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Original Article

The effectiveness of eight weeks of a movement-based program on functional movement patterns in male professional soccer players

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Abstract:

Poor functional movement is a risk factor for injuries in soccer players. Players with dysfunctional movement patterns, measured by the Functional Movement Screen (FMSTM), are more likely to suffer an injury compared than those who have higher scores on the FMSTM. The purpose of our study was to assess the effectiveness of 8-weeks of functional movement-based training on fundamental movement patterns. Two groups of Professional male soccer players (experimental, N=15, and control N=15), aged between 18 and 28, of an Italian second division team were compared using the pre-post FMSTM scores after intervention. RM-MANOVA 2 Groups (experimental and control) X 2 Test (pre and post) on the FMS scores revealed a significant a difference for the interaction between Groups and Tests (Wilk's lamba .712, $F(3,26) = 3.50$, $p = .029$ Eta2 = .288 Power .713). Following Univariate results on the three subscales of the FMSTM revealed significant interaction between group and test on advanced movement ($F(1,28) = 5.19$, $p = .03$, eta2 =.157, observed power .595) and mobility ($F(1,28) = 3.89$, $p = .050$, eta2 =.122, observed power .478) but not on stability ($p = .305$). The results of this study suggest that an 8- week intervention program was an effective way for improving FMSTM scores in a group of male professional soccer players, particularly for advanced movement and mobility subscales. From an applied point of view this findings provide more evidence on the efficacy of qualitative intervention on functional movement pattern improvement that is related to the injury prevention and suggest the importance of specific movement-based intervention with soccer players.
Key words: Functional movement screen, professional soccer players, injury

Introduction

Injury is a huge problem in professional sport and it affects so many athletes to such an extent that they are often forced to withdraw from competitions (Emery & Pasanen, 2019). Specifically, in soccer the incidence of injuries is quite high. For instance, Ekstrand, Hägglund and Waldén (2011) (Altavilla, Raiola, 2018, Raiola, D'Isanto, 2016) examined the injuries' characteristics in soccer players investigating 23 teams selected among the top 50 in Europe. They found that the incidence of injuries was 8 every 1000 hours of practice, with a greater probability that they occur during the match rather than during training practice, especially during the competitive season (i.e., September to May), when most high-intensity matches are played. Moreover, they highlighted that injury can occur towards the end of each half, when fatigue increase and the amount of high-intensity running and technical performance is lowered. A variety of intrinsic factors predispose athletes to injury, including structural abnormalities, agonist/antagonist muscle ratios for strength, endurance and contra-lateral muscular imbalances (Chorba, Chorba, Bouillon, Overmyer & Landis, 2010). As sport-related injuries occur frequently, steps to reduce injuries can have an impact on their frequency and associated costs. Soccer is a sport that requires different skills such as speed, power, explosiveness, balance and neuromuscular coordination, and exposes players to direct contact with the opponent; in fact, most of the injuries in this sport are caused by contrasts, therefore defined as traumatic accidents (Tegner & Lorentzon, 1991). Despite the contact between players is the main cause of injuries occurred in the game, most of the injuries found in training have an indirect traumatic nature (Agel, Arendt & Bershadsky, 2005). In soccer players, most of the injuries involve hamstring strains and traumas of the tendons and ligaments of the knees. It has been estimated that between 50% and 80% of these injuries are excessive in nature and affect the lower limbs. Emery and Meeuwisse (2010) confirmed that the tibio-tarsal joint and the knee joint are those most prone to injury in the practice of soccer. The main causes are of a musculoskeletal nature: recent studies have recorded an increase in the recognition of muscular imbalances, poor neuromuscular control and instability of the nucleus as potential risk factors for athletic injuries; corrective exercises have been developed to retrain dysfunctional movement patterns, establish symmetrical movement, and balance posture. Cook, Burton and Hoogenboom (2006) 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

