FMS screening for middle distance running

APPLIED INSIGHTS

FMS screening for middle distance running: a case study of the impact of a four-week training intervention

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OVERVIEW

The purpose of this randomised case-control study was to examine the Functional Movement Screen (FMS) scores in a group of recreational middle-distance runners and to determine whether a four-week specific training intervention improved their initial scores. A pre- and post-intervention test was conducted. The study showed how four weeks of additional specific training could improve FMS scores and motor control in recreational runners. The present FMS scores and training intervention can be used as a reference for strength and conditioning specialists to address identified musculoskeletal imbalances which may predispose an athlete to injury.

Introduction

Due to the repetitive and high-impact nature of running, the majority of running-related injuries (RRIs) are of an overuse type.[37,51] An overuse injury is defined as a localised pain caused by repetitive micro trauma.[42] Despite even minimal changes in training volume and progressing training intensity incorrectly, RRIs are common.[37,53] In particular, those most at risk are: runners with less running experience,[10] those that have a high BMI35 and previous injuries,[35,50] and those who tend only to run and do not perform any other sports or conditioning training.[25]

Running encourages specific muscle groups to become dominant and overactive, while other key muscle groups exhibit comparative weakness.[17] The action of running involves balanced and powerful movements of the body and – in order to minimise the impact of the bodyweight at the point of ground contact during each running step[16] – a good level of muscular strength, limb symmetry and balance is required.[17] From an injury prevention point of view, the current literature suggests that weakness of the core[17,43] and gluteal muscles[4,23,31,37,48] can lead to atypical lower extremity functional mechanics. In fact, these muscles control rotational and cross-lateral movement patterns, similar to those observed in axial sports.[10]

Therefore, improving both strength and motor control by employing unilateral and rotational movement patterns may reduce the risk of injury.[25,29,51] This can be achieved by training the core using a multi-joint-integration exercise approach that elicits activity from a broader range of muscle groups while challenging the sensory systems for balance simultaneously.[21] However, readers should be aware of some major limitation of the studies cited: Fredericson's paper[17] is a clinical commentary and an opinion workpiece; Sato and colleagues' study[43] found only a reduction in race time and not in running mechanics after a core training intervention, and Leetun[31] concluded that logistic regression analysis revealed that hip external rotation strength was the only useful predictor of injury status even if it led, overall, to a general paucity of core stability.

Imbalances in the neuro-musculoskeletal system may influence injury risk[1,7,28,34,38,45] and overtraining may exacerbate the symptoms of a previous injury,[35,42,49] potentially leading to a different biomechanical pattern, which leads to the overloading of other musculoskeletal structures. Epidemiological studies have shown that even though injury risk is multifactorial, those components that impair normal movement patterns are one of the principle biomechanical predictive factors for RRI.[2,26,27] Recently, substantial bodies of literature have also shown that body asymmetries exposed to repeated sport-related-activities represent an important risk of injury.[5,40,41,54] According to previous researches, basic testing of body asymmetries may be beneficial for injury prevention in runners.[23]

One of the most practical and popular screening tests is the Functional Movement Screen (FMS), which has been previously described[14,15] and is used in several sports to identify deviations from the norm in functional movement patterns. Authors have debated[3,8,11,24,33] the sensitivity of the FMS test as a predictor of injury, finding an overall low sensitivity for all tests. However, despite an agreement in common literature about the limitations that FMS screening could have, and the fact that FMS was not designed to evaluate the incidence of injury, researchers do support the use of this screening; it is supported, even in association with others, to examine baseline and gross movement patterns

