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Frohm Nine-Test Screening Battery for Elite Soccer Players: A Cross-Sectional Study

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Original Article

Abstract

Introduction: Football as a sport may result in various injuries of the upper and lower limbs, which impose considerable time and money to rehabilitate and cure. Identifying people at risk is possible through evaluating the movement patterns and individual performance. The Frohm functional test is one of the most comprehensive screening tools. Therefore, the aim of the current research was to compare the results of Frohm functional tests in injured and uninjured elite soccer players.

Materials and Methods: 148 elite young soccer players participated in the present study in four groups of "without injury", "upper limb", "ankle", and "knee" injury. The injuries were confirmed through Fuller's questionnaire and with the approval from the team's doctor and coach. Nine performance tests were taken from them. Then, in order to compare test scores between football players with and without injury, Kruskal-Wallis statistical method was used and logistic regression was used to predict the injury report from the test.

Results: The results of the Kruskal-Wallis test showed that injury caused a significant decrease in deep squat test, one-legged squat test, in-line lunge test, active hip flexion test, seated rotation test, functional shoulder mobility test, total score (P = 0.001), and push-up test (P = 0.004) in elite soccer players with and without injuries. Besides, the results of multivariable regression in soccer players with and without history of injury showed that one-legged squat test [odds ratio (OR) = 11, 95% confidence interval (CI) = 3.66-32.99] and deep squat test (OR = 13.751, 95% CI = 5.186-36.462) could predict injury report in soccer players.

Conclusion: Frohm nine-test screening battery can predict injury reports and these tests can be effective for pre-season screening to predict injury, eliminate possible injuries, and increase sports performance of athletes.

Keywords: Football; Injuries; Injury prediction

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Introduction

Soccer is known as the popular sport in the world with millions of players (1). In professional football, due to the combination of physical and mental stress, the risk of injury is very high (2); that is why, for every 1000 hours of playing (practice and competition), 6.6 injuries occur in this sport (3). The head, neck, upper limb, and trunk were identified as the injury sites in the upper quarter of the body, and the hip, knee, leg, Achilles tendon, ankle, and foot were identified as the injury sites in the lower quarter of the body in football sports (2, 4, 5), among which are injuries in the lower limbs with an incidence rate of 6.8 injuries, trunk with an incidence rate of 0.4, and upper limbs with an incidence rate of 0.3 injuries per 1000 hours of play, respectively. They are known as the common places of injury (6). Most football injuries occur during the game (7-10) and mostly require surgery (9), which this issue can be a serious risk to football players compared to other sports.

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The negative impact of football injuries on the health and performance of players is not a secret, and mostly injured individuals hardly return to their pre-injury performance level (11). Therefore, due to the long time of absence and return of the athlete to the matches after football injuries, it is important to identify the individuals at risk for injury prevention and rehabilitation. One of the important things to identify individuals at risk is to evaluate the movement patterns and performance of the individual and to determine the risk factors present when performing functional movements. Nowadays, sports science specialists, physiotherapists, and doctors believe that the evaluation of movement performance and training strategies can be useful in predicting, preventing, and reducing the rate of sports injuries and improving sports performance (12, 13). In fact, movement evaluation is one of the main components in determining movement efficiency and potential risks for injury (14) and is considered a very important aspect in the diagnosis and rehabilitation of movement control (15). In the pyramid of preventing injuries to athletes, the first step is to determine the movement performance of athletes and the condition of people in basic movement tests (16). Accordingly, one of the important factors in preventing injury and improving performance is the detection of asymmetries and defects in movement and stability, which lead to changes in movement patterns (formation of compensatory movement patterns) in the closed movement chain and eventually, injury (17). Cook et al. introduced the Functional Movement Screen (FMS) test, which is a set of seven basic movement patterns; subjects need to apply mobility and stability for a current execution (involvement of the neuromuscular system, movement control). These tests have the potential to identify the limitations and changes of normal movement patterns, which are designed for the interaction between the movement of the chain and the stability required for the execution of functional movement patterns (18). However, except FMS, there are many other tests for screening the movement patterns that have covered the defections of FMS and can be used to measure functional movements.

