Progress in Nutrition 2020; Vol. 22, Supplement 2: e2020007 DOI: 10.23751/pn.v22i2-S.10465 

Original article

# The relationships of elite sailors' functional movement screen scores and some of their motoric features with lower extremity pain

*Utku Gönener[1], Kürşad Sertbaş[1], Ahmet Gönener[1]*

[1] Faculty of Sports Sciences, Kocaeli University, Kocaeli, Turkey.

**Abstract.** *Study Objectives:* This study aimed to investigate the relationships of elite sailors' functional movement screening scores (FMS) and some of their motoric features with lower extremity pains. *Method:* The study included n=23 participants aged between 15-17 years. Functional movement screening, handgrip strength test, vertical jump test, sit-and-reach flexibility test, 1 RM bench press test, 1 RM squat test, and back strength dynamometer test were applied 3 times in pre-season, mid-season, and post-season. In addition to these tests, pains and injuries experienced sufficiently enough to prevent the athletes from training any day during the season were recorded every week from the beginning to the end of the season in accordance with the statements of the athletes. *Results:* A statistically significant and negative correlation was found between the number and severity of pains experienced in the 17th and 18th regions and the pre-test, mid-test, and post-test FMS scores ($p<0.01$). However, the number and severity of pains experienced in the 41st region were found to have no statistically significant relationships with pre-test, mid-test, and post-test FMS scores and motoric features ($p>0.05$). Likelihood ratios and R2 indices revealed that the 17th region was closer to the significance limit, but the FMS scores had no effect on the number and severity of pains. *Conclusion:* When FMS scores and regional pain were examined separately, statistically significant and negative relationships were found between the FMS scores and the number and severity of pains in the 17th and 18th regions. The results of the regression analysis showed that the effects of the FMS scores and some motoric features on lower extremity pain were not statistically significant ($p>0.05$).

**Keywords:** Functional movement screen, Pain, Injury, Sailing.

## Introduction

Injuries and pains are considered natural parts of sports. Sailing athletes are also at risk of experiencing injuries, accidents, and pains for various reasons. These risks are known to increase more in hiking, gybe, tack, other technical movements, and sudden tensions on the sea and on the boat (1,2). The literature covers fewer studies regarding the injury risks and types of sailing and sailors compared to other branches, although it is a widespread sports branch in the world with its reputation in both Olympics and prestige in youth classes. The movements to create a more artificial force on the sail, especially the hiking movement, increase the risk of injury due to their patterns and practices (3,4). In addition, various injuries may occur due to the sudden movements of the sailboat on the sea and movements to be made in different positions owing to the poor ergonomics of the sailboat (5). There is a need for the development and improvement of primary and auxiliary motor features to prevent or minimize these and similar injuries. While planning the training sessions of athletes whose strength, strength endurance, flexibility, and endurance features should be absolutely perfect, it is necessary to know the developmental and physiological characteristics of the branch's own characteristics and age categories. At this point, many researchers are interested in responses to strength training before and after adolescence. As such, the mechanisms of responses to strength increases, being undertrained, and injury risks are leading hot topics in strength training in children (6). Studies have shown that untimely and improper training, undertrained unilateral, bilateral, and agonist-antagonist muscle groups, and impairments in strength ratios can lead to injuries (7,8). For this reason, it is deemed to be necessary to perform strength training suitable for age groups from the early adolescent period to prevent injuries caused by strength disproportion and insufficient strength. Flexibility and mobility are also known to be critical in preventing injury. Increased joint movement limits and high muscle-ligament flexibility will reduce the risk of injury caused by sudden tensions during training and competitions (9). Athletes frequently experience sports injuries and pains related to such injuries. Many scientists do preventive studies for these injuries and accidents and try to identify risk factors for some injuries (10). Unfortunately, there is no robust test to identify and define future disability risks (11). Some studies are carried out to predict these injuries with the help of some screening components. One of them is the Functional Movement Screen (FMS) method. FMS is a screening tool that aims to define the risk of injury to be experienced by athletes during training or competitions and consists of 7 movement models, including locomotive, manipulative, and stabilizing practices that evaluate balance, mobility, and stabilization (12). Ultimately, this study aimed to examine the relationships of elite sailors' FMS scores and some of their motoric features with lower extremity pain.

## Material and Methods

### *Participants*

The research started with the participation of 30 sailors aged between 15-17 years who compete at national and international levels. Three participants left the research due to their education, and 4 participants left the study with their own will. Therefore, the sample of the study consisted of 23 athletes.

### *Experimental Design*

Kocaeli University Non-Interventional Ethical Clinical Research Ethics Committee submit the relevant approval to the study with KÜ GOKAEK 2019/164 research project number. The research protocol was explained to the participants who agreed to participate in the study, and their informed consent was obtained.