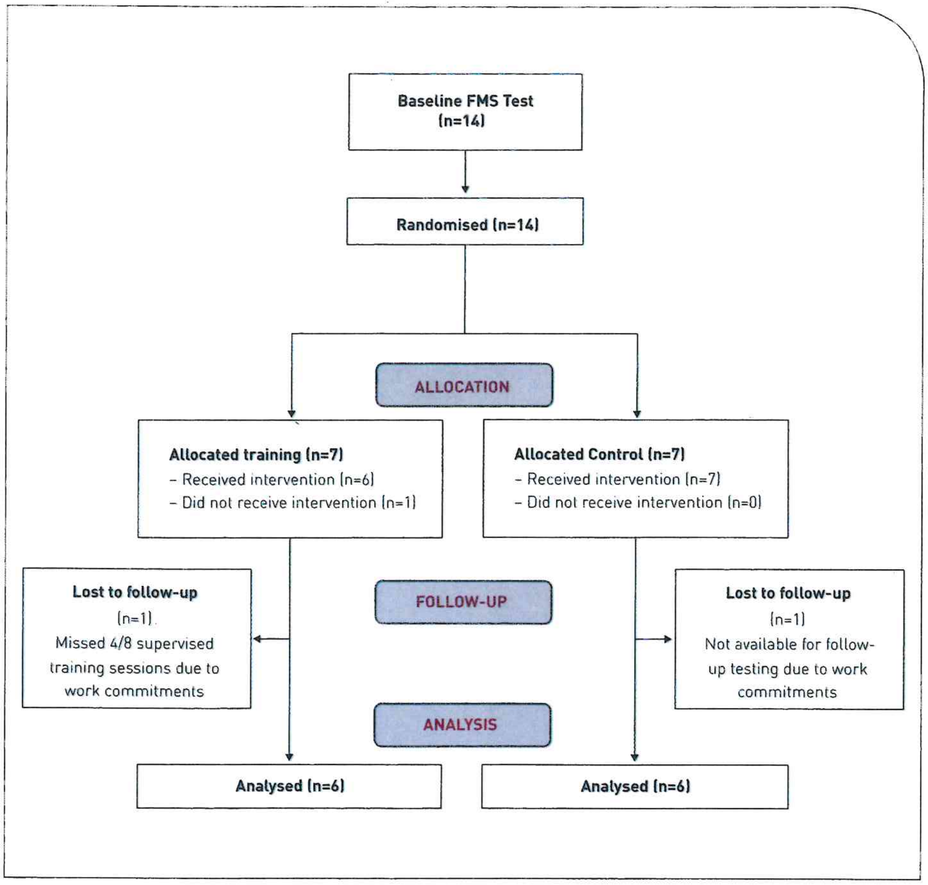

Figure 1. Intervention flow diagram

that are generic across sports and human movement.[12,13,39]

Therefore, it appears rational to use this type of cheap-fast-reliable-consistent screen[19,30,46,47] with a general population of recreational middle-distance runners, since some authors outline the importance of whole body-alignment and mechanics during running;[55] others report less risk of injury in those athletes who run less frequently[36] but for longer distances and have more recovery time between running sessions[44,53] – for instance, marathon athletes.

To the authors' knowledge, despite the increased risk of injury among recreational runners due both to a mismanagement of training load and poor biomechanics (that could lead to an ineffectively absorption/reuse of force), there is only one study to date that has characterised the FMS score for a similar population[1] and none that report a runner's routine-training programme. In this one study, injury-free runners training for a half or full marathon were tested and the mean FMS value was found to be 13.13±1.8. Unfortunately, middle distance runners were not included and there was no detail of their weekly training schedules. Therefore, a more in-depth knowledge of this population could provide guidelines for training management and practical training-routines for the prevention of injuries among this wide sector.

Previous literature[1,7,8,28,34,38,45,46] used a standard cut-off for FMS of ≤14 (perfect score is 21) to categorize an athlete with critical body imbalance and poor movement control. Other research[32] has suggested setting the cut-off score at ≤17, although no data are available in middle distance runners. The purpose of this research was first to examine baseline movement characteristics in middle distance runners using the FMS and secondly, to determine whether a four-week running-specific strength and conditioning (S&C) intervention improved the initial FMS score, compared to a group of runners continuing their normal training.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

A randomised, un-blinded, independent groups design was used to determine the effects of a S&C intervention on FMS scores in middle distance runners compared with those who continued their normal running training. Participants were randomised to a training intervention group or a control group, using a permuted blocks randomisation with FMS scores established at baseline and re-tested at the end of four weeks of training or control exposure. The control group was told not to change their training routine or to perform any 'new' exercise seen during the test. A training diary had to be provided by both groups at the end of the four weeks, proving that their usual training (Table 4) was not changed; it was also compared with an initial questionnaire regarding participants' running routine. Participants of both groups followed a standard routine for food, training and warm-up prior to baseline testing and on re-assessment after the intervention.