One of the appropriate instruments for screening movement and functional patterns is the Frohm test. This test is one of the available and suitable instruments for screening movement and performance patterns, which is used to measure a set of physical functions (19). Defects in the implementation of these basic movement patterns will lead to the activation of compensatory movement patterns, and the continuous use and strengthening of these compensatory patterns can lead to the weakness of the biomechanical pattern and ultimately increase the potential for injury (20). Based on the research conducted by Frohm et al., to screen functional movement and predict injury and rehabilitation in elite football players, it seems that this test is a suitable instrument for injury prevention, rehabilitation, and performance improvement, and has high validity and reliability (19).

On the other hand, knowing the player's performance level can be useful in identifying individuals at risk to prevent injuries (21) and using the Frohm test to assess the risk of injury seems necessary (22). Previous researches have not comprehensively compared the performance of soccer players with and without injuries through the Frohm test; considering the high prevalence of injuries in the upper and lower limbs of football players and its negative effects on the performance level of individuals (23-25), the purpose of this study is to investigate the difference in Frohm scores in two groups of football players with a history of previous injury and without injury and to determine the dysfunctions in movement patterns, movement limitations, and the existence of asymmetry between these two groups. Based on the results of the study, it is determined whether there is a relationship between the dysfunction in functional movement patterns and the rate of injury in this sport. It is also determined whether these types of tests can be a suitable measure for predicting injury and disorder in movement patterns, movement limitations, and the presence of asymmetry in soccer players.

Materials and Methods

Research plan: This comparative causal study was applied and cross-sectional in terms of design. The steps of this research were designed based on ethical considerations in accordance with the instructions of the Ethics Committee of University of Tehran, Tehran, Iran, and were approved by this committee.

Subjects: One hundred and forty-eight elite football players participated in this study (18 to 28 years old); they were selected and investigated by available and targeted sampling. The criteria for including the study were: age range from 18 to 28 years old, employment in the Premier League and First Division League, having experience of at least three years and three training sessions every week, not having pain and injury on the day of the test, not having surgery or fracture on the lower and upper limbs in the last 6 months, and not having visible skeletal muscle abnormalities in the lower and upper limbs. Exclusion criterion was the presence of detectable abnormalities in the feet and soles of the feet. All participants signed the consent form before participating in this research.

Research implementation method: The time of the test was at the beginning of the years 2022-2023 and before the start of the teams' competitions in such a way that the players working in the Premier League and the First Division of Iranian football league were selected, and the purpose and how to conduct the research were explained and the consent form was obtained from the individuals. They were invited to attend the School of Physical Education of University of Tehran on a certain day, and then the research process began. At first, the height and weight of the subjects were measured using a tape measure and a digital scale (Fluke, USA), then the information related to the injury of the individuals was collected through a modified Fuller questionnaire, which includes various sections such as the time of injury, type of injury, injured area, and factors. The hazard and the details of the injured person (26) were collected and recorded. It is noteworthy that the content validity of this questionnaire was confirmed by a group of sports medicine specialists and physical education professors, and its internal reliability was obtained with Cronbach's alpha of 0.86 (27). It is of note that the information related to the type and characteristics of the injury was determined by the doctor and the medical staff and recorded in the players' medical file and questionnaire. In this way, elite football players who were injured in the previous season, at least 6 months had passed since their injury, were not injured in the new season and on the day of the test, and were in training and competition conditions were used. Next, to evaluate people's performance, a nine-test screening battery was used. This test is one of the available and appropriate tools for screening movement and performance patterns and consists of 9 different tests that were presented for the first time in 2011 by Frohm et al. to screen sports movement patterns (19). In fact, the purpose of using these 9 tests is to evaluate fundamental movements and apply specific pressure on components such as stability and mobility in the body's movement chain, and each exercise is standardized to evaluate mobility, stability, and neuromuscular control (19).

