Assessment of the impact of functional training on the result of the Functional Movement Screen tests in footballers

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Abstract

Background: Systematic physical training has a positive impact on the body, but it can also cause injuries and damage to the musculoskeletal system. Training and medical staff are constantly looking for methods to accurately assess the risk of injury, as well as training programmes to reduce this risk.

Aims: The aim of this study was to evaluate the effects of functional training on Functional Movement Screen (FMS) scores in a group of football players.

Material and methods: A group of 30 football players of GKS "Pniowek-74" Pawlowice was recruited and randomly assigned to two comparison groups: group A, which in addition to the standard training cycle also followed a functional training programme, and group B, which participated only in the standard training cycle. The FMS test, consisting of 7 tests assessing general movement patterns, was used for functional assessment.

Results: When the functional assessment was completed in Measurement II, an increase in the mean FMS score was observed in both groups when compared to Measurement I, however, it was the Group A that achieved a significantly higher difference when compared to Group B ($p<0.01$). The Deep Squat ($p<0.05$) and Active Straight Leg Raise ($p<0.01$) tests showed the greatest improvement over the comparison group. Moreover, Group A showed statistically significant improvement in 5 out of 7 tests while Group B in none.

Conclusion: Implementing functional training has a positive impact on the overall FMS test score. Implementing functional training positively influences the evaluation of individual trials in the FMS.

Key words

physiotherapy, functional evaluation, functional training, Functional Movement Screen, training, stability training.

Introduction

Systematic physical training has a positive effect on all of our body's systems and organs. It improves the physical performance of the body, delays the effects of ageing and tissue degeneration, and has a positive impact on mental health. However, sport does not only entail benefits [1-3]. Despite numerous beneficial aspects of physical activity, it is also a source of various injuries and strains that constantly accompany athletes. Any injury may make it necessary to limit or even completely stop physical activity for a specific period of time [4-7].

Injuries and damages are an integral part of the life of today's athlete. They very often balance on the edge of endurance, which unfortunately has a negative impact on the body [5,6,8,9]. The growing commercialisation of sport and its media popularity are largely considered to be the cause of this phenomenon. Athletes are often paid substantial salaries for their strong performances, which makes the competition even more intense [8,10]. In order to live up to the expectations, they practice even harder, often having to control their own pain. Disregarding pain for a prolonged period of time leads to an accumulation of micro-injuries, as a result of which a seemingly harmless injury can develop into a longer convalescence. Every injury prevents a player from taking an active part in trainings for some time, which, for instance in the case of team sports, depletes the team and limits the coach's tactical possibilities and squad rotation. Moreover, with each successive injury there is a deterioration of health, not only physical but also mental health [7,8,11,12]. Different injuries will have specific consequences, such as increasing financial costs, which are a serious financial burden on the budget of the club or the player himself [10,13].

Medical staff, aware of the danger of injuries, are placing increasing emphasis on various methods of prevention and early detection of injury risk, as well as comprehensive motor preparation to reduce the risk of strain and injury as much as possible and, once an injury has occurred, to facilitate the healing process [9,13,14].

Aims

The aim of this study was to investigate the influence that individually tailored functional training has on the overall Functional Movement Screen (FMS) score, as well as its individual trials in a group of football players.

Material and methods

A total group of 30 football players from GKS "Pniowek-74" Pawlowice, between 17 and 24 years of age, who play in the III league and class B of the Tychy Sub-District (Silesian Football Association), were qualified for the research conducted between November 2020 and February 2021. The subjects were randomly assigned to two groups: group A, in which the athletes, in addition to standard training sessions, also participated in a functional training programme designed on the basis of their performance in functional tests, and group B, in which the subjects followed a standard training programme without any specific recommendations. Each player from both groups attended training sessions lasting between 1.5h-2h, at least 3 times a week. A detailed description of the study groups was provided in the table below **(Table 1)**.

Inclusion criteria for the research were: a minimum of 3 years of experience as a professional football player, systematic participation in trainings and league games, no injury preventing the player from training within the last 3 months from the start of the research, current permission from the sports medicine doctor to participate in games; consent to participate in the research.

Exclusion criteria for the study included: an injury that necessitated cessation of training in the last 3 months, the occurrence of any injury in the period preceding the research and persisting pain during training that required a reduction or temporary suspension of training sessions.

