CHAPTER III

METHODOLOGY

The need to prevent athletic injuries in sports is extremely high, especially in Division I-A intercollegiate football because at this level teams are expected to be successful. In order to achieve this objective, a team needs to have players on the field who are healthy and uninjured. For this to occur, it is a prime concern to keep the number of injuries to a minimum. Also, if the total number of injuries is minimized, the potential to keep costs down within an athletic program is improved.

Research indicates that athletic injuries are caused by multiple factors; no one factor causes athletes to become injured. To date, the significant research on using assessment tools to identify athletes who are at risk of sustaining injuries has examined only one risk factor. One of these instruments is the Functional Movement Screen™ (FMS). This assessment tool attempts to test multiple body segments in movement patterns that resemble how an athlete moves during activity. Typical assessment tools examine one body segment at a time. The FMS assesses both mobility and stability of athletes as a predictor of athletic injuries. Research indicates that if an athlete is deficient in mobility and stability, there is an increased likelihood that this individual will sustain a non-contact injury during his sports season. If an athlete lacks sufficient mobility and stability, he should score lower on the FMS than another athlete who is not deficient in those areas.

To date, little research has examined how multiple factors, such as position played, athlete height, athlete weight, and athlete relative body weight, predict the incidence of athletic injuries. There is even less research investigating how risk factors affect scores on screening instruments that attempt to assess other variables which can cause athletic injuries, such as deficient mobility and stability. If additional risk factors affect scores on assessment tools designed to find deficiencies in other variables, then those instruments must find a way to incorporate those other risk factors into their scoring system. This must be done for that testing system to be considered a valid method of locating athletes who have a greater chance of sustaining injuries during their sports seasons.

Since athletic injuries are caused by multiple risk factors, it is the premise of this study that some of the same risk factors can also contribute to lower FMS scores, not just deficiencies in mobility and stability. Therefore, research on the effects of multiple risk factors on FMS scores is needed. This study was conducted on male football players to determine if risk factors affect the scores that athletes achieve on the FMS; a screening instrument was designed to detect deficits in individual mobility and stability. Position played, height, weight, and relative body weight were used as risk factors to determine if those factors affect FMS scores.

Subjects

The subjects consisted of 136 male Division I-A football players from Virginia Polytechnic Institute and State University (n=37), West Virginia University (n=73), and East Carolina University (n=26). Preexisting data were utilized for this study. Athletic Testing Systems, Inc. (ATS), the developers of the FMS, provided the data for this study. Prior to receiving the data, ATS received verbal permission from the participating institutions for the information to be utilized for this study. Verbal permission from the individual athletes was not needed because the FMS testing was performed as part of the team testing during the course of the academic year.

Instrumentation

The FMS (Appendix B) assesses the quality of movement of an athlete. It includes seven tests that assess mobility and stability (Athletic Testing Services, Inc., 2000, p. 1). The seven tests are the Deep Squat ©, Hurdle Step ©, In-line Lunge ©, Shoulder Mobility ©, Active Straight Leg Raise ©, Trunk Stability Push-up ©, and Rotational Stability ©.

Deep Squat ©

The purpose of the Deep Squat is "to assess bilateral and symmetrical mobility of the hips, knees, and ankles. The dowel held overhead assesses bilateral, symmetrical mobility of the shoulders as well as the thoracic spine" (Athletic Testing Services, Inc. 2000, p. 10). One four (4) foot long wooden dowel and one four (4) foot long two (2) inch by six (6) inch wooden base are needed to conduct this test (Athletic Testing Services, Inc., 2000, p. 25) (Appendix B).

The ability to perform this test requires closed-kinetic chain dorsiflexion of the ankles, flexion of the knees and hips, extension of the thoracic spine and flexion and abduction of the shoulders (Athletic Testing Services, 2000, p. 11).

Hurdle Step ©

The Hurdle Test is designed "to assess bilateral mobility and stability of the hips, knees, and ankles" (Athletic Testing Services, Inc., 2000, p. 12). To conduct this test, the following equipment is required:

- One (1) four (4) foot long wooden dowel
- One (1) hurdle made from three (3) 2.5 foot long pieces of PVC pipe
- Four (4) "T" PVC pipes
- Two (2) six (6) inch pieces of PVC for the base
- Two ¾ inch pieces of PVC to connect the "T" bars
- One (1) string with clip for adjustment (Athletic Testing Services, Inc., 2000, p. 25).