Fuller questionnaire: In this study, Fuller et al. injury report questionnaire was used to record individuals' injury information. This questionnaire has categorized the information in three parts. The first part contains information about the frequency of damage to the general organs of the body (head and face, trunk and vertebral column, upper and lower limbs); the organs were divided into more detailed parts. The second part contains information about the frequency of all types of injuries in the body (skin, muscle-tendon, joint-ligament, bone, and pain), and the third part is related to mechanism information. It is the cause of damage (26). It is of note that knee and ankle injuries during the season were recorded in the relevant form with the approval of the team's doctor and coaches, and the meaning of the injury was the injuries that happened in training or the match and the injured player was unable to play and participate in that training and competition session and the next session (defining injury based on absence from training and competition) (28, 29).

FMS test (Frohm): The nine-test screening battery is one of the available and suitable instruments for screening movement and functional patterns (20, 30). This test includes nine tests: deep squat test, one-legged squat test, in-line lunge test, active hip flexion test, straight leg raise test, push-up test, diagonal lift test, seated rotation test, and functional shoulder mobility test (31), including the one-legged squat test taken from the movement pattern screening system from the United States Tennis Association (USTA) (19) and six tests of deep squat test, in-line lunge test, active hip flexion test, push-up test, diagonal lift test, and functional shoulder mobility test derived from a number of FMS tests, taking into account some modifications in them (32) which actually meet all FMS requirements (33). Finally, two tests, straight leg raise test and seated rotation test, which were considered by Frohm research group to evaluate the dynamic performance of trunk flexors and rotators of lumbar vertebrae (18), are part of this collection (19). Therefore, in general, the Frohm test is standardized to evaluate mobility, stability, and neuromuscular control (19).

To implement each of the nine-test screening battery, the athlete moved from the starting position to the final position according to specific instructions. Each test was performed 3 times consecutively for a total time of 30 minutes with bare feet and sports clothes, so that the maximum ability of the person was tested, and numbers (0, 1, 2, and 3) were used for scoring (19). After three trying, the score of two tests that were similar was recorded as the score of that test (34). A score of 3 indicates performing the movement correctly without compensatory movements, 2 indicates performing the correct movement using compensatory movements, 1 shows not performing the correct movement according to the provided instructions even with performing compensatory movements, and 0 indicates not being able to perform the test under any conditions (19). The total score of all 9 tests is 27 (19, 20). According to the study conducted by Frohm et al., a score of less than 14 indicates that the person is susceptible to injury, although it should be noted that the high combined score of this test compared to the standard score does not definitively indicate the absence of injury (19). The examiner did not know about the injury (blinding) and in the injured group, the injury occurred at least six months ago and the person was in competition and training conditions on the day of the test. Therefore, the examiner could not guess from the performance whether the person was injured or healthy.

Statistical analysis method: In order to investigate the statistical differences, in the descriptive statistics section, mean and standard deviation (SD) and in the inferential statistics section, in order to compare the scores of the Frohm test of football players without a history of injury and those with a history of injury, the Kruskal-Wallis test, and to predict the injury report using functional tests, logistic regression were used. Moreover, univariate logistic regression analysis was used to predict the possible relationship between the performance tests and the grade received. Variables with $P < 0.2$ were included in the multivariable logistic regression model with reverse elimination (35) and their relationship with injury was investigated. Besides, the results were reported as odds ratio (OR) and 95% confidence interval (CI). The OR in categorical variables indicates the change in the chance of injury for a one-unit increase. The significance level was 0.05 and the analyses were performed using SPSS software (version 26, IBM Corporation, Armonk, NY, USA).

Results

One hundred and forty-eight elite football players entered this project, then 148 people of them completed the tests. 1 person from the group with upper limb injury was excluded from the study due to unwillingness to cooperate (Figure 1).

