

RELATIONSHIP OF PRESEASON MOVEMENT SCREENS WITH OVERUSE SYMPTOMS IN COLLEGIATE BASEBALL PLAYERS

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ABSTRACT

Background: The shoulder mobility screen of the Functional Movement Screen™ (FMS™) and the upper extremity patterns of the Selective Functional Movement Assessment (SFMA) assess global, multi-joint movement capabilities in the upper-extremities. Identifying which assessment can most accurately determine if baseball players are at an increased risk of experiencing overuse symptoms in the shoulder or elbow throughout a competitive season may reduce throwing-related injuries requiring medical attention.

Purpose: The purpose of this study was to determine if preseason FMS™ or SFMA scores were related to overuse severity scores in the shoulder or elbow during the preseason and competitive season.

Study design: Cohort study.

Methods: Sixty healthy, male, Division III collegiate baseball players (mean age = 20.1 ± 2.0 years) underwent preseason testing using the FMS™ shoulder mobility screen, and SFMA upper extremity patterns. Their scores were dichotomized into good and bad movement scores, and were compared to weekly questionnaires registering overuse symptoms and pain severity in the shoulder or elbow during the season.

Results: Poor FMS™ performance was associated with an increased likelihood of experiencing at least one overuse symptom during the preseason independent of grade and position (adjusted odds ratio [OR] = 5.14, p = 0.03). Poor SFMA performance was associated with an increased likelihood of experiencing at least one overuse symptom during the preseason (adjusted OR = 6.10, p = 0.03) and during the competitive season (adjusted OR = 17.07, p = 0.03) independent of grade and position.

Conclusion: FMS™ shoulder mobility and SFMA upper extremity pattern performance were related to the likelihood of experiencing overuse symptoms during a baseball season. Participants with poor FMSTM performances may be more likely to experience at least one overuse symptom in their shoulder or elbow during the preseason. Additionally, individuals with poor SFMA performances may be more likely to report overuse symptoms during the preseason or competitive season.

Level of evidence: Level 3

Key words: Functional Movement Screen™, movement dysfunctions, movement system, prevention, risk factors, sports injury.

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INTRODUCTION

Throwing a baseball is one of the most dynamic movements in all of sports. During the throwing motion, large forces are repetitively generated as the arm moves through vulnerable end-range positions.¹ Due to the nature of the overhead throwing motion, baseball players are susceptible to micro-trauma in the soft tissue structures that can eventually result in chronic injury.^{2,3,4} Many high school and collegiate level injuries receiving medical attention do not occur as a result of one particular pitch, but rather through cumulative micro-trauma.⁵ Pitchers have been identified as the primary position to experience shoulder injuries when compared to other positions, resulting in greater time loss and surgical interventions.⁶ However several throwing-related risk factors exist for all players including: sport specific adaptations,^{7,8,9,10} throwing velocity,¹¹ overuse,¹² muscle imbalances,^{2,13,14,15,16,17,18,19} and previous injuries.^{14,20}

A pre-participation physical exam should provide the athlete and sports medicine professionals with information that might prohibit/alter sport participation, along with information meant to improve performance and/or prevent injury from the musculoskeletal exam.²¹ However traditional pre-participation physical exams have only proven effective at identifying current injuries as opposed to predicting future injuries.²² A standard musculoskeletal screen that correlates to future injuries should be incorporated into the pre-participation exam process for grouping and classifying individuals to forecast injury risks.²³

The assessment of full body, multi-joint movements that gauge the quality of human movement have gained in popularity among sports medicine professionals.²⁴ The Functional Movement Screen™ (FMS™) and Selective Functional Movement Assessment (SFMA) are two commonly used screening tools, which have both demonstrated high inter- and intra-rater reliability in individuals who are certified and have greater experience administering the screens.^{25,26} They are both time-efficient, and are used to identify potential dysfunction within different movement patterns.²⁷ While the FMS™ is often used to determine asymmetries, imbalances, and injury risk, the SFMA is a clinical model often used

as a diagnostic tool designed to identify musculoskeletal dysfunction in patients with pain.

To date there are no studies comparing both the FMS™ and SFMA upper extremity screens as tools to find relationships with overuse symptoms in baseball players. The purpose of this study was to determine if preseason FMS™ shoulder mobility scores or SFMA upper extremity pattern scores could accurately identify players at increased risk for in-season overuse symptoms that may contribute to more significant time-loss injuries. Poor FMS™ and SFMA scores were hypothesized to increase the likelihood of reporting at least one overuse symptom in the preseason or competitive season.