Functional movement screening, handgrip strength test, vertical jump test, sit-and-reach flexibility test, 1 RM bench press test, 1 RM squat test, and back strength dynamometer test were applied to the participants 3 times in pre-season, mid-season, and post-season. In addition, from the very beginning of the season to the end, the athletes were asked each week whether they experienced any pains and injuries sufficiently enough to prevent them from training, and such incidents were recorded with a visual analog scale in accordance with the statements of the athletes.

Visual analog scale: The visual analog scale is a type of scale used to convert some values that cannot be measured visually into numerical form. Definitions of the parameters to be evaluated are written on both ends of a 10 cm line, and the subject is asked to mark its pain severity between 0-10 on this line. The distance from the point where the pain level is 0 to the point where the subject has marked indicates the severity of the pain. Then, as an evaluation method, the values obtained are averaged. A graphic rating scale, which is the basis of the visual analog scale, has previously been generated and designed to be used in different scientific fields (13). The reliability coefficient was found to be 0.97 in a reliability study conducted for the use of the visual analog scale in acute pain measurements (14). When the subjects experienced pain due to injury during or after training to prevent them from participating in the next training, they recorded the severity and region of pain(s) on the scale at the end of each day.

*Test Protocol*

The subjects were informed about the FMS test. The movements to be made during the test were explained to the subjects orally and practically, respectively. The subjects dit not warm up before the test since the FMS test was designed considering the basal state of athletes. The athletes were informed that the test would be stopped if they experienced any pain during the test. Bilateral movements were scored separately as right and left, while unilateral movements were scored as a whole. The low sore was taken into consideration in bilateral movements. Scoring was done between 0-3 points, where 0 refers to the lowest score, and 3 means the highest score. The lowest score that can be obtained from the test was 0 point, and the highest score was 21 points. In the evaluation of scores obtained at the end of 7 movements, a score of 14 points and below indicates that the subject's functional movement capacity and basic movement patterns are poor. However, a score above 14 points indicates that the subject's functional movement capacity and basic movement patterns are high.

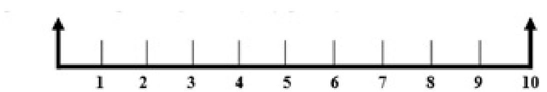


**Figure 1.** Visual analog scale

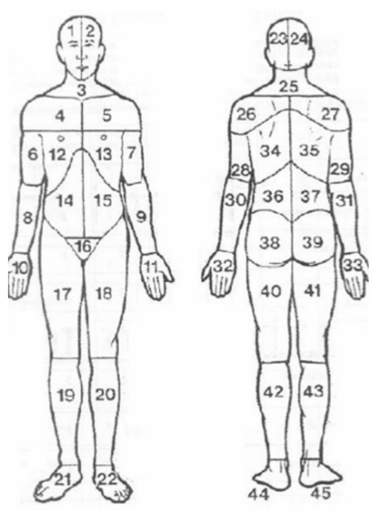


**Figure 2.** Body pain regions

*Statistical Analysis*

Wilcoxon Signed-Rank test was used for the analyses of functional movement screen and some motoric features of the subjects obtained through pre-test, mid-test, and post-test. Spearman's rho correlation analysis and logistic regression analysis were performed to examine the relationships of the FMS scores and some motoric features of the subjects with their pain scores. Statistical analyses were done via the IBM SPSS 25.0 program.

## Results

The results of the research are presented below.

While the youngest of the participating athletes was 15 years old, the oldest was aged 17 years, and the sample had a mean age of 16.35 ± 0.78 years. The BMI values were between 19.38 and 27.40 and had a mean of 22.67 ± 1.93. The sample, consisting of participants who had been actively doing sports for at least 5 years and at most 10 years, had a mean sports experience of 7.30 ± 1.36 years.

The results in Table 3 suggest that there was an increase in the mean values for FMS scores and some motoric features from pre-test to post-test.