Table 1. Characteristics of the studied footballers.

Groups	**Number** [n]	**Age** [years]	**Body mass** [kg]	**Body height** [cm]	**BMI** [kg/m^2]
Group A	15	19.3 ± 1.9	72.2 ± 5.8	177.4 ± 3.6	22.90 ± 1.0
Group B	15	20.5 ± 2.2	75.1 ± 4.3	180.4 ± 2.5	23.19 ± 1.1

The test used to functionally assess the athletes and measure the effects of trainings was the FMS system [15,16]. It consisted of 7 simple tests (supplemented with other 3 challenge tests) enabling to locate the "weakest links" in the biokinematic chain. These are: Deep Squat, Hurdle Step, Inline Lunge, Shoulder Mobility, Active Straight Leg Raise, Trunk Stability Push-Up, Rotational Stability tests. Each trial was scored on a scale of 0 to 3 and a maximum of 21 points could be obtained collectively [17-19]. This was the best possible result, indicating correctly executed movement patterns (without the involvement of compensatory patterns). A score between 18 and 20 points was indicative of a great test performance and minimal risk of injury. A total score of 14-17 points meant that the subject showed predominantly compensatory patterns and asymmetries, and the risk of injury ranged between 25% and 35%. An overall score of less than 14 points indicated more than 50% of potential risk of injury [15,16,20-22]. The functional analysis itself is based on repeating each of the 7 basic movement tests three times and then selecting the one that was performed best. The whole process was preceded by a warm-up and detailed instructions on how to perform each test correctly. In addition, when both limbs were assessed, the limb that performed worse was taken into account for the final result [15,16,20,21].

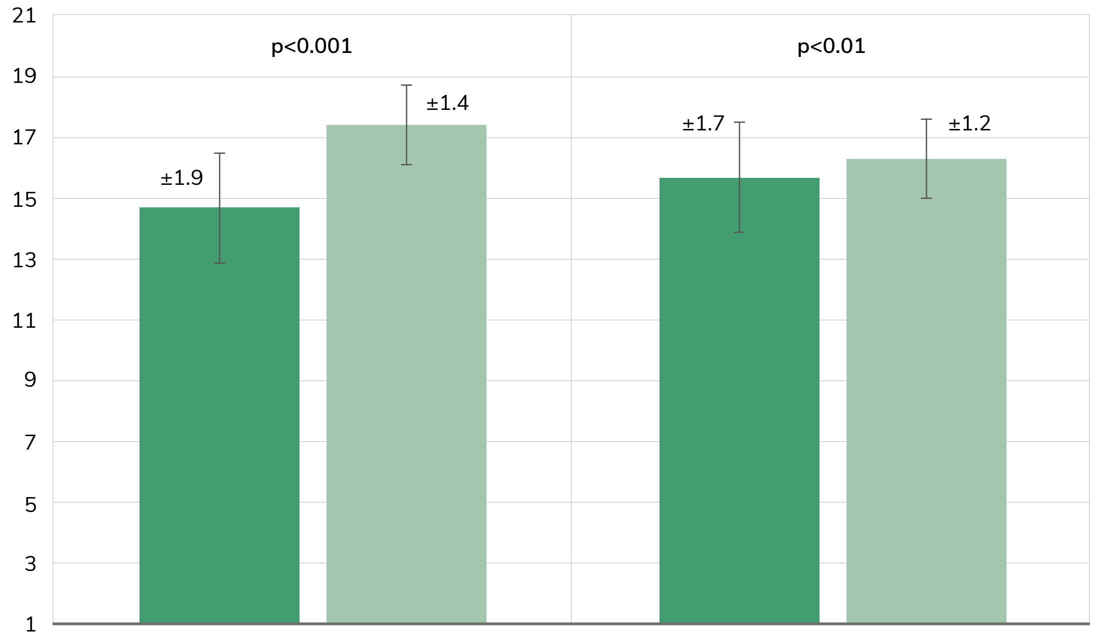
After completing the first stage of the research, all the FMS results were summed up and the obtained scores provided a comprehensive picture of the functional state of the athletes, based on which an improvement programme was selected for the experimental group. An additional training programme was started immediately after the first stage of the FMS testing in early November 2021. During this time, the athletes participated in 40 training sessions, with 15 of these sessions taking place with the researcher. In addition to the standard training programme, they took part in a short functional training programme lasting approximately 30 - 45 minutes. This process continued until the end of February 2021, when the second phase of the FMS testing measuring the effects of the training took place.

