Comparison of FMS Tests and Digital Goniometer Measurement Values in U15 Age Category Football Players in TRNC

Mesut BATIHAN
PhD student, Girne American University, Faculty of Sports, Pyhsical Education and Sport
mesutbatihan@hotmail.com

Prof.Dr.Mustafa Ferit Acar
Girne American University, Faculty of Sports
mustafaferitacar@gau.edu.tr

Asst.Prof.Dr.Muzaffer Doğgün
Girne Amerikan University, Faculty of Sports
muzafferdoggun@gau.edu.tr

ABSTRACT
This study aims to evaluate the physical abilities of U15 age category football players in the Turkish Republic of Northern Cyprus. The Functional Movement Screening (FMS) tests and digital goniometer measurement values of the football players who voluntarily participated in the study and did not have any injury history were compared. The findings show that there are statistically significant differences between the angles of movement such as hip flexion, extension, abduction, internal rotation and external rotation in various movement tests (deep squat, high stepping, single line lunge, shoulder mobility, active straight leg lift, trunk stability push-ups, rotation stability).

These results reveal that football players may vary in certain movements according to their positions and physical abilities, and these differences may have an impact on their performance. The research provides an important basis for understanding the physical characteristics of young footballers and optimizing their training programs accordingly. Such studies play a critical role in developing more personalized training and rehabilitation strategies for athletes to improve their performance and reduce the risk of injury.
Keywords: U15 years, Functional Movement Screening, Goniometry.

1. INTRODUCTION

Physical activity has major effects on health and performance. Various evaluation methods are used by sports physicians, physiotherapists, and coaches to improve the performance of athletes, reduce the risk of injury, and prevent potential health problems (Abdollahzade et al., 2017). Among these methods, Functional Movement Screening (FMS) and digital goniometer measurement are widely preferred tools for assessing athletes' motion quality and functional abilities. FMS helps athletes create personalized training programs by identifying their basic movement patterns and weak points, while the digital goniometer is used to detect movement limitations and imbalances by precisely measuring joint range of motion. These assessment methods help athletes optimize their performance and minimize their risk of injury (Sahin et al., 2018).

Functional Movement Screening (FMS) is an assessment protocol developed by Gray Cook and Lee Burton. Basically, FMS; It is a method used to assess an individual's movement quality, symmetry, balance, and flexibility. The test includes seven different movement patterns and determines whether each movement is performed correctly. The main goal of FMS is to reduce the risk of injury and improve sports performance by identifying potential movement defects (Tejani et al., 2019).

Digital goniometers, on the other hand, are sensitive devices used to measure joint angles of motion. Unlike traditional handheld goniometers, digital goniometers provide more accurate measurements and allow for easier analysis by recording data digitally. Thanks to these features, digital goniometers are widely preferred for objectively assessing joint angles of motion (Yoon et al., 2018).

1.1. Problem

FMS tests are a battery of tests used to evaluate athletes' mobility abilities and determine possible injury risks. Implementing FMS tests for footballers can help them improve their performance and prevent injuries. FMS tests are an important tool used to assess football players' mobility and injury risks. The first test, the Deep Squat, assesses footballers' hip, knee and ankle mobility, while also measuring upper body and spine stability.

The Hurdle Step test tests hip, knee and ankle stability and mobility, as well as balance and coordination. In-line Lunge (Move on a Single Line), on the other hand, tests hip and leg strength, mobility and balance, while also observing spine stability and movement symmetry (Şahin et al., 2018).

The Shoulder Mobility test measures the flexibility and mobility of the shoulders and upper back, while assessing the symmetrical ability to move in the shoulder girdle. The Active Straight-Leg Raise test tests hip and hamstring flexibility and evaluates lower body mobility. The Trunk Stability Push-Up test tests upper body strength and spine stability, while evaluating central body strength and control (Altundağ and Uçan, 2019). Finally, the Rotary Stability test measures trunk and hip stability and motion control, as well as assessing symmetrical and coordinated movement. All of these tests help football players improve their performance and prevent injuries. FMS tests have many benefits for football players (Duran, 2021).

