Journal of Physical Education and Sports Management
December 2021, Vol. 8, No. 2, pp. 34-39
ISSN 2373-2156 (Print) 2373-2164 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jpesm.v8n2a4
URL: https://doi.org/10.15640/jpesm.v8n2a4

Functional Movement Screen Differences between Male and Female Collegiate Soccer Players

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Abstract

BACKGROUND: The stated aim of the Function Movement Screen (FMS) sum score is to identify the presence of compensatory movement patterns that are indicative of increased injury risk and inefficient movement that causes reduced performance. The purpose of this study is to evaluate the effectiveness of the FMS as a tool during preparticipation screening of asymptomatic collegiate soccer players for the identification of potential musculoskeletal injury. METHODS: The study tested the FMS on female (n=13) and male (n=14) NCAA Division 1 soccer players for differences in musculoskeletal injury occurrences and FMS composite scores over a competition season (10 training weeks). Researchers collected data and used SPSS predictive analysis software to analyze correlations between injury occurrences and FMS score, sex and injury occurrences, and sex and FMS score. RESULTS: Correlation between injury occurrence and FMS score was slight. Correlation between sex and musculoskeletal injury was significant. Correlation between sex and FMS score was significant. CONCLUSIONS: The findings of the study suggest female soccer players exhibit higher FMS scores and higher injury rates than male soccer players. The authors suggest that this may be grounds for increasing FMS cutoff score for females as a predictor of injury, but more research is warranted given their smaller sample size.

Keywords: preparticipation, athletes, gender, injury, college athletics

Acknowledgments

The results of this study do not constitute endorsement of the product by the authors. The authors do not have any professional relationships with the creators or manufacturers of the Functional Movement Screen. The authors thank Rayanne Nguyen, MS, RD, LDN, for her editorial assistance on multiple drafts of this article and the teams, coaches, and athletic trainers for their willingness to participate and assist with the study. The results of the present study do not constitute endorsement of the Functional Movement Screen by the authors or the NSCA.

1. Introduction

According to the National Collegiate Athletic Association (NCAA) Injury Surveillance System, a recorded 182,000 injuries occurred between the years of 1988 and 2004, averaging to 11,000 injuries a year (Hootman, Dick, & Agel, 2007). Since 2004, the number of athletes competing has risen dramatically as have the needs to protect the athletes' safety. Significant research has been extended towards the study of injury prevention through proper screening and treatment methods. One tool, the Functional Movement Screen (FMS), has drawn particular attention from the athletic community for its purpose of (Cook, 2010):

1. Identifying individuals at risk, who are attempting to maintain or increase activity level.
2. Assisting in program design by systematically using corrective exercise to normalize or improve fundamental movement patterns.

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3. Providing a systematic tool to monitor progress and movement pattern development in the presence of changing fitness levels.
4. Creating a functional movement baseline which will allow rating and ranking movement for statistical observation.

The FMS tests an individual's movement patterns and side-to-side symmetry utilizing seven exercises that examine mobility, neuromuscular control, balance, and stability through specific, fundamental movement patterns. Most recently, the FMS has been commonly used as an indicator for potential injury. (Garrison, Westrick, Johnson, & Benenson, 2015; Kiesel, Plisky, & Butler, 2011; Lisman, O'Connor, Deuster, & Knapik, 2013)

The purpose of this study is to evaluate the effectiveness of the FMS as a tool during preparticipation screening of asymptomatic collegiate soccer players for the identification of potential musculoskeletal injury. Previous studies have evaluated the tool in military, collegiate and elite athlete populations (Brown, 2011; Chorba et al., 2010; Garrison, et al., 2015; Kiesel et al., 2011; Warren, Smith, & Chimera, 2015). These studies evaluated the use of the FMS as a predictor of injury. Many of these studies have indicated composite scores below 14 as correlating to increased risk of injury (Garrison et al., 2015; Kiesel et al., 2011; Lisman et al., 2013). Chorba and colleagues (2010) suggested such with the stipulation that the correlation was to lower body injury only. In contradiction to these findings, Warren et al. (2015) found that the FMS could not be used as a predictor of future injury. Additional analysis will be dedicated to the exploration of potential correlations between FMS scores, rate of injury, and differences between male and female athletes.

To the best of the authors' knowledge, this study will be the first to report significant differences in FMS scores between healthy male and female collegiate soccer players. Although significant differences in FMS scores between males and females have not been reported previously, the potential findings of this study may correlate with previously published evidence that females have deficits in intrinsic factors like muscle activation (Hart et al., 2007), neuromuscular control (Brophy et al., 2009), and core stability when compared with males (Brophy et al., 2009; Zazulak et al., 2007). Each of these intrinsic factors has the ability to contribute to overall movement patterns and capacity. This study may add additional evidence that female athletes may be at higher risk for injury than male athletes.