Descriptive statistics of the anthropometric characteristics of the research subjects, including age, height, weight, and body mass index (BMI) by group are presented in table 1.

The studied groups did not have significant differences in anthropometric characteristics. The Kruskal-Wallis test was used to compare the scores of the Frohm test in soccer players with and without a history of injury (Table 2).

The results of the Kruskal-Wallis test (Table 2) showed that in the in-line lunge test, one-legged squat test, active hip flexion test, seated rotation test, functional shoulder mobility test, deep squat test, push-up test, and also in the total score, there was a significant relationship between the group of soccer players with and without history of injury ($P \geq 0.004$).

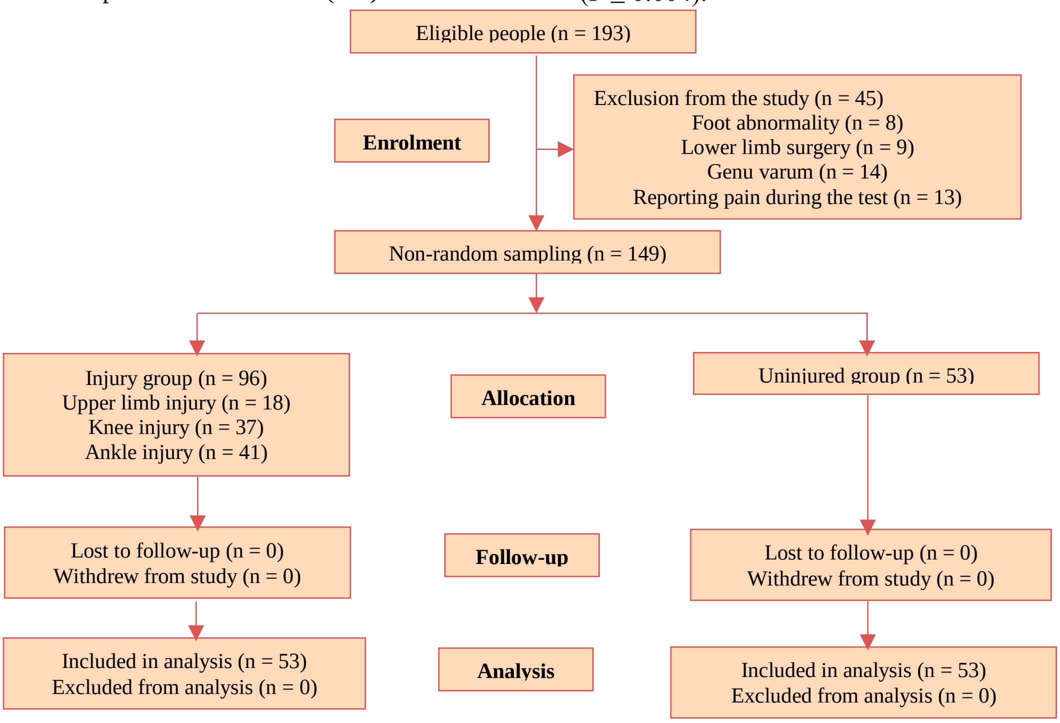

Figure 1. Chart of the dropout of participants in different parts of the study

Table 1. Anthropometric characteristics of the participants by group in the study

Variables	No injuries (n = 53)	Upper limb injury (n = 17)	Ankle injury (n = 41)	Knee injury (n = 37)	P-value (between group)
Age (year)	22.28 ± 2.78	22.06 ± 2.98	23.73 ± 2.68	22.95 ± 3.34	0.073
Weight (kg)	72.68 ± 5.57	72.47 ± 5.05	73.78 ± 5.72	74.43 ± 5.96	0.438
Height (cm)	177.58 ± 6.27	177.18 ± 5.90	179.05 ± 6.59	179.14 ± 6.73	0.528
BMI (kg/m^2)	23.03 ± 0.79	23.07 ± 0.67	22.98 ± 0.63	23.16 ± 0.63	0.713

Data are presented as mean ± standard deviation (SD)
BMI: Body mass index

Therefore, as expected, the injury had an effect on the grades received from the tests. In other words, the injury caused a significant decrease in the individual's record in performance tests. However, in other tests, no significant relationship was observed between two groups of soccer players with and without history of injury (P < 0.050).