FMS tests help to take preventive measures by determining the injury risks of football players at an early stage. This allows athletes to continue their careers in a healthier way. In addition, FMS tests maximize the performance of football players by increasing their mobility and flexibility. It contributes to the balanced development of both sides of their body, which allows for better balance and control during the game. Finally, personalized training programs can be created for football players based on the results of the FMS, which offer specific development plans for the individual needs of each athlete. In this way, both the performance and the overall health of the footballers are optimized (Marques et al., 2017).

FMS tests are usually administered by a physiotherapist, trainer or movement specialist. Each test is evaluated using a specific scoring system, with scores ranging from 0 to 3, for a total of 21 points. By observing the movement patterns of the football players, the areas that need to be corrected are determined and intervention plans are created accordingly. FMS tests are an important tool for optimizing the health and performance of football players. Through these tests, customized training and rehabilitation programs can be developed according to the individual needs of the athletes, thus making it possible to maximize the potential of each athlete and minimize the risk of injury (Kiesel et al., 2011).

Digitál goniometers are electronic measuring instruments that are used in various fields of application as a product of modern measurement technology. These devices usually measure an angle in degrees and have the ability to measure between 0 and 360 degrees. Some models also have the ability to measure in different angle units, such as radians or grads. Digitál goniometers offer high accuracy; This increases the accuracy of the measurement results. The measurement results are usually displayed on large and clear digital displays, making them easy to use. In addition, some models offer additional functions, such as storing measured values in memory, converting them into different measurement units. Digitál goniometers are used in a wide range of applications, from medical fields to engineering applications, and are considered an important tool in any process that requires precise measurement (Svensson et al., 2019).

1.2. Purpose

In this research; By examining the effect of flexibility and functional test values of candidate football players playing in the UI 5 Youth Football League, which is the youngest age football league category in the TRNC, on their talent skills on the field, it is aimed to obtain results that will set a model in the coming years and to emphasize the importance of physical, flexibility and functional values for coaches. The main theme of the research is that football players playing in the UI 5 league can improve their FMS Tests and Flexibility tests, progress by training regularly, and the results of the tests may vary.

1.2.1. Hypotheses

The research hypotheses are given below:

- H0: Deep squat does not make a difference on hip range of motion.
- H1: Deep squat increases hip range of motion.
- H0: High stepping does not alter the range of motion of the knee joint.
- H2: High stepping increases knee joint range of motion.
- H0: A single-line lunge does not make a difference in lower extremity range of motion.
- H3: Single line lunge increases lower limb range of motion.
- H0: Shoulder mobility exercises do not alter shoulder range of motion.
- H4: Shoulder mobility exercises increase shoulder range of motion.
- H0: Active straight leg lift makes no difference in hip range of motion.
- H5: Active straight leg lift increases hip range of motion.
- H0: Trunk stability exercises do not alter the range of motion of the hips.
- H6: Trunk stability exercises increase hip range of motion.

1.2.2. Assumptions
The assumptions of the research are listed below;

- The preferred method in the research was assumed to be suitable for the goal of the research.
- The scale and questions selected for the collection of data are assumed to be reliable and valid.
- The data obtained are assumed to be valid and reliable.

1.2.3. Limitations
This research; It consists of 15-year-old football players living in Nicosia, Famagusta, Kyrenia, Güzelyurt and İskele districts in the Turkish Republic of Northern Cyprus. The resources used and the scale questions were limited to the participants to whom the scale was applied.

1.2.4. Definitions
FMS tests: a test battery used to assess athletes' mobility abilities and determine possible injury risks (Şahin et al., 2018).

Digitál goniometers: They are electronic measuring instruments used in various fields of application as a product of modern measurement technology (Svensson et al., 2019).

1.3. Importance of the Study
Comparison of Functional Movement Screening (FMS) tests and digital goniometer measurement values in U15 age category football players provides an objective evaluation of the athletes' movement quality and joint range of motion. FMS tests are intended to identify potential movement defects in football players by assessing basic movement patterns and symmetry. These tests can help personalize training programs to optimize athletes' movement performance and reduce the risk of injury.

