

BEMIDJI

STATE UNIVERSITY

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Assessing Physical Limitations and Fear
of Injury in DII Female Track and Field Athletes

Exercise Science

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*Assessing Physical Limitations and Fear of Injury in DII
Female Track and Field Athletes.*

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Abstract

The primary purpose of this research project was to identify physical limitations or asymmetries in regular body movement using the Functional Movement Screening (FMS) system on the Bemidji State University female track athletes. A secondary purpose was to examine if fear of injury influences FMS overall scores. The FMS has been frequently used in the exercise and medical communities. The primary intent of this project was to identify how the FMS can be used to recognize deficiencies, in prior physical training methods. The FMS test examines, strength, range of motion and flexibility asymmetry. The intended purpose of this screening is to help individuals maximize their potential by optimizing their time-spent training. Gray Cook, the creator of the FMS, states why this system works, there is a need to appraise 'human movement' with a proven system to precede physical training and performance, (Cook, 2009). This research project determined performance level capabilities and limitations through human subject research and testing using the FMS. The Bemidji State University Woman's Track and Field team will be divided into groups based on the events they compete in, long distance runners (LDR), running races long than 800 meters up to 3,000 meters through 30,000 meters, throwers (T), athletes who participate in either Discus, Javelin, Shot Put or Hammer Throw, hurdlers and sprinters (HS).

Introduction

The primary purpose of this research project was to identify physical limitations or asymmetries in regular body movement using the Functional Movement Screening (FMS) system on the Bemidji State University female track athletes. A secondary purpose was to examine if fear of injury influences FMS overall scores.

Gray Cook and Lee Burton, two exercise science experts, constructed Functional Movement Screening (FMS) to develop a tool that improves objectivity and collaboration between professionals of physical therapy, while predicting strength and conditioning and while enhancing athletic training. Gray Cook, the founder of the FMS, is a Physical Therapist, a Board Certified Orthopedic Clinical Specialist, Strength and Conditioning coach and a USWLF Weightlifting Coach. His work is at the forefront of fitness, conditioning, injury prevention and rehabilitation (Cook, 2010). Lee Burton, co-founder of the FMS, is a certified Athletic Trainer through NATA-BOC, a certified Strength and Conditioning coach through NSCA and a speaker on injury prevention and performance enhancement (Burton, 2010). Together, these two men created the FMS in hopes of identifying physical limitations and body asymmetries. Originally designed to gather objective data for statistical analysis of human movement patterns in relation to functional performance and injury prevention, the Functional Movement Screening is now used in various health professions to illustrate exercise fitness and to identify and potentially prevent injuries caused by the patient's functional performance.

Currently, medical therapy specifically focuses on using FMS for athletes to (1) rehabilitate those with a current injury, (2) prevent future injuries from occurring, and (3) test patients to give the client a baseline on their current health in relation to their functional performance (Neurosport, 2013). The Functional Movement Screening is a useful tool to prevent a future injury based on the results and observations during the screening process. Neurosport's research verified the accuracy of the screening process and outcomes.

This research will include:

- Evaluating active individuals
- Collecting prior injury history and basic demographic information
- Performing the Functional Movement Screening

- Collecting data to form a conclusion based on the data
- Prescribing exercises to individuals based on FMS results

The conclusion of this paper compared and contrasted the FMS differences between the various track and field specialties. FMS results may likely differ between the throwers and the runners. Shoulder flexibility, hip flexor range of motion, core stability and hurdle step results may vary between the two main groups. The athletes benefited by receiving actionable prescriptions to prevent injury and maximize performance.

Literature Review

The primary purpose of this research project was to identify physical limitations or asymmetries in regular body movement using the Functional Movement Screening (FMS) system on the Bemidji State University female track athletes. A secondary purpose was to examine if fear of injury influences FMS overall scores.

