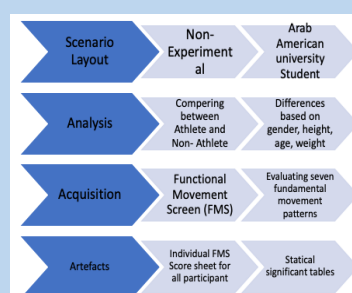


Functional Movement Screening (FMS) and Body Balance Issues among Athletes and Non-Athletes: *Clinical implications for the Arab American University students*

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Abstract: This study aims to assess postural stability and functional movement quality among students at the Arab American University by applying the Functional Movement Screen (FMS) protocol. A total of 44 participants (22 males and 22 females) were divided into athletic and non-athletic subgroups. The FMS test was used to evaluate performance across seven fundamental movement patterns: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability. The study followed a non-experimental cross-sectional design, and all participants were free of musculoskeletal injuries in the six weeks preceding the assessment. The findings showed that athletes demonstrated significantly higher FMS scores and better postural stability than non-athletes. Significant differences were found based on height, while gender, age, and weight did not significantly affect the outcomes. Female participants outperformed males in the active straight-leg raise, whereas male participants achieved better scores in rotary stability. The overall mean FMS score among all participants was 17.05 out of 21, representing 81.2% of the maximum possible score.



Keywords: Postural Stability, Functional Movement Screen, University Students, Athletic Performance, Injury Prevention, Biomechanics, Physical Activity, Movement Quality.

Introduction

The Functional Movement Screen (FMS) is a widely used and validated tool designed to assess basic movement patterns and identify potential functional limitations or asymmetries that may contribute to an increased risk of injury. The assessment consists of seven fundamental movement tasks: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raises, trunk stability push-up, and rotary stability.

Numerous studies have demonstrated that the FMS exhibits high inter- and intra-rater reliability. For instance, a systematic review reported intraclass correlation coefficients (ICCs) of approximately 0.81 for both types of reliability assessments. Additionally, research has shown that individuals scoring 14 or below on the FMS are more than twice as likely to sustain an injury compared to those with higher scores [25].

The Functional Movement Screen (FMS) evaluates key risk factors related to balance, flexibility, and strength, aiming to identify individuals who may be susceptible to injury across both athletic and non-athletic groups. Developed by its creators as an objective assessment tool, the FMS is used to detect asymmetries and movement limitations within fundamental patterns, particularly in relation to functional and dynamic activities [10].

Currently, there is a limited amount of research confirming the effectiveness of the Functional Movement Screen (FMS) in

accurately assessing its intended parameters. Evidence suggests that individuals exhibiting fundamental movement asymmetries or those with low levels of sports participation are at a greater risk of injury and balance impairments compared to individuals who achieve higher FMS scores [11]. Additionally, the FMS has demonstrated strong inter-rater reliability and is considered a practical tool for use by trained clinicians in various healthcare settings.

The (FMS) has demonstrated effectiveness in identifying functional limitations, suggesting its potential utility in predicting injury risk and balance impairments, particularly in relation to dynamic and sport-specific movements common in athletic activities. Nevertheless, there remains a lack of research applying the FMS specifically to sports characterized by a high incidence of severe injuries and balance-related disorders [12, 13].

The Functional Movement Screen (FMS) offers a cost-effective and time-efficient approach for evaluating military personnel and athletes, helping to identify individuals who may be at increased risk of injury and balance impairments and thus warrant more comprehensive evaluation. Previous research has reported moderate to high levels of both interrater and intratester reliability for the FMS, supporting its consistency as an assessment tool [14, 15].

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The assessment of injury risk and movement patterns has increasingly become a concern for trainers, coaches, and physical or occupational therapists. It is well understood that regular exercise and physical activity bring significant health benefits, such as maintaining healthy weight, improving cardiovascular function, and strengthening bones [1]. Conversely, lack of physical activity can lead to weak bones, impaired organ function, and weight gain, which may contribute to balance-related medical conditions such as muscular weakness and balance disorder [2]. As interest in achieving higher levels of fitness, strength, and athletic performance grows, it becomes essential to emphasize the development of fundamental movement patterns before progressing to more advanced physical activities. Neglecting this foundational aspect often leads individuals to prioritize training and performance over proper movement mechanics, which may increase the risk of injuries and negatively impact physical balance and overall performance [3].