**Table 1.** FMS scoring table (15). (Okada et al., 2011)

| FMS Tests | 3 Points | 2 Points | 1 Point | 0 Point |
|---|---|---|---|---|
| **Deep Squat** | The upper body is parallel to or perpendicular to the tibia; the femur is below the horizontal line; knees are aligned with feet; FMS plastic bar is aligned with feet; and arms are fully extended. | When a 2x6 inch sized FMS platform is placed under the heels, all of the 3 points criteria are met, except the criterion of knees aligned with feet. | The upper body is not parallel to the tibia; the femur is not below the horizontal line; knees are not aligned with feet. | Any pain during the test. |
| **Hurdle Step** | The hips, knees, and ankles are aligned in the sagittal plane; the lumbar spine is almost motionless; FMS plastic bar and obstacle are parallel. | The hips, knees, and feet become misaligned. | Foot contact occurs with the obstacle; balance is lost. | Any pain during the test. |
| **Inline lunge** | The torso is almost immobile; the foot maintains its position in the sagittal plane on the FMS platform; the knee touches the heel of the anterior foot. | Any movement is observed in the torso; the feet are not in the sagittal plane; the knee does not touch the heel of the anterior foot. | Balance is lost during movement. | Any pain during the test. |
| **Shoulder mobility** | There is a hand or less distance between two fists. | There is a 1.5 hand distance between two fists. | There is more than 1.5 hand distance between two fists. | Any pain during the test. |
| **Active straight leg raise** | The stick is between mid-thigh and anterior upper iliac. | The stick is between mid-thigh and knee joint. | The stick is below the knee joint. | Any pain during the test. |
| **Trunk stability push-up** | Males do 1 repetition with palm and thumb aligned with the forehead; females do 1 repetition with palm and thumb aligned with the chin. | Subjects can do 1 repetition in the modified version of the test; males do 1 repetition with palm and thumb aligned with the chin; females do 1 repetition with palm and thumb aligned with the chest. | Subjects cannot do 1 repetition in the modified version of the test. | Any pain during the test. |
| **Rotary Stability** | Subjects can do 1 straight repetition with the knee and elbow aligned with the platform and the back parallel to the platform. | Subjects can do 1 straight diagonal flexion and extension when the back is parallel to the platform and the ground. | Subjects cannot do diagonal repetition. | Any pain during the test. |

**Table 2.** Age, weight, height, BMI, and active sports experience of the participating athletes

| | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Age (years) | 15 | 17 | 16.35 | 0.78 |
| Height (cm) | 165 | 178 | 172.41 | 4.32 |
| Weight (kg) | 53.4 | 77.1 | 67.36 | 5.80 |
| BMI (kg/cm²) | 19.38 | 27.40 | 22.67 | 1.93 |
| Active sports experience (years) | 5 | 10 | 7.30 | 1.36 |

The results in Table 4 suggest that the FMS scores of the athletes experiencing pain during the season were lower than those who did not experience pain.

As seen in Table 5, while the differences in the FMS scores were not significantly differed between the pre-test and mid-test ($p > 0.05$), the differences of all other scores were statistically significant ($p < 0.05$). There were statistically significant differences in the FMS scores in all measurements between pre-test and post-test ($p < 0.05$). The differences of all scores were statistically significant ($p < 0.05$), except for FMS ($p > 0.05$), between mid-test and post-test.

According to Table 6., the number of pains was at most 1 in the 41st pain region, and the mean pain values were equal. The highest number of pains was seen in the 17th pain region with a mean of 0.43 ± 0.73, followed by the 18th pain region with the same number of pains. Although the range of variation was the same, the difference in the mean values was due to the difference in the number of people experiencing pain in these regions. When the total number of pains was examined by regions, it was seen that the highest number of pains was experienced in the 17th and 18th

**Table 3.** Pre-test, mid-test, and post-test values for functional movement screen scores and some motoric features of the participants

| | Pre-test | | Mid-test | | Post-test | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| FMS | 16.35 | 2.25 | 16.61 | 1.88 | 16.70 | 1.84 |
| Handgrip (right) | 37.80 | 8.69 | 39.15 | 8.85 | 40.37 | 9.17 |
| Handgrip (left) | 37.28 | 7.56 | 39.00 | 7.87 | 39.99 | 8.93 |
| Vertical jump | 43.70 | 9.38 | 45.74 | 9.11 | 48.17 | 9.04 |
| Flexibility | 6.79 | 9.24 | 9.79 | 7.73 | 12.56 | 6.73 |
| Benchpress | 61.52 | 22.04 | 65.20 | 21.92 | 68.04 | 22.25 |
| Squat | 77.72 | 18.28 | 82.61 | 19.24 | 86.30 | 19.77 |
| Back strength | 91.39 | 17.07 | 97.91 | 17.92 | 104.57 | 20.08 |

**Table 4.** Pre-test, mid-test, and post-test values for the FMS scores of the participants experiencing pain

| | Pre-test | | Mid-test | | Post-test | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| FMS scores of athletes experiencing pain | 14.63 | 2.72 | 15.38 | 2.13 | 15.62 | 2.19 |
| FMS scores of athletes not experiencing pain | 17.27 | 1.27 | 17.27 | 1.39 | 17.27 | 1.39 |