PARTICIPANTS

Fourteen recreational middle-distance runners (seven women and seven men) volunteered to participate in the study. Subject demographics are summarised in Table 1. Eligibility criteria specified that the participant should be: (a) male or female between 18 to 40 years of

Table 1: Subject demographics (Mean ± SD)

GROUP	N	GENDER	AGE (Y)	HEIGHT (M)	WEIGHT (KG)
Experimental	7	5 F; 2 M	31.5 ± 6.0	1.72 ± 0.10	65.6 ± 13.0
Control	7	3 F; 4 M	26.1 ± 4.0	1.71 ± 0.10	74.3 ± 7.3

Table 2: Exercises and their progression used as treatment for the experimental group

EXERCISE	LOAD	SET	REPS	REST	COMMENT
MOBILITY DRILLS					
Toy soldier exercise	BW	2-4	8		
Walking deep lunge	BW	2-4	8		Progress to trunk side flexion/rotation
Downward dog ankle pumps exercise	BW	2-4	8		
Trunk/arms/shoulders rotation	BW	2-4	8		
PLYOMETRICS					
Hops forward/side	20 cm box/step	2	20	1-3 min	Total foot contacts: 120; progression to 200
Bounding forward/ lateral	20 cm box/step	2	20	1-3 min	Total foot contacts: 120; progression to 200
DYNAMIC HIP STABILISATION					
Running man touch	BW	2-3	15-20		Execution: Single-leg balance with hip flexion. Progress touching in all directions
Side ('monster') walk	Elastic band	3-4	8-15		
STRENGTH TRAINING					
Bulgarian split squats	BW/ 70% 1RM	2-4	11-20	30 s -1 min	Progression: increasing 2 s holdover head deep squat with broomstick
Single leg dead lift	BW/ 70% 1RM	2-4	11-20	30 s -1 min	Exercise progression: increasing 2 s hold
Side lunge	BW/ 70% 1RM	2-4	11-20 per side	30 s -1 min	
Hip abduction/ lateral rotation	BW/ 70% 1RM	2-4	11-20	30 s -1 min	Execution: With slight knee and hip flexion in side-lying ("clam"). Exercise progression: elastic band
Push ups	BW	3	6-12	30 s -1 min	
CORE TRAINING					
Lateral and frontal plank	BW	5	30 s hold	30 s	Exercise progression: increasing 5 s hold
Supine opposite 1-arm/ raise	BW	2-3	10	30 s	Progress to 4 sets and 15 repetitions

age; (b) injury-free for the previous six weeks; (c) currently running a minimum of 10km per week inclusive of 800m to 3000m track-based runs; and (d) involved in recreational activities (involving running/jogging) for at least one year. The subjects' flow diagram is provided in Figure 1. Ethical approval and participant consent were obtained prior to the study.

FMS TEST

The FMS test consists of seven fundamental movement patterns to test mobility and stability which have been described previously,[5] including: the deep squat (DS); hurdle step (HS); in-line lunge (ILL); shoulder mobility (SM); active straight leg raises (ASLR); trunk stability push-up (TSPU); and rotary stability (RS). Each test was scored in accordance with previous recommendations.[14,15] All participants were filmed during their test (front/ side view) with a digital video camera (Panasonic HC-V100, Panasonic, UK). Both supervised sessions and tests were conducted by a postgraduate student who was trained by physiotherapists and FMS license holders.

TRAINING INTERVENTION

The intervention consisted of two supervised and one unsupervised strength session per week in addition to the usual training of the experimental group. The main targets of the exercises were to improve lower limb, hip and trunk strength, coordination and proprioception. Unilateral kinetic chain exercises and cross rotational movement patterns were used to reduce limb imbalance. Each supervised session included selected exercises based on previous studies investigating injury prevention in runners,[17,23,26,29,31,43,48,52] or

Table 3: Unsupervised exercises for the participants of the experimental group performed during the four-week intervention period