Individuals engaged in sports or regular physical activity should be mindful of the potential risk of injury. Although injury occurrence is influenced by a variety of factors, many of these are intrinsic to the individual. Such intrinsic factors may include muscular imbalances, joint instability, poor flexibility, inadequate core strength, and previous injury history. These internal characteristics can compromise movement efficiency and increase susceptibility to biomechanical stress, thereby elevating the likelihood of injury during physical exertion [4]. Implementing a practical and reliable screening tool to anticipate injury risk could offer significant benefits in sports, fitness, and healthcare environments by guiding participants and helping to minimize injury-related complications. Reports from the past two years indicate a steady growth in student participation in sports programs and physical exercise [5]. With this vast increase in involvement in athletics, the number of injuries is assumed as has also increased.

The rise in sports participation is evident across both genders; however, male and female athletes face a heightened risk of injuries and balance impairments attributable to the physical demands of their activities. Research comparing balance-related issues and injury incidence between athletes and their non-athlete counterparts has consistently found that athletes, regardless of gender, exhibit significantly higher rates of balance dysfunction and injury [6].

A key role of sports medicine professionals at all levels of athletic participation is to implement strategies aimed at injury prevention and reducing the likelihood of balance-related disorders. Recent studies have focused on identifying risk factors that influence injury rates in athletes, highlighting the impact of prior injuries, overall physical fitness, and the quality of practice during athletic movements [7].

Screening athletes and individuals for injury risk as part of pre-participation physical evaluations can provide valuable insights for injury prevention. The Functional Movement Screen (FMS) is one assessment tool that has demonstrated utility in identifying movement impairments and potential risk factors for injury. [8]. The Functional Movement Screen (FMS), functions primarily as a screening mechanism to identify potential movement dysfunctions. The assessment evaluates seven

fundamental movement patterns: squatting, stepping, lunging, reaching, leg raising, push-up, and rotary stability [9].

Aims and Significance of the Study: This study aims to:

Main Objective

This study aims to explore the factors influencing postural stability among both male and female students at the Arab American University by applying the Functional Movement Screen (FMS) protocol.

Sub-Objectives

1. To evaluate movement quality and detect potential dysfunctions across seven fundamental movement patterns, including deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability.
2. To identify asymmetrical or dysfunctional movement patterns that may compromise performance or increase the risk of injury.
3. To compare the FMS test results and movement quality between athletes and non-athletes, considering variables such as Gender, Height, Age, Weight.

Materials and Methods

Research Design: The design of this study is a none experimental research study design, with the aim to assess and explore the factors affecting the body balance status of the Arab American University students in Jenin-Palestine.

Samples and Setting

The study was conducted at the Arab American University in Jenin and included a total of 92 participants (55 females and 37 males) from the Faculty of Physical Therapy. The sample consisted of third- and fourth-year undergraduate students who met the inclusion criteria. The study was conducted in Palestine using a simple random sampling method to select participants from the university student population. The final sample consisted of (44) students, representing 47.8% of the total target population, all of whom were enrolled during the fall semester of the 2023–2024 academic year. The participants were divided as follows: (12) male athletes, (10) non-athletic males, (12) female athletes, and (10) non-athletic females. All participants were between (18 – 23) years of age. Athletes were identified from non-athletes by asking sample members about practicing certain sports and classifying them based on the answer.

Athletes: are those who practice any specialized sport (football, basketball, etc.).

Non -Athletes: are those who do not practice any specialized sport.

Table [1] presents the mean values, standard deviations, and Z-scores for the data of the study sample. Upon reviewing the values shown in the table, it is evident that the Z-scores ranged between (0.50–0.75). These values are not statistically significant, indicating that the distribution of the data for these variables is normal.

Table (1): Socio-demographic characteristics of the study sample, results of the Kolmogorov-Smirnov Test, and sample homogeneity according to study variables

No:	Variables	Category	Frequency	Percentage	Mean	SD	Z	Sig
1	Gender	Male	22	50				
		Female	22	50				
	Total		44	100				

No:	Variables	Category	Frequency	Percentage	Mean	SD	Z	Sig
2	Age	Less than 20 years	18	40.9	21.2	1.67	0.50	0.93
		20-23 years	26	59.1				
	Total		44	100				
3	Height	Less than 160cm	5	11.4	168.8	4.87	0.75	.098
		160-169 cm	17	38.6				
		170-180 cm	18	40.9				
		More than 180 cm	4	9.1				
	Total		44	100				
4	Weight	50-59 kg	23	52.3	63.4	2.45	0.70	0.78
		60-70 kg	11	25.0				
		More than 70 kg	10	22.7				
	Total		44	100				
5	Students sport orientation	Athlete	20	45.5				
		Non-athlete	24	54.5				
	Total		44	100				
6	Hand dominance	Right	41	93.2				
		Left	3	6.8				
	Total		44	100				