METHODS

Participants

For this study, 135 male NCAA Division III collegiate baseball players (mean age = 20.1 ± 2.0 years) were recruited from four local universities. Among those recruited were 31 seniors, 25 juniors, 35 sophomores, and 44 freshmen. Participants were included if they were actively participating in all team activities on the date of testing. Participants were excluded if; (1) they were being treated for a shoulder or elbow injury or (2) they reported upper extremity injuries at the time of testing. This study was approved by a university institutional review board and written informed consent was obtained from all participants before beginning the study.

Data Collection

The screening dates, for each university, took place during the two-week period in the beginning of Spring 2016 before the start of official team practices. The examiner for all subject data collection was a certified FMS™ and SFMA practitioner, with over 5 years of experience screening individuals. All participants completed a questionnaire on position and grade in school. All participants were individually screened in random order with the FMS™ shoulder mobility and both upper extremity patterns of the SFMA, while including the clearing tests for rotator cuff impingement and for acromioclavicular (AC) joint impingement as described by Cook, et al.²⁷ Total FMS™ scores were dichotomized into “good” and “poor” groups (good = 2 or 3, poor = 0 or 1).

Table 1. *Shoulder/Elbow Overuse Injury Surveillance Questionnaire (modified from the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire)*

<p>Shoulder / Elbow Problems Please answer all questions regardless of whether or not you have problems with your shoulder/elbows. Select the alternative that is most appropriate for you, and in the case that you are unsure, try to give an answer as best you can anyway. <i>The term “shoulder/elbow problems” refers to pain, aches, stiffness, swelling, instability/giving way, locking or other complaints</i></p>
<p>Question 1 <i>Have you had any difficulties participating in normal training and competition due to shoulder/elbow problems during the last week?</i></p> <p><input type="checkbox"/> Full participation without shoulder/elbow problems <input type="checkbox"/> Full participation, but with shoulder/elbow problems <input type="checkbox"/> Reduced participation due to shoulder/elbow problems <input type="checkbox"/> Cannot participate due to shoulder/elbow problems</p>
<p>Question 2 <i>To what extent have you reduced your training volume due to shoulder/elbow problems during the past week?</i></p> <p><input type="checkbox"/> No reduction <input type="checkbox"/> To a minor extent <input type="checkbox"/> To a moderate extent <input type="checkbox"/> To a major extent <input type="checkbox"/> Cannot participate at all</p>
<p>Question 3 <i>To what extent have shoulder/elbow problems affected your performance during the past week?</i></p> <p><input type="checkbox"/> No effect <input type="checkbox"/> To a minor extent <input type="checkbox"/> To a moderate extent <input type="checkbox"/> To a major extent <input type="checkbox"/> Cannot participate at all</p>
<p>Question 4 <i>To what extent have you experienced shoulder/elbow pain related to your sport during the past week?</i></p> <p><input type="checkbox"/> No pain <input type="checkbox"/> Mild pain <input type="checkbox"/> Moderate pain <input type="checkbox"/> Severe pain</p>

SFMA scores were dichotomized into “good” and “poor” (good = functional non-painful (FN), poor = dysfunctional painful (DP), dysfunctional non-painful (DN), and functional painful (FP).

Throughout the preseason and competitive season, overuse symptom surveillance was tracked for each participant using a weekly questionnaire to register any shoulder/elbow complaints and/or time loss from practice or competitions. The four-question questionnaire was a modified version of the Oslo Sports Trauma Research Centre (OSTRC)

Overuse Injury Questionnaire²⁸ (Table 1). The questionnaires were completed over four preseason weeks (in which only indoor practices occurred), and eight competitive-season weeks (in which both games and practices occurred). Based on each subject’s answers, they were given a symptom-severity score. The higher the total severity score, the more overuse symptoms existed for each given week. Participants with a severity score of 0 meant they were asymptomatic, and were fully healthy for that given week.²⁸ This was used as an objective measure to determine overuse problems for the shoulder or

elbow, and was used to create dichotomous overuse symptom scores (i.e. score of “0” or “1”) for both preseason and the competitive season time periods. Individuals were identified as having preseason overuse symptoms (i.e. score of “1”) if they reported any overuse symptom during the 4 weeklong preseason. Individuals were identified as having competitive season overuse symptoms (i.e. score of “1”) if they reported any overuse symptom during the eight week competitive season time period.

