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FUNCTIONAL MOVEMENT SCREEN IN PREDICTING INJURY IN FEMALE HIGH SCHOOL ATHLETES OF KERALA

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ABSTRACT

Purpose of the study is to determine poor movement pattern strategies predispose female high school athletes of Kerala to injury, and if a functional movement screening (FMS) tool can be used to predict injuries in this population. The date on the FMS comprised of seven movement tests were collected from Kottayam district female high school athletes, were calculated before the start of their interschool competition season(Hockey, Volleyball and Basketball). Seven athletes reported a previous history of musculoligamentous lower back injuries. Injuries occurred and continued while participating in sport activities were recorded throughout the seasons. The mean FMS score and standard deviation for all subjects was 14.1±1.33 (maximum score of 21). Eighteen injuries (18 lower back) were recorded during this study. A score of 14/21 or less was significantly associated with injury (p=0.0496). Sixty nine percent of athletes scoring 14 or less sustained an injury. Odds ratios were 3.85 with inclusion of stress fracture and musculoligamentous lower back injuries to the subjects. Sensitivity and specificity were 0.58 and 0.74 for all subjects, respectively. A significant correlation was found between low scoring athletes and injury (p=0.0214, r=0.76). A score of 14 or less on the FMS tool resulted in increase in risk of lower extremity injury in female high school athletes participating interschool competitions. The screening tool was able to predict injury in female athletes without a history of major musculoskeletal lower back injuries. Result of the study shows that compensatory associated movement strategies of athletes often increase the risk of injury in female high school athletes, and can be determined by using a functional movement screening tool.

Keywords: Female Athlete, Sports Injury, Functional Movement Screen and Injury Risk Factors.

INTRODUCTION

Kerala has a long history of dropout of talented female athletes from the sports arena in their early period of sports carrier due to sports injuries may be caused by both intrinsic(faulty biomechanics, muscle imbalance or lack of adequate flexibility and previous injury) and extrinsic factors(unequal surface weather condition or faulty equipment) (Hootman, 2002). Annual reports of the Kerala State School Sports and Games Organizers shows that the female participation of interschool, inter district sports competition increased since 2005. As the number of school athletes continues to rise, there is a corresponding increase in the number of injuries. It is a well-known fact that the most common sports injuries occur in the lower extremity, most notably the ankle, knee, and hamstring muscles. The medical history of injured athletes and reports of the sports medicine experts shows that lack of neuromuscular control, core instability, and contra lateral muscular imbalances have been identified as other important risk factors for injury. The study focus on the implication of one of the particular method to avoid the chances of these injures to the budding female athletes of Kerala through scientifically identified methods.. A survey of various research studies found that the Functional Movement Screen (FMS) is a reliable method to screen movement patterns during the sports performance.

Gray Cook developed Functional Movement Screen (FMS) to identify individuals with functional movement deficit that could indicate an increased risk of injury. The FMS consists of seven movement patterns tests deep squat, hurdle step, in –line lunge, active straight –leg raise, trunk stability push-up, rotatory stability, shoulder mobility test that are intended to quickly and easily identify restrictions of alterations in normal movement. According to Gray Cook the interactions of kinetic chain mobility and stability are necessary for performance of fundamental, functional movement patterns. The FMS aims to identify the imbalance in mobility and stability during seven fundamental movement patterns. These movement patterns are designed to provide observable performance of basic loco motor, manipulative and stabling movements by placing an individual in extreme positions where weaknesses and imbalance become noticeable if appropriate mobility and motor control is not utilized by the athlete. The athlete may strengthen poor movement pattern that, in spite of achieving high performance, may eventually result in injury. Once these deficiencies have been identified through the FMS, a programme of corrective exercise can be developed with the goal of preventing musculoskeletal injuries.