Data Collection Tools: Accurate evaluation of the seven fundamental movement patterns requires the use of specialized equipment to ensure tester consistency and to accommodate compensatory movements. The necessary tools include: (i) a 2x6 board, which functions as a stable platform to support load-bearing and compensation during the deep squat test, as well as serving as a reference during the in-line lunge, active straight leg raise, and rotary stability assessments; (ii) a 5-foot dowel, utilized to improve reliability and enhance the functional quality of tests including the deep squat, active straight leg raise, hurdle step, and in-line lunge; (iii) a hurdle, applied during the hurdle step test to promote proper movement patterns and facilitate accurate scoring; and (iv) a tape measure, primarily used for assessing shoulder mobility and measuring tibial height differences during the in-line lunge to accommodate individual anatomical variations [16].

All of these equipment's were prepared from wood with the help of a carpenter according to a well set and standardized measurements. Numbers (scaling) were set on the equipment's according to the fundamentals of FMS. It was easy and interesting to have our own equipment made for the testing.

Validity and Reliability: The reliability of the study was tested by using the Cronbach's Alpha formula which yielded a reliability coefficient of (0.801), which is extremely reliable and acceptable for the purpose of the study. Further, internal consistency was calculated via Pearson correlation coefficients to be found highly consistent; an indication of high validity.

Study Procedure: After participants experiencing pain were excluded before the study. And selecting the study sample, we used a universal score sheet for every and each student in order to insert the scores of their performance on the seven movements of the FMS. The score ranges from zero to three,

where three is the best possible score and zero means that the person feels no any pain as a result of the performance.

We tested the right and left sides and for both sides scores were assigned. The lower score of the two sides recorded is considered and counted with the total score. There are also three clearing tests for pain that are added to three performances which are graded as positive or negative, where positive means that there is pain and negative means that there isn't. When scoring a positive pain, the total score for this performance is scored as (0). Finally, all scores were gathered from the (44) students, and data was prepared to be dealt with statistically.

Scoring of FMS

Each individual test within the FMS is scored based on the quality of movement and the presence of pain. A score of zero is assigned if the participant experiences pain during the movement. A score of one indicates an inability to perform the movement. A score of two reflects the ability to complete the movement but with observable compensations. A score of three denotes flawless execution of the task without compensation. The scores from all seven tests are summed to produce a composite score out of (21), which serves as an indicator of injury risk. Research suggests that individuals with total scores below (14) are more likely to sustain injuries, likely due to underlying functional limitations such as restricted joint mobility and compromised stability (17). The creators of the Functional Movement Screen (FMS) propose that individuals scoring (14) points or below are at a higher risk of injury compared to those scoring above (14). Each participant receives a score for every individual test, with a maximum total score of (21) points. Five of the tests involve bilateral assessment, where both sides are evaluated; however, the overall score reflects the lower score of the two sides for each respective test. [18].

Table (2): Functional Movement Screen (FMS): The 7 Tests Explained [6].

No.	Test	Purpose	Movement
1	Deep Squat	Assesses total body mechanics, ankle, knee, hip, shoulder mobility, and thoracic spine stability.	The person holds a dowel overhead and performs a deep squat with feet shoulder-width apart, heels flat.
2	Hurdle Step	Evaluates stride mechanics and stability of the pelvis and core during single-leg stance.	The person steps over a string (at knee height) with one leg while keeping balance and alignment.
3	In-Line Lunge	Assesses mobility and stability of the lower body and core control in a narrow, straight-line position.	The person lunges forward with one foot directly in front of the other while holding a dowel along the spine.
4	Shoulder Mobility	Measures shoulder range of motion and scapular stability.	The person tries to touch their hands together behind their back (one over the shoulder, one under).