*See Appendix D for picture of hurdle.

For an athlete to perform this test, it requires the stability of the stance leg at the ankle, knee, and hip joints. Step leg open-chain ankle dorsiflexion, and knee and hip flexion are also necessary. During this test, sufficient single leg stance is also needed (Athletic Testing Services, Inc., 2000, p. 13) (Appendix B).

<u>In-line Lunge ©</u>

The purpose of the In-line Lunge is "to assess bilateral mobility and stability, as well as ankle and knee stability" (Athletic Testing Services, Inc., 2000, p. 14). In order to conduct this test properly, one four (4) foot long wooden dowel, one four (4) foot long two (2) inch by six (6) inch wooden base and one tape measure are needed (Athletic Testing Services, Inc., 2000, p. 25).

The In-line Lunge test requires the athlete to perform stance leg stability at the ankle, knee and hip. Closed-kinetic chain hip abduction is needed. Adequate balance, ankle dorsiflexion, and step leg mobility of hip adduction are also required (Athletic Testing Services, Inc., 2000, p. 15) (Appendix B).

<u>Shoulder Mobility ©</u>

"The Shoulder Mobility test is used to assess bilateral shoulder range of motion combining internal rotation with abduction and external rotation with abduction" (Athletic Testing Services, Inc., 2000, p. 16). To conduct this test, the equipment needed is one tape measure (Athletic Testing Services, Inc., 2000, p. 25).

For an athlete to perform this test, shoulder mobility, using a combination of abduction/external rotation and adduction/internal rotation motions, is required (Athletic Testing Services, Inc., 2000, p. 17) (Appendix B).

Active Straight Leg Raise ©

The purpose of the Active Straight Leg Raise test is "to assess active hamstring and gastroc/soleus flexibility, while maintaining a stable pelvis" (Athletic Testing Services, Inc., 2000, p. 18). A four (4) foot long wooden dowel and one four (4) foot long two (2) inch by six (6) inch wooden base is needed in order to conduct this test (Athletic Testing Services, Inc., 2000, p. 25).

Functional hamstring flexibility is needed for an athlete to demonstrate the ability to perform the Active Straight Leg Raise test. He has to show sufficient lower abdominal strength, along with appropriate passive iliopsoas flexibility (Athletic Testing Services, Inc., 2000, p. 19) (Appendix B).

Trunk Stability Push-up ©

In order "to assess trunk stability in the sagittal plane while a symmetrical upper extremity motion is performed" (Athletic Testing Services, Inc., 2000, p. 20), the Trunk Stability Push-up test is performed. For this particular test, no equipment is needed.

For an individual to perform the Trunk Stability Push-up correctly, he has to demonstrate the symmetrical "trunk stability in the sagittal plane during a symmetric upper extremity movement" (Athletic Testing Services, Inc., 2000, p. 21) (Appendix B).

Rotational Stability ©

This "test is used to assess multiplanar trunk stability while a combined upper and lower extremity motion is performed" (Athletic Testing Services, Inc., 2000, p. 22). To have the athlete perform this test correctly, a four-foot two-inch by six-inch board is needed.

"The ability to perform the Rotational Stability test requires asymmetric trunk stability in both sagittal and transverse planes during asymmetric upper and lower extremity movement" (Athletic Testing Services, Inc., 2000, p. 23) (Appendix B).

Functional Movement Screen™ Scoring (FMS)

The FMS uses a (3) three-point scoring for each test. The maximum score for each test is three. In order to achieve a perfect score on this tool, the athlete needs to get a score of twenty-one (21). Each individual test has a separate criterion for each score. If an individual experiences pain or discomfort during any of the seven tests, he is given a score of zero for that specific test. Otherwise, the scores, three, two, and one each have separate criteria for each test.

The Shoulder Mobility©, Trunk Stability Push-up©, and Rotational Stability© tests also have clearing tests. If an athlete experiences pain or discomfort during any of the clearing tests, the score for that specific test is a zero. The zero score is given to the athlete even if the individual achieves a three for that test.