Statistical Analysis

Data analyses were conducted using the Statistical Package for the Social Sciences version 23.0 (SPSS, Inc., Chicago, IL). Initial chi-square analyses were performed to assess relationships between FMS™ or SFMA performance category and presence of any overuse symptom during the preseason or competitive season. Logistic regression analyses assessed relationships between FMS™ or SFMA performance category and presence of any overuse symptom during the preseason or competitive season, while controlling for effects of grade and position. Statistical significance was determined *a priori* at $p < 0.05$. Power analyses revealed that for the chi-square analyses 88 subjects were needed to identify a moderate effect size of 0.30 at an alpha level of 0.05 and an achieved power of 0.80. For logistic regression analyses 113 subjects were needed to achieve an odds ratio of 2.0 at an alpha level of 0.05 and an achieved power of 0.80.

RESULTS

The primary positions of the 135 participants initially enrolled in this study were: pitchers ($n=60$), catchers ($n=16$), middle infielders ($n=31$), corner infielders ($n=34$), and outfielders ($n=29$) (several participants documented splitting time played between multiple positions). Although 135 participants were initially enrolled in the study, not all submitted complete responses to the questionnaires. As a result of missing data, 60 participants were included in the chi-square and logistic regression analyses assessing relationships between FMS™ performance category and presence of any overuse symptom during the preseason. Chi-square and logistic regression analyses assessing relationships between FMS™ performance category and presence

of any overuse symptom during the competitive season were performed on data from 36 subjects. Similarly, 60 and 36 participants were included in the chi-square and logistic regression analyses assessing relationships between SFMA performance category and presence of any overuse symptom during the preseason and competitive season, respectively.

FMS™ Score

Poor FMS™ performance was associated with an increased likelihood of experiencing at least one overuse symptom during the preseason both with (adjusted odds ratio [OR] = 5.14, $p = 0.03$) and without (unadjusted OR = 3.73, $p = 0.03$) controlling for the effect of grade and position (Table 2). FMS™ performance was not associated with experiencing at least one overuse symptom during the competitive season in either chi-square or logistic regression analysis.

SFMA Score

Poor SFMA performance was only associated with an increased likelihood of experiencing at least one overuse symptom during the preseason when controlling for the effect of grade and position (adjusted OR = 6.10, $p = 0.03$) (Table 2). Poor SFMA performance was associated with an increased likelihood of experiencing at least one overuse symptom during the competitive season both with (adjusted OR = 17.07, $p = 0.03$) and without (unadjusted OR = 5.71, $p = 0.046$) controlling for the effect of grade and position.

DISCUSSION

There were several primary findings in this research. Participants with poor FMS™ scores (scores of 0 or 1) were more likely to experience at least one overuse symptom in their shoulder or elbow during the preseason when compared to participants with good FMS™ scores (scores of 2 or 3), independent of grade or position; the same was true of SFMA performance. There was no association between FMS™ performance and overuse symptoms during the competitive season. SFMA performance however, was related to overuse symptoms during the competitive season independent of grade or position.

These findings suggest upper extremity movement screens may help identify players at an increased risk of developing overuse symptoms during the

Table 2. Relationship between FMS™ or SFMA performance categories and overuse symptoms

	Unadjusted ^b		Adjusted ^c	
	Odds Ratio (95%CI)	p-value	Odds Ratio (95%CI)	p-value
FMS™ Performance^a				
Preseason (n=60)	3.73 (1.14, 12.20)	0.03*	5.14 (1.15, 22.94)	0.03*
Competitive Season (n=36)	2.08 (0.52, 8.33)	0.49	4.22 (0.55, 32.24)	0.17
SFMA Performance^a				
Preseason (n=60)	2.50 (0.80, 7.81)	0.16	6.10 (1.22, 30.55)	0.03*
Competitive Season (n=36)	5.71 (1.12, 29.41)	0.046*	17.07 (1.39, 210.20)	0.03*