The FMS assesses the participant's deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability pushup, and rotary stability (Cook, 2010). Each of these assessments is intertwined together providing a means to evaluate the common strengths and weaknesses of the human body. These components (squat, hurdle step, etc.) are scored separately on a scale from zero to three, three being exceptional, and zero showing an area of possible injury or need for improvement. A score of zero is given any time the participant experiences pain. The participant scores a one if they are unable to perform the movement pattern or unable to assume the position to perform the movement. A score of two is received if the participant is able to perform the movement, but compensates in some manner to complete the movement. Lastly, the participant scores a three if they are able to perform the movement without any compensation. (Cook, Burton, Hoogenboom, 2006)

Other research analyzed FMS scores between female (mean age = 33.5 years) and male (mean age = 39.3 years) long distance runners. There were no significant differences between the composite scores of the sexes. However, there were significant differences between males and females in the push-up and the straight leg test scores, with the women, scoring better on each test. A significant difference is found in the composite scores between younger and older runners as well (Loundon, Parkerson-Mitchell, Hilderbrand, Teaque, 2014). The study done by Loundon and other researchers will be used as a reference for comparing the FMS scores in the Track and Field Athletes of the proposed research.

Furthermore, research published in the *International Journal of Sports Physiology & Performance*, exhibits score variances having a great effect on future injury. Subjects that scored less than or equal to 14, or, with at least 1 bilateral asymmetry, have greater future injury incidence than subjects with F scores greater than 14 or no movement asymmetries. To conclude this study, functional movement ability, known to be associated with the likelihood of future injury, is also related to the ability to improve longitudinal competitive performance outcomes (Chapman, Laymon, Arnold, 2010-2011).

The other element of my research focuses on is the fear of injury. An estimation of sport and recreation-related injuries in the United States may be as high as 7 million per year (Conn, Annest, & Gilchrist, 2003). Injuries can vary from bruising to debilitating spinal cord damage. The most prevalent injury is in the knee or ankle (Emery et al., 2006). This injury is a common amongst track and field athletes. After an athlete goes through the challenging task of healing and recovery the transition back into competitive performance can be frightening. The fear of re-injury is defined by the term, Kinesiophobia, which is an irrational and debilitating fear of physical movement resulting from a feeling of vulnerability to painful injury or re-injury. This fear is linked to a decrease in physical performance

and a contributor to reluctance to engage in activities that may lead to re-injury (Kori, Miller, & Todd, 1990).

During the recovery stage, the athlete will experience a decrease in strength and range of motion due of the lack of physical activity while recovery. Once healthy and cleared to begin physical training, the athlete may experience pain and discomfort from losing the strength and range of motion causing avoidance in the movements that cause this uncomfortable sensation (Vlaeyen, Kole, Snijders, Boeren, & van Eek, 1995). This information, in conjunction with research linking kinesiophobia to disability suggests that fear of re-injury may be a significant predictor of postsurgical levels of sporting activity and confidence in the athlete's ability to return to sport (Tripp, Ebel-Lam, Stanish, Brewer, Birchard, 2011).

Research discussed above, gives myself a good baseline to set up a FMS assessment as well as to identify what to expect by the results of these tests. Reviewing these studies shows there may be some variations in scores between the runners and the throwers on the BSU Track and Field team. However, what may cause the variations in FMS scores still needs to be examined and that is what this research study is aimed to conclude.

Methods

Participants

The participants for this study are the women's Bemidji State Track and Field team. The coaches have granted permission to the researcher to use their athletes to participate after a briefing on the logistics of the study. The athletes will complete a demographic questionnaire and Lower Body Performance Self- Efficacy Questionnaire. Each athlete will be given the opportunity to opt out of the study if uncomfortable with participating. The study will focus solely on female athletes because the

track team is comprised of women. The ideal number of participants for this study is 12-15 athletes but that range may also vary depending on the willingness to participate. The researcher will begin collecting data from the athletes after their regular warm-up ran by the coaches during their workouts. The researcher, along with the co-researcher, will escort each athlete, one at a time to perform the FMS testing. The environment will be safe and comfortable for the athletes that will be done in a racquetball court located in the Recreational Center or in the Human Performance lab also located in the Recreational Center. Each athlete will be with the researchers for a maximum of 45 minutes to complete the test and have any questions or concerns answered. After data collection is complete the researchers will analyze the individual scores of the athletes to create personalized exercise training programs to help increase strength or range of motion in areas the athletes scored low on. All information received during data collection will remain confidential with access only granted to the researcher, co-researcher, and advisor, Dr. Jim White.

Purpose

The primary purpose of this research was to identify physical limitations or asymmetries in regular body movement using the Functional Movement Screening (FMS) system on the Bemidji State University female track athletes. A secondary purpose is to examine if fear of injury influences FMS overall scores.