Recording of the test results is entered on The Functional Movement Screen Scoring Sheet (Appendix C). One sheet is used for each athlete. Specific grading criteria for each test will be discussed in the procedures section of this chapter.

Positioned Played

ATS provided information about the position played by each athlete based on the information given them by the Athletic Training staff from the participating football programs.

The positions of the athletes were then divided into three groups: the skill group, the combo group, and the line-of-scrimmage group. The skill group was composed of receivers, cornerbacks, rovers, and safeties. Linebackers, tight ends, quarterbacks, tailbacks, and fullbacks made up the combo group. Finally, defensive tackles, defensive ends, and offensive linemen formed the line-of-scrimmage group.

Owing to the fact that ten subjects had missing values, there were a total of 126 players whose positions and FMS scores were recorded in the data sets. The skill group had thirty-five athletes, combo group forty players, and the line-of-scrimmage group a total of fifty-one.

Height, and Weight

Height and weight data were also collected from pre-existing data provided by Athletic Testing Services, Inc. Both player height and weight were rounded to the nearest one-half inch or half-pound. From the recorded data, the body heights of fifty-nine athletes were collected and compared to those individuals' FMS scores. For body weight, sixty-two subjects' data were compared to their FMS scores. Unfortunately, height and weight were not recorded for every athlete. Furthermore, data from one institution did not include the height and weight of the athletes. The height and weight from one program was not provided because no pre-existing data were provided by that institution. Also, since the data were provided by ATS, it was not possible to contact the institution to attain the data.

Relative Body Weight (BMI)

Relative body weight was calculated from using the formula of weight in kilograms divided by height in meters squared (BMI = kg/m^2) (American Heart Association, 2001, p. 1).

BMI = Body Mass Index

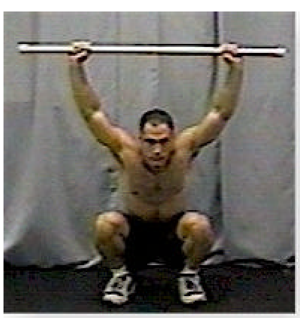
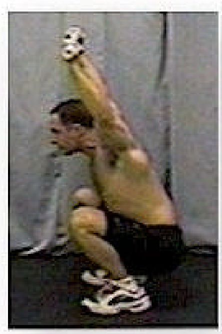
Kg = kilograms

M^2 = meters squared

Since the data were taken using pounds for weight and inches for height, the Body Mass Index Calculator http://www.thriveonline.oxygen.com was used in order to convert the figures from English to metric standards.

To calculate BMI, each athlete's height in feet and inches was entered, followed by his weight in pounds. When the calculate icon was chosen, the athletes' BMI was calculated to the nearest one-tenth. For this assessment, the data of fifty-nine athletes were calculated. Calculation of scores on individual FMS tests is performed as follows:

Deep Squat©. The athlete assumes the starting position with his feet shoulder width apart. The hands are adjusted on the dowel so that the elbows are positioned at a 90-degree angle so that the dowel is overhead. The dowel is then pressed overhead so the shoulders are flexed and abducted, and the elbows are fully extended. Next, the athlete slowly descends into the squat position. When the athlete completes the correct squat position his heels should be on the floor, his head and chest are facing forward, and the dowel is overhead in a fully pressed position. The athlete can perform up to three repetitions (Athletic Testing Services, Inc., 2000, p. 10).

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The grading criteria for the Deep Squat are as follows. For an athlete to achieve a score of three:

- The upper torso is parallel with the tibia or toward vertical
- The femur is below parallel with the floor

- The knees are aligned over the feet
- The dowel is aligned over the feet. (Athletic Testing Services, Inc., 2000, p. 10)

If the athlete is unable to perform the test following the grade three criteria, a two-inch by six-inch board is placed under the individual's heels (Athletic Testing Services, Inc., 2000, p. 10). He is then asked to perform the Deep Squat again. If the athlete then performs the test correctly with the board under his heels, the highest score he can attain on the test is a grade of two.