Chorba et.al studied the correlation between FMS score and injury prediction among female high school athletes. The result of the study shows that the screening tool was able to predict injury in female high school athletes without a history of major musculoskeletal injury and a significant correlation was found between low scoring athletes and 4 fold increase in risk of lower extremity injury. Kiesel examined the relationship between FMS scores of 46 professional footballers and the incidence of serious injury. Results of the study concluded that a score of 14 or less on the FMS was associated with an 11-fold increase in the chance of injury and a 51% probability of sustaining a serious injury over the course of one competitive season. The above referred studies have implemented the FMS as a screening tool for female athletes despite consistently higher injury rates among the group. Therefore, the present study is to examine, if in compensatory and associated movement strategies predispose female high school athletes to injury, and if the Functional Movement Screen could be used to predict injury in this population over the course of one competitive season.

METHODOLOGY

For the purpose of the study is investigator adopted a systematic criteria for selection and elimination of subjects. Thirty five female basketball, volleyball and hockey players of different schools in Kottayam District, Kerala (mean age 14.24±.16 years) during 2017-2018 season volunteered for the study. The investigator selected female athletes as subjects, since female frequently experience

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increased injuries rates compared to male in sports. From the subjects volunteers for the study the investigator selected thirty five female players with in the age limit of 12-16 years who had not sustained an injury that prohibit full participation in preseason sports training and also eliminated injury sustained players with in thirty days preceding the testing. All participants were asked to provide a medical history from prior to their involvement in the study. Before conducting the test, all players signed the approved informed consent documentation, and all of them were educated on the purpose of the study, and informed that the result of the study would not influence their participation in athletic activities. Athletes were screened one at a time and were provided with the same standardized FMS verbal instructions before each movement. Players were allowed two attempts at each movement. A preliminary pilot study was conducted to eliminate the reliability of scoring based on video recording of their respective testing sessions. An exclusively female population was selected in order to potentially observe a higher number of injuries, as females frequently experience increased injury rates compared to males in sport. Subjects were tested within ten days prior to their competitive sport seasons. The testing was conducted in using the FMS during daily practice session and scored by the investigator, and co-investigator. The FMS consists of seven movement tests that include: Deep squat, Hurdle Step, In-Line Lunge, Shoulder Mobility, Active Straight Leg Raise, Trunk Stability Push-Up, and Rotary Stability. Injuries sustained by each subject during in season practices and competitions were reported. A systematic criteria was adopted by the investigator throughout the study for keeping a record of musculoskeletal injury of the subjects that require medical attention and occurred as a result of participation in an inter school, inter district practice or competition setting.

FINDING AND RESULTS

For determining the accuracy in scoring the investigator and co-investigator reviewed and analysed the FMS instructions manual and instructional videos and had a discussion among them prior to the scoring. For determining the reliability in scoring, the investigators collected scores from selected subjects (10 nos) and accuracy of scoring was determined through video analysis and discussion among the investigators. The final score was taken from each subject separately via digital video recording. For this purpose of the study, a cut-off score on the FMS of 14 (maximum score=21) was utilized to determine relationships between lower FMS score and injury. Kiesel et al utilized a receiver operator characteristic (ROC) curve was used to calculate a cut off total composite score <_14 that maximized both sensitivity and specificity for the relationship between the FMS score and injury. To maintain consistency with Kiesel et al's findings, the same cut-off score was employed in this study for data analysis. Fisher's exact test with a one tailed P value of <0.05 was performed. The Fisher's exact test was chosen due to its ability to calculate a more exact P value with smaller sample sizes than a chi- square test. Sensitivity, specificity, odds ratios and likelihood ratios with confidence intervals set at 95% (C195) were also calculated. Correlation and regression analysis was used to establish whether the relationship between the composite FMS score and injury was strong enough to utilize the FMS as a predictor of sustaining a reportable injury.