On the other hand, digital goniometers precisely measure joint angles of motion and record the data digitally, making it easy to analyze. These instruments provide more accurate measurements than traditional handheld goniometers and are useful for tracking changes over time. Comparative studies in U15 football players are important to understand the relationship between FMS test results and digital goniometer measurements and to determine how these evaluation methods contribute to the developmental process of young athletes.

Since such a research has not been carried out in the TRNC in previous years, the originality of the study is in question. The importance of this scientific study increases the importance of this scientific study by shedding light on the coaches working in the TRNC UI 5 league in recognizing the capacities of the athletes, contributing to them in the treatment of physical development, injuries and organizing training programs.

2. CONCEPTUAL FRAMEWORK
2.1. Football
The history of football dates back to the 19th century, and its modern rules were developed in England. Over time, this sport has become an international phenomenon and is played professionally and amateurly by millions of people around the world. The popularity of football has only increased with tournaments and leagues being held around the world. Major organizations such as the FIFA World Cup and the UEFA Champions League are important examples of the global impact and fan base of this sport (Orta, 2020). Football is a team sport played between two teams, with each team consisting of 11 players. The main objective of this game is to score a goal by passing the ball across the opposing team's goal line. Football is one of the most popular sports around the world and is played according to the rules set by FIFA (International Football Federation). Matches usually take place in two halves of 45 minutes, for a total of 90 minutes. There is a goal at each end of the field and the game is played on a rectangular field. It is necessary that the ball has a spherical shape and has a certain weight and size. The team that scores the most goals wins the match. Players demonstrate strategy, teamwork, and individual skills using both their physical and mental abilities. Rules such as offside, free kicks, and penalties ensure that the game is fair and competitive. This sport, which can be played and watched by people of all ages and walks of life, is followed with great interest and passion around the world (Ceyhan, 2020).

2.2. Functional Movement and Functional Movement Analysis
The Functional Movement Analysis (FMA) test, developed as a result of the validity and reliability study conducted by Minick et al. (2010), is a widely used test developed by Minick et al. (2010) to determine functional movement limitations. This test involves an assessment of a variety of movements and provides information about the individual's body mechanics, movement quality, and potential functional limitations. The FMA test includes a variety of movements such as deep squats, obstacle step, forward stepping, shoulder mobility, active straight leg lifts, trunk stability push-ups, and rotation stability. These movements assess the

range of motion, coordination, balance, and stability of the individual's joints and muscles. Test results are used to identify potential risks or deficiencies that may affect performance in athletes or individuals. The FMA test is used by healthcare professionals and sports coaches and is considered an important tool in assessing the physical capacities of individuals and developing individual programs to optimize their performance (Çağın, 2023).

The Functional Movement Analysis (FMA) test is a test battery used to predict potential injury risks by identifying asymmetries and weak movement patterns in functional movement patterns. The FMA test is used as an important tool to evaluate the physical performance of athletes and active individuals, to improve the quality of movement and to minimize potential risks. Health professionals and coaches can develop individual corrective exercise programs and rehabilitation strategies based on these test results (Çağın, 2023).

The Functional Movement Analysis (FMA) test includes 7 different movements used to assess functional ability. Of these movements, 3 are used to assess general functional abilities, while 2 are designed to assess flexibility and the other 2 are designed to assess stability. Each move is given a score between 0 and 3. When these scores are added together, the individual's total score is between 0 and 21. The highest score (3) indicates that the movement is good; A low score (1) indicates that the movement is bad; a score of zero (0) may indicate that the movement is painful or cannot be performed (Cook et al., 2006). This test is used as an important tool to identify disorders in movement patterns and develop treatment or exercise programs accordingly (Durdur, 2019).