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without compensation. Moreover, individuals who continue to train using unsatisfactory movement patterns would be more susceptible to injury, thus adding "fitness on movement dysfunction". One screening tool that has gained in popularity among physical therapists, athletic trainers, strength and conditioning coaches and fitness professionals is the Functional Movement Screen (FMS^{TM}; Cook et al., 2006). The FMS^{TM} has been widely used as a pre-participation evaluation tool to identify levels of proficiency in seven fundamental movement patterns. The FMS^{TM} was originally developed to help in assessing functional movement insufficiencies and asymmetries in the healthy population, as well as to identify risk of injury. Additionally, tailored intervention programs could be designed to correct movement pattern dysfunction, and to create a baseline for observation through research. Its low cost, its simplicity of application and its non-invasive qualities contribute to develop its use by professional and amateur athletes. To perform the FMS^{TM}, an examiner observes the subject while performs seven fundamental movements in order to identify non-functional movement patterns. Muscle imbalances can lead to compensatory motion patterns, resulting in poor biomechanics, micro or macro lesions poor functional movement is a risk factor for injuries in soccer players. Players with dysfunctional movement patterns, those measured by the FMS, are more likely to suffer an injury than those who score higher on the FMS^{TM}. Kiesel, Plisky and Voight (2007) stated that the FMS^{TM} 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. Moreover, Chorba et al. (2010) have even hypothesized that with scores lower than 14 on the FMS^{TM} there is an increase of about 4 times the risk of lower limb injuries in soccer players. Later, Kiesel, Plisky and Butler (2011) 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. Furthermore, Lisman, O'Connor, Deuster and Knapik (2013) examined a population of US Marines and found that a score of 14 or less on FMS^{TM} showed limited ability to predict all traumatic musculoskeletal injuries, confirming previous studies.

Corrective exercises have been developed to retrain dysfunctional movement patterns, establish symmetrical movement, and balance posture. To establish if FMS^{TM} scores could be enhanced, Kiesel et al. (2011) 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. Their findings 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 asymmetry. Yet, the study failed to include a control group; therefore, it is difficult to determine how effective the intervention program was. Cowen (2010) examined FMS^{TM} scores in fire fighters before and after an intervention program consisting of yoga techniques. The results revealed that the intervention significantly improved FMS^{TM} scores to above the injury factor of 14. In a recently study, fifty-six male firefighters volunteered to participate in a program to examine the effects of an 8-week individualized corrective exercise training program on Functional Movement Screen (FMS^{TM}) scores. A significant increase in total FMS^{TM} score was found after the program (Stanek, Dodd, Kelly, Wolfe & Swenson, 2016).

In order to support the study by Kiesel et al. (2011), and overcome the limitation of the absence of the control group, the purpose of our study was to assess the effectiveness of 8-weeks of functional movement-based training on fundamental movement patterns. Two groups of Professional male soccer players (experimental and control) of an Italian second division team were compared using the pre-post FMS^{TM} scores after intervention. The Hypothesis is that the total FMS^{TM} scores (and related subscales) of experimental group of players would be higher after 8-week of specific intervention program based on functional movement pattern. Specifically we expect to see an improvement in some specific subscales such as advanced movement, mobility and stability.

Materials & Methods

Design

Experimental cross over repeated measure design non-counterbalanced.

Participants

A sample of 30 male soccer players aged between 18 and 28, members of the same soccer team of the Italian 2nd division championship, have been involved in the study. They were randomly divided into two groups (15 in the Experimental Group and 15 in the Control Group). Information about their body mass index and year of professional practice are described in Table 1.

Table 1. Characteristics of the study participants

Group	Age (years)	Body height (cm)	Body mass (kg)	BMI (kg/m2)	Year of professional practice
Experimental (N.15)	23.80 (± 4.6)	178.6 (±4.1)	75.1 (±3.9)	23.5 (±1.3)	6 (±2)
Control (N.15)	24.78 (±2.08)	177.2 (±0.15)	76.35 (±3.71)	24.2 (±2.1)	6 (±3)

Instruments and materials

We used the FMSTM screening system in order to assess the fundamental movement patterns. Cooke et al. (2006). The FMS™ include seven fundamental movement patterns (tests) that require a balance of mobility and stability (including neuromuscular/motor control). These fundamental movement patterns are designed to provide observable performance of basic locomotor, manipulative, and stabilizing movement. Specifically they are: 1) the deep squat that evaluates the functional mobility of hips, knees and ankles; 2) the obstacle that examines the mechanics of the step; 3) the in-line lunge that evaluates the mobility and stability of the hip and trunk, flexibility of the quadriceps and stability of the ankle and knee; 4) mobility of the shoulder that evaluates the range of movement and scapular stability; 5) the rise of the active straight leg that evaluates the flexibility of the rear chain; 6) the push-up of stability of the trunk; and 7) the rotary stability test that evaluates the stability of the multi-plane trunk. This 7 items can be grouped in three main subscales, which are named Advanced movement, Mobility and Stability (Kiesel et al. 2011). Mobility subscale include the active straight leg raise (ASLR) and shoulder mobility (SM). Stability subscale included the trunk stability push-up (TSP) and the rotary stability (RS) assessment. Advanced movements included the deep squat (DS), hurdle step (HS), and inline lunge (ILL).

