THE EFFECT OF AN INTERVENTION PROGRAM ON FUNCTIONAL MOVEMENT SCREEN TEST SCORES IN MIXED MARTIAL ARTS ATHLETES

JAMIE G. BODDEN, ROBERT A. NEEDHAM, AND NACHIAPPAN CHOCKALINGAM

Center for Sport, Health and Exercise Research, Faculty of Health Sciences, Sport & Exercise, Staffordshire University, Stoke on Trent, United Kingdom

ABSTRACT

Bodden, JG, Needham, RA, and Chockalingam, N. The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes. J Strength Cond Res 29(1): 219–225, 2015—This study assessed the basic fundamental movements of mixed martial arts (MMA) athletes using the functional movement screen (FMS) assessment and determined if an intervention program was successful at improving results. Participants were placed into 1 of the 2 groups: intervention and control groups. The intervention group was required to complete a corrective exercise program 4 times per week, and all participants were asked to continue their usual MMA training routine. A mid-intervention FMS test was included to examine if successful results were noticed sooner than the 8-week period. Results highlighted differences in FMS test scores between the control group and intervention group ($p = 0.006$). Post hoc testing revealed a significant increase in the FMS score of the intervention group between weeks 0 and 8 ($p = 0.00$) and weeks 0 and 4 ($p = 0.00$) and no significant increase between weeks 4 and 8 ($p = 1.00$). A $\chi^2$ analysis revealed that the intervention group participants were more likely to have an FMS score $>14$ than participants in the control group at week 4 ($\chi^2 = 7.29, p < 0.01$) and week 8 ($\chi^2 = 5.2, p \leq 0.05$). Finally, a greater number of participants in the intervention group were free from asymmetry at week 4 and week 8 compared with the initial test period. The results of the study suggested that a 4-week intervention program was sufficient at improving FMS scores. Most if not all, the movements covered on the FMS relate to many aspects of MMA training. The knowledge that the FMS can identify movement dysfunctions and, furthermore, the fact that the issues can be improved through a standardized intervention program could be advantageous to MMA coaches, thus, providing the opportunity to adapt and implement new additions to training programs.

KEY WORDS assessment, corrective, exercise, training, prehabilitation

INTRODUCTION

Strength and conditioning programs have become a fundamental aspect of the modern day mixed martial arts (MMA) athlete (2,3,31). The goal of any strength and conditioning program is to improve performance and help prevent the risk of injury by enhancing the stability of a joint through improving strength of the surrounding musculature (2,13). Amtmann and Berry (2) and Amtmann (1) stated that boxers and MMA athletes had a tendency to develop the anterior musculature greater than the posterior musculature. This could be a consequence of the myth that training the chest and arms using pushing movements, such as the bench press, created greater punching power (12) or maybe strength and conditioning programs have become too specific to meet the demands of the sporting movement. Other common anterior dominant exercises used in boxing and MMA training were abdominal exercises such as sit-ups or crunches (2,12,29). Recently, there has been a debate on the inclusion of such spinal flexion exercises into training programs. McGill (24) recommended a complete exclusion of these repeated spinal flexion exercises. Moreover, in a recent podcast, McGill (25) elaborated on this topic and stated that repeated flexion would cause delamination of the annulus between the intervertebral disk, thus allowing the nucleus to pass though causing a herniation.

Amtmann and Berry (2) and Amtmann (1) documented that the anterior dominance would create a muscle imbalance that could be detrimental to the athlete, exposing them to increased risk of injury. This statement coincided with the work of Sahrmann (30) who stated that repeated movements or prolonged postures may cause a change in movement patterns through tissue adaptation, consequently altering motor control. One area of prolonged posture observed in contact sports is the chin down or tucked position causing a kyphotic and rounded shoulder posture (21).
Cook et al. (7) established that numerous strength and conditioning programs often failed to take into consideration the quality of the client's basic fundamental movements; pre-activity movement screening would be advantageous to establish competency without compensation. Moreover, individuals who continue to train using unsatisfactory movement patterns would be more susceptible to injury, thus adding "fitness on movement dysfunction" (6). The functional movement screen (FMS) is an assessment tool developed to investigate the fundamental movement patterns of individuals (5,20). The FMS consists of 7 fundamental movement pattern assessments and 3 clearing tests requiring mobility, stability, and balance; each test is scored on a scale of 0–3 with a maximum value of 21 for the 7 tests (6). Normative FMS values of general active males have been reported to be 15.8 ± 1.8 (32).