Table 2. Kruskal-Wallis test for comparing the scores of Frohm test

Tests	Groups	Mean (range)	Mean rank	df	Kruskal-Wallis	P-value
In-line lunge test	No injury	3 (1-3)	91.09	3	29.79	0.001*
	Upper limb injury	3 (2-3)	94.94			
	Ankle injury	2 (1-3)	63.48			
	Knee injury	2 (1-3)	53.55			
One-legged squat test	No injury	3 (1-3)	98.81	3	42.39	0.001*
	Upper limb injury	3 (2-3)	84.32			
	Ankle injury	3 (1-3)	59.24			
	Knee injury	3 (1-3)	52.07			
Active hip flexion test	No injury	3 (2-3)	82.99	3	15.46	0.001*
	Upper limb injury	3 (2-3)	77.32			
	Ankle injury	3 (1-3)	76.99			
	Knee injury	3 (1-3)	58.28			
Diagonal lift test	No injury	3 (1-3)	75.56	3	4.81	0.186
	Upper limb injury	3 (2-3)	62.53			
	Ankle injury	3 (1-3)	74.87			
	Knee injury	3 (2-3)	78.08			
Seated rotation test	No injury	3 (2-3)	83.18	3	31.35	0.001*
	Upper limb injury	2 (1-3)	44.35			
	Ankle injury	3 (2-3)	72.12			
	Knee injury	3 (2-3)	78.60			
Functional shoulder mobility test	No injury	3 (2-3)	81.46	3	15.54	0.001*
	Upper limb injury	2 (1-3)	49.26			
	Ankle injury	3 (1-3)	72.82			
	Knee injury	3 (2-3)	77.99			
Deep squat test	No injury	3 (2-3)	104.28	3	75.02	0.001*
	Upper limb injury	3 (2-3)	99.76			
	Ankle injury	2 (1-3)	48.00			
	Knee injury	2 (1-3)	49.59			
Push-up test	No injury	3 (1-3)	77.50	3	13.40	0.004*
	Upper limb injury	2 (1-3)	49.44			
	Ankle injury	3 (1-3)	78.30			
	Knee injury	3 (1-3)	77.50			
Straight leg raise test	No injury	3 (2-3)	74.42	3	0.06	0.990
	Upper limb injury	3 (2-3)	75.29			
	Ankle injury	3 (1-3)	75.05			
	Knee injury	3 (1-3)	73.65			
Total score	No injury	26 (22-27)	111.08	3	63.79	0.001*
	Upper limb injury	24 (19-27)	66.38			
	Ankle injury	23 (20-26)	55.01			
	Knee injury	23 (19-25)	47.43			