EXERCISE	LOAD	SET	REPS	REST	COMMENT
MOBILITY DRILLS					
Straight leg raise	BW	2 - 4	20 - 40	30 s - 1 min	Execution in supine position
Hip abduction/ lateral rotation					
BW	2 - 4	20 - 40	30 s - 1 min		Execution: With slight knee and hip flexion in side-lying ("the clam" exercise)
					Exercise progression: Elastic band 70% 1RM
Isometric hip abduction / lateral rotation	BW	2 - 4	11-20	30 s - 1 min	Execution in standing position
					Exercise progression: Elastic band 70% 1RM
Lateral and frontal plank	BW	5	30 s hold	30 s	Exercise progression: increasing 5 s hold

Table 4: Description of group's usual training

	RUNNING TRAINING	OTHER OCCASIONAL SPORT ACTIVITIES
Frequency and duration	From 2 to 7 running sessions per week (minimum 10km per week);	From 2 to 8 times in one month, maximum 16 hours per month;
Description	Running in different environments: roads, gyms, countryside and parks	Yoga, football, swimming, weights, boxing, biking

adapted exercises found to be effective rehabilitative interventions for common RRI (see Tables 2 and 3).[4,37] The control group continued their usual training as described in Table 4. Participants were excluded from the study if they missed three supervised sessions (Figure 1).

STATISTICAL ANALYSES

All FMS data were tested for normality using the Shapiro Wilk test, but given the low participant number the data were also checked manually for outliers. The baseline cross-sectional FMS data were summarised using descriptive statistics (mean and standard deviation (SD). A mixed-design two-way analysis of variance (ANOVA) was used to compare the responses of the intervention and control groups between pre- and post-intervention. Levene's test for homogeneity of variance was performed. The significance level was set at $P < 0.05$ and effect sizes were assessed using partial eta-squared values that were square rooted to give correlation coefficients that were compared with the effect sizes: 0.1–0.3 as small, 0.3–0.5 as moderate, 0.5–0.7 as large, and 0.7–0.9 as very large. Percentage and proportion of all participants that scored $\leq$ 14 was calculated before and after the intervention. A graphic difference in mean (SD) between groups, for each FMS movement, was reported (see Figure 3). The median and interquartile for each of the seven baseline tests was calculated (see Figure 4 on page 20).

RESULTS

The baseline mean FMS score (± SD) for the recreational runners was 12.0 ± 3. The median for each of the seven tests was respectively: 2; 1; 1; 2.5; 2; 2; 1; with interquartile ranging from 0,75 to 3 as described in Figure 4. There were 12/14 (86%) participants with an FMS score $\leq$ 14. After the four-week intervention period, the participants from both groups significantly increased their scores with a main effect of time with a very large effect size ($P < 0.001$; $F = 39.36$; $ES = 0.9$). Following the intervention, only 3/12 (25%) participants had an FMS score $\leq$ 14. There was no main effect of group ($P = 0.08$; $F = 3.91$; $ES = 0.5$). Importantly, the significant interaction effect with a very large effect size ($P = 0.009$; $F = 10.25$; $ES = 0.7$) showed that the experimental group increased their FMS score by 50% (18.5 ± 1.6), significantly more than the 17% improvement of the control group (14 ± 3) (Figure 2). Figure 3 shows the changes in FMS scores for each test that makes up the FMS total score.

DISCUSSION

This study characterised the FMS scores for a small group of 14 middle-distance recreational runners. Twelve of the group obtained baseline scores of $\leq$14, a threshold which has previously been associated with a higher likelihood of musculoskeletal injury.[8] These findings could provide useful suggestions for better managing training loads for these athletes.

A key finding was the significant improvement of the quality of movement found in participants after the short intervention period. These data are in agreement with previous literature that in general - albeit with limitations - demonstrate that neurological adaptations occur between two and four weeks from the administration of a new stimulus of different nature.[7,20,22] This short period of time seems to be sufficient to modify the quality of fundamental movement and body control. Therefore, training improvements in FMS score could be due to a reduction in the identified muscle imbalances and improved motor control. Surprisingly, all post-intervention scores of the training group increased above the threshold of 14, after only four weeks of additional training.