The criteria to achieve a grade of two on the Deep Squat is:

- The upper torso is parallel with the tibia or toward vertical
- The femur is below horizontal
- The knees are aligned over the feet
- The dowel is aligned over the feet. (Athletic Testing Services, Inc., 2000, p. 10)

The only difference in the appearance of a grade two and a grade three score is a two-inch by six-inch board is under the athlete's heels.

A grade one for the Deep Squat entails:

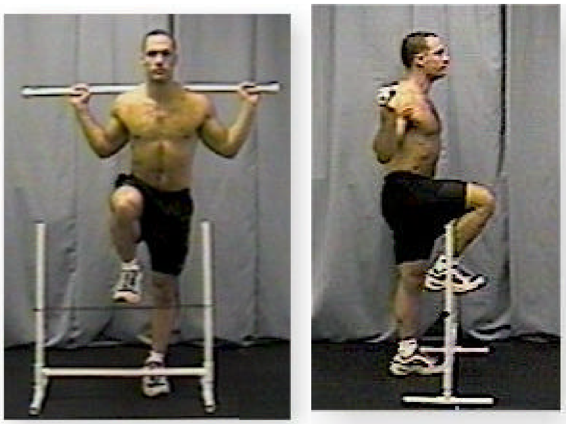
- A two-inch by six-inch board is under the athlete's heels
- The tibia and upper torso are not parallel
- The femur is not below horizontal
- The knees are not aligned over the feet
- Lumbar spine flexion is observed. (Athletic Testing Services, Inc., 2000, p. 10)

A grade of Zero (0) is given to anyone who experiences pain or discomfort during any part of the Deep Squat (Athletic Testing Services, Inc., 2000, p. 10).

If an individual receives a score less than three on this test, it can be due to limited motion in the upper torso, possibly caused by poor glenohumeral and/or thoracic spine mobility. If he demonstrates limitations in motion in the lower extremities, it may be due to deficient closed-kinetic chain dorsiflexion at the ankle and/or lack of hip flexion (Athletic Testing Services, Inc., 2000, p. 11).

Hurdle Step©: To correctly perform the Hurdle Step, the athlete assumes the starting position by putting his feet shoulder-width apart. The height of the hurdle is then adjusted so that it is level with the athlete's tibial tuberosity (just below the knee). The dowel is then placed across the person's shoulder below the neck, and his toes are aligned directly under the hurdle.

Then the athlete is instructed to slowly step over the hurdle and touch his heel on the ground while he maintains his standing leg in an extended position. To conclude the test, he is told to slowly return to the original position. Three repetitions are to be performed with each leg, both the right and left sides (Athletic Testing Services, Inc., 2000, p. 12).



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For the athlete to attain a score of three for this test, the following criteria must be observed:

- The hips, knees and ankles remain in a straight line
- There is minimal movement observed in the lumbar spine
- The dowel and hurdle remain parallel with the ground throughout the test

A grade of two is given if:

- The alignment is lost between the hips, knees, and ankles
- There is movement observed in the lumbar spine
- The dowel and hurdle do not remain parallel to the ground throughout the test.

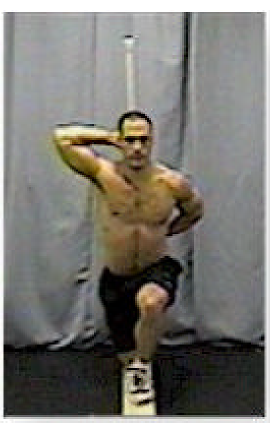
The individual will receive a score of one on the Hurdle Step if he exhibits the following criteria.

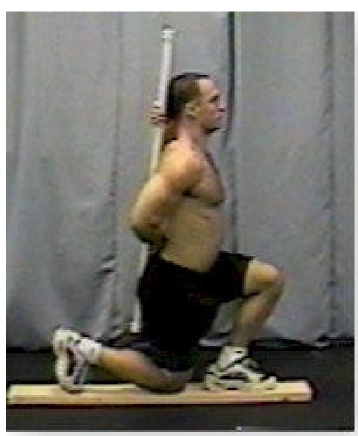
- If the foot contacts the hurdle during any part of the test
- He loses his balance at any point during the test

As with the Deep Squat, the athlete will receive a zero if he experiences any pain during the test (Athletic Testing Services, Inc., 2000, p. 12). For this test, the lower score between the right and left side count as the final Hurdle Step score.