For each test the players received a score from zero to three and the evaluation criteria are as follows: 0) the pain was reported during the movement; 1) failure to complete the movement or loss of balance during movement; 2) completion of the movement with compensation; and 3) execution of the movement without compensation. For each test the players performed three trials and the best one is recorded. Final scores for each test were summed to determine a composite score for the three subscales and the final total score of FMSTM.

Procedure

Data were collected in the gym of the team's sports center during two separate visits, with the pre-test occurring during the week prior to beginning the intervention program and the post-test occurring during the weeks after the conclusion of the intervention program.

Two FMSTM-certified athletic trainers performed the evaluation for each player individually. Trainers instructed the players using the standard suggestion of the test.

Therefore, the intervention group completed a 8-week movement-based program which duration was 30 minutes before the technical tactical session three times x week. The control group performed the standard training program, which was based on technical-tactical routing of warm up. The data collection formed part of the professional teams' routines in which players are frequently assessed across the season. Therefore, the normal ethics committee clearance was not required (Winter & Maughan, 2009). Nevertheless, to ensure team and player confidentiality, all identifying information on the athletes was removed before data analysis, which was performed by an assessor not involved in the FMSTM assessments and the investigation was conducted following the declaration of Helsinki guidelines.

The movement-based program (Table 2) did not require special and expensive equipment, but only elastics bands, medicine balls and foam rollers. It included self- administered trigger point treatment and individual or couple stretching of major muscle groups. Furthermore, strength and stability exercises were included in order to stimulate natural core muscle activation to enhance the relationship between core muscle function and fundamental movement (Cook & Fields, 1997). The first part of the program, which lasted 15 minutes, involved mobility and flexibility exercises (exercises from 1 to 6 in table 2). The remaining 15 minutes included exercises aimed at improving stability and posture (exercises from 7 to 13 in table 2). Each session has been supervised by a specialized trainer.

Table 2. The movement-based program

Exercise		Set	Time	Rest	Description
1	Foam Roller-Hamstring	1	1 min.	10 sec.	Start in supine position with hamstring placed directly on the foam roller. Roll the hamstring across the foam roller from high to low and outside to inside
2	Foam Roller-Adductor	1	1 min.	10 sec.	Start in prone position with foam roller positioned on the inside of the leg. Using both hands and the leg not on the foam roller as support of body weight, being to roll the groin muscle on the foam roller
3	Dorsiflexion from Half Kneeling with Dowel	2	20 sec.	5 sec.	Start in half kneeling position with stick on outside of foot. Lean forward take knee outside of stick. The heel of the front should maintain contact with the floor. Stretch should be in calf on the front foot