Participants were tested in the beginning of their indoor track and field season noting that some of the participants may have participated in Cross Country during the fall months. In addition, this research will investigate a possible correlation in low scores in the FMS and the area of specialty in Track and Field. As stated earlier, FMS utilizes seven movements; the deep squat, in-line lunges, hurdle step, active straight leg raise, shoulder mobility, rotary stability, and trunk stability push-ups that are

scored of 0-3. The Exercise Science Department will supply already owned FMS kits consisting of a 2x6 board used in several of the assessments. Additionally, the FMS kits include a five-foot dowel, the hurdle, and tape measure used to measure the participant's body positions. The instructions for the individual assessments are explained by the Functional Movement Screen and Exercise Progressions Manual, (2009) and include:

Deep Squat

- Subject holds dowel with both hands over head in order for both shoulders and elbows to maintain a 90 degree angle
- Place feet in a comfortable position, approximately shoulder width or slightly greater than shoulder width apart, toes pointing forward at all times
- Maintaining an upright posture, dowel over head, heels on the floor, descend into a deep squat, thighs breaking parallel with the floor (Score subject)
- Return to starting position
- Repeat three times if necessary
- Modification followed if subject is unable to perform task
- Place 2x6 board beneath subject's heels, and proceed with procedure above

Hurdle Step

- Toes against the base of the testing board standing comfortably, place dowel across shoulders
- Subject stands with feet, hips and shoulders square to the hurdle
- A band connecting the two dowels on either side of the testing board will be adjusted to be inline with subject's tibial tuberosity forming the hurdle
- Dowel is placed across subject's shoulders and held with both hands
- Maintain upright posture, step over hurdle without making contact with the string

- Tap floor with your heel and return to starting position
- Repeat instructions 2 and 3 for left foot (score subject)
- Repeat 3 times per side if necessary

In-Line Lunge

- Subject holds dowel with both hands and positions it along their spine with right hand against back of neck and left hand against the low back
- Step onto the 2x6 board with subject's right foot along back edge and place left foot with heel just past the black line, pointing toes forward and keeping them pointed forward
 1. Mark length is determined by the length of the subject's tibia from the Hurdle Step
- Maintaining upright posture, descend into a lunge, touching right knee along black line behind left heel
- Subject maintains contact with dowel against spine and head while in the lunge position
- Return to starting position, returning right heel flat on the board
- Repeat up to four times per leg

Shoulder Mobility

- Subject stands in comfortable position
- Subject makes a fist with thumbs tucked into fist
- In single motion, place right fist on left shoulder and left fist behind the back
- Subject cannot move hands closer after initial placement
- Measure distance between the fists
- Repeat instructions 2 with opposite hand placement (score subject)
- Sub-part: Active Shoulder Stability
- Place right hand on left shoulder

- Maintaining hand placement, subject will raise right elbow toward forehead
- Ask subject if they feel any pain
- Repeat both tests on both sides of body

Active Straight Leg Raise

- Subject lays on back with back of their knees against 2x6 board
- Arms at side, palms facing upward and toes pointing up
- Subject lifts toes of right foot toward their shin, legs remaining straight and toes pointing toward ceiling
- Raise right leg as high as possible without any movement occurring in left leg
- Measure lift in relation to opposite leg
- Repeat instruction 2 with the left sides

Trunk Stability Push-Up

- Subject lays on stomach with hands positioned shoulder width apart
 1. Males: Thumb in line with forehead
 2. Females: Thumbs in line with chin
- Raise toes toward shin and place them on the ground
- Extend knees off of ground
- Subject maintains rigid torso, raising self as one unit with no lag in low back into push-up position
- Repeat up to three times

Prone Press-up: used if back pain went undetected in test above

- Subject lays on stomach
- Place both hands with palms down beneath shoulders

- Press chest off of floor by extending elbows, arching back as much as possible
- Keep hips in contact with floor during chest push off

Rotary Stability

- Subject gets on hands and knees
- Position shoulder and hips at 90 degrees with thumbs and knees touching sides of the 2x6 board
- Subject raises both right arm and right leg off ground pointing arm forward and leg backward
- Subject then touches elbow and knee over board
- Return to extended position then back to starting position
- Repeat up to 3 times per side
- **Passive Spinal Flexion: Subtest to Rotary Stability, expose back pain**
- Starting position on hands and knees
- Subject maintains contact with hands on floor, rocking back to heels
- Lower chest to knees, reaching arms in front on the floor
- If pain occurs, subject receives a zero for Rotary Stability test

This general description of each movement in precisely the steps the athletes go through during their testing. It is important to both the reader and the researcher to know exactly what the athletes go through during the assessment to show the complexity of each movement.