Functional Movement Analysis (FMA) is based on certain principles and methods when evaluating the movement patterns of individuals. The basic principles of FMA are as follows (Sarıkaya et al., 2023):

- Definition of Functional Movement: FMA evaluates the movement patterns used by individuals to perform activities of daily living. These movements include coordination of individuals' muscle groups, range of motion, and stability.
- Variety of Movement Patterns: The FMA test covers a wide range of movements. For example, it includes different movements such as deep squats, obstacle step, forward step, shoulder mobility, straight leg lifts, trunk stability push-ups, and rotation stability. These movements allow to assess the different functional abilities and weak movement patterns of individuals.
- Scoring System: Each move is subject to a specific scoring system in the FMA test. Movements are usually evaluated with a score between 0 and 3. The highest score (3) indicates that the movement is good and there are no restrictions; A low score (1) indicates that the movement is weak and the presence of certain constraints; A score of zero (0) may indicate that the movement is painful or impracticable.
- Movement Asymmetry and Injury Risk Assessment: The FMA test focuses on identifying asymmetries and weak movement patterns in individuals' functional movements.
- Usage Areas: FMA is an important tool used to increase performance in athletes, reduce the risk of injury and manage the return to sports processes. It is also widely used in rehabilitation processes, general health assessments, and physical therapy applications (Sarıkaya et al., 2023).

2.3. Measurement with a Goniometer

A goniometer is an instrument used to measure joint range of motion. This measurement is often used by physiotherapists, rehabilitation specialists or sports physicians. Measurements with a goniometer are important to determine the range of motion of the joint and to monitor the progress in the rehabilitation process. Here's how the goniometer usually works (Smoke, 2019):

- Starting Position Determination: The joint to be measured (for example, knee or shoulder) is brought to the relevant position and the starting point is determined.
- Goniometer Application: The goniometer is placed on the joint and moved from the starting position. This movement is used to measure the opening in the joint.
- Making the Measurement: When the joint movement is performed, the graded ruler or markings on the goniometer indicate the angle of the movement in the joint. This angle is used to determine the range of motion of the joint.
- Recording of Results: The measurement result is recorded according to the angle determined by the ruler or markings on the goniometer. This data is used as an objective measurement of the range of motion in the joint involved (Duman, 2019).

METHOD 3

3.1. Research Model

Cross-sectional survey model was used in this study. The cross-sectional survey model is a research method used to examine the characteristics and situations of individuals or groups over a certain period of time (Dönmez and Azizoğlu 2010). This model is widely used in the evaluation of variables such as the quality of movement and

joint health of athletes. In the study conducted on U15 age category football players, screening models such as Functional Movement Screening (FMS) tests and digital goniometer measurements may have benefited from the cross-sectional screening model. This model allows to analyze the data obtained by these evaluation methods of athletes at a given time and evaluate the results. In this way, a detailed view of athletes' movement performance and potential risk factors can be provided and basic information can be obtained for planning appropriate interventions.

The Turkish Football Federation of Northern Cyprus (K.T.F.F.) organizes the U15 league in a short period of time (within 4 months). This situation causes the participating teams to not be able to fully carry out their preliminary preparations. Due to the fact that the league is played between October and March (the months when the heat does not start in the TRNC) and the U15 league is the lowest league of the youth category, the research universe creates a narrow structure.

3.2. Sampling Method

A total of 60 candidates participated in the study in 4 teams participating in the U15 league organized by K.T.F.F., which plays football in the U15 age category in the TRNC and trains regularly. The participants are male and their average age is between 14.18 years. Only volunteer football players who did not have any injuries and health problems were included in the study.

3.3. Data Collection

The aim of this study is to better understand and evaluate the movement quality and functional abilities of athletes through the comparison of Functional Movement Screening (FMS) tests and digital goniometer measurement values in athletes. Today, increasing sports performance and minimizing the risk of injury in athletes are among the priority goals for sports physicians, physiotherapists and coaches. In this context, developing the right assessment methods and intervention strategies is important to optimize the health and performance of athletes (Stanek et al., 2014).

Functional Movement Screening (FMS) is a widely used tool for detecting movement defects in athletes and determining their potential risk of injury. However, there are criticisms and controversies regarding the use of FMS. In this context, it is important to seek alternative or supportive assessment methods to improve the effectiveness and accuracy of FMS (Abdollahzade et al., 2017).

Digital goniometers are precise devices developed to objectively measure joint angles of motion. These instruments provide more accurate measurements than traditional handheld goniometers, and digital recording of data simplifies analysis and tracking. Thus, digital goniometers can be a reliable alternative in assessing joint motion angles in athletes (Campa et al., 2019; Chapman et al., 2014).