4	Strap Assisted Straight Leg Stretch with Ankle Circles	2	30 sec.	30 sec.	Start in supine posture by positioning the face up so that the back is on the floor. Starting by safely anchoring the band around the foot and place both feet on a bolster. Slowly lower the leg back down to the ground
5	Trunk Stability Rotation Knees Flexed	2	30 sec.	30 sec.	Layout on back, knees and hips flexed to 90 degrees, shoulder at 90 degrees and arms straight. Place a ball between the knees. Turn the knees to one side. Return to starting position and proceed toward the other shoulder
6	Prone T-Spine Rotation	2	20 sec.	5 sec.	Lying on the ground with the hips in contact with the ground and the upper body raised off the ground supported by the elbows. Take an arm and wrap it around your lower back so that the arm is locked. Turn to the side of the locked arm by turning the head.
7	Get-up Post to High Pelvis Bridge Isolations	2	20 sec.	3 sec.	With arms behind the back, plant both palms on the ground with the fingers pointed backward and off to the side. Bend one leg and extend the other. Being to bridge with the leg that is in the flexed position moving the hips up toward the ceiling
8	Plank	3	30 sec.	15 sec.	Start in a plank position with both forearms on the ground and the legs straight with the feet about shoulder width apart
9	Side Plank with Legs Straight	3	20 sec.	15 sec.	Position on side and create a bridge with elbow underneath the shoulder, the lower hip off the ground and the feet are split with the top leg in front and so the sides of shoes are flat on the ground
10	Hip Hinge Single Leg with Dowel	2	30 sec.	30 sec.	Stand with the feet shoulder with apart and a dowel running along the spine. Hands should be in reciprocal position. Flex forward on one hip with slight knee bend. The opposite hip is extended and foot backward. Alternate hand and foot positions between sets
11	Single Leg Stance with Core Engagement with elastic bands	2	20 sec.	30 sec.	Stand with the feet together in a narrow stance. Raise the arms overhead and grab onto each of the handles. While standing in a tall position being to pull both handles down towards the hips at the same time. Do the same movement with the other leg
12	Single Leg Chop with Med Ball	2	30 sec.	20 sec.	Start in a single leg stance position with one foot freely elevated. Take a med ball with both hands and begin with it up above the shoulder. In a diagonal pattern, throw the med ball toward the open side so it can be caught by a partner
13	Single Leg Lift with Med Ball	2	30 sec.	20 sec.	Start in a single leg stance position with the non-weight bearing leg forming a 90 degrees angle at the knee. Take a med ball with both hands and begin with it beside the thing of the down leg. In a diagonal pattern, throw the med ball toward the closed side so that the med ball can be caught by a partner

Statistical analysis

Data were preliminary checked for the analysis of the normal distribution through the Kolmogorov-Smirnov test. The test yielded no significant results ($p < .05$) for any subscale of the test indicating that the data met criteria for normality. Therefore, Repeated Measure Multivariate ANalysis of VAriance (RM-MANOVA) were performed comparing experimental and control groups for each dependent variable of the FMS^{TM} test, pre and post intervention. The statistical analysis was conducted using SPSS version 22.0 and the level of significance was set to $p<0.05$.

Results

Descriptive statistics are reported in table 3.

Table 3. Descriptive Statistics

	PRE		POST	
	Control M (SD)	Experimental M(SD)	Control M(SD)	Experimental M(SD)
Advances Movement	5.80 (1.2)	5.87 (0.64)	6.07 (1.16)	6.93 (0.59)
Mobility	4.40 (1.24)	4.93 (1.03)	4.27 (1.22)	5.33 (0.81)
Stability	3.87 (0.64)	3.73 (0.96)	3.87 (0.91)	4.07 (0.96)
Total FMS Score	14.07 (1.03)	14.53 (0.88)	14,21 (1.1)	16,33 (0.79)

RM-MANOVA 2 Groups (experimental and control) X 2 Test (pre and post) on the FMS scores revealed no differences between groups Wilk's lamba .797, $F_{(3,26)}$ = 2,22, p = .11. However, we found a significant difference within subjects for Test on FMS scores (Wilk's lamba .572, $F_{(3,26)}$ = 6.49, p =.002 Eta^2 = .428 Power .944) and more interest for the aim of the investigation a significant a difference for the interaction between Groups and Tests (Wilk's lamba .712, F(3,26) = 3.50, p =.029 Eta2 = .288 Power .713).

Following Univariate results on the three subscales of the FMS^{TM} revealed a statistically significant effect on Test on advanced movement (F$_{(1,28)}$_= 14.43, p _ .01, _eta2_ =.340, observed power .956) but not on Mobility (p = .332) and stability (p = .305). Moreover we found a univariate significant interaction between group and test on advanced movement (F$_{(1,28)}$ = 5.19, p = .03, eta^2 =.157, observed power .595) and mobility ($F_{(1,28)}$ = 3.89, p = .050, eta^2 =.122, observed power .478) but not on stability (p = .305). Figure 1 and 2 shows respectively the trend for Advanced Movement and Mobility which showed significant difference in the interaction between group and test. A qualitative analysis of the Figure 3 shows that the interaction between group and test did not reach significant level for Stability because the control group had a higher level of scoring before intervention with respect the experimental group and having a look to statistical analysis the variance was overlapped.