If an individual performs poorly in the Hurdle Step, it can be caused by "poor stability of the stance leg or poor mobility of the step leg" (Athletic Testing Services, Inc., 2000, p. 13). It may also be due to limitations in ankle dorsiflexion, limited hip flexion in the step leg, or asymmetric hip immobility as the result of an anteriorly tilted pelvis (Athletic Testing Services, Inc., 2000, p. 13).

In-line Lunge©. Prior to initiating the test, the examiner first measures the length of the athlete's tibia with a tape measure. Next, the athlete places the right foot on the end of the two-inch by six-inch board. The dowel is then placed the individual's back so that it makes contact with the head, thoracic spine, and sacrum. The right hand is placed at the top of the dowel, and the left hand holds the bottom of the dowel. Once this position is achieved, the examiner measures the athlete's tibial length on the board from the tips of the toes of the right foot toward the front of the board, marking a point on the board that would indicate the total length of the tibia. The athlete then places his left heel on the forward mark on the board. Once he achieves this starting position, he is asked to lower the right knee until it touches the board behind the left foot. Both feet should be in the same line and point forward throughout the test. The athlete then returns to the standing position. Up to three repetitions are performed for this test. The process is then repeated with the left foot at the back of the board and the left hand on the top of the dowel. If the scores differ between the right and left sides, the lower score is recorded for this test (Athletic Testing Services, Inc., 2000, p. 14).





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A score of three (3) is given to the athlete if exhibits the following during the test:

- Minimal to no movement of the torso
- The feet remain pointing forward on the two-inch by six-inch board
- The back knee touches the two-inch by six-inch board behind the heel of the forward foot.

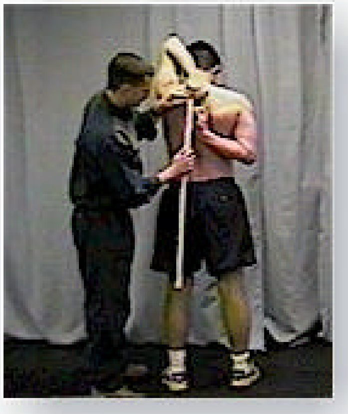
A score of two is given to the individual if he performs the In-line Lunge in the following manner.

- There is movement observed in the torso
- The feet do not remain pointing forward during the test
- The back knee does not touch the board behind the heel of the forward foot.

A score of one is given to an athlete who loses his balance at any point during the test. Finally, zero is given if the athlete experiences pain or discomfort during any portion of the examination (Athletic Testing Services, Inc., 2000, p. 14).

Several factors can cause lower scores in the In-line Lunge test. They include inadequate hip mobility in either lower extremity, lack of stability in the stance leg knee or ankle, imbalance between the hip adductor weakness and hip abductor tightness, or decreased rectus femoris flexibility in the stance leg (Athletic Testing Services, Inc., 2000, p. 14). If an athlete scores a two on this test, it is often the result of limitations of hip adduction in one or both hips (Athletic Testing Services, Inc., 2000, p. 14).

Shoulder Mobility©. To conduct the Shoulder Mobility test, the hand length of the athlete is first measured. This is accomplished by measuring the distance between the distal crease of the wrist and the tip of the third finger. Next, the athlete makes a fist in each hand with his thumbs inside the fist. He is then asked to maximally adduct and internally rotate the right shoulder until it is behind his back. Then the left shoulder is maximally abducted and externally rotated so that his hand is in the area of his upper back. The distance between the two fists is measured. The hands are to remain in the fisted position during the entire test. Three attempts are taken at this side. The movement then repeated on the opposite side and the lowest score from the test is recorded (Athletic Testing Services, 2000, p. 16).