*Significant difference at P < 0.05 level
df: Degree of freedom

The inter-group comparison showed that in the in-line lunge test, between the groups without injury and the ankle injury group (P = 0.003) and the knee injury group (P = 0.001), and between the upper limb injury group and the ankle injury group and knee injury group (P = 0.01 for both comparisons), there was a significant difference. In the one-legged squat test, there was a significant difference between the uninjured group and the ankle injury and knee injury groups (P = 0.001 for both comparisons), and between the upper limb injury group and the ankle injury group (P = 0.03) and knee injury group (P = 0.006). In the active hip flexion test, there was a significant difference between the uninjured group and the knee injury group (P = 0.0001), the upper limb injury and knee injury group (P = 0.03), and the knee and ankle injury group (P = 0.008). In the seated rotation test, there was a significant difference between the groups without injury and the upper limb injury, and between the upper limb injury group and the ankle injury and knee injury groups (P = 0.001 for all three comparisons). In the functional shoulder mobility test, there was a significant difference between the groups without injury and upper limb injury (P = 0.001), and the upper limb injury group with the ankle injury group (P = 0.02) and the knee injury group (P = 0.001). In the deep squat test, there was a significant difference between the uninjured group with the ankle injury and knee injury group, and the upper limb injury group with the ankle injury and knee injury groups (P = 0.001 for all four comparisons). In the push-up test, there was a significant difference between the groups without injury and upper limb injury (P = 0.002), and between the upper limb injury group and the ankle injury and knee injury groups (P = 0.005 for both comparisons). There was a significant difference in the total score of the test between the groups without injury and each of the three injury groups (P = 0.001).

Logistic regression test was used to predict injury report using functional tests. The results of univariate logistic regression analysis between two groups with and without injury history are shown in table 3. In this analysis, for each test, correct performance without defects was considered as the reference level and the model was built according to it.

The results of univariate logistic regression analysis (Table 3) in football players with and without history of injury showed that average performance (score 2) in in-line lunge test, one-legged squat test, seated rotation test, and deep squat test was related to injury. Moreover, the results of univariate logistic regression analysis in soccer players with and without history of injury showed that poor performance (score 1) in in-line lunge test and one-legged squat test was related to injury.

Table 4 shows the results of multivariate logistic regression. After univariate logistic regression analysis in soccer players with and without history of injury, variables whose significance level was less than 0.2 (P < 0.2) were added to multivariate logistic regression.

The results of multivariate regression in soccer players with and without history of injury showed that one-legged squat test (OR = 11.00, 95% CI = 3.66-32.99) and deep squat test (OR = 13.75, 95% Cl = 5.18-36.42) could predict injury report in soccer players.

Table 3. Univariate logistic regression analysis results

Tests	Level*	OR (95% CI)	P-value
In-line lunge test	Average performance	4.87 (2.03-11.66)	0.001*
	Poor performance	4.66 (1.24-17.43)	0.020
One-legged squat test	Average performance	11.50 (4.42-29.88)	0.001*
	Poor performance	13.52 (1.65-110.80)	0.015*
Active hip flexion test	Average performance	2.05 (0.70-6.03)	0.189
	Poor performance	0.01 (0.01-0.01)	0.990
Diagonal lift test	Average performance	0.01 (0.45-4.14)	0.571
	Poor performance	1.37 (0.03-9.37)	0.696
Seated rotation test	Average performance	0.57 (1.40-85.11)	0.020
	Poor performance	0.01 (0.01-0.01)	0.176
Functional shoulder mobility test	Average performance	1.98 (0.73-5.37)	0.990
	Poor performance	0.01 (0.01-0.01)	0.001*
Deep squat test	Average performance	14.89 (6.24-35.56)	0.990
	Poor performance	0.01 (0.01-0.01)	0.817
Push-up test	Average performance	0.89 (0.33-2.35)	0.117
	Poor performance	5.35 (0.65-43.67)	0.470
Straight leg raise test	Average performance	0.71 (0.29-1.77)	0.990
	Poor performance	0.01 (0.01-0.01)	

*Correct performance was considered as the reference level; Significant difference at P < 0.05 level
OR: Odds ratio; CI: Confidence interval

Table 4. Results of multivariate logistic regression analysis

Injury variable	No injuries [OR (95% CI)]	Upper limb injury [OR (95% CI)]	Ankle injury [OR (95% CI)]	Knee injury [OR (95% CI)]
In-line lunge test			16.93 (1.01-281.53) P = 0.049	29.14 (2.27-373.97) P = 0.001
One-legged squat test	11.00 (3.66-32.99) P = 0.001		12.40 (2.06-74.59) P = 0.006	74.60 (5.91-940.92) P = 0.001
Active hip flexion test				
Diagonal lift test		3.91 (0.97-15.76) P = 0.050		
Seated rotation test				
Functional shoulder mobility test				
Deep squat test	13.75 (5.18-36.46) P = 0.001		93.05 (13.01-665.38) P = 0.001	271.86 (13.29-556.25) P = 0.001
Push-up test				
Straight leg raise test				