Note: CI = Confidence Interval; FMS™ = Functional Movement Screen; SFMA = Selective Functional Movement Assessment
^aGood performance is reference group
^bUnadjusted OR and p-value calculated from 2x2 contingency table
^cAdjusted OR calculated from binomial logistic regression
 *Statistically significant odds ratio at p < 0.05

preseason. These findings are similar to those previously published on FMS™ shoulder mobility scores and shoulder injuries. Poor performance on the FMS™ shoulder mobility has been previously demonstrated in collegiate athletes who self-report prior shoulder injuries or shoulder surgeries.²⁹ These potential relationships may be explained by sport-specific adaptations that typically occur in the dominant arms of baseball players, particularly glenohumeral internal rotation deficits (GIRD). GIRD is a condition resulting in the loss of internal rotation of the glenohumeral joint as compared to the contralateral side.^{9,14,30,31} This altered range of motion is likely due to a combination of soft-tissue and structural changes in anatomy. The stress of throwing may create a chronic stretching of the anterior capsule and tightening of the posterior capsule; leading to changes in soft-tissue creating instability and impingement.³²

It is unclear why SFMA scores were related to overuse symptoms during the competitive season, whereas FMS™ scores were only found to be significant during the preseason. It could be due to differences in scoring criteria. There is a margin for asymmetry to exist on either arm with the FMS™, since the arms are reciprocally being tested. The cutoff range to score (3, 2, or 1) has a distinct benchmark for allowable distance between the fists as the subject attempts to concurrently reach behind their back. The SFMA however, only has the criteria to touch a landmark of either the inferior angle of the opposite scapula in pattern one, or the spine of the opposite scapula in pattern two. An inability to reach the landmark could occur with as little as

a half-inch distance, or six inches of distance, with both resulting in the score of DN if no pain was present. An inability to touch such landmarks may be the threshold of minimum mobility that is necessary to reduce the chances of overuse.

Knowledge gained through this research suggest that the FMS™ shoulder mobility and SFMA upper extremity patterns may provide value in a pre-season screen for collegiate baseball players. These screens quickly and accurately identify individuals who have limited or painful mobility, and poor performance on both screens increased the likelihood of overuse severity symptoms in the preseason, while the SFMA performance was also associated with increased likelihood of overuse severity symptoms in the competitive season. However due to the wide confidence intervals surrounding the odds ratios the true extent to which FMS™ and SFMA scores are related to increased risk of experiencing overuse symptoms is uncertain.

This study is not without limitations when interpreting the data. The sample included in this study was a convenience sample of four area colleges. Overuse symptoms were self-reported by the athletes and therefore may be underreported. Due to subject attrition with questionnaire responses, this study ended up being underpowered, possibly explaining some of the insignificant findings. Fatigue, conditioning levels, pitch counts, and throwing velocities were not included in this study and so we were unable to assess the relationship between FMS™ or SFMA performance and overuse symptoms independent of these other proposed injury risk factors. The total volume

of throwing each subject encountered throughout the 2015 summer and fall seasons and 2016 spring season was not controlled for, nor could the amount of outside physical activity that may contribute to shoulder or elbow related injuries (i.e. strength and conditioning programs, physical labor jobs, etc.). The questionnaire used in this study was a modified version of the OSTRC overuse questionnaire which has currently only been validated for knee injuries.

Future research should investigate other sports with repetitive overhead motions such as tennis, swimming, volleyball, javelin, football quarterbacks, etc. It may also prove valuable to quantify movement competency in other regions of the body, along with the shoulder and elbow because dysfunctional movement in the upper extremities may influence dysfunctional movement elsewhere in the kinetic chain, possibly increasing both the acute and chronic stress on the shoulder or elbow. Lastly, an intervention study aimed at improving participants' movement scores through various strategies (e.g. static stretching, dynamic movements, shoulder stability exercises) is necessary to develop rehabilitation protocols that improve scores and subsequently reduce the risk of overuse symptoms.

CONCLUSIONS

This study identified relationships between FMS™ performance, SFMA performance, and overuse symptoms in DIII collegiate baseball players. Specifically, participants with poor FMS™ performances may be more likely to experience at least one overuse symptom in their shoulder or elbow during the preseason. Additionally, individuals with poor SFMA performances may be more likely to report overuse symptoms during the preseason or competitive season. Implementing the FMS™ shoulder mobility screen and SFMA upper extremity patterns into baseball pre-participation screens may help identify individuals most likely to experience overuse symptoms over the course of a season.

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