**Table 5.** Results of Wilcoxon Signed-Rank test performed regarding the pre-test, mid-test, and post-test differences of the FMS scores and some motoric features of the participants

| | Pre-test – Mid-test | | Pre-test – Post-test | | Mid-test – Post-test | |
|---|---|---|---|---|---|---|
| | **Z** | **p** | **Z** | **p** | **Z** | **p** |
| FMS | −1.897 | 0.058 | −2.126 | 0.033 | −1.414 | 0.157 |
| Handgrip (right) | −3.698 | **0.000** | −3.802 | **0.000** | −3.607 | **0.000** |
| Handgrip (left) | −4.047 | **0.000** | −3.316 | **0.001** | −2.297 | **0.022** |
| Vertical jump | −4.151 | **0.000** | −4.233 | **0.000** | −4.246 | **0.000** |
| Flexibility | −4.198 | **0.000** | −4.198 | **0.000** | −4.153 | **0.000** |
| Benchpress | −4.221 | **0.000** | −4.257 | **0.000** | −3.947 | **0.000** |
| Squat | −4.268 | **0.000** | −4.258 | **0.000** | −4.116 | **0.000** |
| Back strength | −4.217 | **0.000** | −4.206 | **0.000** | −4.205 | **0.000** |

***p<0.05***

**Table 6.** Distribution of the number of pains by pain regions

| Number of Pains | Minimum | Maximum | Total Number of Pains | Mean | SD |
|---|---|---|---|---|---|
| 17th pain region | 0 | 2 | 10 | 0.43 | 0.73 |
| 18th pain region | 0 | 2 | 8 | 0.35 | 0.65 |
| 41st pain region | 0 | 1 | 1 | 0.04 | 0.21 |

pain regions. The distribution of the number of pains by pain severity is shown in Table 7.

The most pain severity was in the 17th region with a mean value of 2.35 ± 3.65, followed by the 18th region. The 41st pain region was the one where the least pain severity was reported. Pain severity increases up to 9 points in the 17th, 18th, and 41st pain regions.

There were statistically significant and negative correlations among the number and severity of pains in the 17th region and the pre-test, mid-test, and post-test FMS scores (p <0.01).

There were statistically significant and negative correlations among the number and severity of pains in the 18th region and the pre-test, mid-test, and post-test FMS scores (p <0.01).

The results showed that there were no statistically significant correlations among the number and severity of pains in the 41st region and the pre-test, mid-test, and post-test FMS scores and the motoric features considered (p >0.05).

The results presented in Table 11 indicated that the effect of the FMS scores on pain was not statistically significant (p> 0.05). Likelihood ratios

**Table 7.** Distribution of the numbers of pains by pain severity

| Pain Severity | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| 17th pain region | 0 | 9 | 2.35 | 3.65 |
| 18th pain region | 0 | 9 | 2.00 | 3.46 |
| 41st pain region | 0 | 9 | 0.39 | 1.88 |

**Table 8.** The results of the analysis for the relationships of the FMS scores and some motoric features with pain severity and scores in the 17th pain region.

| | Number of Pains | | Pain Severity | |
|---|---|---|---|---|
| | r | p | r | p |
| ***Pre-test*** | | | | |
| FMS | **–.612**** | **0.002** | **–.616**** | **0.002** |
| Handgrip (right) | 0.040 | 0.855 | 0.062 | 0.779 |
| Handgrip (left) | 0.190 | 0.385 | 0.200 | 0.361 |
| Vertical jump | –0.131 | 0.553 | –0.163 | 0.457 |
| Flexibility | –0.113 | 0.606 | –0.057 | 0.798 |
| Benchpress | 0.184 | 0.400 | 0.198 | 0.364 |
| Squat | 0.300 | 0.165 | 0.257 | 0.236 |
| Back strength | 0.266 | 0.220 | 0.256 | 0.238 |
| ***Mid-test*** | | | | |
| FMS | **–.600**** | **0.002** | **–.602**** | **0.002** |
| Handgrip (right) | 0.020 | 0.930 | 0.048 | 0.828 |
| Handgrip (left) | 0.215 | 0.324 | 0.198 | 0.365 |
| Vertical jump | –0.118 | 0.591 | –0.150 | 0.495 |
| Flexibility | –0.097 | 0.660 | –0.043 | 0.847 |
| Benchpress | 0.174 | 0.427 | 0.183 | 0.403 |
| Squat | 0.273 | 0.208 | 0.246 | 0.258 |
| Back strength | 0.274 | 0.205 | 0.260 | 0.230 |
| ***Post-test*** | | | | |
| FMS | **–.609**** | **0.002** | **–.606**** | **0.002** |
| Handgrip (right) | –0.013 | 0.952 | 0.024 | 0.914 |
| Handgrip (left) | 0.217 | 0.320 | 0.193 | 0.378 |
| Vertical jump | –0.085 | 0.698 | –0.128 | 0.559 |
| Flexibility | –0.036 | 0.871 | –0.067 | 0.761 |
| Benchpress | 0.164 | 0.456 | 0.177 | 0.419 |
| Squat | 0.223 | 0.306 | 0.205 | 0.348 |
| Back strength | 0.217 | 0.320 | 0.211 | 0.335 |

and $R^2$ indices pointed out that the FMS scores had no effect on the number and severity of pains even though values in 17th the region were closer to the significance level.