Kiesel et al. (20) and Kiesel et al. (19) stated that the FMS had the ability to predict athletes at risk of injury and established athletes who scored below =14 on the FMS were 11 times more likely to become injured throughout the season. Furthermore, Kiesel et al. (19) reported that athletes who possessed an asymmetry were 3 times more likely to become injured even with scores above the injury risk factor of 14. Similar results were seen in the military population; Raleigh et al. (28) reported that recruits who scored ≤14 were twice more likely to sustain a musculoskeletal injury and not graduate the training camp.

Corrective exercises have been developed to retrain dysfunctional movement patterns, establish symmetrical movement, and balance posture (6). To establish if FMS scores could be enhanced, Kiesel et al. (18) carried out a study to determine if an intervention program of corrective exercises improved the results of subjects to above the injury risk factor of 14 and corrected any asymmetry. The study results confirmed that the intervention significantly increased the number of players who were above the injury risk factor of 14 and also significantly increased the percentage of players who were free of symmetry. Yet, the study failed to include a control group; therefore, it is difficult to determine how effective the intervention program was. Cowen (8) examined FMS scores in fire fighters before and after an intervention program consisting of yoga techniques. The results revealed that the intervention significantly improved FMS scores to above the injury risk factor of 14. However, no control group was included, and it was noted from a pre-activity questionnaire that subjects were very physically active outside of work, which could have impacted on results. Conversely, Frost et al. (14) reported no significant increase in FMS scores when comparisons were made against a control group during an intervention program. However, the study appeared to portray confounding factors that could have impacted the outcome. Although the decision regarding FMS exercise selection was made by coaches based on the initial screening results, the programs were instructed by strength and conditioning professionals who were unaware of the results. Furthermore, the study does not specify if the professionals assigned to implementing the intervention had any prior experience or certification regarding corrective exercises; skill to oversee corrective exercise could vary significantly between individuals. Finally, there was a high priority placed on strength, power, and aerobic development for the intervention group. However, if the program was generic for all participants, particular exercises could have been contraindicated depending on limitations and weakest links identified from the initial screening, therefore, could have negated the corrective exercise focus.

Although not all movement screens are identical and it does not apply to all athletic populations, this study focuses on MMA. Although there are reports on factors leading to injuries within this group (1,2), there is a clear paucity of information on functional screening, which would inform exercise and strength conditioning prescription, which will have an effect on reducing injuries. Furthermore, the reliability of FMS has been scrutinized by previous research and has been reported to have a strong inter- and intra-tester reliability (17,26,34).

The purpose of this study was to assess the basic fundamental movements of semiprofessional MMA athletes using the FMS assessment and to determine if an 8-week intervention program was successful at improving FMS scores. Importantly, a control group and an intervention group were included. A mid-intervention FMS test was integrated at week 4 to examine if successful results were noticed sooner than the 8-week period as recommended by Kiesel et al. (18). In addition, the study determined if there were a greater number of players above the injury risk factor of 14 poststudy compared with prestudy. Also, because of the previously discussed literature linking asymmetries with risk of injury, the study examined whether a greater number of players were free from asymmetry at the end compared with at the start.

**Methods**

**Experimental Approach to the Problem**

Mixed martial arts fighters volunteered to participate and were placed into 1 of the 2 groups: intervention and control groups. Their FMS scores were measured before, during, and after an 8-week intervention program. Participants in the intervention group were required to complete a corrective exercise program 4 times per week; this quantity has previously been successful at improving FMS scores (18). All participants were asked to continue their standard MMA training routines.

**Subjects**

The participants in this study included 25 male MMA athletes competing at a semiprofessional level, with a mean age of 24.31 ± 4.46, height (cm) 178.42 ± 732, and weight (kg) 78.38 ± 10.67. All participants were clear of any musculoskeletal disorder and had been in full unrestricted training. University ethics review board approved the study, and all the participants gave their informed consent before any data collection.