Previously, no data were available to examine FMS scores in recreational middle-distance runners. One study[1] has characterised FMS values for longer distance endurance runners, with Agresta et al[1] showing a composite score of 13.13 ± 1.8, which is higher than the current study at baseline (12.0 ± 3.0). However, Agresta et al[1] used a mixed population (both half marathon and full marathon runners) who ran longer distances during their weekly training, with more rest between training days. This training difference, along with the wide number of participants used in Agresta et al's paper, could have contributed to improving the long-distance athletes' FMS since literature reports that less risk of injury is found in athletes who run less frequently,[36] but for longer distances with more recovery days.[44,53] Therefore, our results can be considered as an expansion of the data of the previous study.

The baseline scores for all the participants in the present paper can be considered a preliminary reference for this cohort of athletes. The composite FMS score for recreational middle-distance runners was 12.0, which is below a cut-off score of 14 which has previously been associated with injury.[1,7,8,28,34,38,45,46] Although participant numbers for this study are not representative for the entire population of runners, the high proportion of runners tested who demonstrated a low FMS score might in part explain the large number of injuries among recreational middle-distance runners compared with other participant groups previously tested.[1,7,28,34,38,45]

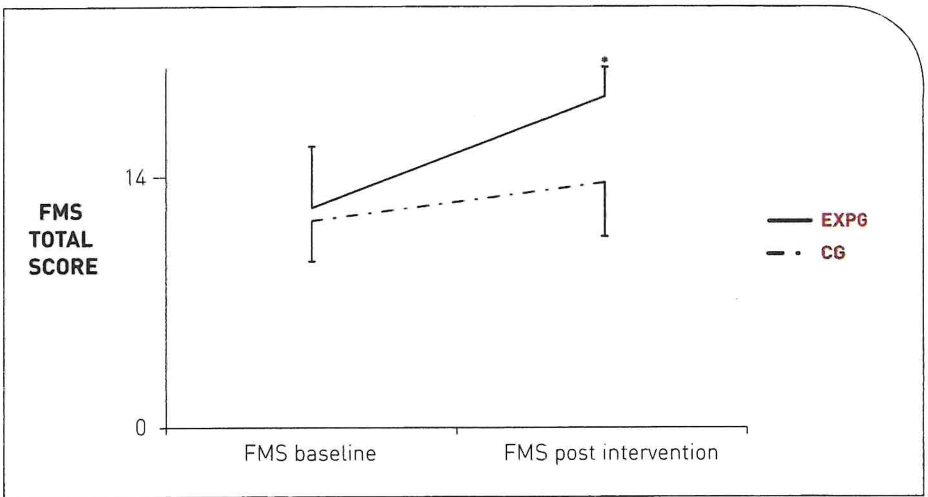

Figure 2. FMS value before and after four-week period intervention

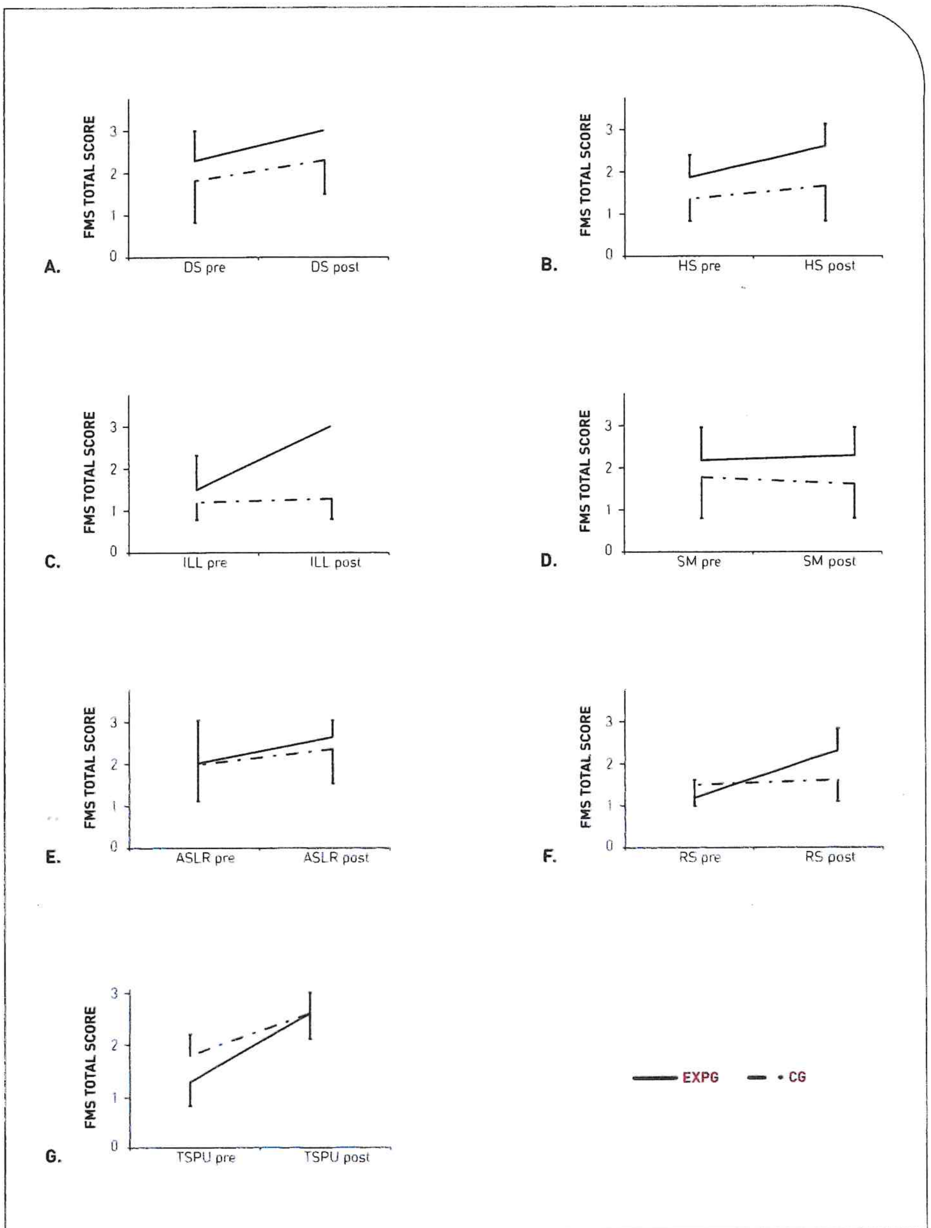

Figure 3. Difference between groups' mean score for each FMS movement test

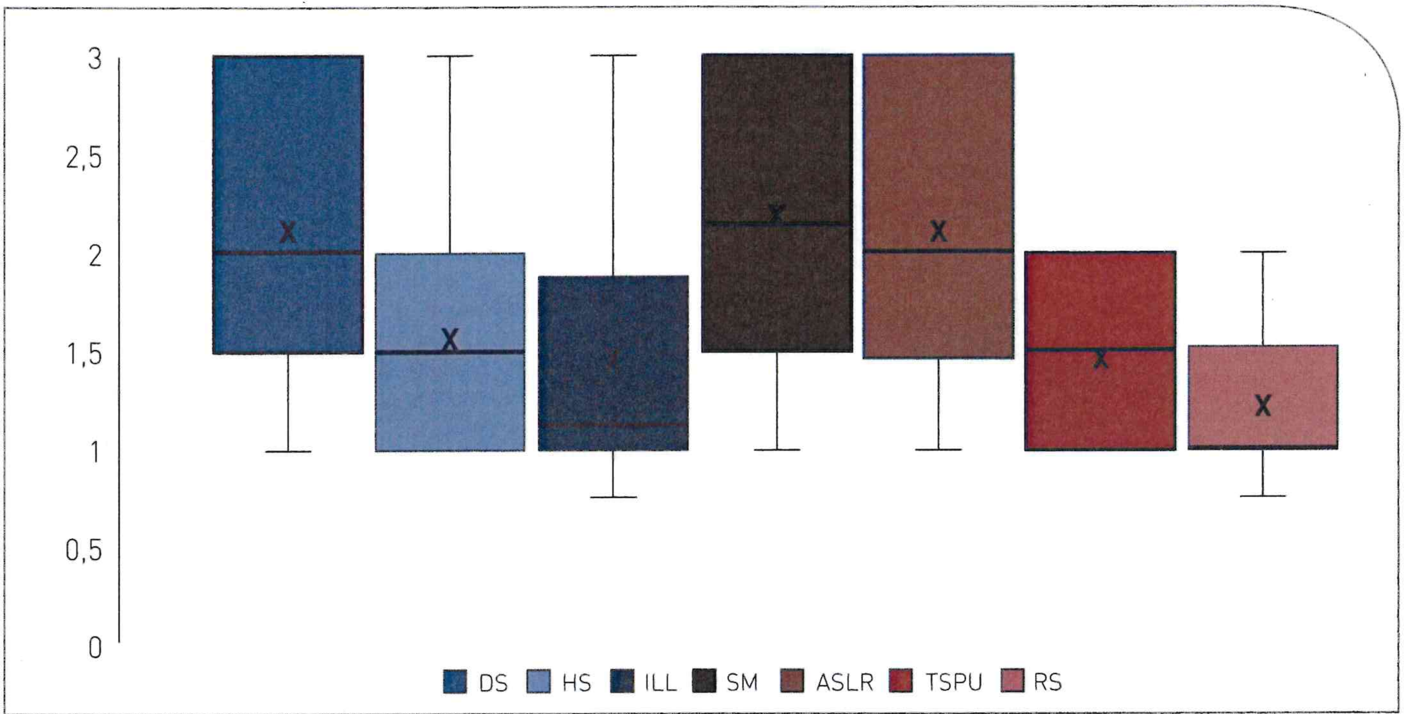

Figure 4. Baseline scores for the seven composite tests of FMS

