost three weeks of time, and 17.4, if uninjured[6]. Our scores revealed an average of 15.7 for all four universities. This study did not distinguish injured and uninjured, but many of these athletes had previous injuries that required loss of time. These included, but were not limited to, sprained ankles, ACL tears and reconstructions, fractured limbs, fractured vertebrae, strained muscles, and concussions. All of the cheerleaders that volunteered were actively participating on their squads at time of screening and no athletes that were injured at time of screening were included in the study. By having higher or similar scores to uninjured football players, this study supports Shields et al by indicating that cheerleaders show a lower likelihood of injury when compared to other sports[6,25].

This study was also able to observe a modified version of the FMS™ when scoring an above the knee amputee cheerleader, who currently performs partner stunts and tumbling passes. This participant scored an 18 and completed all movements bilaterally with minimal modification to adjust for the elevated flexion point on left leg. The designers of the FMS™ stated that this screening process was suitable for all activities that required balance, coordination and normal flexibility, and this participant demonstrated that it can be used as a tool for a wide demographic[1]. This participant's scoring and involvement in this study supports the ability for this scoring system to reach a wide demographic.

Pre-participation Screening

This wide demographic also validates how FMS™ can be utilized effectively for pre-participation exams. Team or sports physicians utilize pre-participation exams for physical and medical conditions, which can include heart, lung, and blood disorders[8,17-19]. Additionally, some may also include some form of movement screening, such as duck walks or spinal extensions, to observe ailments due to severe trauma or surgery. Few may even perform tests to determine physical prowess[1]. However, physicians sometimes neglect to observe functional movement patterns. In order to be proactive in injury prevention, clinicians should be aware that faulty movement patterns require corrective exercises, habitual movement changes, and muscular lengthening sessions[1]. Habitual practices due to weakness, tightness, or structural abnormality can eventually lead to compensations and positions that place the body at greater risks. By providing functional movement screenings to athletes, such as those used for this study, practitioners may be able to prevent injury and decrease potential issues for pain or discomfort, therefore preventing loss of time due to injury and decreasing financial burden. An inexpensive, time effect screening process, such as the Functional Movement Screen™, is a simple way physicians and other healthcare providers can screen their patients.

FMS™

The FMS™ is not meant to be diagnostic, but is a tool used to distinguish mobility, stability, or muscle imbalance issues[1]. The score itself, though necessary for quantitative analysis, is not as important as the implications and interpretation of that score. This system along with other special tests and techniques can eventually determine inferences for injuries. Lower scores can provide implications for improvement of conditions that may lead to injuries[1].

The Functional Movement Screen™ can indicate possible susceptibility to injury, but it cannot create a cause and effect relationship[1]. However, practitioners may use this screen to observe improper technique and faulty movement patterns. This insight may then be used for injury prevention, establishing baseline scores for return to play, and improving movement patterns to possibly improve athletic performance. Shields et al associated injury rates among cheerleaders with the level of coaching expertise, training, and qualification yet found many discrepancies[25]. With an average score of 15.7 (15.7 ± 2.53) and all members fully participating in activity, the majority of participants supported that they are less prone to injury. This is not to state that all scored above 14, but that the majority were higher. The lowest score obtained was an 8 and the highest was a 20.

Future Studies

The number of participants obtained and the use of a single researcher strengthened this study. This study was also strengthened by using a variety of squads differing in competitive companies, performance levels (Division I and Division II), and competitive success rates (recent and non-recent national champions). Limitations of this study were utilizing four mid-west universities and only using one small coed and one all-girl squad.

Future studies could observe the change of scores for a single team over a college career to determine implications for change over time or compare baseline scores between sports to determine differentiation between injury risks. Additionally, our subjects may have benefited from prior exposure to the FMS™ and an individualized treatment program, if scores were below 14, post scoring. The overall results represent the performance of four college cheerleading squads and may not be generalized to other populations.

CONCLUSION

Therefore, the Functional Movement Screening™ scores of this study support evidence that cheerleaders perform activities that require full body functional movements and the majority maintain this requirement. However, there is a distinction in mobility and stability between genders and the positions each athlete holds on the squad. These findings suggest further investigations on different subject pools, athletic and non-athletic, should be conducted. Increased understanding of functional movement patterns, mobility, stability, and injury prevention will aid in the development of rehabilitation and strengthening programs.

REFERENCES

1. Cook G, Burton L, Kiesel K, Rose G, Bryant M. *Movement: Functional Movement Systems Screening- Assessment- Corrective Strategies*. Santa Cruz, California: On Target Publications; 2010.

2. Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function- part 1. *N Am J of Sports Phys Ther.* 2006;1(2):62-72.

3. Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function- part 2. *N Am J of Sports Phys Ther.* 2006;1(3):132-139.

4. Chorba RS, Chorba DJ, Bouillon LE, Overmyer CA, Landis JA. Use of functional movement screening tool to determine injury risk in female collegiate athletes. *N Am J of Sports Phys Ther.* 2010;5(2):47-53.

