Journal of Sport & Movement Sciences
Spor & Hareket Bilimleri Dergisi

OPEN ACESS
RESEARCH ARTICLE

Effects of corrective exercises applied to volleyball players on functional movement screening test scores

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Received:
September 15, 2025

Accepted:
January 01, 2026

Online Published:
January 13, 2026

Keywords: Corrective exercises, Functional movement, Screening, Volleyball.

Abstract. The aim of this study was to determine the effects of corrective exercises applied to volleyball players on functional movement screening (FMS) test scores. Twelve male athletes between the ages of 15-17, who play for the Silifke İdman Yurdu Volleyball team and regularly attend volleyball training, participated in the study voluntarily. Participants were administered a corrective exercise program before volleyball training, 3 days a week, 30 minutes a day, for 8 weeks. FMS test scores of all athletes were determined by a physiotherapist before and after the training program. SPSS 18 statistical package program was used to evaluate the data obtained from the study, and the significance level was accepted as 0.05. The Wilcoxon test was used to test the significance of the difference between the athletes' FMS pre-test and post-test. As a result of the analyses, only the increases in shoulder mobility, rotation stability, and total FMS values were found to be statistically significant ($p<0.05$). Statistically non-significant increases were found in the post-test values for the deep squat, hurdle step, and active straight leg raise compared to the pre-test values. In conclusion, it can be said that eight weeks of corrective exercises, in addition to regular volleyball training, positively affected volleyball players' FMS test scores.

Introduction

Volleyball is a team sport that requires skill and continuous movement, employing multiple muscle groups simultaneously (Çelenk & Yıldıran, 2000). It is an explosive and fast-paced sport consisting of jumps, rapid changes of direction, and continuous overhead movements (Black, 1995). Volleyball athletes participate in multiple training sessions and matches during the competition period. Players are exposed to various injuries due to the high number of training sessions and matches (Solgard et al., 1995). Muscular imbalances that occur in athletes' bodies due to unilateral loading, uniaxial training, and training only certain body parts (upper extremity only, lower extremity only, right side only, etc.) negatively impact athletes' daily lives and competitive performance. Therefore, it is necessary to analyze certain physical fitness and performance conditions to measure an athlete's skill level, aptitude for sports, and performance (Ergun & Baltacı, 2006).Functional impairments can occur when functional movements, defined as the ability to perform manipulative and stabilizing movements that provide control throughout the kinetic chain, are not performed correctly (Lockie et al., 2015). These functional impairments can lead to imbalances in an individual's muscle strength, a lack of neuromuscular control, or asymmetrical deformities in the body, compromising an individual's physical performance (Cook et al., 2010; Cook et al., 2014). For exercise to yield positive results, the type, duration, frequency, and intensity of exercise must be optimally planned and implemented. Correct and regular exercise has a positive impact on athletes (Günay et al., 2008).

The Functional Movement Screening (FMS), developed by Cook et al. (2006) and whose reliability and validity studies were conducted by Minick et al. (2010), is used to identify

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Cite: Şimşek, A., İribalcı, Ş., & Revan, S. (2026). Effects of corrective exercises applied to volleyball players on functional movement screening test scores. *J. Sport Mov. Sci.*, 7(1), 1-8.

functional limitations. The FMS is a reliable test battery that allows for the application of basic physical movements, is inexpensive, non-invasive, and allows for the application of basic physical movements. The FMS allows for simple, on-field measurement without the need for performance application laboratories or expensive equipment, allowing athletes to monitor their developmental status more frequently. Furthermore, by using the FMS test to identify deficiencies in athletes and implement corrective exercises tailored to planned and desired training practices, it has been observed that performance athletes' physical fitness and competition performance are improved in their movements (Altundağ et al., 2019). In their systematic review, Fitton Davies et al. (2022) concluded that children and adolescents who scored higher on the FMS test were more likely to score higher on tests related to agility, running speed, balance, strength, and cardiovascular endurance.

Seven tests are used to test functional mobility and three to assess pain. The FMS is calculated using a 0-3 scale. The maximum score for the FMS is 21 points. The FMS is used by certified professionals to test athletes' mobility. The exercises are easy and straight forward to perform. These tests include deep squats, hurdle crossings, single-line lunges, shoulder mobility, active straight leg raises, trunk stability push-ups, and rotational stability tests (Cook et al., 2010). It has been reported that individuals with a total FMS score of less than 14 points are more likely to experience injury than those with a score greater than 14 points (Kiesel et al., 2007).