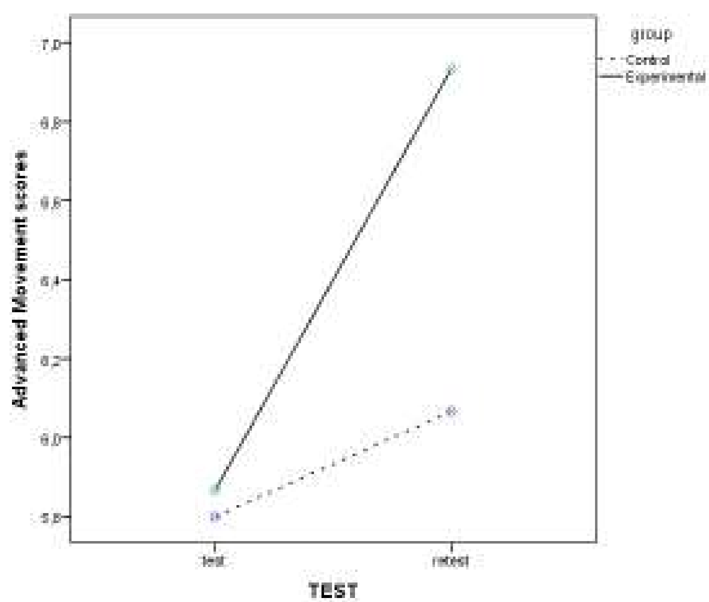

Fig. 1. Advanced Movement scoring for control and experimental group before and after intervention

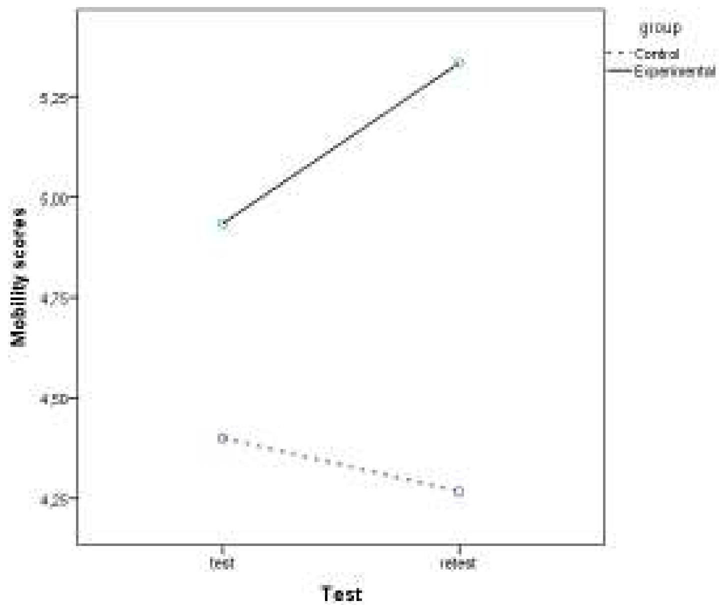

Fig. 2. Mobility scoring for control and experimental group before and after intervention

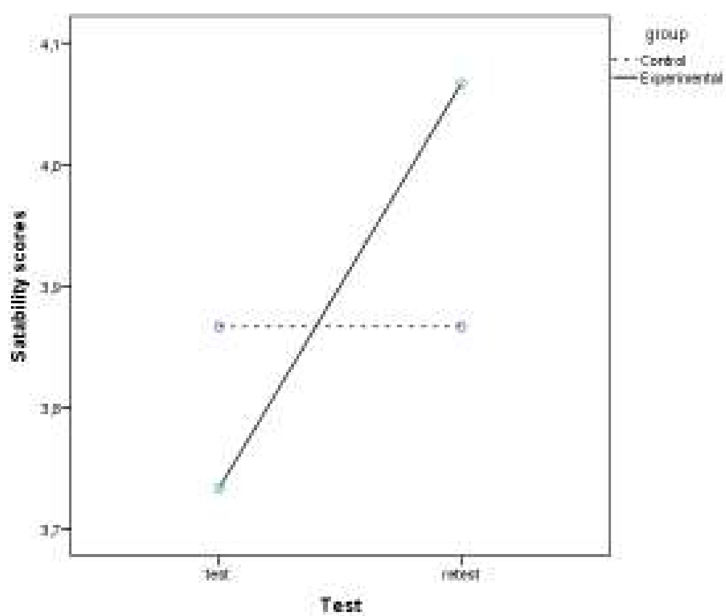

Fig. 3. Stability scoring for control and experimental group before and after intervention