Thus, the purpose of this study is to evaluate the effectiveness of the FMS as a screening tool in determining rate of injury in Division 1 college athletes' predisposition to injury and whether the correlation of FMS score and rate of injury differ between males and females. The researchers hypothesize that an FMS composite score less than or equal to 14 is an effective predictor of injury for men and women (that there is a correlation between composite FMS score and injury occurrence), that there will be a significant difference between sex and musculoskeletal injury occurrence, and that males will score significantly lower on the composite FMS scores than their female counterparts.

2. Methods

2.1. Participants

For this study, 36 student-athletes, age 18-22, from a NCAA D1 men's and women's soccer program were recruited by the research team. The inclusion criteria was clearance by the athletic training staff for participation; absence of a head, musculoskeletal, or spine injury within the last 3 months; and no report of vestibular, visual, or balance disorders. Participants were recruited from the men's (n = 20) and women's (n = 16) soccer programs prior to the start of the spring season. The study protocol was approved by the institution's institutional review board, and written informed consent was obtained from all participants before any data collection. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (Navalta, Stone, & Lyons, 2020).

2.2. Protocol

After confirmation of study eligibility, participants performed the FMS during a single session administered by the lead researchers/authors. The FMS involved a series of seven screening tests, each of which were used during data collection. The FMS tests included the deep squat, hurdle step, incline lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability. All subjects were tested at the start of the competitive Spring sports season, with subject testing occurring just before team practice sessions. Subjects were provided the opportunity to complete a voluntary 5-minute warm-up before FMS testing. Participants were given verbal instructions for task performance and allowed 3 attempts for each task. Each movement task was scored using standard composite scoring. If the participant was able to correctly perform the movement task without any compensation, a score of 3 was be awarded; completion of the movement task with compensation was scored a 2, and inability to complete the movement task was scored a 1.

Any task that produced pain was scored a 0. Tasks with right and left side components were scored individually; the lowest score was used in the calculation of the total composite score. Total composite scores ranged from 0 to 21 points, and individual task scores ranged from 0 to 3 points. Clearance screens were scored either positive or negative based on the presence of pain. Two raters, both of whom had experience using the FMS in clinical practice, scored participant performance on the movement tasks. FMS scores were shared with program's soccer coaching staff and strength and conditioning coaches following testing.

Injuries acquired by the athletes during the course of a recent season (10 training weeks) were diagnosed and recorded by the program's athletic training staff. Injuries were recorded on a hard copy health record maintained by the athletic training staff. Injury records were then transferred to data collection sheets that received an identification number and identifiable information was removed. The recordings were used to quantify the number of injuries throughout the season. Data collection sheets recorded the injury anatomical location, type of injury, and time off from practice and play. In addition, days of treatment and history of injury were added to data collection sheets. At the conclusion of the sports season, data were abstracted for analysis.

2.3. Statistical Analyses

For each subject, FMS data collection sheets were compiled and entered into a spreadsheet where each athlete's composite score was then calculated. Data was analysed using SPSS predictive analysis software (IBM Corp.; version 22.0; 2013).

Correlation between injury and composite FMS score was first ran using Pearson Correlation test. The dependent variable, injured or not injured, was converted to numerical code (noninjured = 0, injured = 1). The independent variable, composite FMS score, remained scored as a range from 0 to 21. The p value was set at 0.05.

To determine the difference between rate of injury and sex an independent samples t-test was used with p value set at 0.05. The independent variable, sex, was converted to numerical code (female = 0, male = 1). The dependent variable, injured or not injured, was also convereted to numerical code (noninjured = 0, injured = 1). This test was run to determine whether respective musculoskeletal injury occurrence means from the two groups were statistically significantly different.

The difference between FMS composite score and sex was determine using an independent samples t-test with a p value set at 0.05. The independent variable, sex, was converted to numerical code (female = 0, male = 1). The dependent variable, FMS composite score, remained scored as a range from 0 to 21. This test was run to determine whether respective FMS means from the two groups were statistically significantly different.

3. Results

A total of 36 student-athlete soccer players were eligible for participation at the start of the study. Nine of those were excluded from the study due to history of injury 3 months prior to testing (n = 3), unable to attend the test session (n = 5), or leaving the soccer program after starting (n = 1), leaving 27 participants in the final sample. A full description of the sample is available in Table 1.

Table 1. Description of Participant Eligibility

Group	N	Injury in Previous 3 Months	Unable to Attend Test Session	Left Soccer Program
Female	16	2	1	0
Male	20	1	4	1

As shown in Table 2, the average FMS score for the female athletes (n = 13) was 16.769 ± 1.235. The average FMS score for the male athletes (n = 14) was 15.357 ± 1.447. Females scored approximately 1.4 points higher than male subjects. Additional analysis using independent samples t-test reveals a significant difference (p< 0.05) between sex and FMS composite score. Females had a significantly higher FMS score.

A Pearson product-moment correlation was run to determine the relationship between FMS score and injury occurrence. There was a small, positive correlation between these two variables, which was statistically significant (r = 0.195, n = 27, p< .05).