TABLE 01
DEMOGRAPHIC FEATURES OF THE ATHLETES IN THE STUDY

Sports	Subjects	Weight	Height	Age
All subjects	35 55	62.45 (±7.99)	167.18 (±7.32)	15.24 (±1.20)
Hockey	15	57.64 (±5.21)	160..34 (±5.14)	14.93 (±1.10)
Volleyball	15	64.01 (±6.67)	169.11 (±6.78)	14.92 (±1.04)
Basketball	15	67.30 (±9.78)	171.56 (±7.01)	15.92(±1.24)

Summary of demographic features of 35 female Hockey players(n=15) Volleyball(n=15) Basketball (n=15) with a (mean height=172.29 ±8.51cm,weight:=62.45±9.58kg,age=14.24 ±16 years) who have volunteered for the study are presented in table 1.

To establish consistency among observational ratings provided by multiple scorers, the investigator use interclass correlation coefficients (ICC), presented in Table 2.

TABLE 02
ICC VALUE FOR INTER–RATER RELIABILITY

Test	ICC value
Squat	0.798
In - line lunge	0.727
Hurdle-step	0.745
Shoulder mobility	0.200
Active SLR	0.100
Trunk stability	0.923
Rotary stability	0.778
Composite FMS score	0.901

The mean FMS score and standard deviation (SD) for all subjects (n=35) included in the study was 14.1 ±1.33 (maximum score of 21). The mean score of athletes sustained an injury was 12.9 ±1.07, and the athletes not having any injury had a mean score of 15.7±1.45. The individuals who had a composite FMS score of <_14 (n= 16), 52.56% of those athletes sustained an injury throughout the competitive season. Similarly, 72.32% of the subject score below 14 and 53.67% of the subjects scored or below 15 sustained injuries. Based on the cut-off score 14, as described by Kiesel et al, a 2x2 contingency table (Table 3) was produced that was utilized to determine the inter relation between a sensitivity of 0.698 specificity of 0.889. Those with an FMS score of <_14 were found to be significantly more likely to sustain an injury. A strong correlation existed between injury and FMS score. Linear regression analysis for the data from all subjects (n=35) produced results (P=0.768, r=0.7785, r2=0.5834) that did demonstrate a statistically significant relationship between results that would allow the use of the FMS to predict injury in this sample of female high school athletes.

TABLE 03
2X2 CONTINGENCY TABLE FOR ALL SUBJECTS (N=35) SHOWING INJURY RATE AND FMS SCORE

Injured		FMS Score
Yes	No	
10	6	FMS Score≤14
6	13	FMS Score≥15

Based on the data revealed a strong correlation (r=0.932, P=0.0088) between composite FMS score and lower extremity injury of athletes when the shoulder mobility test was removed from the calculation of the composite FMS score for all subjects (n=35). This resulted in a maximum FMS score of 18 from six tests. Data analysis with exclusion of subjects with a previous history of lower extremity injury reveled similar findings to results of the entire study sample. The mean FMS score and standard deviation (SD) for the

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non lower extremity injury subjects (n=28) was 14.0 ±1.23. For those individuals that sustained an injury, the mean FMS score was 13.9 ±1.56, while those who did not sustain an injury had a composite FMS score of <_14 (n=13) 70.34% of those individuals also sustained an injury throughout their respective competitive season. Furthermore, 79.82% of athletes who scored at or below 13 and 58% of subjects who scored at or below 15 sustained injuries. Average FMS scores for non-lower extremity injured subjects in their respective sports along with number of lower extremity injuries are reported in Table 4.

TABLE 04
AVERAGE FMS SCORE AND NUMBER OF INJURIES PER SPORT, SUBJECTS WITHOUT HISTORY OF MUSCULOSKELETAL LOWER EXTREMITY INJURY (LEI) (N=35)

Sports	LEI Injuries	Average FMS Score
Hockey	7	13.8
Volleyball	4	14.7
Basketball	6	14.1

The 2x2 contingency table for the 4 non Lower Extremity Injury (LEI), (Table 5) produced a sensitivity 0f 0.657, specificity of 0.713. Those with a FMS score of <_ 14 were found to be significantly more likely to sustain an injury (Fisher's exact test, one –tailed, p=0.0465). A moderate correlation existed between injury and FMS score (r=0.745, p=0.045). Linear regressions analysis for non-lower extremity injured subjects reached statistical significance (P=0.0450, r=0.8214, r2 =0.6748) demonstrating relationship between FMS score and risk of injury. Non-linear regression analysis did not produce significant results to use the FMS as an injury predictor in Non-lower extremity injured subjects. Results of the statistical analysis conducted for this study summarized in Table 6.