No.	Test	Purpose	Movement
5	Active Straight-Leg Raise	Assesses hamstring and calf flexibility, and core stability during isolated lower limb movement.	Lying down, the person raises one leg as high as possible without moving the other or bending the knee.
6	Trunk Stability Push-Up	Tests core strength and spinal stabilization during upper body movement.	The person performs a push-up while maintaining a straight spine and no sagging or arching.
7	Rotary Stability	Evaluates neuromuscular control, core stability, and coordination during complex, asymmetrical movement.	The person performs a bird-dog movement (simultaneously moving same-side arm and leg) from a quadruped position.

Data Analysis

After completion of data collection and data coding, data were analyzed by using the Statistical Package for Social Sciences (SPSS) program, to provide us with the suitable results. Frequencies, means and percentages were calculated. T - tests and Spearman's rho and related correlation coefficients were also calculated. All were tested through IBM SPSS Version (22).

Results and Discussions

Study Socio-demographic Characteristics

Obviously, the number of respondents were all the selected (44) subjects, and Table (4.1) shows their socio-demographic characteristics. Participants were asked to bring data pertaining to their gender, age, height and weight. The largest number of respondents designated their age was between (20-23) years old (n=23; 59.1%), nevertheless, the least age group with (n=18; 40.9%) indicated to be Less than 20 years old as well. Even number of respondents of both genders were detected (n=22; 50.0%). When it comes to respondents' height and weight, the largest number of respondents indicated their height was between (170-180) cm (n=18; 40.9%), nevertheless, the least height group with (n=4; 9.1%) indicated to be more than 180 cm as well. In addition, respondents were demanded to state with reference to their weight; the majority of the studied subjects (n=23; 52.3%) indicated their weight to be between (50-59) kg, while (n=10; 22.7%) informed their weight to be more than (70) kg. Both athletes and non-athletes were represented. Forty-four (44) cases were screened (n=20; 45.5%) as athletic students, while (n=24; 54.5%) were non-athletic students.

Further respondents were categorized on the bases of their hand/leg users. Forty-four (44) cases were screened where to find that (n=41; 93.2%) students of them use their right hand/leg, while (n=3; 6.8%) use their left hand/leg. Scoring both the right and left sides is essential, with the lower score from either side being recorded and included in the total score. This approach highlights any asymmetry or imbalance between the two sides.

Table (3) below, demonstrates the general calculated means and percentages of individual FMS scores. Obviously, male and female students' trainers of shoulder mobility/R exercise had an even mean for both exercises carried out by both genders (mean=2.73; 91.0%), while with left shoulder differ in favor of female slightly. On average, male participants demonstrated superior performance in the inline lunge (both left and right sides) and rotary stability tests, whereas female participants showed better results in the deep squat, active straight leg raise, and shoulder mobility assessments.

Those females who practice the active straight-leg raise/L exercise had (2.73; 91.0%) compared to males who did the same practice (2.50; 83.3%). Those males who practice rotary stability/L and rotary stability/R exercises with their left and right legs and hands had (2.45; 81.7%) in practicing both exercises excel female students who did the same practice (2.23; 74.3%) and (2.36; 78.7%) respectively.

Table (3): Means and percentages of male and female categorization on FMS tests (n=44).

Functional Movement Screen Tests	Male		Female	
	Mean	Percent	Mean	Percent
Deep Squat	2.41	80.3%	2.59	86.3%
Hurdle Step/L	2.91	97.0%	2.95	98.3%
Hurdle Step/R	2.91	97.0%	2.82	94.0%
Inline Lunge/L	2.95	98.3%	2.82	94.0%
Inline Lunge/R	2.91	97.0%	2.86	95.3%
Shoulder Mobility/L	2.41	80.3%	2.45	81.7%
Shoulder Mobility/R	2.73	91.0%	2.73	91.0%
Impingement Clearing Test/L	1.86	62.0%	1.86	62.0%
Impingement Clearing Test/R	1.95	65.0%	1.91	63.7%
Active Straight-Leg Raise/L	2.50	83.3%	2.73	91.0%
Active Straight-Leg Raise/R	2.59	86.3%	2.64	88.0%
Trunk Stability Pushup	2.59	86.3%	2.50	83.3%
Press-Up Clearing Test	1.82	60.7%	1.68	56.0%
Rotary Stability/L	2.45	81.7%	2.23	74.3%
Rotary Stability/R	2.45	81.7%	2.36	78.7%
Posterior Rocking Clearing Test/L	1.95	65.0%	2.00	66.7%

In the case of age groups, Table (4) below validates the means and percentages of both aged groups (less than 20 years and 20-23 years) for FMS scores. Apparently, less than (20) year group students' trainers of shoulder mobility/L exercise had a mean (2.39; 79.70%), while with the (20–23) year group shoulder mobility/L (2.46; 82.0%), slightly. However, shoulder mobility/L recorded a difference from shoulder mobility/R for the same category (less than 20-year group) (2.39; 79.7%) and (2.94; 98.0%) respectively.