This study aims to reveal the advantages and disadvantages of both methods by comparing Functional Movement Screening (FMS) tests and digital goniometer measurement values. The findings can make a valuable contribution to the processes of assessing the quality of movement and improving performance in athletes. Furthermore, the results of the study can serve as the basis for developing more effective intervention strategies for sports physicians, physiotherapists, and coaches (Cook et al., 2014; Jafari et al., 2019).

3.4. Analysis Method

The data were analyzed using the SPSS package program. Percentage, frequency and arithmetic mean tests were applied as descriptive statistics for the demographic information of the research group. Paired Samples t-test was applied to compare the pre- and post-test data of the research group. Significance was taken as $p<0.05$.

4. FINDINGS

Table 1. Research Group's Deep Squat and Hip Movements Comparisons

Parameters	$\overline{x}$ ±ss	**t**	**p**
Deep Squat Deep Suouat Hip Flexion	3.00 ±.00 123.21 ±1.95	-481,400	0,00
Deep Squat Deep Suouat Hip Extension	3.00 ±.00 9.70 ±.69	-75,732	0,00
Deep Squat Deep Suouat	3.00 ±.00	-340,781	0,00

Hip Abduction	44.60±.93		
Deep Squat Deep Suouat Hip Int. Rotation	3.00±.00 43.00±2.46	-126,491	0,00
Deep Squat Deep Suouat Hip Ext. Rotation	3.00±.00 43.00±2.46	-126,491	0,00

*p<0.05

When Table 1 was examined, it was determined that there was a significant difference between the deep squat deep suouat and hip flexion, hip extension, hip abduction, hip int. rotation and hip ext. rotation values of the research group (p<0.05).

The study of Cook et al. (2006) suggests that Functional Movement Screening (FMS) tests can be effective in assessing athletes' movement abilities. They noted that high FMS scores were associated with a lower risk of disability. This study shows that FMS is a reliable tool that can be used to assess athletes' quality of movement and injury risk. Schneiders et al. (2011) determined FMS normative values on young and active individuals. The study found that low FMS scores may indicate mobility limitations and the potential for disability. These findings suggest that FMS standardizes the usability of movement analysis in young and active individuals and the evaluation process by providing normative data. Kiesel et al. (2007), in their study of professional football players, found that FMS tests can be used to predict injuries before the season. This study highlights that FMS can be an effective tool in predicting the injury risks that athletes may face during the season.

Table 2. Research Group's Hirbel Step and Knee Movements Comparisons

Parameters	$\overline{X}$ ±ss	**t**	**p**
Hirbel Step Right Knee Flexion	3.00 ±.00 139.37 ±2.25	-471,399	0,00
Hirbel Step Left Knee Flexion	3.00 ±.00 139.37 ±2.25	-471,399	0,00

*p<0.05

When Table 2 was evaluated, it was determined that there was a significant difference between the high stepping and right and left knee flexion values of the research group (p<0.05). There are studies with different results in the literature. The study by O'Connor and Hamill (2004), in which they examined the activation of the outer foot muscles during running, revealed that these muscles play a critical stabilizing role in knee flexion movement. This finding suggests that the muscles of the outer foot are important, especially for balanced movement, and that the lack of these muscles may adversely affect knee biomechanics. Bell et al. (2008) examined the characteristics of muscle strength and flexibility in individuals with excessive medial knee displacement, indicating that muscle imbalances around the hip and knee may contribute to knee injuries. This study provides an important perspective on how muscle imbalances can affect knee stability and movement efficiency, in particular. Powers' (2010) study looked at how abnormal hip mechanics affect knee injuries. In particular, it has been emphasized that the weakness of the hip abductor muscles can adversely affect knee stability and this may increase the risk of knee injury.