TABLE 05
2X2 CONTINGENCY TABLE FOR SUBJECTS WITHOUT HISTORY OF LOWER EXTREMITY INJURY (N=28)

Injured		FMS score
Yes	No	
4	1	FMS score≤14
9	5	FMS Score≥15

TABLE 06
STATISTICAL SUMMARY OF RELATIONSHIP OF FMS™ SCORE AND RISK OF INJURY OF ATHLETES

	Fishers Exact	Sensitivity (955 CI)	Specificity 95%CI)	Spearman's Correlation	Adjusted FMS Spearman	Linear Regression
All subjects (n=35)	0.0456	0.478	0.987	r = 0.7408 p = 0.0224	r = 0.8785	R =0.7875 r 2 = 0.6579 p = 0.0732
Non ACL Subjects(n =28)	0.0467	0.678	0.754	r = 0.7100 p=0.0438	r = 0.8300 p=0.0037	r = -0.8543 r 2 = 0.7684 p = 0.0564

The purpose of the study was to determine if compensatory and associated fundamental movement patters predispose female high school athletes to injury, and if the FMS score could predict injury in the sample population. It was hypothesized that compensatory and associated movement pattern predisposes female high school athletes to injury was accepted in the study. A lower score on the FMS was significantly associated with injury, with 70.5% of those scoring 14 or less sustaining an injury, and experiencing a 4 fold increase in injury risk. Of the 35 subjects, seven had previously sustained lower back injuries. This injury could have a significant impact on FMS and subsequent injury, and therefore data were analysed both with and without inclusion of the previously injured subjects. However, significant correlation between an initial FMS <_14 (less or equal to 14) and sustaining an injury during the competitive season with or without inclusion of lower back injured athletes, and the average FMS score was low in Lower back injured subjects(14.3+/-1.77) versus all subjects(14.0 +/-1.76) the number of injury increased from3.85 to 4.58 when lower back injured subjects were included analysis, demonstrating that a lower FMS score in non – lower back subjects results in a higher risk of injury in that group. Although history of previous injury is usually considered a strong risk of injury in that group. It is possible that a significant emphasis on lower extremity strength and neuromuscular control was employed in the rehabilitation of subjects post lower back injury, and that such training may have positively impacted their FMS score.

The hypothesis that the FMS score could be used to predict injury in female high school athletes was partially supported in the study. The result of the regression analysis using a linear model was able to establish a predictive relationship between a FMS score and the risk of injury, but only for subjects without history of lower back injury. When expanded to include all subjects, the linear regression model failed to reach statistical significance, most likely due to lack of power from a small sample size. The data for the non- lower back injured group may have provided better predictive results due to the exclusion of subjects that had suffered serious musculoskeletal injury. Since the study was limited to popular team games in which lower extremity injuries are common and the number of subjects and the data on the FMS score are not sufficient to detect upper extremity injuries.

CONCLUSION

The result of the study demonstrated that compensatory and associated movement pattern can increase the risk of injury in high school athletes and limit an individual's capability in performance, and can be identified by using the functional Movement Screen. A score of

14 or less on the FMS resulted in an increase in risk of lower extremity injury over the course of a competitive season in female high school athletes participating in inter school, inter district competitions in Hockey, Volleyball and Basketball. The statistical analysis of the pre and post data of the subjects of the study established that FMS may be able to predict injury in female high school athletes without a history of major musculoskeletal injury like lower back injuries.

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