A review of studies in the literature has focused on the relationship between athletes' FMS test scores, injury risks, and athletic performance (Lloyd et al., 2015, Parchmann and McBride, 2011, Rowe, 2020, Zarei et al., 2022). This study aimed to examine the effects of corrective exercise programs implemented in addition to regular training programs on the functional movement patterns of volleyball players.

Material and Methods

Twelve healthy male volleyball players, aged 15-17, who regularly train for the Silifke İdman Yurdu Volleyball Team, participated in this study. At the beginning of the study, all athletes' pre-season descriptive characteristics (age, height, body weight, and age at the sport) and FMS test scores were determined by an expert. In addition to their regular volleyball training, the athletes participated in a 30-minute corrective exercise program, 3 days a week, for 8 weeks. At the end of the study, the FMS test was repeated, and statistical analyses were conducted by comparing the FMS values with the pre-study values. Participation criteria included having no health problems preventing sports participation, training and matches at the same club throughout the season, having no injuries in the last four months, and not engaging in high-intensity exercise or training within the 24 hours prior to the measurements. Necessary permissions were obtained from the Silifke İdman Yurdu Sports Club before the study. Before the study, all participants and their families were informed about the study and were asked to sign a voluntary consent form acknowledging their voluntary participation.

Data Collection Tools

Determination of height and body weight

Athletes' heights were measured in centimeters (cm) using a wall scale, with their feet bare, their arms hanging freely at their sides, their shoulders relaxed, their feet upright, breathing deeply, and their heels off the ground. This measurement was recorded in centimeters (cm) from the point at the crown of their head. Body weight was recorded in kilograms (kg) using a scale with a precision of 0.1 kg, while the subject was in an anatomical position.

The Functional Movement Screening Test

The FMS test, which consists of seven tests (deep squat, hurdle crossing, single-line lunge, shoulder mobility, active straight leg raise,

trunk stability push-up, and rotation stability), was used to assess functional movements developed by Cook et al. (2006) for the volleyball players participating in the study. FMS tests are scored between 0 and 3 points. The maximum total score for these tests is 21. A participant completes the test by obtaining a score between 0 and 21. The total FMS score for the participant is calculated by summing the scores obtained from each test. During the scoring of the tests, the participant's scores were noted, and the total test score was determined by adding the scores at the end of the test (Cook et al., 2010).

Corrective Exercise Program

Athletes participating in the study were administered a corrective exercise program consisting of relaxation and corrective exercises for 30 minutes, 3 days a week, for 8 weeks before volleyball training. The relaxation exercises included foam roller hamstrings, foam roller quadriceps, foam roller adductors, foam roller iliotibial band, and foam roller upper and lower back exercises (30 seconds x 8 repetitions). Corrective exercises included dorsiflexion from half kneeling with dowel, assisted leg lowering, chop and lift from half kneeling, single-leg hip hinge, hard roll, and quadruped rock back exercises (8 repetitions x 2 sets).

Statistical Analysis

The SPSS 18 statistical package program was used to evaluate the data obtained from the study, and the significance level was accepted as 0.05. The Wilcoxon test was used to test the significance of the difference between the athletes' FHT pre-test and post-test.

Findings

Table 1. Descriptive Characteristics of the Research Group (n=12).

Variables	Minimum	Maximum	Mean	SD
Body weight (kg)	63.0	80.0	72.3	4.3
Height (cm)	175.0	200.0	183.3	6.6
Age (years)	16.0	17.0	16.6	0.5
Sports age (years)	1.0	6.0	3.3	1.4

SD: Standard deviation

Table 2. The FMS Pre-Test Scores of the Research Group (n=12)

FMS Subtests	Minimum	Maximum	Mean	SD
Deep squat	2.0	3.0	2.8	0.4
Hurdle step	2.0	3.0	2.8	0.4
In-line lunge	3.0	3.0	3.0	0.0
Shoulder mobility	1.0	3.0	2.3	0.6
Active straight-leg raise	2.0	3.0	2.8	0.5
Trunk stability push-up	3.0	3.0	3.0	0.0
Rotary stability	1.0	2.0	1.2	0.4
FMS total score	17.0	20.0	17.8	1.0