Each subject in group A, who scored ≤ 2 on a particular test, performed a series of exercises that were designed to maximally enhance the traits they scored worst on the FMS test. It was based on previous similar research [23,24,25,26], as well as information from the official FMS website [27]. The programme consisted of elements aiming to: improve the quality of movement and flexibility of tissues, increase motor control in both statics and dynamics, and strengthen the stability of individual body segments, using elements of stabilisation training, stretching, or myofascial relaxation using a Foam roller, massage ball, or floss band [23,24-27]. The sample training sessions consisted of a general warm-up with elements of running, dynamic and static-dynamic stretching aimed at the most important muscle groups used by football players. The groups were then separated: group B took part in standard training sessions consisting of elements of conditioning, strength training, coordination, and small games, while group A participated in a functional training programme. This programme consisted of all the elements mentioned above, starting with short myofascial release, or stretching to then move on to the main exercises for strengthening the weakest links identified in the FMS test, starting with the simplest versions and gradually moving on to more demanding ones progressively. The groups would then re-join, ending the training session with tactical elements or a match.

Analyses were performed using MS Excel and Statistica Data Miner 13.3 PL/EN licensed by the Medical University of Silesia in Katowice. The Wilcoxon test was used to detect a significant difference between pairs of two variables, while differences between groups were inspected using the Mann-Whitney U test. The result of a statistical test is a probability value (p), with small values indicating the existence of statistically significant differences. The following criteria were used in this research: $p<0.05$ – statistically significant difference; $p<0.01$ – high statistically significant difference; $p<0.001$ – very high statistically significant difference.

Results

Among all 30 evaluated football players, the mean FMS test score in the first stage of the study was 15.2 ± 1.8 points. During the measurement I, a greater average was obtained by group B when compared to group A, but this difference was not statistically significant ($p>0.05$). After measurement II was taken, it was group A that performed better than group B, obtaining a statistically significant difference ($p<0.05$) and significantly improving its score when compared to the measurement I ($p<0.001$). Group B also showed an improved score when compared to the first stage of the study ($p<0.01$), but it was not as high as in group A. The results were illustrated on the graphic below (**Figure 1**).



	Group A	Group B
measurement I	14.7	15.7
measurement II	17.4	16.3

Figure 1. Results of the FMS test during measurement I and II.

The highest recorded score during the measurement I was 19 points and was achieved by 3 individuals, two of which belonged to group A and one to group B. Meanwhile, the lowest score was 13 points and was achieved by 6 people who belonged exclusively to group A. The worst scoring test for both groups, out of all 7 tests in the first stage of the study, was the Deep Squat test. The results were 1.9 ± 0.7 points for group A and 1.8 ± 0.4 points for group B. The highest scoring trials, on the other hand, varied depending on the group. Group A performed best in the Shoulder Mobility test: 2.5 ± 0.6 points, while for group B it was the In-line Lunge (squat in the stride) test: 2.6 ± 0.6 points.

Following measurement II, it is important to highlight the significant improvement of Group A when compared to measurement I. A statistically significant change was observed across the results of 6 out of 7 tests. The table below illustrates the results of group A during the measurement I and II (**Table 2**).

Group B also showed improvement in FMS test scores, however, not to the same extent as Group A. They performed better in 5 out of 7 tests, although the difference was not statistically significant in any of them. The details were presented below (**Table 3**).

Table 2. Comparison of the results of measurement I and II for group A.

FMS test	Measurement I	Measurement II	X [%]	Difference
Deep Squat	1.9 ± 0.8	2.2 ± 0.4	15.79	p < 0.05
Hurdle Step	2.2 ± 0.4	2.5 ± 0.5	13.64	p < 0.05
In-line Lunge	2.3 ± 0.5	2.8 ± 0.4	21.74	p < 0.01
Shoulder Mobility	2.5 ± 0.6	2.7 ± 0.5	8.00	NS
Active Straight Leg Raise	2.0 ± 0.7	2.4 ± 0.5	20.00	p < 0.05
Trunk Stability Push-up	2.1 ± 0.6	2.7 ± 0.5	28.57	p < 0.001
Rotational Stability	1.8 ± 0.5	2.4 ± 0.8	33.33	p < 0.01

Notes: NS – *statistically not significant difference (p* > 0.05); X – *percentage change between measurement I and II.*

Table 3. Comparison of the results of measurement I and II for group B.