Table (4): Means and percentages of age categorization on FMS tests (n=44).

Functional Movement Screen Tests	Less than 20 years		20-23 years	
	Mean	Percent	Mean	Percent
Deep Squat	2.56	85.3%	2.46	82.0%
Hurdle Step/L	2.89	96.3%	2.96	98.7%
Hurdle Step/R	2.83	94.3%	2.88	96.0%
Inline Lunge/L	2.89	96.3%	2.88	96.0%
Inline Lunge/R	2.83	94.3%	2.92	97.3%
Shoulder Mobility/L	2.39	79.7%	2.46	82.0%
Shoulder Mobility/R	2.94	98.0%	2.58	86.0%
Impingement Clearing Test/L	1.78	59.3%	1.92	64.0%
Impingement Clearing Test/R	1.89	63.0%	1.96	65.3%
Active Straight-Leg Raise/L	2.50	83.3%	2.69	89.7%
Active Straight-Leg Raise/R	2.56	85.3%	2.65	88.3%
Trunk Stability Pushup	2.50	83.3%	2.58	86.0%
Press-Up Clearing Test	1.67	55.7%	1.81	60.3%
Rotary Stability/L	2.28	76.0%	2.38	79.3%
Rotary Stability/R	2.33	77.7%	2.46	82.0%
Posterior Rocking Clearing Test/L	1.94	64.7%	2.00	66.7%

When it comes to Table (5) below, it displays the means and percentages of individual FMS scores in the case of athlete and non-athlete subjects. Athletic student trainers of hurdle step/L training had a mean of 2.96 with a percentage 98.7% compared to non-athletic students' trainers of hurdle step/L training (mean=2.90; 96.7%). Those athletes who practice the deep squat exercise had (2.71; 90.3%) compared to non-athletes who did the same practice (2.25; 75%). Those athletes who practice active straight-leg raise exercise with their right leg had (2.75;

91%) excel non-athletics who did the same practice (2.45; 81.7%). It is noted that non-athletics who use their straight-leg raise exercise with right legs surpass their non-athletic peers who use their left legs (2.45; 2.40) respectively. However, unlike, it is prominent that athletes who practice active straight-leg raise exercise with their right leg had less mean score than using the left one (2.75; 2.79) respectively, signifying that athletes who practice active straight-leg raise exercise with their right or left leg score no or lack difference. It is that much clear that students who do not practice sports regularly are more likely to sustain injuries and have less balance than persons who do practice the same regularly.

Table (5): Means and percentages of athletes and non-athletes categorization on FMS tests (n=44).

Functional Movement Screen Tests	Athlete		Non-Athlete	
	Mean	Percent	Mean	Percent
Deep Squat	2.71	90.3%	2.25	75.0%
Hurdle Step/L	2.96	98.7%	2.90	96.7%
Hurdle Step/R	2.88	96.0%	2.85	95.0%
Inline Lunge/L	2.88	96.0%	2.90	96.7%
Inline Lunge/R	2.92	97.3%	2.85	95.0%
Shoulder Mobility/L	2.54	84.7%	2.30	76.7%
Shoulder Mobility/R	2.83	94.3%	2.60	86.7%
Impingement Clearing Test/L	1.83	61.0%	1.90	63.3%
Impingement Clearing Test/R	1.92	64.0%	1.95	65.0%
Active Straight-Leg Raise/L	2.79	93.0%	2.40	80.0%
Active Straight-Leg Raise/R	2.75	91.7%	2.45	81.7%
Trunk Stability Pushup	2.63	87.7%	2.45	81.7%
Press-Up Clearing Test	1.79	59.7%	1.70	56.7%
Rotary Stability/L	2.33	77.7%	2.35	78.3%
Rotary Stability/R	2.50	83.3%	2.30	76.7%
Posterior Rocking Clearing Test/L	2.00	66.7%	1.95	65.0%

Further, in the present study, four additional clearing tests were incorporated alongside the standard FMS assessments. These clearing screens are evaluated solely based on the presence or absence of pain, with a positive result indicating pain and a negative result indicating no pain. A positive clearing screen automatically results in a score of zero for the corresponding test, which directly impacts the overall FMS score. It is essential to document the individual scores for each test on the scoring sheet for future reference, regardless of whether the final score is zero.