**Procedures**

The data collection, intervention program design, and implementation were carried out by an FMS level-2 certified...
coach. The reliability of the FMS has been reported by Minick et al. (26), who established the FMS to have a high interrater reliability and proposed reliable scores could be achieved by individuals who have completed the standard FMS program. The corrective exercise intervention program followed the exercise selection guide as recommended in the FMS advanced corrective exercise manual (15) and on the FMS certification training course instructed by D'Agati and Jones (10). Because the current physical activity of the participants might have an impact on the outcome of this study, the participants who already follow a training regime were instructed not to change from their training routine. This study assessed the improvement from this baseline.

Before data collection, corrective exercise programs for each of the 7 FMS tests were filmed. After the filming, screenshots were taken to produce paper file exercise programs and, subsequently, Internet video files were created within the video analysis software (Dartfish Pro Video Analysis Software v.4.5; Dartfish company, Fribourg, Switzerland) to produce video exercise programs. The participant’s gym location determined placement into the control or intervention group. The rationale for this grouping was based on the competitive nature of the participants and the sport in general. This experimental design enabled us to reduce the confounding variables by avoiding the participants modifying their training program with an influence from the other experimental group.

The administration of the FMS was carried out in accordance with the previously published guidelines (6); other than the verbal instructions, no additional coaching points were used during the screening process. The intervention program was 8 weeks in duration and included an FMS test at week 4 to monitor progress as recommended by Kiesel et al. (18). The individual programs were based on the algorithm recommended by Cook (6) and focused on the weakest and asymmetrical scores, with primary focus on mobility patterns and secondary moving onto stability patterns if appropriate. The testing procedures were scheduled in such a way that it ensured no influence from other confounding factors, such as the time of the day, had an impact on the movement capabilities of the participants.

Statistical Analyses
To carry out the statistical analysis, the subjects were divided into the control and intervention groups. The main hypothesis was interpreted using a “mixed between-within subjects analysis of variance (ANOVA)” as described by Pallant (27) to compare between the groups and within the time frames in the intervention program. A post hoc Bonferroni test established whether there was a significant increase in FMS scores and at what point in the intervention program the significance occurred. A 1-way ANOVA was used to establish where the significance was between the control and intervention groups at each of the 3 test periods (27). The analysis of the subsequent hypothesis was performed using a χ² test for independence to determine if the group was related to improvement over the injury risk factor.

Results
A significant main effect was found for the groups, highlighting differences in FMS test scores between the control group and intervention group (f² = 9.26, p = 0.006) (Figure 1). There was also a significant time by group interaction effect for FMS test scores during the intervention program (f² = 11.33, p = 0.00). A post hoc Bonferroni test revealed a significant increase in the intervention groups’ FMS score between weeks 0 and 8 (p = 0.00). In addition, for the intervention group, post hoc testing identified a significant increase in FMS scores between weeks 0 and 4 (p = 0.00) and no significant increase between weeks 4 and 8 (p = 1.00) (Figure 1). This suggested that a 4-week intervention program was sufficient at improving FMS test scores.

A 1-way ANOVA was used to further identify where the differences were between the groups and at what time periods. It was established that there was no significant difference in FMS test scores between the control and
intervention groups at week 0 ($f = 0.002$, $p = 0.962$). There
were significant differences in FMS scores at week 4 ($f = 15.51$, $p = 0.001$) and week 8 ($f = 14.40$, $p = 0.001$) (Figure 1). This highlighted the
improvements in FMS test scores for the intervention group at week 4 and week 8 compared with the control group (Figure 1).

At the initial test period, only 1 participant displayed a score of above the injury factor of 14 (Figure 2). A $\chi^2$ analysis revealed significant differences based on group and FMS score $\leq 14$ or $>14$. Figure 2 illustrates that participants who followed an 8-week intervention program were more likely to have an FMS score $>14$ than participants in the control group ($\chi^2 = 5.2$, $p \leq 0.05$). Additionally, significant improvements in FMS score to above the injury risk factor of $>14$ were identified after week 4 testing ($\chi^2 = 7.29$, $p < 0.01$) (Figure 2).