A general demographic and descriptive questionnaire is administered to each participant before the initial test. The questionnaire will consist of 10 questions regarding the athlete's confidence in performance. The questionnaire is titled, "Performance Activity Self-Efficacy Scale" (original scale Knee Activity Self-Efficacy Scale but modified to fit the needs of this research study). Included in this questionnaire are questions on previous and/or current injuries specifically knee injuries, performance ability in the lower extremities, track and field events, etc. (See Appendix 1). In addition, because these

athletes are participating in a school-sponsored athletics they will already have a physician's exam clearing the athlete to exercise.

The research is approved through Bemidji State University IRB process prior to data collection. To abide by confidentiality, the participants are given an identification number. The filing process was be alphabetized using the first initial of the subjects last name along with their identification number, with the first participant being A-0.1, the second participant B-0.2 and so on. If last names begin with the same initial the filing will go as follows: A1-0.1.

The researcher and the researcher's assistant will be in charge of data collection from the FMS. Subjects will be evaluated two at a time, one subject going to researcher 1 and one subject going to researcher 2. Scoring was recorded for each movement the subject performs in regards to the FMS assessment. Names will remain anonymous using the same method used for the questionnaire.

Expected Outcome

Coming to a conclusion of the final outcome for this research will be viewed in a variety of aspects. As an overall conclusion, the researcher expects to see similarities in the FMS scores in the lower bodies amongst all athletes. Each of the running and throwing events use their lower body, either as a main form for movement or a secondary form. Throwing events typically have the legs work as a push-off movement for the maximum peak power i.e. shot-put, discus. Runners use their legs as the main form of movement when simulating a forward run action. This gives the researcher the belief the results will show similarities in the lower body FMS scores.

However, scoring discrepancies will appear within the upper body scores, specifically shoulder mobility. Throwing athletes use the shoulder as the main form of movement during the event. With the main focus on the shoulder, the researcher hypothesizes that the throwers will have better shoulder

mobility than the runners strictly because the shoulder primary source of movement. Consequently, the research also hypothesizes that the athletes that specialize in throwing events will report a previous injury due to over use. The potential of this is due to the constant repetitive motion in the shoulder and shoulder joints. The motion will cause fatigue within the shoulder subsequently resulting in a shoulder injury.

Timeline

September 2016: Meet with my thesis advisor and discuss possible topics and begin researching topics. Pick topic and begin research.

October 2016: Continue to meet with advisor once a week. Also set up meeting with Bemidji State Track and Field Coaches for a meet and greet. Continue to work on thesis rough draft finalizing research. Complete IRB proposal and CITI training

November 2016 – December 2016: Turn in thesis proposal to Honors Council board. Turn in proposal of IRB board to grant permission to research on human subjects.

January 2017 - February 2017: Begin data collection and working with the track coaches to guarantee accuracy in data collection and a ground relationship amongst the coaching staff and the athletes.

March 2017: Finish analyzing data collection and put together final thesis project.

April 2017: Present thesis at Student Achievement Day and American College of Sport Medicine conference

January 2018 – February 2018: Finish final thesis and defend.

Budget

This project did not require a budget due to the resources the Health, Sport, and Exercise Science department had. The FMS kits were already apart of the lab along with the software used to make individual exercise plans for each athlete that was tested.

Personnel

This study specifically focused on Bemidji State's Female DII Track and Field athletes. Each athlete specialized in one or more areas of track and field and indicated on their basic demographic questionnaire given before actually testing is administered. Each athlete was assigned a basic demographic questionnaire, fear of injury questionnaire, and a consent form. Once completed, each athlete was administered the test by either myself or by my co-researcher. Once the athlete completed the FMS assessment and their data was analyzed, they were given a personalized exercise plan to improve areas in which they may have scored below a 3 on the FMS assessment.