As Table 6 shows, descriptive statistics and frequency counts were calculated. Participants who have pain in Impingement Clearing Test/L were (n=8; 13.6%), while (n=38; 86.4%) had no pain to complete the exam. Further (n=41; 93.2%) had no pain to complete Impingement Clearing Test/R, while a solitary (n=1; 2.3%) suffered pain to practice the Posterior Rocking Clearing Test.

Table (6): Calculated frequencies and percentages of FMS clearing tests (n=44).

No:	Variable	Category	Frequency	Percentage
1	Impingement Clearing Test/L	Positive	8	13.6
		Negative	38	86.4
	Total		44	100
2	Impingement Clearing Test/R	Positive	3	6.8
		Negative	41	93.2
	Total		44	100
3	Press-Up Clearing Test	Positive	11	25.0
		Negative	33	75.0
	Total		44	100
4	Posterior Rocking Clearing Test	Positive	1	2.3
		Negative	43	97.7
	Total		44	100

Hypothesis Testing: our main set hypothesis says that: "There are no differences at ($\alpha \leq 0.05$) in practicing FMS tests,

that could be attributed to gender, age, height, weight, athlete and none athlete variables." Simply, in the case of gender, age, and weight, we accept the hypothesis, since the calculated p-value is more than (0.05), while in the case of height and sport orientation (i. e., being athletic/ nonathletic) hypothesis was rejected, for the calculated p-values were less than (0.05). Tables 7-11 show such findings in details.

Table (7): Mean, percent and t - test values according to gender variables.

Gender	N	Mean	SD	T	df	Sig. (2-tailed)
Male	22	2.6	0.54	0.523	42	0.604
Female	22	2.5	0.66			

Table (8): Mean, percent and t - test values according to age variable.

Gender	N	Mean	SD	T	df	Sig. (2-tailed)
Less than 20 years	18	21.1	0.57	0.985	42	2.018
20-23 years	26	21.3	0.72			

Table (9): Mean, percent and t - test values according to Height variable.

	Source of Variation	Sum of Squares	df	Mean Square	F-value	Sig. Level
Height	Between Groups	3.42	3	1.14	3.19	0.006*
	Within Groups	25.32	40	0.63		
	Total	28.74	43			

Table (10): Mean, percent and t - test values according to Weight variable.

	Source of Variation	Sum of Squares	df	Mean Square	F-value	Sig. Level
Weight	Between Groups	2.67	3	0.133	3.19	0.81
	Within Groups	23.64	40	0.64		
	Total	23.9	43			

Table (11): Mean, percent and t - test values according to age variable.

Students sport orientation	N	Mean	SD	T	df	Sig. (2-tailed)
Athlete	20	2.1	0.71	2.53	42	0.016
Non- Athlete	24	2.8	1.01			

The effect of NEURAC (the abbreviation for Neuromuscular Activation) sling exercise was used which aims to free patients from pain during movements and other body functions, on the new scores of the FMS. In the two months, training was done twice a week. Between the first and the second measurement, the analysis showed no difference, however between the first and second, and between the second and the third there was a noticeable improvement in the results of the FMS ($p \leq 0.01$) from the use of the sling exercises. There was a positive influence on the male subjects of volleyball players. More than (90%) of the subjects had a total FMS score of ≥ 17 , which is important in preventing sport injuries. This shows that increased FMS score as a result of the stabilization exercises is important to be included in the training of teenage volleyball players [18].

Several studies have examined whether composite scores from the Functional Movement Screen (FMS) can predict future injury. One systematic review aimed to evaluate the strength of association between FMS composite scores and injury risk across a sample of (24) individuals. The findings indicated strong evidence of only a small association in male military personnel, with a pooled risk ratio of (1.47) (95% CI: 1.22–1.77, $p < 0.0001$, $I^2 = 57\%$). For Athletes, like soccer players, the evidence supporting the predictive value of FMS scores was considered moderate. However, for other Athletes (American football players, collegiate athletes, basketball players, ice hockey players, runners, police officers, and firefighters) the evidence was either limited or contradictory. These findings suggest that the predictive utility of FMS composite scores varies across

different populations and may not consistently support injury prediction [19].

