Diploma in Exercise and Health Fitness

Module 2 – Research Skills and Program Development in Exercise and Health Fitness

# Is Functional Movement Screening (FMS) a Reliable Predictor of Musculoskeletal Injury?

A Literature Review

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## Introduction

Pre-season screening procedures are becoming more commonplace in sporting circles to provide information on an athlete's medical health and fitness in an attempt to identify possible risk factors for participation (Schneiders, et al., 2011). According to Hirth (2007, pg 10) structural alignment, flexibility, strength and co-ordination can all influence movement. Okada et al. describes how functional movement allows the performance of fundamental movement patterns with accuracy and efficiency with the ability to maintain a balance between mobility and stability along the kinetic chain. In citing Lehance et al (2009) and Kiesel et al (2009), Frohm et al (2012 p.306) hypothesized that "*a non-functional movement pattern can predispose for injuries*". An injury, according to Kumar (2001) is the mechanical disruption of tissues resulting in pain. Dysfunctional tissues were also cited as a pre-cursor to injury due to residual strain caused by ongoing compensations in functional movements.

Therefore, it can be concluded that assessing functional movement patterns and identifying the patterns in people that lack the ability to move with adequate mobility and stability are at higher risk of musculoskeletal injury. The project undertaken, is to provide students with a course entitled “Introduction to Functional Movement Screening – 4 Assessments to Identify Dysfunctional Movement Patterns”. The reliability of the FMS directly relates to the reason for implementing the course which is to administer functional movement tests to identify soft tissue dysfunction/faulty movement patterns before they cause pain or injury and give clients the appropriate interventions.

**What is Functional Movement Screening?**

Functional Movement Screening (FMS) was first introduced by Gray Cook and Tim Burton in 1995. At that time there were no standardized means of identifying movement dysfunctions or limitations as most tests were geared towards skill and/or athletic performance. The FMS website also clearly states that its screening protocol has the “*potential*” to improve performance and improve an athlete’s “*resistance*” to exercise (Systems, 2013). The FMS contains a battery of 7 movement assessments. They are the Deep Squat, Hurdle Step, Inline Lunge, Shoulder Mobility, Active Straight-Leg Raise, Trunk Stability Push-Up and Rotary Stability. These movement tests place clients in positions where, trained health and fitness practitioners can easily observe dysfunction (asymmetries, weaknesses, imbalances and limitations). Cook (2011) also suggests that should these dysfunctional movement patterns continue the client predisposes themselves to future injury. A score is assigned on a scale from 0 to 3 for each of the assessments. Zero is scored on any test should a client experience pain. A score of 1 is assigned if the movement patter is incomplete. Two is scored if the movement pattern is completed but the client exhibits some form of compensation and 3 is scored if the client completes the movement pattern pain free without compensation or loss of form (Cook, 2011, p. 74).

**Why assess functional movement?**

Liebenson noted "*the brain doesn't think in terms of individual muscles. It thinks in terms of movement*" (Liebenson, 2012, p. 170). Testing the preparedness of an individual for activity can reveal mobility and stability shortcomings during functional movements and provide information to allow athletes to proactively avoid injuries (Informatik, 2011). Hirth explains that assessment can form "*the basis for therapeutic exercise recommendations for stretching of potentially overactive and tight muscles and for strengthening of underactive and weak musculature*" (Hirth 2007 p.10). He goes on to state that in order to optimize functional ability (not just single muscle, single joint movement) that a functional exercise program must be undertaken. White House Physician to John F. Kennedy , Janet Travell spoke of the functional deficits that remain post injury when she said "*after an injury tissues heal, but muscles learn, they readily develop habits of guarding that outlast the injury*" (Liebenson, 2012, p. 176). Functional screening must be used as a predictor of injury due to poor movement patterns but also an indicator of poor rehabilitation of previous injury leading to dysfunction causing a vicious circle.

**Inter-Rater Reliability of the FMS**

In order for the FMS, or any other screening tool, to be an effective predictor of injury the reliability of the test must first be examined. If any individual was scored by 2 or more testers with both results completely different, the validity of the screen would be called into question. Therefore, the FMS must be seen as reliable and standardisation may be necessary. A study was undertaken to assess the reliability of the FMS to this end. Forty subjects were videotaped performing the 7 FMS tests and their tests were independently scored by 4 independent raters (2 experts who instruct FMS training courses and 2 novices who completed an FMS training course). The final scores were calculated by using a Kappa value (the rate of disagreement) between raters.The closer the Kappa value is to 1.0 the higher the rate of agreement for that particular test. The novice raters agreed with eachother on 14 of the 17 tests and the expert raters on 13 of the 17. When the novice raters were paired with the expert raters all 17 test components showed substantial to excellent agreement (Minick, et al., 2010).

The results speak for a high level of reliability between scorers of the FMS once a standardised training program is undertaken. One factor that may have affected agreement between raters was the two dimensional approach (video) used in this study. High inter-rater reliability is also confirmed by Onate, et al (2012). The notable difference between Onate (2012) and Minick (2010) is that Onate's study used civilian raters and no expert raters further cementing the inter-rater reliability of the FMS once the standardized scoring protocol is adhered to. There are a limited amount of studies to assess the reliability of the FMS between raters. However, both studies referred to showed very strong results to suggest reliability. The two studies used were the only studies to date on this topic. Further studies may be necessary to categorically confirm the FSM's inter-reliability

**Predicting Injury through Functional Movement Screening**

According to Egger et al. (1999) there are two main types of injury. They are direct/extrinsic and indirect/intrinsic. Direct/extrinsic injury is caused by collision with an outside force causing trauma or an environmental factor such as a poor surface. No matter how sound a person's movement patterns, injuries caused by outside forces can be difficult to predict, especially in sport. Indirect/intrinsic injury is stated to be caused by stress within the body's soft tissue. Acute overuse injuries are caused by lack of sufficient warm-up or stretching and chronic overuse injuries instigated by long term micro-trauma or inadequate rehabilitation of a prior injury. Micro-trauma to tissue occurs through small amounts of stress being placed on tissues over time due to poor movement bio-mechanics (movement mistakes caused by poor posture, misalignment of joints and poor muscle co-ordination) and overtraining (Cook, 2003).