Table 3. The FMS Post-Test Scores of the Research Group (n=12)

FMS Subtests	Minimum	Maximum	Mean	SD
Deep squat	3.0	3.0	3.0	0.0
Hurdle step	3.0	3.0	3.0	0.0
In-line lunge	3.0	3.0	3.0	0.0
Shoulder mobility	2.0	3.0	2.8	0.5
Active straight-leg raise	2.0	3.0	2.9	0.3
Trunk stability push-up	3.0	3.0	3.0	0.0
Rotary stability	1.0	2.0	1.6	0.5
FMS total score	18.0	20.0	19.3	0.9

Table 4. The FMS pre-test-post-test comparison of the research group (n=12)

FMS Subtests		Mean	SD	Z	p
Deep squat	Pre-test	2,83	0,38	-1,414	0,157
	Post-test	3,00	0,00		
Hurdle step	Pre-test	2,83	0,38	-1,414	0,157
	Post-test	3,00	0,00		
In-line lunge	Pre-test	3,00	0,00	0,000	1
	Post-test	3,00	0,00		
Shoulder mobility	Pre-test	2,25	0,62	-2,449	**0,014***
	Post-test	2,75	0,45		
Active straight-leg raise	Pre-test	2,75	0,45	-1,000	0,317
	Post-test	2,92	0,27		
Trunk stability push-up	Pre-test	3,00	0,00	0,000	1
	Post-test	3,00	0,00		
Rotary stability	Pre-test	1,17	0,38	-2,859	**0,004***
	Post-test	1,58	0,51		
FMS total score	Pre-test	17,83	1,03	-2,859	**0,004***
	Post-test	19,25	0,86		

* $p<0,05$, SD: Standard deviation,

Minimum, maximum, mean and standard deviation values of the participants' body weight, height, age and sports age variables are shown in Table 1.

The minimum, maximum, mean and standard deviation values of the participants' FMS total scores and subtests before the corrective exercise program are shown in Table 2.

Minimum, maximum, mean and standard deviation values of the participants' FMS total scores and subtests after the corrective exercise program are shown in Table 3.

As a result of the pre-test-post-test comparison of the participants' variables, a statistically significant difference was found in shoulder mobility, rotation stability and total FMS values ($p<0.05$) (Table 4).

Disscusion and Conclusion

The use of functional movement patterns in athletes can be used as a tool to assess movement competence in both sports and healthcare settings, monitor physical performance, and help identify injury risks early (Cook et al., 2014; Dorrel et al., 2015; Q'Brien et al., 2021). In this context, this study was conducted to examine the changes in functional movement screening test scores of athletes following corrective exercises in addition to regular volleyball training. Statistically significant increases were found in shoulder mobility, rotational stability, and total FMS values ($p<0.05$). Statistically non-significant increases were found in the post-test values of the deep squat, hurdle step, and active straight leg raise compared to the pre-test values.

There are many studies in the literature consistent with the design and findings of the current study (Altundağ, 2018, Aktuğ et al., 2019; Song et al., 2020; Altundağ et al., 2021; Aktuğ et al., 2023; Akkoyunlu and Aka 2024; Akoğlu et al., 2025). Aktuğ et al. (2019) found a statistically significant increase in shoulder mobility test scores and total FMS values as a result of 12 weeks of corrective exercises applied to volleyball players, and stated that the difference was in favor of the post-test. They observed that the total pre-test mean FMS score, which was determined as 12.92 points before the study, increased to 15.46 points at the end of the study. In the same study, they stated that although there was no statistical difference between the pre- and post-test results of the deep squat and hurdle step tests, which are FMS tests, the mean score increased in favor of the post-test. The results of this study are similar to those of the current study. As a result of this study, it was determined that the pre-test score in the shoulder mobility test was 2.25±62

and the post-test score was 2.75±45, and the total pre-test FMS score average increased from 17.83 to 19.25, a statistically significant increase in favor of the post-test. This is thought to be due to volleyball players' more active use of the upper extremities. In another study, Song et al. (2020) reported a significant difference in the functional movement assessment of volleyball players following a 10-week body stability exercise program, with the total FMS score increasing from 10.90±1.30 at the beginning of the study to 13.81±0.60 at the end. Additionally, a significant increase in strength, agility, and balance ability was observed as a result of the implemented program. Researchers concluded that a 10-week physical stability exercise program was effective in preventing and reducing injury, improving speed, agility, functional movement and balance in volleyball players at risk of injury.