Another study evaluated the effectiveness of an eight-week training program on improving Functional Movement Screen (FMS) scores among a group of (56) active-duty firefighters. The aim was to assess whether targeted physical interventions could enhance functional movement patterns within this physically demanding profession. There was no structured program studied to improve the movement quality in these individuals. The firefighters volunteered to complete the baseline of FMS testing and an FMS pro (360) system which is subscription-based software that creates workout with corrective exercises for each individual based on their test scores. There were two corrective exercises program, (4) weeks each, for each participant. At the end of (8) weeks participants finish their FMS testing follow up the findings demonstrated a notable improvement in overall FMS scores following the eight-week training program, with mean total scores increasing from 12.09 ± 2.75 to 13.66 ± 2.28 . Significant gains were also observed in stability-related components (pre: 4.13 ± 1.21 ; post: 4.55 ± 0.83) and advanced movement tasks (pre: 4.45 ± 1.28 ; post: 5.36 ± 1.29). However, no statistically significant change was recorded in the mobility component, where scores slightly increased from 3.52 ± 1.09 to 3.75 ± 0.90 . From the results we saw that the (8) weeks corrective exercise program has a good effect on the improvement of FMS scores. The risk of injury could be minimized when each individual is provided by a corrective exercise program to improve level of dysfunction or maintaining/enhancing function [20].

In an additional study, movement patterns were assessed in (11) male and (7) female surf athletes (mean age: 18.3 ± 6.3 years; weight: 60.0 ± 9.6 kg; height: 168.6 ± 8.1 cm) using the Functional Movement Screen (FMS) as part of their daily sports training. The findings revealed a statistically significant difference between genders only in the Trunk Stability Push-Up test. Furthermore, 57% of the variance in the right-side Knee to Wall test was explained by a multiple regression model that included the Deep Squat and Trunk Stability Push-Up, which proved to be statistically significant ($F(2,15) = 13.097$; $p = 0.001$). Additionally, 50.3% of the variance in Squat Jump height was explained by the Trunk Stability Push-Up alone, also forming a significant model ($F(1,16) = 18.182$; $p = 0.001$). The study concluded that individual physical variables were more effective predictors of performance than the total FMS score, with the Trunk Stability Push-Up identified as the only reliable indicator of physical performance in surf athletes. [21].

A study involving (301) junior Australian football players aged (15 – 18) years utilized the Functional Movement Screen (FMS) to evaluate movement quality. The assessment revealed a high incidence of dysfunctional (FMS score ≤ 14), asymmetrical (unequal scores between sides), and painful movement patterns. Injury-related absences over the previous 22-game seasons were also recorded.

Results indicated that 60% of participants scored ≤ 14 , 65% showed at least one asymmetrical movement pattern, and 38% reported pain during at least one sub-test. Additionally, 42% of the athletes had missed at least one game in the previous season due to injury. No significant relationship was observed between previous injury and either the total FMS score ($p = 0.951$) or asymmetry ($p = 0.629$). However, previous injury was significantly associated with pain during testing (odds ratio = 1.97; 95% CI: 1.23–3.18; $p = 0.005$). The study highlights the widespread presence of movement dysfunction, asymmetry, and pain in this athletic population [22].

Additionally, another study examined differences in Functional Movement Screen (FMS) performance between (20)

individuals with chronic low back pain and (20) healthy control subjects. Participants with chronic low back pain recorded significantly lower FMS scores compared to the control group. The findings suggest that specific FMS components—such as the deep squat, hurdle step, active straight leg raise, and rotary stability—are effective in identifying movement limitations associated with chronic low back pain and may serve as useful tools in screening and assessment [23].

A study involving (98) active male collegiate athletes investigated the relationship between the Functional Movement Screen (FMS) and the Landing Error Scoring System (LESS). The analysis demonstrated a moderate negative correlation between the two measures ($\rho =$ approximately -0.53 ; $p < 0.001$), suggesting some association between overall functional movement quality and landing mechanics. However, low correlation coefficients ($r = 0.23$ – 0.26) indicated limited agreement between the screening tools. These results imply that the FMS and LESS assess distinct components of movement performance, and strong results on one test do not necessarily predict comparable outcomes on the other. (Everard et al., 2017).