Finally, the results highlighted that a greater number of participants in the intervention group were free from asymmetry at week 4 and week 8 compared with the initial test period (Figure 3).

**DISCUSSION**

To the authors’ knowledge, this was the first study to include both a control group and an intervention group with a mid-intervention test and to compare differentials between groups and changes in FMS test scores based on an intervention
The results uphold that there was a significant difference in FMS test scores between control and intervention groups at both 4- and 8-week periods. Additionally, the results of this study suggested that a 4-week intervention program of corrective exercise was successful at significantly improving FMS scores. Although post hoc testing revealed no significant improvements in the intervention groups’ test scores between weeks 4 and 8, care should be taken when interpreting this outcome. It was noticed that a number of subjects at week 4 testing achieved considerable improvements in FMS scores, which in theory would have changed the subjects’ weakest movement patterns and, furthermore, their corrective exercise program. However, to standardize the study, subjects persisted with the program from the initial screening for the entire 8-week period. A built-in exercise progression would have been valuable at week 4 to target the change in the weakest links of the improved subjects, which consequently could have produced further improvements during this period.

Because of the limited research including both a control group and an intervention group while implementing an intervention program to improve FMS scores, it was difficult to compare the differences established in the current study with previous literature. However, significant improvements in FMS scores after a standardized intervention program compared with previous research were established in American footballers (7) and fire fighters (8). Additionally, this study established similar findings to Frost et al. (14) regarding a large number of participants with the score of 2 on particular tests. Furthermore, a score of 2 encompassed a broad range of movement quality and differences between subjects, i.e., good 2’s and bad 2’s. However, based on the scoring criteria, the same score had to be given. Frost et al. (14) tried to overcome this problem by using a modified 100-point scoring system based on possible compensations. However, the criteria could be complex to implement without video analysis, which could taint the FMS ability to be a simplistic and time-effective screening tool. That been said, it should not deter coaches making notes during the screening process, with regard to the compensations identified, until a superior live scoring system is available.

The results also indicated that the intervention program significantly increased the number of participants whose scores exceeded the previously established injury factor of 14. When exclusively focusing on the intervention group, pre-intervention testing (week 0) identified that no participant scored above the injury factor of 14, whereas, at 4- and 8-week test periods, 66% of participants increased scores to >14. These findings are comparable with the results of Kiesel et al. (18), who reported that 11% of participants pre-intervention scored >14 compared with 63% postintervention. Finally, the results highlighted that a greater number of participants in the intervention group were free from asymmetry at week 4 and week 8 testing compared to the start of the study.

The mean pre-intervention FMS test scores for both the control and intervention groups were 13.23 ± 0.80 and 13.25 ± 0.87, respectively. These results were compared with the scores of professional nonlinemen American football players who displayed a mean score of 13.3 ± 1.9 (18) and fire fighters 13.25 ± 2.25 (8). The mean postintervention test scores were 15.17 ± 1.21 (week 4) and 15.33 ± 1.43 (week 8), which were comparable to values of general active males 15.8 ± 1.9 (32). In addition, the results from the pre-intervention screening revealed a number of trends regarding dysfunctional movement patterns in both control and intervention groups, including 13 shoulder mobility scores of 1 or asymmetries and 10 active straight leg raise (ASLR) scores of 1 or asymmetries. Although the sample size was small, the participants came from 5 unconnected gyms and were under the instruction of different coaches resulting in a variety of training methods and, therefore, represented a varied population, suggesting the movement dysfunctions could be a common trait apparent in other MMA fighters at this level.

Further investigation of the initial screening identified that all asymmetrical ASLR scores were superior on the dominant kicking leg. This could be a consequence of the continued use of the limb during training and competition. As Turner (35) suggested, limb dominance was 1 of 3 demands placed on the body that could influence functional asymmetries.