FMS test	Measurement I	Measurement II	X [%]	Difference
Deep Squat	1.8 ± 0.4	1.9 ± 0.3	5.56	NS
Hurdle Step	2.5 ± 0.5	2.5 ± 0.5	0	NS
In-line Lunge	2.6 ± 0.6	2.7 ± 0.5	3.85	NS
Shoulder Mobility	2.3 ± 0.9	2.4 ± 0.6	4.35	NS
Active Straight Leg Raise	1.9 ± 0.3	1.9 ± 0.3	0	NS
Trunk Stability Push-up	2.1 ± 1.0	2.4 ± 0.8	14.29	NS
Rotational Stability	2.4 ± 0.5	2.5 ± 0.5	4.17	NS

Notes: NS – *statistically not significant difference (p* > 0.05); X – *percentage change between measurement I and II.*

Comparing the results of both groups against the measurement II, it can be noted that in the vast majority of tests, a greater improvement is seen in the group additionally performing functional training, however, the difference was found to be statistically significant only for two tests: Deep Squat and Active Straight Leg Raise. The precise data was provided in the table below (**Table 4**). On the Deep Squat test, three players from group A scored maximum points, while in group B not a single player scored 3 points. A similar scenario occurred in the Active Straight Leg Raise test, where as many as six athletes in the test group achieved 3 points, while no one in the comparison group did.

Considering the entire study, the lowest score increased from 13 to 15 points, while the highest score was 20 points. In Group A, more than half of the players reached the threshold of ≥18 points (five scored 18 points, two scored 19 points, and one scored 20 points). It is also worth mentioning that each of the 15 athletes from the group participating in the functional training programme improved their overall FMS score against the measurement I. Comparatively, 8 out of 15 players in the control group improved their score, against the first stage of the research. However, only two players reached the threshold of ≥18 points.

Table 4. Comparative characteristics of group A and B.

Tests	Group A		Group B		Difference
	Mean ± SD	X [%]	Mean ± SD	X [%]	
Deep Squat	2.2 ± 0.4	15.79	1.9 ± 0.3	5.56	p < 0.05
Hurdle Step	2.5 ± 0.5	13.64	2.5 ± 0.5	0	NS
In-line Lunge	2.8 ± 0.4	21.74	2.7 ± 0.5	3.85	NS
Shoulder Mobility	2.7 ± 0.5	8.00	2.4 ± 0.6	4.35	NS
Active Straight Leg Raise	2.4 ± 0.5	20.00	1.9 ± 0.3	0	p < 0.01
Trunk Stability Push-up	2.7 ± 0.5	28.57	2.4 ± 0.8	14.29	NS
Rotational Stability	2.4 ± 0.8	33.33	2.5 ± 0.5	4.17	NS

Notes: NS – *statistically not significant difference* ($p > 0.05$); X – *percentage change between measurement I and II.*

Discussion

The FMS test is one of the most widely used methods for functional assessment in both medicine and the world of sport [28,29]. It allows for the identification of potentially hazardous functional limitations that may predispose to various musculoskeletal injuries. Simple mobility tasks are included to serve as a screening tool, testing general movement patterns in order to select an appropriate exercise programme focused on injury prevention, rehabilitation support, and improvement of athletic performance [29,30]. It is believed that the FMS alongside isokinetic muscle testing and injury risk assessment questionnaires is one of the most popular systems for detecting injury predisposing factors among professional footballers. McCall et al., [31] analysing the practice of medical staff of some of the top football clubs in the world, showed that approximately 66% of them use the above 3 methods in injury risk assessments [31].

A number of studies can be found in the literature evaluating the effects of a particular type of training on the researcher's chosen tests. Papiez et al. [23] conducted a study of a similar nature to the presented work. They evaluated the impact of corrective activities, strictly based on the FMS analysis, comparing a group of football players to those undertaking physical activity only recreationally. Similarly, to our findings, they reported improved test scores after implementing functional training, while also achieving a slightly higher overall FMS score (18.2 ± 0.6 points) when compared to the athletes examined in our study (17.4 ± 1.4 points). The In-line Lunge test proved to be the best performed among examined footballers, with each player receiving the maximum number of points. In our own study, the In-line Lunge also proved to be the best performed test, however, the obtained results were slightly worse (2.8 ± 0.4 points). Meanwhile, Rotational Stability test was considered to be the worst performed, where the average score was around 2.14 points, which turned out to be lower when compared to our own research (2.4 ± 0.8 points). Therefore, they were able to demonstrate that the introduction of FMS-based correction into typical football training can significantly improve the functional performance of athletes and reduce the risk of injury [23].