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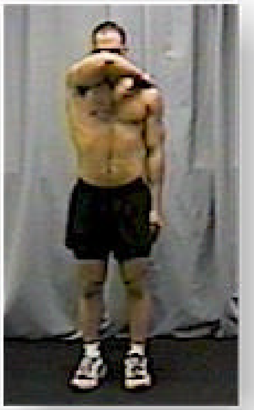
The athlete is awarded a score of three if the two fists are within one hand length of one another. If the fists measure within one and one-half lengths of the hand, a score of two is given. If the measurement between the fists is greater than one and one-half hand length, the score awarded is one. Zero is given if pain is experienced during any portion of the test (Athletic Testing Services, 2000, p. 16).

After this test is completed, "a shoulder stability screen should be performed even if the athlete scores a three" (Athletic Testing Services, 2000, p. 16). To conduct this test, the athlete places his hand on his opposite shoulder. He then tries to point his elbow upward. If pain is experienced during this test, the score given to the athlete is zero (Athletic Testing Services, 2000, p. 16).



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There are several reasons that can cause an athlete to score less than three on this test. One reason is that he has limited glenohumeral joint internal rotation as compared to external rotation. Rounded shoulders caused by shortened pectoralis minor and/or latissimus dorsi muscle may also cause a lower score on this test. Finally, decreased glenohumeral mobility may be the result of scapulothoracic dysfunction (Athletic Testing Services, 2000, p. 17). This dysfunction can limit motion in the shoulder joint, especially shoulder abduction.

Active Straight Leg Raise©. The starting position for the Active Straight Leg Raise has the athlete supine with his arms at his side. His palms are facing up and his head is flat on the floor. The two-inch by six-inch board is placed posterior aspect of the athlete's knees. Then, the athlete's anterior superior iliac spine (ASIS) and the mid-point of the patella are palpated. The athletic is instructed to raise the right lower extremity while keeping the ankle dorsiflexed and knee extended. Throughout the entire test, the posterior aspect of the left knee should stay in contact with the board, while his head remains flat on the floor. Once the end range position is reached, the dowel is placed at the medial malleolus, at a right angle to the floor, of the raised extremity. This test is also performed bilaterally with as many as three attempts on each side. The lowest score for the entire test is recorded (Athletic Testing Services, Inc., 2000, p. 18).

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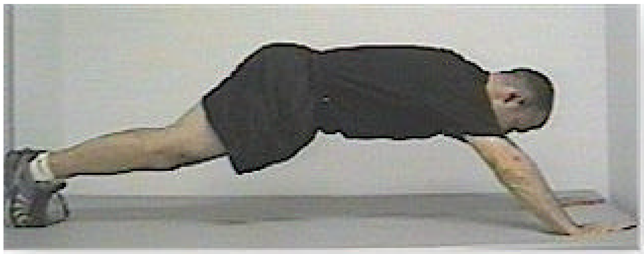
In order to achieve a score of three, the dowel must sit perpendicular to the floor between the mid-thigh area and the ASIS. A score of two is awarded if the dowel rests between the mid-thigh area and the mid-patella. If the dowel resides below the mid-point of the patella, the athlete is awarded a score of one for the test. Again, zero is given as a score if pain or discomfort during any point of the test (Athletic Testing Services, Inc., 2000, p. 18).

An athlete would score less than three on the Active Straight Leg Raise test if he demonstrates one or more of the following factors. One factor is inadequate functional hamstring flexibility. Another factor is poor passive flexibility of the stationary lower extremity because of a tight iliopsoas muscle that results in an anteriorly tilted pelvis (Athletic Testing Services, Inc., 2000, p. 19).

Trunk Stability Push-up©. For this particular test, the procedure and scoring of this test are gender based. For a male to perform the Trunk Stability Push-up test, the athlete starts in the prone position. His hands are placed shoulder width apart with the thumbs above his head. The athlete is then instructed to perform one push-up while maintaining the present position. When he performs the test, his body should be lifted as a rigid unit. There should be not sagging in the lumbar spine during any portion of the test. If the athlete is unable to perform one push-up in this position, he is asked to lower his hands so that his thumbs are in line with his chin, and the push-up is performed again. Up to three attempts are performed for this test (Athletic Testing Services, Inc., 2000, p. 20).