5. Schneiders AG, Davidsson A, Horman E. Functional movement screen™ normative values in a young, active population. *Int J of Sports Phys Ther.* 2011;6(2):75-82.

6. Kiesel K, Plisky PJ, Voight ML. Can serious injury in professional football be predicted by a preseason functional movement screen? *N Am J of Sports Phys Ther.* 2007;2(3):147-158.

7. Hands B. How fundamental are fundamental movement skills? *Active & Healthy Magazine.* Vol 192012:14-17.

8. Goldberg B, Saraniti A, Witman P, Gavin M, Nicholas JA. Pre-participation sports assessment- an objective evaluation. *Pediatrics.* 1980;66(5):736-744.

9. Floyd RT. *Manual of Structural Kinesiology* 6ed. Boston: McGraw Hill; 2007.

10. Borsa PA, Laudner KG, Sauers EL. Mobility and stability adaptations in the shoulder of the overhead athlete- a theoretical and evidence-based perspective. *Sports Med.* 2008;38(1):17-36.

11. Peate WF, Bates G, Lunda K, Francis S, Bellamy K. Core strength: a new model for injury prediction and prevention. *J Occup Med and Toxi.* 2007;2(3).

12. Yeung SS, Suen AMY, Yeung EW. A prospective cohort study of hamstring injuries in competitive sprinters: preseason muscle imbalance as a possible risk factor. *Br J Sports Med.* 2009;43:589-594.

13. Susan H. *Basic Biomechanics*. 5 ed. Boston: McGraw Hill; 2007.

14. Page P. Shoulder muscle imbalance and subacromial impingement syndrome in overhead athletes. *Int J of Sports Phys Ther.* 2011;6(1).

15. Joshi M, Thingpen CA, Bunn K, Karas SG, Padua DA. Shoulder external rotation fatigue and scapular muscle activation and kinematics in overhead athletes. *J Athl Training.* 2011;46(4):349-357.

16. Vera-Garcia FJ, Moreside JM, McGill SM. Abdominal muscle activation changes if the purpose is to control pelvis motion or thorax motion. *J Electromyogr Kines.* 2011;21:893-903.
17. Eberman LE, Clearly MA. Preparticipation physical exam to identify at-risk athletes for exertional heat illness. *Athlet ther today.* 2009;14(4):4-7.
18. Seto CK, Pendleton ME. Preparticipation cardiovascular screeing in young athletes: current guidelines and dilemmas. *Curr sports med rep.* 2009;8(2):59-64.
19. Campbell RM, Berger S, Drezner J. Sudden cardiac arrest in children and young athletes: the importance of a detailed personal and family history in the pre-participation evaluation. *Br J Sports Med* 2008;43:336-341.
20. Teyhen DS, Shaffer SW, Lorenson CL, et al. Functional movement screen: a reliability study in service members. *AMEDD Journal.* 2010.
21. Shultz R, Mooney K, Anderson S, et al. Functional movement screen: inter-rater and subject reliability. *45.* 2011:310-384.
22. Teyhen DS, Shaffer SW, Lorenson CL, et al. The functional movement screen: a reliability study. *J Orthop Sports Phys Ther.* 2012;42(6).
23. Mo An H, Miller C, McElveen M, Lynch J. The effect of kinesio tape on lower extremity functional movement screen scores. *Int J of Ex Sci.* 2012;5(3):196-204.
24. Minick KI, Kiesel K, Burton L, Taylor A, Plisky PJ, Butler RJ. Interrater reliability of the functional movement screen. *J Strength Cond Res.* 2010;24(2):479-486.
25. Shields BJ, Smith GA. Cheerleading-related injuries in the United States: A propsective surveillance study. *J Athl Training.* 2009;44(6):567-577.

VITA

Anda Marie Udris

Candidate for the Degree of

Master of Science

Thesis: DIFFERENCE OF RAW FUNCTIONAL MOVEMENT SCREEN™ SCORES OF MALE AND FEMALE COLLEGIATE CHEERLEADERS

Major Field: Athletic Training

Biographical:

Education:

Completed the requirements for the Master of Science in Athletic Training at Oklahoma State University, Stillwater, Oklahoma in May, 2013.

Completed the requirements for the Bachelor of Science in Athletic Training at Missouri State University, Springfield, Missouri in May, 2011.

Experience:

Head Camp Manager and Athletic Trainer for Varsity Brands, Inc. ’08-Present
Oklahoma State University Spirit Squad Athletic Trainer ’11- ‘13
Oklahoma State University Preceptor of the Year 2013
Missouri State University Student Athletic Trainer: Football, Men’s Basketball, Men’s Soccer, Parkview High School, Ozark High School, St. John’s Sports Medicine Clinic ’08-‘11
Missouri State University Student Athlete; Track and Field ’06-‘10

Professional Memberships:

National Athletic Trainers’ Association (NATA) ’08- Present
Mid-America Athletic Trainers Association (MAATA) ’08-Present