Similar conclusions were also reached by Campa et al. [32], Baron et al. [33], and Song et al. [26]. Also, Campa et al. [32] carried out research on a group of footballers belonging to some of the top 4 youth clubs in Italy. They wanted to investigate the extent to which a corrective exercise programme (tailored specifically to the athletes, based on the dysfunctions shown during FMS testing) would affect the functional status of the athletes. Before the introduction of the training, the overall score on the FMS test was, on average, 12.63 ± 1.80 points, which was lower than results in our study. Following a 20-week training cycle, the football players significantly improved ($p < 0.001$) their overall FMS test score (14.59 ± 0.87 points), however, this score was still lower than the one obtained in our sample. The authors were able to prove that the taken measures definitely influenced the tests results, thereby reducing the occurring asymmetries and dysfunctional movement patterns [32].

Baron et al. [33] conducted a study investigating young football players competing in the Central Junior League. The aim of their research was to evaluate functional and physical parameters in order to select an appropriate improvement process, however, unlike our study, they only focused on 3 FMS tests (Deep Squat, Hurdle Step, and In-line Lunge) and additionally performed speed tests. In evaluation conducted prior to the training programme, the athletes performed worse in the above 3 FMS tests when compared to our own research. They scored an average of 1.55 ± 0.51 points on the Deep Squat test, 1.85 ± 0.49 points on the Hurdle Step test, and 1.65 ± 0.59 points on the In-line Lunge. However, after completing the functional training cycle, a significant change in functional test scores ($p < 0.05$) could be observed among evaluated players, which were similar to the results obtained in our study. The authors demonstrated that properly adjusted functional training, aimed at strengthening fundamental motor skills and eliminating functional limitations, can be a useful tool in supporting the training cycle [33].

Song et al. [26] assessed the impact of functional training, based on FMS assessment, on the physical performance of youth baseball team players. Similarly, to our study, in addition to physical exercises they introduced into the training programme elements of myofascial relaxation using a foam roller. After completing a 16-week training cycle, it was shown that the applied improvement programme contributed to the enhancement of such qualities as strength and flexibility [26].

Boguszewski et al., [34] performed an analysis on a group of female basketball players, with the aim of investigating the effects of proposed 8-week stabilisation training programme on physical fitness. In addition to the FMS analysis, they used the Core Muscle Strength and Stability Test (CMS&ST) to measure the strength and stability of the trunk muscles. In the first stage of the research, the mean of the individual FMS test scores, as well as the overall trial, differed slightly from the results observed in our own study. After completing the stabilisation training cycle, the researchers observed a visible improvement in test scores ($p < 0.001$) against the measurement I and a visible change relative to the group that followed a standard training programme. The mean score for all FMS tests increased to a value of 15.64 points, which was in turn a significantly lower score, when compared to our own study. The scores of the individual trials did not differ much from those obtained in our study, with the exception of the Trunk Stability Push-up test (1.93 ± 0.47 points), in which the basketball players performed almost 50% worse [34]. Similar conclusions were reached by Kolodziej G. and Kolodziej K. [19], who demonstrated that an appropriate stabilization training program, can positively affect the functional state of an athlete.

In the literature, one can also find research that does not support an improvement programme based on the FMS testing. For instance, Dossa et al. [36] state that the FMS concept cannot be used as a method for pre-season injury risk assessment in a youth ice hockey team, noting that this requires further research. Venter et al., [37], on the other hand, believe that women netball players, due to the specific demands of the sport, have developed characteristics that do not fully correspond to the FMS assessment. Furthermore, a study conducted by Dorrel et al. [38] indicated a low diagnostic reliability of this test in assessing injury risk.

Conclusions

Implementing individually tailored functional training has a positive effect on the overall FMS test score. Furthermore, the individually tailored functional training programme used has a positive impact on each of the individual trials in the FMS testing system.

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