Consistent with the results of the current study, Altundağ et al. (2021) reported that core and corrective exercise programs applied to volleyball players for 8 weeks significantly increased shoulder mobility, rotational stability, and FMS total scores in the post-test, and although no significant differences were found in the scores obtained from other tests, an improvement was observed. In a study conducted to determine the effects of warm-up programs on FMS test results of 22 female volleyball players playing in the Turkish Women's 2nd Volleyball League, significant differences were found in the deep squat, step forward, trunk stability push-up, rotational stability subtests, and FMS total scores in favor of the post-test (Akkoyunlu & Aka 2024). Akoğlu et al. (2025) conducted a study to determine the functional movement quality of 46 adolescent female volleyball players with (n: 23) and without (n: 23) chronic ankle instability. Athletes with chronic ankle instability were found to have lower FMS-motion scores compared to the control group. They emphasized that this condition may affect athletes' athletic performance and increase susceptibility to future injuries.

In the literature, corrective exercise programs have been applied to improve functional movements not only for volleyball athletes but also for athletes of different age groups in various sports, and FMS values have been determined. Studies have concluded that the applied corrective exercises are beneficial for the development of functional movements and athletic performance, based on test results. Furthermore, it has been reported that FMS is effective in predicting injuries in athletes, and that prepared training programs and corrective exercises increase FMS scores (Bodden et al., 2015; Campa et al., 2019; Aktuğ et al., 2019; Altundağ et al., 2019; Song et al., 2020; Suziki et al., 2021; Keçe, 2023). Kiesel et al. (2007) reported that individuals with a total FMS score lower than 14 points are more likely to suffer an injury than those with a score higher than 14 points. In addition to studies examining the effects of corrective exercises on athletes, there are also studies examining their effects on sedentary individuals. The results of these studies similarly emphasize that regular corrective exercises can positively improve individuals' FMS test scores and thus benefit overall health. They concluded that corrective exercises increase flexibility in the back and shoulder region and reduce pain and tension in these areas (Stanek et al., 2017, Bilgiç & Duymaz, 2018, Cho et al., 2019; Ščepanovic et al., 2020).

When the results of the above studies are examined, the athletes' total FMS scores exceed the critical threshold of 14, indicating a low risk of injury. Furthermore, as mentioned in the literature, regular corrective exercises have been shown to have positive effects on various variables of the FMS in athletes. The results of the current study revealed that corrective exercises applied to volleyball players resulted in significant positive increases compared to pre-test values in all FMS subtests (deep squat, hurdle step, active straight leg raise, shoulder mobility, and rotation stability), except for the single-line lunge and trunk stability push-up tests, as well as in the total post-test scores of

the FMS. Furthermore, it was observed that the athletes felt more comfortable performing the movements compared to the initial test, and that flexibility in the shoulder region increased. These results parallel the results of the studies mentioned in the literature and the current study. The main differences between the studies are thought to stem from the different training protocols applied to the athletes, their athletic age, and the study involving athletes from different age groups.

The current study had several limitations. First, the sample consisted of male volleyball players recruited from only one geographic region (Mersin). This limits the generalizability of the findings to other volleyball players, particularly those of different genders, regions, or competitive levels. Second, all athletes participating in the current study participated in a corrective exercise program, and no control group was established.

In conclusion, it can be said that regularly implemented corrective exercise programs can be used to improve volleyball players' functional movement patterns and prevent injuries. Therefore, based on the results of this study, it is important for coaches to consider athletes' injury risks when planning training and utilize corrective exercises based on the areas where they want to improve their functional movement patterns.

Financial Support

This research did not receive any specific grant from fundingagencies in the public,commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that there is no conflict of interest regarding this article.

Ethics Approval and Consent to Participate

The study was approved by the local ethics committee (Protocol number 91-05.12.2022 Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey) in accordance with the Declaration of Helsinki. Before the assessment, every participant received the same detailed information about the procedure.

Authors' Contribution:

Study Design: AŞ, Şİ
Data Collection: AŞ
Statistical Analysis: SR
Manuscript Preparation: AŞ, Şİ, SR

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