The FMS is designed to identify these movement dysfunctions and can be presumed to be a good predictor of injury. Peate et al (2007) performed the 7 movements outlined in the FMS (shoulder mobility, stability push-up, deep squat and active straight leg raise, hurdle step and in-line lunge) on a sampling of 433 firefighters in an attempt to identify if there was a correlation between performance on the FMS and occurrence of injuries. The total FMS was scored up to a maximum of 21. The fire fighters then participated in a training program emphasizing functional movement and prevention of injuries. All injury cases where assessed for 1 year prior and 1 year post conducting this study. The results of this study indicated that despite a decrease in mean FMS score (due to linear regression i.e. increase in age, rank and time on the job) the intervention was successful in reducing injury rates by 42%. An interesting result showed that a previous musculoskeletal injury reduced the FMS score by 3.44. This study speaks for the implementation of an exercise/training program to reduce the incidence of injuries. In order for the FMS to be deemed a predictor of injury the intervention should have been excluded. Thus, if those with low score (<16) were injured on more occasions than those with a high score (>16) it could be deemed that a low score is a predictor of future injury.

In comparison to Peate et al (2007), Schneiders et al (2011) indicated that a score of <14 on the FMS was an indicator of a higher risk of injury. This was determined from a previous study on 46 professional football players. It is not clarified how the cutoff point of 14 is reached. It simply states that 31% of participants scored below this point. The author does state that due to the small sampling size that caution should be used when applying this cutoff point and that more study is needed before determining a standard cutoff point. Supporting the 14 point cutoff is a study by Chorba et al (2010) which produced results of a study on whether or not functional movement screening can be used to determine the risk of injury in 38 NCAA Division 2 female collegiate athletes. A score of <14 was determined as a risk factor for injury as 69% of those who scored 14 or less sustained an injury over the course of one competitive season. The types and mechanism of injury are not specified, nor are the percentage of participants injured who scored >14. If dysfunctional movement patterns are to be a predictor of future injury, surely these injuries should be as a result of the dysfunction and not obtained through a direct trauma.

In a study of professional (American) football players by Kiesel et al. (2007) the FMS was utilized to determine if a relationship could be found between the score obtained on the FMS and the likelihood of serious injury. For the purpose of this study a serious injury was deemed to be any injury which placed a player on the "*injured reserve*" for 3 weeks or more. It was noted in the discussion that this placed a limitation on the study as other injuries, despite meaningful to the study, had to be omitted as they did not meet the criteria set for injury. Players on the active roster at the beginning of the season were tested using the FMS and injury data collected over the course of a season of 4 ½ months. The authors cites Turbeville, et al.(2003), Meeuwisse (1994) and (Gomez, et al.(1998) when he writes that the risk of injury in multi-factoral including body mass index, body composition, playing experience and playing surface. This goes back to (Egger, et al., 1999) and his explanation of intrinsic and extrinsic injury risks.

The mean score for those who sufferd an injury was 14.3. It was determind that a score of <14 maximized specificity and sensitivity of the FMS as a predictor of injury. In his discussion, the author outlines that a more robust definition of injury needs to be used. This may contribute to a more effective study to establish a cause-effect relationship between dysfunctional movement and injury. Despite the limitations of this study, it concluded that the FMS can be easily tested and that a score of <14 increased the athletes chance of suffering serious injury by 15%. This study again failed to identify the cause and type of injuries suffered by those who scored under 14 on the FMS. Not including those injuries of <3 weeks duration may also have effected the results of this study.

**Discussion**

In order for the FMS to be a reliable predictor of musculo-skeletal injury, the type of injury needs to be specified. In a sporting environment the risk of injury is high and can be caused by intrinsic and extrinsic factors. The risk of injury in sport is widely deemed as an inevitable and acceptable risk due to the contact nature of many sports. In contrast, in the work or domestic environment, injuries are deemed as unacceptable. Injury causation in a sporting environment should be based upon whether or not it is a contact sport, the players interaction/behaviour, and biomechanical considerations (Fuller, 2007). The FMS will only ever be a predictor of injury based upon movement patterns (biomechanics). Studies to prove/disprove the FMS as a reliable predictor of injury (Kiesel, et al., 2007), (Schneiders, et al., 2011), (Peate, et al., 2007) have not defined the injuries sustained or the manner in which they were sustained. In order for the FMS to be a reliable predictor of injury it must be specified the type of injury to be predicted and causal factors explained. Despite this, the FMS is demed to be a reliable tool to identify dysfuncational movement patterns when administered by a trained individual (Onate, et al., 2012), (Minick, et al., 2010). Further studies may be needed in this area to cement this reliablitity.

## Conclusion

According to the literature examined, the FMS can be deemed a reliable predictor of musculo-skeletal injury. Its standardised approach to scoring basic movement patters provides a foundation for identifying possible weak links in an individuals armour. Fuller (2007) states "*although the risk of injury in sports is high, effective management can control or reduce the level of risk".* The FMS tool provides coaches, trainers and athletes an injury risk management tool. Poor bio-mechanics is a pre-cursor to injury (Frohm, et al., 2012) and the FMS reliably identifies poor movement patterns and therfore a chance to correct them before they become a causal factor in injury.

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