A study was conducted to evaluate the predictive value of the Functional Movement Screen (FMS) for non-contact injury occurrence in relation to match performance. The sample included 89 senior male players from five semi-professional clubs in the League of Ireland, with an average age of (23.2 ± 4.4 years, height of 179.5 ± 6.6 cm), and body mass of (77.5 ± 7.8) kg. During the observation period, 66 non-contact injuries were recorded. Statistical analysis revealed no significant difference between players who sustained non-contact injuries and those who did not ($p = 0.96$). Furthermore, no meaningful difference was found between players scoring 14 or below and those scoring above (14) on the FMS in terms of injury incidence (0.36 vs. 0.29). The odds ratio for sustaining a non-contact injury among players scoring (14) or below was 0.63 ($p = 0.45$; 95% CI: 0.19–2.07), indicating no significant predictive relationship. Therefore, from the results we can see that it's not necessary that non-contact injury increases as a result of lower FMS total scores and it's not a good prediction to know whether or not a player is likely to receive a non-contact injury (Smith et al., 2016).

Martin C et al in (2016) used the FMS to predict the injuries in (27) male adolescent cricket pace bowlers and found out that there was no FMS difference in term of total score between the injured group (16.1 ± 2.07) and the non-injured group (16.55 ± 2.57), moreover bowlers who scored ≤ 14 also didn't show any variations. Therefore, providing a less than 14 score in the FMS does not necessarily predict risk injuries among adolescent pace bowlers and is considered a poor predictor [24].

Regardless of age and weight of each student, we concluded together with the previous studies about the FMS that it doesn't necessarily predict risk injuries in athletes, and more concentration should be on each performance and not the whole screen as a total score. We also concluded that the total score didn't have a major difference for athletes and non-athletes, and also for females and males.

Limitations in our study was that we didn't have a wide range of weight, height and age measures, as all participants were students from the same university.

Implication

According to our results and conclusions and according to the screens that we did on our sample, we got some data that is important to make awareness of the FMS screen and inform people about it especially athletes in order for them to notice in the future their weaknesses and imbalances. It is also a good

idea to introduce the FMS in clinical centers, sport centers and other centers which deal with stability, imbalances, and symmetries.

Conclusion

Among the 44 participants assessed, only one individual reported pain during the Posterior Rocking Clearing Test, suggesting minimal discomfort during the FMS protocol. A large majority (93.2%, n=41) were right-handed and right-legged, which may reflect typical limb dominance trends within the population. The analysis revealed a statistically significant difference in FMS performance between athletes and non-athletes, favoring athletes, which underscores the positive influence of regular physical activity on movement quality. However, no significant differences were found across gender or age groups, indicating that FMS performance is not strongly influenced by these variables. Height was found to have a significant effect on test results, while weight did not demonstrate a notable impact. The average FMS score of 17.05 suggests a generally low risk of injury and supports the use of FMS as a reliable screening tool to identify individuals at potential risk. Beyond injury prediction, the FMS also contributes to enhancing athletic performance by promoting movement efficiency and correcting dysfunctional patterns. Furthermore, it serves as a structured, user-friendly method for evaluating mobility, stability, and overall movement quality, thereby enabling coaches and physical therapists to make informed decisions regarding training and rehabilitation programs.

Recommendations

- Future research is necessary to develop and validate effective interventions and corrective protocols for individuals who receive low scores on the Functional Movement Screen.
- Greater emphasis should be placed on analyzing the scores of individual tasks rather than relying solely on the composite total score when interpreting FMS results.
- Differences in ages may give difference in performances and as a result different scores, therefore, age difference should be considered in future researches for more reliability and validity of the research.
- Weight is another factor to be considered since it can give different results in the total score.

Disclosure Statement

- **Ethics approval and consent to participate:** Not applicable
- **Availability of data and materials:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.
- **Author's contribution:** The authors confirm contribution as follows: Study design: Amoudi, Mosab & Abu Hassan, Wael Data collection: Amoudi, Mosab & Abu Hassan, Wael & Saleh, Bashar Analysis: Saleh, Bashar & Abu Hassan, Wael & Almutawa, Aysha Draft preparation: Amoudi, Mosab & Abu Hassan, Wael & Saleh, Bashar All authors reviewed and approved the final version.
- **Consent to Participate:** All participants were fully informed about the purpose, procedures, and potential risks of the study. Written informed consent was obtained from each participant prior to their inclusion. Participation was entirely

voluntary, and participants had the right to withdraw from the study at any time without any penalty.

- **Consent for Publication:** All participants provided written informed consent for the publication of the study results. Any data used in the study were anonymized to ensure confidentiality and privacy.
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