## Discussion and Conclusion

In this study, it was aimed to investigate the relationship of the FMS scores and some motoric features of elite sailors with their pain scores during the season.

There are many studies in the literature that have been investigating the motoric features of athletes. The athletes need to strive for their physical development based on their ages, individual characteristics, and skill levels to utilize these features effectively. A versatile physical development aims to develop the basic bio-motor skills of the athletes, such as endurance, strength, speed, mobility, and coordination. Thus, a higher efficiency opportunity should be provided for athletes with the help of a robust training infrastructure to allow them to perform activities

**Table 9.** The results of the analysis for the relationships of the FMS scores and some motoric features with pain severity and scores in the 18th pain region

| | **Number of Pains** | | **Pain Severity** | |
|---|---|---|---|---|
| | **r** | **p** | **r** | **p** |
| ***Pre-test*** | | | | |
| FMS | **−.764**** | **0.000** | **−.742**** | **0.000** |
| Handgrip (right) | −0.073 | 0.740 | −0.039 | 0.859 |
| Handgrip (left) | 0.083 | 0.707 | 0.133 | 0.546 |
| Vertical jump | −0.183 | 0.403 | −0.180 | 0.412 |
| Flexibility | −0.175 | 0.423 | −0.204 | 0.351 |
| Benchpress | 0.078 | 0.723 | 0.116 | 0.598 |
| Squat | 0.183 | 0.402 | 0.176 | 0.421 |
| Back strength | 0.146 | 0.508 | 0.167 | 0.447 |
| ***Mid-test*** | | | | |
| FMS | **−.739**** | **0.000** | **−.730**** | **0.000** |
| Handgrip (right) | −0.108 | 0.624 | −0.065 | 0.769 |
| Handgrip (left) | 0.094 | 0.668 | 0.126 | 0.566 |
| Vertical jump | −0.168 | 0.444 | −0.168 | 0.444 |
| Flexibility | −0.158 | 0.471 | −0.191 | 0.383 |
| Benchpress | 0.073 | 0.739 | 0.108 | 0.624 |
| Squat | 0.162 | 0.460 | 0.167 | 0.447 |
| Back strength | 0.156 | 0.477 | 0.174 | 0.428 |
| ***Post-test*** | | | | |
| FMS | **−.740**** | **0.000** | **−.728**** | **0.000** |
| Handgrip (right) | −0.121 | 0.581 | −0.085 | 0.701 |
| Handgrip (left) | 0.089 | 0.687 | 0.098 | 0.656 |
| Vertical jump | −0.131 | 0.551 | −0.143 | 0.515 |
| Flexibility | −0.099 | 0.652 | −0.199 | 0.363 |
| Benchpress | 0.065 | 0.770 | 0.100 | 0.649 |
| Squat | 0.105 | 0.633 | 0.116 | 0.599 |
| Back strength | 0.125 | 0.569 | 0.143 | 0.515 |

specific to their sports branches (16). In our study, from the very beginning to the end of the season, there were significant differences among the increases in the results of the pre-test, mid-test, and post-test handgrip strength test (right and left), vertical jump test, sit-and-reach flexibility test, 1 RM bench press test, 1 RM squat test, and back strength dynamometer test ($p < 0.05$). Also, pre-test and post-test FMS scores of the participants differed significantly. ($p < 0.05$). Motoric features are expected to increase during a season. In the period from the general preparation to the transition period, the sea, land, and individual training programs of the athletes will increase some of their motoric features; thus, the expectations of the athletes and their coaches should also be in this direction during the season. Surveillance of the mobility of athletes, as well as their motoric features, should be on the agenda of the

**Table 10.** The results of the analysis for the relationships of the FMS scores and some motoric features with pain severity and scores in the 41st pain region