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The athlete will receive a score of three if he performs one push-up with his thumbs above his head. If one push-up is completed with the thumbs in line with the chin, he is given a score of two for the test. One is awarded for this test if the athlete is unable to perform one repetition with his thumbs in line with his chin. As with the other tests, if the athlete experiences any pain or discomfort at any time of the test, zero is given as a score (Athletic Testing Services, Inc., 2000, p. 20).

Similar to the Shoulder Mobility test, after completing the Trunk Stability Push-up test, the athlete also performs a clearing test. A lumbar extension movement is the clearing test for the Trunk Stability Push-up. To conduct the spinal extension-clearing test, the athlete performs a press-up in the pushup position while keeping his hips on the floor. If the athlete experiences any pain or discomfort during this test, he is given a zero for the Trunk Stability Push-up test, even if he achieved three as a score (Athletic Testing Services, Inc., 2000, p. 20).

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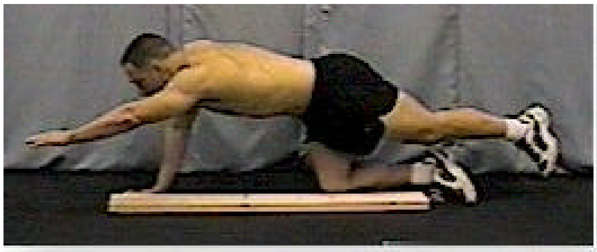
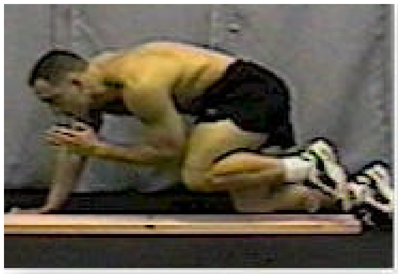
Usually if someone scores poorly on this test, it is usually due to inadequate strength of the trunk stabilizers (Athletic Testing Services, Inc., 2000, p. 21).

Rotational Stability Test ©. The starting position for the Rotational Stability test has the athlete in the quadruped position (on hands and knees) so that the shoulders and hips are at ninety-degree angles to the upper torso. The knees are flexed at ninety-degree angles, and the ankles are dorsiflexed. The two-inch by six-inch board is placed between the hands and knees, touching both the hands and knees, in a head to toe direction.

Next, the athlete is asked to flex the left shoulder and extend the left hip and knee at the same time so that they clear the floor by approximately six inches. The raised upper and lower extremity, as well as the torso, should remain in a parallel line with the two-inch by six-inch board. Once this is completed, the athlete then flexes the left shoulder and knee until the elbow and knee make contact with each other. After the knee and elbow touch, the athlete returns to the starting position, and the movement is complete. This test is performed bilaterally for up to three repetitions. If the athlete is not able to perform the Rotational Stability test following the test criteria, he is instructed to perform the test using a diagonal pattern moving the left shoulder and right hip while using the same procedure discussed above (Athletic Testing Services, Inc., 2000, p. 22).





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For an individual to score a three on this test, he must perform one unilateral repetition while continuously keeping his torso parallel to the two-inch by six-inch board. The same side knee and elbow must also make contact with each other in a line parallel to the board. A score of two is awarded if the athlete is able to perform one diagonal repetition of the test while maintaining the upper torso parallel to the two-inch by six-inch board. The knee and elbow must touch each other over the board. If he is unable to perform one diagonal pattern of the test, one is given as a score. Zero is given to the athlete if any pain or discomfort is experienced during any portion of the test, or he is not able to assume the correct testing position (Athletic Testing Services, Inc., 2000, p. 22).

Upon completion of the Rotational Stability test, the athlete is then asked to perform a Lumbar Flexion clearing test. Again, this test is done even if the athlete scores a three on the Rotational Stability test. To perform this test, the athlete "assumes a quadruped position and then rocking back and touching the buttocks to the heels and the chest to the thighs. The hands should remain in front of the body reaching out as far as possible" (Athletic Testing Services, Inc., 2000, p. 22). If the athlete experiences any pain or discomfort during any portion of the test, zero is given as a score (Athletic Testing Services, Inc., 2000, p. 22).

http://www.functionalmovement.com/SITE/images/fms_rotational_stability4.jpg

If the athlete exhibits difficulty during this test, it is usually the result of the trunk stabilizers being unable to provide sufficient asymmetric stability during this particular movement (Athletic Testing Services, Inc., 2000, p. 23).