R2, or the percentange of variance in injury occurrence accounted for by FMS score, was ~0.04. In other words 4% of the variance in injury occurrence is accounted for by a subjects' FMS score (or in other words, the FMS score reports at least 4% of why injury occurrence would vary).

Analysis using independent samples t-test reveals a significant difference ($p< 0.05$) between sex and musculoskeletal injury occurrence. Females had a significantly higher injury occurrence (7 injuries in 13 females versus 2 injuries in 14 males) (Table 3).

Table 2. Descriptive Measures of FMS Scores within Each Group

Group	Participants	Mean	Standard Deviation	Range
Female	13	16.8*	1.24	15-18
Male	14	15.4*	1.45	13-18

*denotes significant difference ($p< 0.05$)

Table 3. Comparison of Injuries per Participants and Mean FMS Score for Each Group

Group	Participants	Injuries	Mean FMS Composite
Female	13	7	16.7692
Male	14	2	15.3571

4. Discussion

The results of this study did not support our first hypothesis that lower FMS scores correlate with higher risk of injury. There was only slight correlation between FMS score and injury found in this study ($r = 0.195$). The slight correlation lends some support to the understanding that the FMS highlights compensatory movement patterns and increased risk for more severe musculoskeletal injury as suggested by Cook et al. (2006) Several factors may account for the weakness of the correlation. Similar to Warren et al. (2015) our sample sizes represented by two collegiate sports teams may have been too small to support association between injury and FMS. We suggest further analysis of collegiate soccer players, both males and females, in a larger sample size to fully study this correlation or lack thereof. Garrison et al. (2015) found that there was statistically significant difference between injured and uninjured FMS scores. To determine injury, Garrison et al. (2015) clarified musculoskeletal injury to include an association with athletic participation, a consultation to an athletic trainer, physical therapist, or physician, and modified training for a minimum of 24 hours or protective splinting or taping because of injury. This differed from our methods in that musculoskeletal injury was determined by an association with athletic participation, a consultation with the athletic trainer, but did not incorporate a minimum time commitment to modification of training or taping and bracing. Making this change to our methods would suggest that lower FMS score may correlate with musculoskeletal injury requiring 24 hours or greater of training adaptations and may be cause for additional testing.

The results did however support our hypothesis that there would be a significant difference between male and female occurrence of injury. During the ten-week spring competition season, seven of the females were injured while two men were injured ($p < 0.05$). This is consistent with the findings of Warren et al. (2015) and Agel, Arendt, & Bershadsky (2005). Warren et al. (2015) found 30 of 89 male Division II athletes were injured while 44 of 78 female Division II athletes were injured during their respective competition seasons ($p< 0.005$). Agel et al. (2015) contend that the noncontact injury rate for female NCAA athletes is three times higher in basketball and one-and-a-half times higher in soccer. As suggested by Ransdell and Murray (2016), the increased rate of injury for females is likely due to a multitude of factors (Ransdell & Wells, 1999) including smaller muscle fibers and cross-sectional area of muscle (Sale et al., 1987), smaller skeletal frame (Holloway, 1994), lower levels of muscle activation of the gluteus medius (Hart et al., 2007), vastus medialis oblique and vastus lateralis (Kim, Yoo,

& Yi, 2009), lower levels of neuromuscular control (Brophy et al., 2009; Hughes, Watkins, & Owen, 2008), and core stability (Brophy et al., 2009; Zazulak et al., 2007).

The results also supported our hypothesis that there would be a significantly weaker male than female FMS scores. We found that females averaged approximately 1.4 points higher on the FMS than males in the same sport, a significantly higher score ($p < 0.05$). To the best of the authors' knowledge, this is the first study to find significantly weaker male than female FMS scores. The cause of such a correlation is not clear however. Anderson, Neumann, and Bliven (2015) first suggested that there is a significant difference between male and female athletes in their study of the FMS in secondary school athletes but indicated several limitations including the absence of intrinsic factor measures that have not been correlated to the FMS. Likewise, we did not measure intrinsic factors that differ between men and women and may affect FMS scores. The relationship between intrinsic factors such as muscle activation, neuromuscular control, and core stability and FMS scores needs additional research. Further limiting the reliability of the findings was the size of each group sample. We suggest further study with larger samples to verify our findings.

The significant difference between the male and female occurrence of injury in conjunction with the significantly higher FMS scores in females leads us to believe a higher FMS score would be more useful as an indicator of injury risk than the current standard of 14. This differs from Chorba et al. (2010) previous studies involving the female sample that found that a score of 14 or less on the FMS was an accurate predictor of increased to risk in lower body injury. The significance of these findings could aid in the use of the FMS as a preparticipation screening for both male and female athletes. Again, our current sample size was smaller but supports further analysis as the implications of increasing the current cutoff score of 14 to a cutoff score of 16 or 17 could reduce the rate of injuries in females when utilized properly.

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