| | Number of Pains | | Pain Severity | |
|---|---|---|---|---|
| | r | p | r | p |
| ***Pre-test*** | | | | |
| FMS | –0.260 | 0.230 | –0.260 | 0.230 |
| Handgrip (right) | –0.032 | 0.884 | –0.032 | 0.884 |
| Handgrip (left) | 0.064 | 0.771 | 0.064 | 0.771 |
| Vertical jump | –0.225 | 0.302 | –0.225 | 0.302 |
| Flexibility | 0.289 | 0.181 | 0.289 | 0.181 |
| Benchpress | –0.242 | 0.267 | –0.242 | 0.267 |
| Squat | –0.209 | 0.338 | –0.209 | 0.338 |
| Back strength | –0.193 | 0.378 | –0.193 | 0.378 |
| ***Mid-test*** | | | | |
| FMS | –0.228 | 0.295 | –0.228 | 0.295 |
| Handgrip (right) | –0.032 | 0.884 | –0.032 | 0.884 |
| Handgrip (left) | 0.032 | 0.884 | 0.032 | 0.884 |
| Vertical jump | –0.209 | 0.338 | –0.209 | 0.338 |
| Flexibility | 0.289 | 0.181 | 0.289 | 0.181 |
| Benchpress | –0.258 | 0.236 | –0.258 | 0.236 |
| Squat | –0.209 | 0.338 | –0.209 | 0.338 |
| Back strength | –0.225 | 0.302 | –0.225 | 0.302 |
| ***Post-test*** | | | | |
| FMS | –0.228 | 0.295 | –0.228 | 0.295 |
| Handgrip (right) | –0.032 | 0.884 | –0.032 | 0.884 |
| Handgrip (left) | 0.032 | 0.884 | 0.032 | 0.884 |
| Vertical jump | –0.225 | 0.302 | –0.225 | 0.302 |
| Flexibility | 0.289 | 0.181 | 0.289 | 0.181 |
| Benchpress | –0.257 | 0.236 | –0.257 | 0.236 |
| Squat | –0.193 | 0.378 | –0.193 | 0.378 |
| Back strength | –0.225 | 0.302 | –0.225 | 0.302 |

coaches. It is stated that functional movement screen test can be used as a comprehensive application to identify the asymmetries and limitations of athletes since it can allow the surveillance of mobility, stability, and balance features (17). Recently, researchers have used movement studies covering comprehensive movement patterns to predict injury, and studies on the FMS scores of athletes have drawn attention in particular (18,19). The studies conducted to evaluate the risk of injury in different branches before the seasons, it has been stated that the FMS test can be used in the prediction of mid-season injuries and that the values obtained have a significant relationship with the injuries experienced during the season (20,21,17). In a study, injuries of rugby players within 6 months from the date of the test were observed, and it was concluded that the mean FMS scores of players with severe injuries were lower than non-in-

**Table 11.** Results of the logistic regression analysis for significant pain regions

| | B | S.E. | Wald | p | Exp(B) |
|---|---|---|---|---|---|
| ***17th region*** | | | | | |
| FMS pre-test | -2.645 | 1.617 | 2.675 | 0.102 | 0.071 |
| FMS mid-test | 1.656 | 4.397 | 0.142 | 0.706 | 5.240 |
| FMS post-test | -0.105 | 3.952 | 0.001 | 0.979 | 0.901 |
| Age | 1.134 | 1.760 | 0.415 | 0.520 | 3.108 |
| Height | 0.241 | 0.310 | 0.607 | 0.436 | 1.273 |
| Constant | -44.242 | 52.351 | 0.714 | 0.398 | 0.000 |
| Cox & Snell R2: 0.513; Nagelkerke $R^2$: 0.725; Log likelihood: 11.729 | | | | | |
| ***18th region*** | | | | | |
| FMS pre-test | -16.273 | 15225.304 | 0.000 | 0.999 | 0.000 |
| FMS mid-test | 20.636 | 2.614E8 | 0.000 | 1.000 | 9.162E8 |
| FMS post-test | -30.560 | 2.614E8 | 0.000 | 1.000 | 0.000 |
| Age | -0.001 | 14854.537 | 0.000 | 1.000 | 0.999 |
| Height | 4.183 | 1926.785 | 0.000 | 0.998 | 65.534 |
| Constant | -317.404 | 279332.744 | 0.000 | 0.999 | 0.000 |
| *Cox & Snell R2: 0.683; Nagelkerke $R^2$: 1.000; Log likelihood: 0.000* | | | | | |

jured players. (22). In our study, it was found that the FMS scores of the athletes who experienced pain to prevent them from the next training were lower than the FMS scores of the non-injured athletes.

Some studies indicate that the FMS method is not an appropriate method for analyzing the risk of injury. Accordingly, the authors examined the relationship between the FMS scores of the sailors and injury and did not reach a significant result (23). In addition, it was explained that the back pains pointed out in the study might be chronic pains depending on the training age. In another study examining the relationship between pre-season FMS measurements and in-season injuries of young rugby players, it was reported that the FMS scores of ≤14, set as the risk cut-off, were not significantly associated with injuries and pains experienced during the season (24). When it comes to the relationships between the pain regions and the FMS scores in our study, no statistically significant relationship was found between the number and severity of pains in the 41st region and the pre-test, mid-test, and post-test FMS scores of the participants. There was also no significant relationship between the number of pains in these regions and motoric features. Statistically significant and negative correlations were found between the number and severity of pains in the 17th and 18th regions and the pre-test, mid-test, and post-test FMS scores. Regarding the final effect with all variables, it was discovered that the FMS scores and some motoric features did not have significant effects on the number and severity of injury-related pains in the 17th region, although the results were close to the significance level. In a study conducted in the American National Basketball League (NBA), it was determined that the FMS was an important method for detecting movement asymmetries for professional basketball players, but it could not be used as an injury prediction method (25). The statistical data obtained in our study revealed that the FMS showed a significant relationship with the pain experienced in some regions, but did not show significance in injury and pain estimation when examined as a whole with all variables. This result is consistent with the previous results in the literature.