Discussion

The purpose of this study was to examine the effectiveness of an 8-week movement-based program on FMS^{TM} scores in male professional soccer players. The results of this study suggest that an 8- week intervention program was an effective way for improving FMS^{TM} scores in a group of male professional soccer players, particularly for advanced movement and mobility subscales. In particular, our study aimed at supporting the findings by Kiesel et al. (2011) with a randomized experimental group in soccer player. Indeed we confirmed that a specific intervention aimed at improve functional movement pattern can successfully increase the FMS^{TM} score which has been demonstrated to prevent injuries. Kiesel et al. (2011) examined the effectiveness of an off-season training program on FMSTM scores in professional football players. In their investigation, at the end of the intervention, a greater number of players improved their scores above the injury threshold (≤14) compared with before the intervention, and this is congruent with the results of our study. The study by Kiesel et al. also showed a significant change in number of athletes free from an asymmetry from before to after the off-season program, but unfortunately, this study did not include a control group. Our findings are consistent with this previous study, although with a different magnitude and using a control group.

The participants improved the total score by approximately 2 points while previous investigations have shown improvements by 2.5 to over 3 points. The experimental group reported a meaningful improvement in Advanced movements, Mobility and Stability, while the control group did not report any significant variation. Those findings underline the positive effect of the training protocol proposed in this study with professional football players. Furthermore, this study showed slightly lower total FMSTM scores than previous investigations using professional soccer players. The reason for this discrepancy might be the different league the athletes play in. Our investigation is also in line with other five previous studies that have examined the modifiability of the FMSTM with various types of interventions in different sports (Bodden, Needham & Chockalingam, 2015; Cowen, 2010; Frost, Beach, Callaghan & McGill, 2012; Goss, Christopher, Faulk & Moore, 2009; Stanek et al. 2017). For instance, Bodden et al. (2015) studied an intervention program in mixed martial arts athletes and found significant improvements in total FMS™ score following a 4-week individualized intervention, but no additional improvements in FMS™ scores between weeks 4–8 of the program. Similarly, Frost et al. (2012) examined 2 different intervention programs and compared to a control group in a sample of firefighters but no differences were found in FMS™ scores in either intervention or control group. While the findings of these two previous studies were conflicting, the results of our study align with the findings of Bodden et al. (2015) and Stanek et al. (2017). Like Stanek et al. the current study used the individual's pre-test FMSTM score to determine the corrective exercises included within the intervention. It is plausible the differences in findings from those of Frost et al. (2012) could be attributed to the intervention program selection.

Because of the limited research on this argument in soccer players, with few studies analyzing both control and intervention group, it was difficult to compare the differences established in the current study with literature. For this reason, our study present some limitation. For instance, we did not counterbalanced the intervention with the two groups and the sample is limited to one team. Researchers should design new studies improving the sample size, enrolling more players that are professional and more teams, and implementing counterbalanced randomized controlled trials to study the short and long-term effect on the functional movement patter- based intervention. Moreover, it should be designed experiments in which the number of injuries and the quality of their psycho-physiological indices relater to injuries are taken into account.

Conclusion

The current study with soccer players confirm that the evaluation of fundamental movement patterns should be carefully considered: the FMS™ would be an advantageous addition to pre-exercise screening assessments, as the consideration of movement quality should be assessed in terms of quality and quantity of movement. Most if not all, the movements covered on the FMS™ are relate to many aspects of strength and conditioning and soccer training. The knowledge that the FMS™ can identify movement dysfunctions and, furthermore, the fact that the issues can be improved through a intervention program of movement-based exercise could be advantageous to soccer coaches and strength and conditioning specialists, thus providing the opportunity to adapt or implement new additions to training programs. From an applied point of view this findings provide more evidence on the efficacy of qualitative intervention on functional movement pattern improvement that is related to the injury prevention and suggest to strength and conditioning trainers how to organize practice and for instance how to use FMS during the warm up period.

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