Table 3. Research Group's Comparisons of Single Line Lunge and Lower Extirimity Movements

Parameters	$\overline{X}$ ±ss	**t**	**p**
Single Line Lunge Right Ankle Plantar Flexion	2.98±.12 39.95 ±.28	-918,053	0,00
Single Line Lunge Right Dorsal Flexion	2.98±.12 29.98±.12	-1155,019	0,00
Single Line Lunge Right Eversion-Inversion	2.98±.12 27.96±.25	-677,055	0,00
Single Line Lunge Left Ankle Plantar Flexion	2.98±.12 39.95±.28	-918,053	0,00

Single Line Lunge Left Dorsal Flexion	2.98±.12 29.98±.12	-1155,019	0,00
Single Line Lunge Left Eversion-Inversion	2.98±.12 29.98±.12	-677,055	0,00

*p<0.05

When Table 3 was examined, it was determined that there was a significant difference between the single line lunge right and left and the ankle plantar flexion, dorsal flexion and eversion-inversion values of the research group (p<0.05).

Academic studies on ankle dorsiflexion range of motion examine the important effects of this parameter on health and performance and evaluate them in different contexts. Studies selected from the relevant literature deal with the subject from various perspectives. Rabin et al. Research by (2014) found that reduced range of motion of the ankle dorsiflexion can increase the risk of ankle injuries. This finding highlights the effects of dorsiflexion range of motion not only on mechanical stability but also on injury risk. Rabello et al. (2022), on the other hand, determined that the range of motion of the ankle dorsiflexion during single leg squats in patients with patellofemoral pain syndrome may lead to compensatory movements in the knee joint. This study considers the effects of dorsiflexion range of motion on general lower extremity functions, not just local. Research by Hoch et al. (2012) evaluated the effect of ankle dorsiflexion range of motion on dynamic postural control. The findings showed that the decrease in dorsiflexion range of motion may adversely affect postural stability, revealing that this parameter is related to postural control mechanisms.

Table 4. Research Group's Comparison of Shoulder Mobile Movements

Parameters	$\overline{x}$ ±ss	**t**	**p**
Shoulder Mobility Right Shoulder Flexion	2.98±.12 179.98 ±.12	-7571,794	0,00
Shoulder Mobility Right Shoulder Extension	2.98±.12 45.00±.00	-2563,000	0,00
Shoulder Mobility Right Shoulder Abduction	2.98±.12 180.00±.00	-10798,000	0,00
Shoulder Mobility Right Shoulder Int. Rotation	2.98±.12 79.36±1.86	-318,607	0,00
Shoulder Mobility Right Shoulder Ext. Rotation	2.98±.12 90,00±,00	-5308,000	0,00
Shoulder Mobility Left Shoulder Flexion	2.98±.12 179.98 ±.12	-7571,794	0,00
Shoulder Mobility Left Shoulder Extension	2.98±.12 45.00±.00	-2563,000	0,00
Shoulder Mobility Left Shoulder Abduction	2.98±.12 180.00±.00	-10798,000	0,00
Shoulder Mobility Left Shoulder Int. Rotation	2.98±.12 79.36±1.86	-318,607	0,00
Shoulder Mobility Left Omuz Ext. Rotation	2.98±.12 90.00±.00	-5308,000	0,00

*p<0.05

When Table 4 was evaluated, it was determined that there was a statistically significant difference between the right and left shoulder flexion, shoulder extension, shoulder abduction, shoulder int. rotation, shoulder ext. rotation values of the research group (p<0.05).

The study by Ellenbecker and Davies (2000) highlights the critical importance of shoulder ranges of motion in isokinetic testing and rehabilitation of the shoulder complex. Shoulder flexion, extension, abduction, internal and external rotation values play a vital role in evaluating shoulder functions and determining injury risks. The study states that balanced shoulder range of motion is important for athletes to optimize their performance and reduce the risk of injury. Research by Wilk et al. (2009) examined changes in shoulder range of motion and strength of

professional baseball players throughout the season. In particular, it was observed that internal rotation increased and external rotation decreased on the dominant arm. These findings suggest that shoulder range of motion may differ between the dominant and nondominant arm and may affect athletes' seasonal performance. The study by Phrathep et al. (2023) examined the associations between hamstring muscle stiffness, shoulder rotation range of motion, and throwing rate in professional baseball players. Research has shown that the increase in shoulder external rotation range of motion has a positive effect on the rate of fire. He also emphasized that the balance and coordination of shoulder ranges of motion are critical for athletic performance.