In the study conducted in the 2014 Olympic Classes World Championship, it was found that approximately 41% of the injuries experienced by athletes during the season were in the lower extremity, and 29% were in the core region. In addition, 20% of these injuries were intervertebral disc injuries, 13% were arthritis and injuries, and 13% cartilage injuries (26). In our study, the participants generally had pains in their lower extremity muscles. The main reasons for this are thought to be the sudden position changes and trapezoidal movement to maneuver the sailboat. In order for the sailboat to reach the highest speed in strong winds, the hiking position must be maintained at the maximum level, especially when sailing at a narrow-angle to the wind. In this process, high-intensity loads fall on the quadriceps, hamstring, gluteus, and core regions, and athletes have to resist these loads. While resisting such loads, lower extremity muscle groups are exposed to both muscular and nervous fatigue. Long-lasting fatigue, delays in recovery, and severe loads after failure to recover may lead to pains due to possible injuries. Our study shows similarities with the studies in the literature regarding the regions and numbers of pains.

To date, very little quantitative injury data are available on Olympic sailing classes, which is surprising given the growing interest in the physical and physiological requirements of this sports. Depending on the types of injuries reported, elite athletes appear to be at risk of strains and sprains, although there is no data on nature such injuries (4). The force applied to the hiking strap on which Laser athletes, who hike in 15 knots, namely 27.8 km/hour wind speed, place their feet can exceed 800 N (1). This force is balanced with a counter force generated mainly by knees, quadriceps muscles, and lumbar region, thereby increasing the contractions and the associated injury risk in these areas (2). It is thought that Laser athletes are at the highest risk of injury and pain in the hiking position. Errors in the hiking technique and disproportion of strength in the agonist-antagonist muscles may cause the risk of pains and injuries in the hiking movement (1,2). The moment load on the knee and lumbar spine increases during the hiking movement (27). In addition, the position of the feet on the hiking strap is critical in the hiking movement, because the internal rotation of the leg may increase the lateral movement of the patella, which can initiate a condition that may predispose the athlete to chronic knee pains, such as chondromalacia patella (4). For this reason, applying the hiking technique at the highest level can be considered as an important factor in reducing injuries because it is understood from the studies in the literature that the wrong technique will cause an increase in the load on the knees, legs, and waist region. The human body is designed to move and exercises have served to prevent many injuries and health problems that arise (28), but applying the techniques wrong increase the risk of pain and injury. When the FMS scores and regional pains of the athletes were examined separately in line with the results obtained in our study, statistically significant and negative relationships were found between the FMS scores and the number and severity of pains in the 17th and 18th regions. Finally, regression analysis showed that the effects of the FMS scores and some motoric features on lower extremity pain were not found statistically significant ($p > 0.05$).

**Acknowledgement**

This study was obtained from Utku GÖNENER's doctoral thesis.

**Conflict of Interest**

The authors declare that they have no conflict of interest.

**References**

1. Mackie H, Legg S. Preliminary assessment of force demands in laser racing. J Sci Med Sport. 1999;2(1):78-85. doi:10.1016/s1440-2440(99)80186–8
2. Shephard R. Biology and medicine of sailing. Sports Medicine. 1997;23(6):350-356. doi:10.2165/00007256–199723060-00002
3. Bøymo-Having L, Grävare M, Grävare Silbernagel K. A prospective study on dinghy sailors' training habits and injury incidence with a comparison between elite sailor and club sailor during a 12-month period. Br J Sports Med. 2013;47(13):826–831. doi:10.1136/bjsports-2012-091841