Testing

As stated in the early paragraphs, this study focused on female track and field athletes at Bemidji State University. Each participant in the study, roughly 14 athletes, was given a series of questionnaires and consent forms that were given two weeks prior to testing. In collaborating with the track and field coaching staff we solidified how we would administer the test to minimize practice disruptions. Two athletes were taken in at a time and performed the FMS assessment while my co-researcher and I observed their movements and scored them based on the training we received and how the athlete performed the movements. Each athlete spent about 15-20 minutes with us to complete the assessment and answer any follow-up questions we had with their questionnaires, to get to know the athlete better and how they move. We modified how we were going to identify the athletes by using their student ID numbers instead of what was originally proposed because it made it easier for the athletes to remember

their sheets while allowing us to not have a biased or influence on their results. We also had to modify the FMS assessment for some of the athletes who had recently been injured or who were still recovering from a previous injury.

Once each athlete completed the test, an analysis of their data with their fear of injury questionnaire was done to see if there was a pattern in their score on the FMS assessment and what they claimed on their questionnaire. Another analysis was done to also see if the specific event the athlete performed in also affect their score and their report of an injury.

After completion of these analyses, my co-researcher and I used Visual Health Information (VHI) allowed us to create six different exercises tailored specifically to the athlete to help increase their strength in areas they showed weakness while completing the test. Further detail of these results will be explained in the following paragraphs.

Results

Overview

Of the 14 participants, the average age reported was just over 20 years, 20.14 years to be exact. Of the six athletes who reported an injury, only two of these athletes scored below the average score, which totaled to be 16.607 (see Table 1). Five athletes answered “yes” to having sustained an injury while participating in Track and Field within the past 2 years with one athlete, yet to be cleared to return to sport and nine answered “no” to the same question of sustaining an injury. Midseason, an athlete reported a bicep injury before the FMS assessment was administered. The FMS assessment was modified to accommodate her injury so she would still be able to participate in this research study. A paired sample T-test was performed comparing the means of long-distance runners to those of any other event with their FMS scores valuing out to $p = 0.94$ It was hypothesized that the long/mid distance runners would have lower FMS scores because of potential over-use injuries. However, the samples

were extremely close to 1 at a 0.94 meaning there was little variation. This p value was a little surprising but just means the athletes are training properly and have the basic strength they to prevent injuries.

Basic Demographic

This study had a total of 14 female track and field athletes at BSU participate. The average age reported was 20 years old with the youngest athlete being 19 years old and the oldest athlete was 23 years old. Of the 14 athletes, majority of the athletes reported their standing in school to be juniors with two athletes being freshmen, four sophomores, seven juniors and 1 senior. There was a wide range of the length of time an athlete had been competing in track and field including their time at BSU. Around 7 years was the average span of an athlete competing in track and field. The demographic asked if any of the track and field athletes also competed in Cross Country. It was a perfect split with seven girls reporting they were also apart of the Cross Country team and seven strictly competing in track and field only. There was also an even split in what event each athlete reported competing in. Six athletes ran long distance, two were sprinters, and 5 were throwers. Each athlete reported to practice/run 6 days a week and about 124 minutes a day.

Table 1

	FMS Score	Age	Minutes of Practice	Days/week of practice
Average	16.607	20.14	124.64	5.93
Standard Deviation	2.84	1.17	49.63	0.27

The majority of the female track and field athletes stated they had sustained an injury and those that did report said their injuries happened about 6 months to 2 years earlier. The athletes who reported an injury claimed it took about 1-9 months after injury to return back to sport with one still not cleared to return. Prior to this researcher, only one athlete reported to have done the FMS assessment so it was a fun experience for the track and field girls. (see Appendix A: Basic Demographic Questionnaire)

Fear of Injury

This fear of injury questionnaire is a modified version the TSK-11 and was also modified to focus on all aspects of the body and not just the knee. Each athlete is given this questionnaire with their basic demographic and their written consent. The questionnaire is based on a 0 to 5 scale with 0 being no at all confident at performing the movement and 5 being very confident. The averages are reported in this section for each question.