Significant difference at P < 0.05 level
OR: Odds ratio; CI: Confidence interval

That is, with each unit decrease in the one-legged squat test score, athletes reported 16 times more injuries, and in the deep squat test, with each unit decrease in the test score, athletes reported 13.75 times more injuries. In addition, in the same way, the relationship between soccer players without a history of injury and soccer players with upper limb injuries was measured. The results of multivariate regression in football players with upper limb injury and no history of injury showed that the functional shoulder mobility test (OR = 3.91, 95% Cl = 0.97-15.76) could predict the report of injury in these athletes. That is, with each unit decrease in functional shoulder mobility test score, athletes reported 3.91 times more injuries. The results of multivariable regression in soccer players with ankle injury and no history of injury showed that in-line lunge test (OR = 16.93, 95% Cl = 1.01-281.53), one-legged squat test (OR = 12.40, 95% Cl = 2.06-59.74), and deep squat test (OR = 93.05, 95% Cl = 13.01-665.38) could predict injury report in soccer players. That is, with each unit decrease in the score of the in-line lunge test, the athletes reported 16.93 times more injuries, with each unit decrease in the one-legged squat test score, the athletes reported 12.40 times more injuries, and with each unit decrease in the score of the deep squat test, the athletes reported 93.05 times more injuries. The results of multivariate regression in soccer players with knee injury and no history of injury showed that in-line lunge test (OR = 29.14, 95% Cl = 2.27-373.97), one-legged squat test (OR = 74.60, 95% Cl = 5.91-940.92), and deep squat test (OR = 271.86, 95% Cl = 13.29-556.25) could predict injury report in soccer athletes.

Discussion

It is important and practical to identify soccer players at risk through the evaluation of movement patterns and individual performance. Therefore, the aim of the current research was to compare the functional test of Frohm in injured (knee, ankle, and upper limb) and uninjured elite soccer players. The results of this study showed that injury caused a significant decrease in the records of deep squat test, one-legged squat test, in-line lunge test, active hip flexion test, seated rotation test, functional shoulder mobility test, and total score of push-up test in football players. Moreover, the results of multivariate regression in soccer players with and without history of injury showed that one-legged squat test and deep squat test could predict the report of injury in soccer players.

Due to the increase in the occurrence of sports injuries, screening of athletes in order to prevent injuries and increase performance in sports is common today. Cook et al. introduced FMS tests considering pre-season screening and performance-related factors (36). One of the available and appropriate tools for screening movement and performance patterns is the Frohm test, which is designed to identify the limitations of basic movement patterns that make athletes prone to injury (19). This test is not designed to test the joints of the body separately and is used as a tool to determine the capacity of people, including athletes, in order to prevent and identify their injuries (33). However, Frohm's functional test is a valid functional test that measures strength, endurance, power, and motor control (33). In the present study, the overall score of the Frohm test was different between the two groups of without injury and those with a history of injury, in such a way that the group that did not have any injury reported a higher overall score than the people with a history of injury. In the examination of the subsets of the FMS test which are include deep squat test, one-legged squat test, in-line lunge test, active hip flexion test, seated rotation test, are showed a significant relationship between the group of soccer players with and without a history of injury. However, in other tests, no significant relationship was observed between two groups of soccer players with and without a history of injury. On the other hand, the results of univariate logistic regression analysis in soccer players with and without history of injury showed average performance (score 2) in in-line lunge test, one-legged squat test, seated rotation test, and deep squat test, and poor performance (score 1) in in-line lunge test and one-legged squat test was related to injury report. Besides, the results of multivariate regression in soccer players with and without history of injury showed that one-legged squat test and deep squat test could predict injury in soccer players.