Poor movement may increase injury risk when combined with primary injury risk factors for this cohort such as mismanagement of training load.

The very large interaction effect demonstrates that just four weeks of additional specific training is sufficient to significantly improve FMS scores more than runners who continued their routine-training. The FMS improvement obtained in only 28 days is in agreement with a previous study,[7] which observed 66% of athletes who increased their score above 14. In the current study, 80% of the athletes in the experimental group achieved this goal by the end of the training period. Therefore, these data indicate that it is possible to elicit significant improvements in general movement quality after only 28 days of training, rather than the minimum six weeks suggested in previous studies.

It is plausible that at least some of the changes observed over the short training period were due to the sports-specific programme designed from the literature. The exercises specifically targeted core, gluteal and lower limb muscles by promoting neural and muscular adaptations through the addition of unilateral, and single-leg movement patterns. As each subject was previously untrained in these exercises, the learning effect will have been greater. Although one study[18] demonstrated that FMS score improved after minutes when feedbacks and scoring system were provided to participants, we must also recognize that many of the movements included in our programme would be expected to directly benefit performance in some of the FMS tests, through improvements in technique. This occurrence is prevalent among training studies which commonly aim to take advantage of the principle of specificity for their interventions. Regardless, if these improvements have resulted in better movement control, even only through repeating the test movement, then this may still provide tangible benefits for the participants.