Perform a full squat: 4.64

Make a turning movement while standing: 4.86

Walk normally on all types of surfaces: 4.79

Can hop on injured leg (if applicable): 4

Run straight ahead: 5

Make sudden changes in direction while running: 4.29

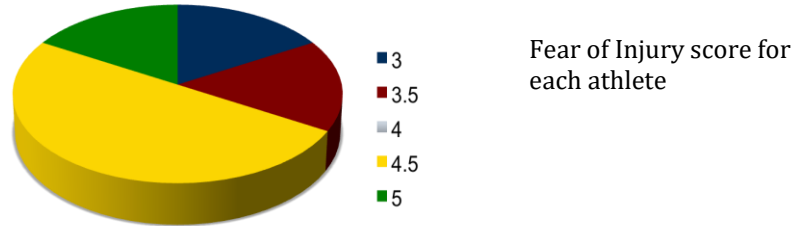
Return to same physical activity level as before injury (if applicable): 4

Avoid new injuries to lower body (if applicable): 3.14

Participate in physical activity even with lower body symptoms (if applicable): 4

Knee will no be worse than before surgery (if applicable): 4

Fear of Injury Results: Figure 1- key indicates participant score

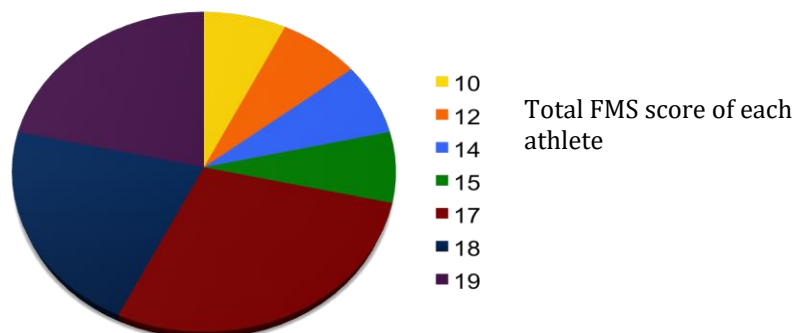


Individually, the average for the whole questionnaire answers were in the high 4's with those who reported injuries were in the lower 4's and even into the 3's. There were some perfects and the lowest individual average score was a 3.2 and this athlete was still injured. (See Appendix B: Fear of Injury Questionnaire)

FMS Scores

The FMS assessment is scored on a scale from 0-3 with 3 showing no difficulty or asymmetries and 0 is given when the movement cannot be completed or pain is reported while performing the movement. The higher the score the less likely the athlete will receive an injury due to weakness in the several areas tested. Overall, each track and field athlete scored relatively high in comparison to the average set score of a 14. The lowest score recorded was a 10. This athlete was unable to do some of the movements without reporting pain and it was also noted that this was the athlete who said she had just received a bicep injury during that week of practice. The average FMS score was a 16.6. A good score that indicates a lower chance of injury is considered to be 15 and above.

FMS Score Results: Figure 2- Participant total FMS score



Only two athletes scored below the minimum score. These athletes had also reported having an injury. Shoulder mobility had the highest amount of athletes that scored 3's and the rotary stability and the hurdle step had the lowest scores of 1's and 2's. Overall, the scores were very good indicating smaller chances of injury, which is good considering most shared that they are practicing or running six days a week. (See Appendix C: FMS Scoring Sheet)

Discussion

Results show the FMS is an accurate predictor of previous injury. Results showed a correlation between lower FMS scores and a Fear of Injury/Re-Injury based off the Basic Demographic along with the modified Fear of Injury Survey. None of the athletes showed significant fear of injury but those who were still on the lower end had scores below 15 on the total FMs score.

Recent research published in 2016, has shown the application of the FMS within track and field to be a good indicator to determine injury occurrence. They found that elite track athletes who scored above a 14 on the FMS had significantly greater performance improvements the following year, while those who scored below a 14 saw their performance decline on average. The data suggests that athletes who had no bilateral asymmetries improved on their performance, while those who had at least one

bilateral asymmetry saw performance decline (FMS). This research relates to the BSU track athletes because most of them scored above a 14 and did not show/claim having injuries. This finding is positive for the athletes and coaches.