Insufficient lumbar pelvic stability may have affected ASLR scores when assessed under the FMS procedure. Hip flexion with decreased lumbar pelvic stability may have caused an anterior rotation of the pelvis, consequently, lengthening the hamstrings because of the biarticular nature (4), therefore, giving a false representation of a tight or short hamstring. Liebenson et al. (23) documented that core engagement through abdominal bracing before the ASLR significantly increased muscle activity around the lumbar pelvic region, which, in turn, increased lumbar spine stability. Liebenson et al. (23) hypothesized that the increased muscle activity may have also facilitated pelvic stability. When taking into account the above research, leg lowering with core engagement, as outlined in the FMS advance corrective manual (15), was used in the corrective strategies to help target this issue. The exercise initiated core activation with a cook resistance band before dissociating the legs, consequently helping stabilize and resequence the muscle activation, altering motor control of the leg raising pattern (4).

The low scores on the ASLR could also be attributed to poor flexibility of the hamstring muscle group, and this would relate back to the research of Schick et al. (33) who established sit and reach test results in MMA athletes to be 30.3 cm ± 10.6, compared with kung-fu athletes’ 45.6 cm ± 6.1. Schick et al. (33) suggested that this was a result of MMA training focusing on flexibility to a lesser extent than more traditional martial arts, which integrated flexibility as an integral aspect of training.

Finally, a common movement was observed during the preliminary testing, which influenced some of the low scores and/or asymmetries on the ASLR. A number of participants failed to sustain the neutral position of the nonmoving
(downward) limb and had a tendency to externally rotate to facilitate the movement of the raised leg. This movement pattern is noted as compensation in Cook (6) and, therefore, had to be taken into account when scoring. External rotation of downward limb is a common and critical feature of the various kicks in MMA to allow rotation of the hip and knee. Because kicking in MMA requires tri-planar movement, it cannot be a direct comparison to the ASLR, which is assessing movement strictly in the sagittal plane. However, it is an active leg raise requiring hip flexion/knee extension of the moving leg and hip extension of the downward leg, disassociating 1 leg from the other; all of which are major components of the ASLR assessment. Therefore, subjects could have displayed a sports-specific adaptation from kicking; moreover, would correcting this movement pattern compensation on the FMS affect the participants’ sporting performance?

Shoulder mobility was another limitation apparent in both control and intervention groups. A possible mechanism behind the insufficient scores in shoulder mobility could be related back to the observations of Amtmann and Berry (2) and Amtmann (1), who recognized that MMA athletes had a propensity to develop the anterior muscles greater than the posterior muscles. The anterior imbalance could accelerate the kyphotic posture adaptations previously identified by Kritz and Cronin (21) in combat athletes, through muscle architecture alterations. Consequently, adaptations in posture such as kyphosis and rounded shoulders have been reported to reduce glenohumeral mobility (9,22). However, in some instances especially whilst the fight is taking place on the feet, this suboptimal posture is actually advantageous for MMA athletes, acting as a defense mechanism from punches and kicks. Although advantageous, these adaptations would need managing through corrective exercise for other aspects of the sport and training.

Another possible reason for insufficient scores and asymmetries may compile from specificity of training becoming too specific, with exercises imitating the biomechanical demands of the sport (16). Most sports-specific exercises are unilateral; Graham-Smith et al. (16) examined a common reverse punch adapted exercise from boxing, using both a dumbbell and a cable column; the exercise required repetitive use of a limb under load. Repetitive use of a unilateral movement in baseball pitchers has been reported to reduce shoulder mobility internal rotation compared with the contralateral side (11). This could compare with the repetitive use of a limb during MMA competition, sparing, and the aforementioned sports-specific exercise training. Graham-Smith et al. (16) suggested that the inclusion of such sports-specific exercises would justify the addition of nonspecific exercises to correct imbalance and asymmetry adaptations.

**Practical Applications**

The FMS would be an advantageous addition to pre-exercise screening assessments, as the consideration of movement quality should be assessed before that of quantity. Most if not all, the movements covered on the FMS relate to many aspects of strength and conditioning and MMA. The knowledge that the FMS can identify movement dysfunctions and, furthermore, the fact that the issues can be improved through a standardized intervention program of corrective exercise could be advantageous to MMA coaches and strength and conditioning specialists, thus providing the opportunity to adapt or implement new additions to training programs, based on the dysfunctions and limiting factors identified using the FMS. Without the FMS, coaches and fitness professionals could be implementing exercises onto an insufficient movement foundation and causing further problems.

**References**