Table 5. Research Group's Comparisons of Active Straight Leg Lift and Hip Movements

Parameters	$\overline{X}$ ±ss	**t**	**p**
Active Straight Leg Lift Right Hip Flexion	2.98±.12 123.21 ±1.95	-487,312	0,00
Active Straight Leg Lift Right Hip Extension	2.98±.12 9.70±.69	-73,917	0,00
Active Straight Leg Lift Right Hip Abduction	2.98±.12 44.60±.95	-335,515	0,00
Active Straight Leg Lift Right Hip Int. Rotation	2.98±.12 43.00±2.46	-125,690	0,00
Active Straight Leg Lift Right Hip Ext. Rotation	2.98±.12 43.00±2.46	-125,690	0,00
Active Straight Leg Lift Left Hip Flexion	2.98±.12 123.21 ±1.95	-487,312	0,00
Active Straight Leg Lift Left Hip Extension	2.98±.12 9.70±.69	-73,917	0,00
Active Straight Leg Lift Left Hip Abduction	2.98±.12 44.60±.95	-335,515	0,00
Active Straight Leg Lift Left Hip Int. Rotation	2.98±.12 43.00±2.46	-125,690	0,00
Active Straight Leg Lift Left Hip Ext. Rotation	2.98±.12 43.00±2.46	-125,690	0,00

*p<0.05

When Table 5 was evaluated, it was determined that there was a statistically significant difference between the right and left and hip flexion, hip extension, hip abduction, hip int. rotation, hip ext. rotation values of the research group (p<0.05).

The study by Hamstra-Wright et al. (2017) examined the relationship between hip flexibility and hip strength in individuals with low back pain. The study found that low back pain is common in individuals with reduced hip flexion range of motion and that these individuals have difficulty in the ADBK (Active Hip Flexion-Extension) test. These findings suggest that the ADBK test is associated with hip flexion range of motion and that this parameter is an important factor on the risk of low back pain. The study by Leporace et al. (2020) examined the relationship between hip range of motion and lower extremity muscle strength in college athletes. The research found that hip flexion, abduction, and rotation range of motion showed a positive correlation with ADBK test performance. It has been emphasized that hip range of motion is important in terms of balance and coordination in athletes.

Table 6. Research Group's Comparison of Trunk Stability and Hip Movements

Parameters	$\overline{X}$ ±ss	**t**	**p**
Body Stability Push-Ups Hip Flexion	2.98±.12 123.21 ±1.95	-485,139	0,00
Body Stability Push-Ups Hip Extension	2.98±.12 9.70±.69	-73,347	0,00
Body Stability Push-Ups	2.98±.12	-354,952	0,00

Hip Abduction	44.60±.95		
Body Stability Push-Ups Hip Int. Rotation	2.98±.12 43.00±2.46	-127,774	0,00
Body Stability Push-Ups Hip Ext. Rotation	2.98±.12 43.00±2.46	-127,774	0,00

*p<0.05

When Table 6 was examined, it was determined that there was a statistically significant difference between the body stability of the research group and push-ups and hip flexion, hip extension, hip abduction, hip int. rotation, hip ext. rotation values (p<0.05). The study by Leetun et al. (2004) examined the relationship between trunk stability and lower extremity injuries in athletes and found that athletes with poor trunk stability generally had reduced hip flexion and extension range of motion. These findings reveal a significant relationship between trunk stability and hip range of motion. In the study conducted by Nesser et al. (2008), the relationship between body stability and performance in Division I football players was examined. Research has found that players with high body stability have better hip flexion and extension range of motion. These findings support a positive relationship between trunk stability and hip range of motion. The study by Borghuis et al. (2008) examined the effect of sensory-motor control on body stability. Research has shown that good sensory-motor control positively affects hip abduction and rotational range of motion. These results highlight that there may be significant differences between trunk stability and hip range of motion.