When using the FMS to assess for injury a score lower than 15 represents a good chance for injury/re-injury. The purpose of this questionnaire was to determine if the score received on this portion correlated with the athlete's FMS score. This relationship could lead to a relationship between fear of injury and potential for injury. The objective of this research was to also examine if FMS scores related to the various events that athletes participated in. Noting that there was a split between long distance runners and throwers, there was a connection within the amount of injuries along with the lower FMS scores in the athletes that participated in long distance running.

However, there were some limitations with research study that is important to keep in mind when making conclusions. First, we had a small sample size (14 participants). A larger sample size ($n > 30$) would have been valuable in completing more advanced statistical analysis and potentially increased generalizability of this study's findings. Also BSU is a relatively small campus limiting the number of student athletes including the track and field team. Our demographic was also only female since BSU only has a female track and field team. FMS scores could be skewed based on gender between males and females. When this assessment was performed the athletes were in mid-season so underlying injuries or weaknesses could have been more prominent. Lastly, when the athletes were assessed some of them had already begun practice, done their warm-ups or had just finished their practice. This timing could also be a factor into skewed data due to fatigue or lack of muscle warmth. These are all important limitations to consider when examining the data.

Additionally, there could potentially be many factors as to why this was the case but looking into how many hours spent practicing these events (average of 124 minutes for 6 days) could show injuries

occurring from overuse along with improper strength. One of the limitations of this study is that some of the participants may have participated in DII Cross Country during the fall months. Although the throwers and runner have the same length of workouts the throwers do more than just continuously throw at practice minimizing their chances of overuse injuries. They work on building the muscle and study technique, whereas the runners are always on their feet running or moving giving them the higher chance for overuse injuries. It was hypothesized that fear of injury would influence the athletes total FMS score to show a higher potential for injury. This fear is caused by the belief that working the effected area would bring about or worsen the already injured area. There was a slight relationship between the athlete's event they performed and their total FMS score.

Conclusion and Take Home Message

The FMS assessment scores athletes on their stability, range of motion, and strength by assessing different movements. The test places athlete in positions that expose weakness and imbalances in functional muscle groups, as well as predict the likelihood of future injuries. Unlike other strength and conditioning assessments, the FMs test allows low impact, body weight movements as well as flexibility assessments. The fear of injury and the FMS assessment may help develop a general idea for the researchers, coaches and the athletes on areas of improvement to enhance performance in their event. A better educated coaching staff, athletic training staff and team allows for a more successful season.

Special Acknowledgements

Some acknowledgements need to be made that allowed this research to be successful. First, recognition to the Bemidji State Women's Track and Field Team is needed for their participation and cooperation during this study. Also to the Track and Field coaching staff for allowing my co-researcher and I to take time from practice to assess the girls and for their help and cooperation in the preparation of this study. Recognition is also in order to Dr. Jim White for the guidance during this process. He was

very helpful in giving tips and pointers along with the written portions of this study. Lastly, a special recognition to the Exercise Science Department for allowing the usage of the lab and the equipment needed to complete this research study.

Appendix A

Subject ID _____ Date ____/____/____ Test Session _____

Please answer the following questions:

1. Age: What is your age? _____
2. Academic standing (*please circle one*)?
a. Freshman b. Sophomore c. Junior d. Senior
3. How many years have you participated in competitive track and field (including years before college)?
a) 3-4 years
b) 5-6 years
c) 7-8 years
d) 9-10 years
e) 11 or more years
4. Do you compete in both Cross Country and Track (*please circle one*)?
YES NO
5. What events(s) do you participate in track and field? - circle which category fits the best.
a) Long distance running
b) Throwing- discus, hammer, javelin – Pole Vault
c) Sprinter/Hurdler/Jumping
Other: _____ (please write in)
6. How many days a week (a.) and for how long (b.) do you train/exercise?
a. _____ days a week
b. _____ minutes per day
7. Have you had a prior sports related injury within the last 6 months that has limited your ability to compete in your event (s) (*please circle one*)?
YES NO
8. IF you answered YES to the Question 7 - When did the injury occur?
a) < 6 months ago
b) 6 months to 2 years ago
c) More than 2 years ago
d) Have not been Injured

9. IF you answered YES in question 7, approximately how long did it take you to return to competing in your event(s)?
_____months

10. Have you ever been tested using the Functional Movement Screen (an assessment to measure strength and flexibility) *(please circle one)*?
YES **NO**

Appendix B

Example Questionnaire:

Performance Activity Self-Efficacy Scale

Subject ID _____ Date ____/____/____ Test Session _____

Please circle one number for each of the following questions.