The results of multivariate regression in soccer players with upper limb injury and no history of injury showed that functional shoulder mobility test could predict injury in these athletes, and soccer players with upper limb injury in most tests except functional shoulder mobility test, push-up test, and seated rotation test performed better than the knee and ankle injury group. Therefore, it seems that in the case of upper limb injury, the tests related to the function of the upper limb from the set of nine tests used challenged the mobility and endurance of the lumbar and shoulder girdle well and determined the decrease in strength, power, and neuromuscular control of the injured people. The results of our research were in line with the previous results, which stated that functional movements were an effective method for evaluating the factors of strength, power, and neuromuscular control (37). In this regard, in their study, Pontillo et al. investigated the relationship between a number of strength and performance tests of soccer players with injuries and the results revealed that the use of these tests was useful in identifying people at risk of shoulder injuries (38).

The results of multivariate regression in the present study revealed that the in-line lunge test, one-legged squat test, and deep squat test could predict injury in soccer players with knee injury and no history of injury. Due to being in the center of the lower limb, the knee is prone to injury as a force transmitter from the pelvic girdle to the ground, and vice versa, from the foot and ankle to the pelvis (39). Moreover, the results of multivariable regression in soccer players with ankle injury and no history of injury showed that in-line lunge test, one-legged squat test, and deep squat test could predict injury in soccer players. The ankle is the support surface of the body that supports the weight and plays an important role in moving the body (40). The initial stage of separating the foot from the ground and overcoming the force of weight, in performing some functional tests, requires the contraction of the plantar flexor muscles, and this process is carried out in uninjured people by increasing the stimulation of mechanoreceptors (41). In ankle injuries, mechanoreceptor excitability decreases, which can decrease the strength of plantar flexor muscles (42). Functional tests, including FMS, as a complete test to check the lower limbs, can show the mechanical characteristics of the structures of the lower limbs of people (43) and for this reason, to predict and identify chronic ankle and its subsequent injuries (44), lower limb strength measurement of athletes with anterior cruciate ligament (ACL) injury is used (45). In line with the performance weakness of injured athletes in the set of nine tests discussed in this study, similar results were reported in some previous studies for league football players (46) and military officers (47). However, some researchers believe that functional tests cannot predict the incidence of injuries due to sensitivity of less than 50% (48). This difference can appear based on gender or activity level of subjects. Performance tests seem to be a good predictor of injury reporting and are a good measure for pre-season screening.

Limitations

This study was conducted on football players who play in Iran's Premier League and First Division, and due to the weather conditions, the level of skill and sports facilities, and other things, it cannot be generalized to other countries. Moreover, the number of players working in Iran's leagues is very large, and only 148 of them participated in the present study, and more subjects were not available.

Recommendations

It is suggested to design a study to show whether it is possible to predict the incidence of injury in the future by using the Frohm functional test in athletes without injuries.

Conclusion

Frohm's nine tests can predict injury reports and these tests can be effective for pre-season screening to predict injury, eliminate possible injuries, and increase sports performance of athletes. It is possible to optimize the pre-season tests by using the Frohm functional test and use them to identify individuals at risk of sports injuries and prevent injury. Due to the weak performance in performing some tests in injured athletes, especially the tests related to the performance of the same area, the necessity of planning, designing, and implementing rehabilitation and targeted specialized exercises for a safe return to sports and preventing the recurrence of injuries is evident.

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Authors' Contribution

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Conflict of Interest

The authors did not have a conflict of interest. This article is extracted from a research project (Registration Code: 1/01/31082) in the School of Physical Education, University of Tehran. Dr. Mousavi and Dr. Karimizadeh-Ardakani are assistant professors of this school and Dr. Mousavi is the principal investigator of the project.

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