Pilot Study

Prior to conducting this study, a pilot study was performed utilizing the FMS data of thirty-six subjects from the testing session conducted during the spring prior to the 1999-2000 season and the injury records from the 1999-2000 season of the Virginia Polytechnic Institute and State University football program (Appendix E). The purpose of this pilot study was to examine whether FMS scores correlated with the number of reportable injuries an athlete suffers, per the definition by the NCAA Injury Surveillance System. Another test was conducted to determine whether there was a correlation between FMS scores and the number of days an athlete missed from practices and games due to muscle strains. For this statistical test, eleven subjects suffered muscle strains during the season. A third analysis was also conducted to compare injury rates to FMS scores. In all three scenarios, a negative correlation would indicate that someone with a high FMS score would have fewer reportable injuries, fewer days missed due to muscle strains, and lower injury rates, and someone with a lower FMS score would have more. This was the anticipated result.

Three separate Pearson Moment Correlation Coefficient analyses were performed measuring the relationship between the FMS scores and each of the three variables. For the correlations examining the relationship between the FMS scores and the number of reportable injuries suffered by each subject, the correlations, r was 0.126 ($p = 0.463$). This demonstrated a positive, non-significant linear relationship (Appendix E).

The relationship between the FMS scores and the days missed from practices and games for those subjects who suffered muscles strains during the season also revealed a correlations, $r = 0.280$ ($p = 0.404$) (Appendix E).

The correlation of FMS scores and injury rates was weakly positive, r = 0.2185 (p = 0.8997) (Appendix E).

The results of the pilot study showed that FMS scores were not negatively correlated with the number of reportable injuries suffered, days missed from practices and games, and injury rate. It was found that athletes who scored higher on the FMS actually suffered more reportable injuries, missed more practices and games due to muscle strains, and had higher injury rates that players who scored lower on the test.

The results of this pilot study contradict the professional literature indicating that athletes who lack mobility and stability suffer more injuries than individuals who do not have deficiencies in those risk factors. From analyzing the seven individual tests, the FMS does indeed assess mobility and stability. Since the research demonstrates that weaknesses in mobility and stability are risk factors for athletic injuries, the FMS should be a valid tool to screen for potential injuries by identifying those weaknesses before an injury occurs. However, the literature also demonstrates that a multitude of other risk factors can cause athletic injuries, not just deficits in mobility and stability.

The premise of this study was that risk factors other than flexibility and strength not only affect athletic injuries, but also affect the results of screening tools, such as the FMS. If it is found that variables other than mobility and stability also affect FMS scores, "passing scores" for the FMS can be developed utilizing multiple factors to develop normative data. By implementing multiple variables into the FMS, "passing scores" will more accurately reflect the individual athlete's potential for injury.

Analysis

Hypothesis One: No significant difference exists between FMS scores of different football position groups in Division I-A football programs that conduct the FMS.
The independent variable for hypothesis one was the position group in which each athlete was categorized. The dependent variable was the score on the FMS. For this hypothesis, an alpha level of .05 (2-tailed) was utilized.

In order to test hypothesis one, and supply support to respond to the research question presented earlier in this paper, a one-way ANOVA with a Tukey Honestly Significant Differences (HSD) test was utilized to verify mean differences between groups for FMS scores. The Tukey HSD, which determines the differences between means was employed because it provides narrower confidence intervals, and is one of the most conservative post-hoc tests (Neter, Wasserman & Kutner, 1990).

Hypothesis Two: No relationship exists between the body height of a Division I-A football player and the score that athletes achieve on the FMS.

Hypothesis Three: No relationship exists between the body weight of a Division I-A football player and the score that athletes achieve on the FMS.

Hypothesis Four: No relationship exists between the relative body weight of a Division I-A football player and the score that athletes achieve on the FMS.

For hypotheses two through four, the statistical procedure utilized was a Pearson Moment Correlation Coefficient. A .05 (2 tailed) alpha level utilized for hypothesis two. The alpha level for hypotheses three and four was .01 (2-tailed).