Examination of the baseline data shown in Figure 4 shows poor movement scores in HS, ILL, TSPU and RS tests. It confirms our initial hypothesis which indicated that major baseline deficiencies would be seen in runners during tests that required higher levels of balance and coordination, qualities defined important for this sport.[34] After the intervention, all of the seven tests improved in the experimental group – in particular HS, ILL, TSPU and RS – outlining the benefits participants gained in the quality of movement after the intervention. The control group also improved on most tests likely due to a prior learning effect and task knowledge; however, their mean increment was lower than their experimental counterparts and in one out of seven movements (SM) their score even decreased (Figure 3).

The results of this study suggest that FMS scores are responsive to short-term training interventions and a four-week specific training programme can significantly improve FMS scores more than running training alone, with a clear magnitude of change. However, we have not demonstrated a measured reduction in injury occurrence. Future studies should establish injury rates in runners before and after an intervention programme in recreational runners. It would also be worthwhile to examine if FMS values vary between runners of different levels, stages of maturation and gender.

PRACTICAL APPLICATION

This study provides baseline FMS scores for recreational middle-distance runners, which can be used as an effective measurement to establish changes in functional movement patterns following a running specific exercise intervention programme. Functional movement screening, along with specific exercises for runners, may also help attenuate the risks associated with magnified training loads through enhanced movement efficiency.

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