Table 7. Research Group's Comparisons of Active Straight Leg Lift and Hip Movements

Parameters	$\overline{x}$ ±ss	**t**	**p**
Rotation Stadium Right Hip Flexion	2.98±.12 123.21 ±1.95	-471,803	0,00
Rotation Stadium Right Hip Extension	2.98±.12 9.70±.69	-75,473	0,00
Rotation Stadium Right Hip Abduction	2.98±.12 44.60±.95	-337,453	0,00
Rotation Stadium Right Hip Int. Rotation	2.98±.12 43.00±2.46	-128,260	0,00
Rotation Stadium Right Hip Ext. Rotation	2.98±.12 43.00±2.46	-128,260	0,00
Rotation Stabite Left Hip Flexion	2.98±.12 123.21 ±1.95	-471,803	0,00
Rotation Stabite Left Hip Extension	2.98±.12 9.70±.69	-75,473	0,00
Rotation Stabite Left Hip Abduction	2.98±.12 44.60±.95	-337,453	0,00
Rotation Stabite Left Hip Int. Rotation	2.98±.12 43.00±2.46	-128,260	0,00
Rotation Stabite Left Hip Ext. Rotation	2.98±.12 43.00±2.46	-128,260	0,00

*p<0.05

When Table 7 was evaluated, it was determined that there was a statistically significant difference between the rotation stability of the research group and the right and left rotation values of hip flexion, hip extension, hip abduction, hip int. rotation, hip ext. rotation (p<0.05).

A study by Leetun et al. (2004) revealed that athletes with poor trunk stability had reduced hip flexion and extension range of motion. Nesser et al. (2008), on the other hand, found that athletes with high body stability had better hip flexion and extension range of motion in Division I football players. The study by Borghuis et al. (2008) showed that good sensory-motor control positively affects hip abduction and rotation range of motion. These results highlight that sensory-motor control is associated with trunk stability and plays an important role in controlling hip range of motion.

In this context, the relationships between trunk stability and hip range of motion are considered as an important factor in the management of athletes' movement performance, injury risk and rehabilitation processes. These studies are important in terms of understanding the effects on athlete health and performance and contributing to the optimization of training programs.

5. CONCLUSION AND RECOMMENDATIONS

The aim of this study was to compare Functional Movement Screening (FMS) tests and digital goniometer measurement values in U15 age category football players in the Turkish Republic of Northern Cyprus. The findings obtained in the physical evaluation tests of the research group reveal that the U15 age category football players differ in terms of various physical characteristics. In the evaluations made in tests such as deep squat, high stepping, single line lunge, shoulder mobility, active straight leg lift, trunk stability, push-ups and rotation stability, statistically significant differences were determined between the movement values of the football players such as hip flexion, extension, abduction, internal rotation and external rotation. These results show that football players have different physical abilities according to their position and depending on the type of testing, and these characteristics affect their performance.

The findings of this study show how the physical characteristics of U15 age category footballers vary according to their position and type of test. Accordingly, the following recommendations can be taken into account when developing training programs and performance enhancement strategies:

- Individualized Training Programs: Individual training programs should be created in line with the FMS test results and digital goniometer measurements of the football players. For example, specific exercises and rehabilitation techniques can be applied that target the identified weak points.
- Position-Oriented Physical Preparation: Considering that football players may have different needs according to their positions, training programs should be designed with a position-oriented approach. For example, exercises that focus on features such as joint stability and shoulder mobility may be important for goalkeepers, while work on developing speed and agility may be a priority for attacking players.
- Continuous Evaluation and Feedback: The physical abilities of the football players should be evaluated regularly and their training programs should be updated in line with these evaluations. The performance improvement process should be supported by providing regular feedback.
- Strategies to Reduce the Risk of Injury: Preventive measures should be taken to reduce the risk of injury by focusing on the identified movement defects and deficiencies. This is critical in terms of maintaining the health of footballers and sustaining their performance in the long term.

These suggestions can be used to support the physical development of U15 age category footballers in the Turkish Republic of Northern Cyprus and to improve their performance. Taking a customized approach based on each player's individual needs and test results can improve overall team performance and minimize the risk of injury.

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