4. Neville V, Folland J. The epidemiology and aetiology of ınjuries in sailing. Sports Medicine. 2009;39(2):129–145. doi:10.2165/00007256-200939020-00003
5. Allen J. Sailing and sports medicine: a literature review. Br J Sports Med. 2006;40(7):587-593. doi:10.1136/bjsm.2002.001669
6. Açıkada C. Çocuk ve antrenman. Acta Orthop Traumatol Turc. 2004;38(1):16–26.
7. Carvalho A, Brown S, Abade E. Evaluating injury risk in first and second league professional Portuguese soccer: muscular strength and asymmetry. J Hum Kinet. 2016;51(1):19–26. doi:10.1515/hukin-2015-0166
8. Croisier J, Ganteaume S, Binet J, et al. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. Am J Sports Med. 2008;36(8):1469–1475. doi:10.1177/0363546508316764
9. Bradley P, Portas M. The relationship between preseason range of motion and muscle strain ınjury in elite soccer players. J Strength Cond Res. 2007;21(4):1155. doi:10.1519/r-20416.1
10. Leetun D, Ireland M, Willson J, et al. Core stability measures as risk factors for lower extremity ınjury in athletes. Med Sci Sport Exer. 2004;36(6):926–934. doi:10.1249/01.mss.0000128145.75199.c3
11. Dorrel B, Long T, Shaffer S, et al. The Functional Movement Screen as a Predictor of Injury in National Collegiate Athletic Association Division II Athletes. J Athl Train. 2018;53(1):29–34. doi:10.4085/1062-6050-528-15
12. Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function-part 1. N Am J Sports Phys. 2006;1(2):62–72.
13. Freyd M. The Graphic Rating Scale. J Educ Psychol. 1923;14(2):83–102. doi:10.1037/h0074329
14. Bijur P, Silver W, Gallagher E. Reliability of the Visual Analog Scale for Measurement of Acute Pain. Acad Emerg Med. 2001;8(12):1153–1157. doi:10.1111/j.1553-2712.2001.tb01132.x
15. Okada T, Huxel K, Nesser T. Relationship Between Core Stability, Functional Movement, and Performance. *J Strength Cond Res*. 2011;25(1):252–261. doi:10.1519/jsc.0b013e3181b22b3e
16. Bompa T, Haff GG. Dönemleme, Antrenman Kuramı Ve Yöntemi. 5th ed. Ankara: Spor Yayınevi ve Kitabevi; 2017.
17. Kiesel K, Plisky P, Voight M. Can serious injury in professional football be predicted by a pre-season functional movement screen?. *N* Am J Sports Phys. 2007;2(3):147–158.
18. Moran R, Schneiders A, Mason J, et al. Do Functional Movement Screen (FMS) composite scores predict subsequent injury? A systematic review with meta-analysis. Br J Sports Med. 2017;51(23):1661–1669. doi:10.1136/bjsports-2016-096938
19. Smith P, Hanlon M. Assessing the Effectiveness of the Functional Movement Screen in Predicting Noncontact Injury Rates in Soccer Players. J Strength Cond Res. 2017;31(12):3327–3332. doi:10.1519/jsc.0000000000001757
20. Attwood M, Roberts S, Trewartha G, England M, Stokes K. Association of the Functional Movement Screen™ with match-injury burden in men's community rugby union. J Sports Sci. 2019;37(12):1365-1374. doi:10.1080/02640414.2018.1559525
21. Garrison M, Westrick R, Johnson MR, et al. Association between the functional movement screen and injury development in college athletes. Int J Sports Phys Ther. 2015;10(1):21.
22. Tee J, Klingbiel J, Collins R, et al. Preseason Functional Movement Screen Component Tests Predict Severe Contact Injuries in Professional Rugby Union Players. J Strength Cond Res. 2016;30(11):3194–3203. doi:10.1519/jsc.0000000000001422
23. Clay H, Mansell J, Tierney R. Association between rowing injuries and the Functional Movement Screen™ in female collegiate Division I rowers. Int J Sports Phys Ther. 2016;11(3):345.
24. Chalmers S, Fuller J, Debenedictis T et al. Asymmetry during pre-season Functional Movement Screen testing is associated with injury during a junior Australian football season. J Sci Med Sport. 2017;20(7):653–657. doi:10.1016/j.jsams.2016.12.076
25. Azzam M, Throckmorton T, Smith R, et al. The Functional Movement Screen as a predictor of injury in professional basketball players. Curr Orthop Pract. 2015;26(6):619–623. doi:10.1097/bco.0000000000000296
26. Tan B, Leong D, Vaz Pardal C, Lin C, Kam J. Injury and illness surveillance at the International Sailing Federation Sailing World Championships 2014. Br J Sports Med. 2016;50(11):673-681. doi:10.1136/bjsports-2015–095748
27. Bojsen-Møller J, Larsson B, Magnusson S, Aagaard P. Yacht type and crew-specific differences in anthropometric, aerobic capacity, and muscle strength parameters among international Olympic class sailors. J Sports Sci. 2007;25(10):1117–1128. doi:10.1080/02640410701287115
28. Işık Ö, Doğan İ. Body components changes and depression scores before competitions among elite female wrestlers. Acta Kinesiol. (2017); 11(1): 23–27.

Correspondence:
Utku Gönener
E-mail: gonener.utku@gmail.com