I am confident that...

1. I can perform a full squat.

0	1	2	3	4	5
---	---	---	---	---	---

2. I can make a turning movement while standing.

0	1	2	3	4	5
---	---	---	---	---	---

3. I can walk normally on all types of surfaces (e.g. stairs, ice, uneven ground).

0	1	2	3	4	5
---	---	---	---	---	---

4. I can hop on the injured leg. If you have not experienced a previous injury to your lower body- circle Not Applicable (NA)

0	1	2	3	4	5
---	---	---	---	---	---

5. I can run straight ahead.

0	1	2	3	4	5
---	---	---	---	---	---

6. I can make sudden changes in direction while running.

0	1	2	3	4	5
---	---	---	---	---	---

7. I can return to the same physical activity level as before the injury. If you have not experienced a previous injury to your lower body – circle Not Applicable (NA)

0	1	2	3	4	5
---	---	---	---	---	---

NA

8. I can avoid new injuries to my lower body. If you have not experienced a previous injury to your lower body – circle Not Applicable (NA)

0	1	2	3	4	5
---	---	---	---	---	---

NA

9. I can participate in physical activity even if I have lower body symptoms (e.g. pain or swelling in the knee, hip, shin). If you have not experienced a previous injury to your lower body – circle Not Applicable (NA)

0	1	2	3	4	5
---	---	---	---	---	---

NA

10. My knee will not be worse than before surgery.

0	1	2	3	4	4
---	---	---	---	---	---

Appendix C

The Functional Movement Screen

Athlete: Scoring Sheet

DATE:

TEST		RAW SCORE	FINAL SCORE	COMMENTS
DEEP SQUAT				
HURDLE STEP	L			
	R			
INLINE LUNGE	L			
	R			
SHOULDER MOBILITY	L			
	R			
IMPINGEMENT CLEARING TEST	L			
	R			
ACTIVE STRAIGHT-LEG RAISE	L			
	R			
TRUNK STABILITY PUSHUP				
PRESS-UP CLEARING TEST				
ROTARY STABILITY	L			
	R			
POSTERIOR ROCKING CLEARING TEST				
TOTAL				

Appendix D

Informed Consent

***Assessing Physical Limitations in DII Track and Field athletes with the Functional Movement Screening Tool.
Examine if fear of injury influences FMS overall score.***

You are selected to participate in a research study involving the use of the Functional Movement Screen (FMS). The FMS is a series of physical assessments using a ranking and grading system to document movement patterns key to a healthy function. The FMS identifies functional limitations and asymmetries. These issues can reduce performance abilities, quality of movement and misrepresent body awareness. The FMS is a useful tool used to identify a possible future injury. You have been selected to participate in this study because of the sport you play.

If you decide to participate, I, Josie Nelson, advised by BSU faculty member Dr. Jim White and co-researcher Alec Weis, will be responsible for administering the Functional Movement Screen assessment. Testing is estimated to take up to 45 minutes to complete. The test is designed to manipulate your body position where strength and balance limitations or asymmetries are exposed. Risks that may occur temporarily include muscle discomfort or fatigue and loss of balance. Note these are all normal reactions to the FMS assessment.

Any information obtained during this study will remain confidential and only viewed and analyzed by the research, advisor and or co-researcher.

Your decision whether or not to participate will not influence your future relationships with Bemidji State University. If you are willing to participate, at any point of time during the assessment you are free to discontinue without penalties.

If you have any questions, please ask me or co-researcher, Alec Weis. For additional questions or concerns contact Dr. Jim White at 218-755-2766 or jwhite@bemidjistate.edu. We are happy to answer them.

Upon request, we can provide a copy of this Letter of Informed Consent for your personal records.

You are making the decision of whether or not to participate by signing below. Your signature indicates your willingness to participate in this research study. If at any time during the assessment you feel the need to discontinue, you will not be penalized for your decision. If you do not feel like you can participate by not signing, you will not be penalized for your decision in any way.

_____ (participant) _____ (date)
Signature

_____ (witness) _____ (date)
Signature

Citation

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