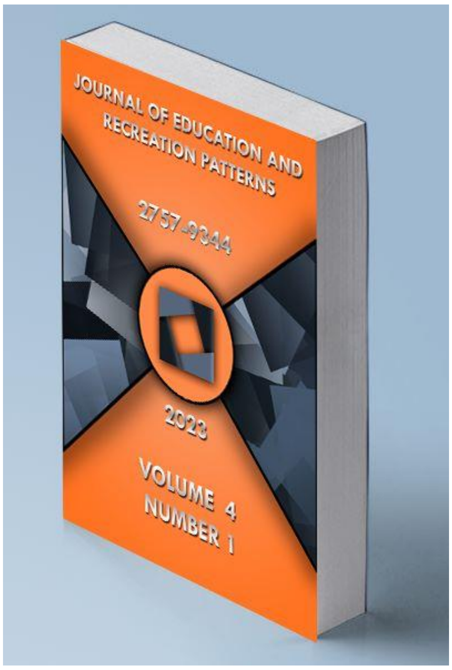


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# The Relationship of Dorsiflexion Angle with Leg Volume, Balance, Speed, and Change of Direction Performance in Amateur Soccer Players

**Veysi CİRASUN[1], Barış BAYDEMİR[2]**

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**ABSTRACT**

The aim of this study is to examine the relationship between dorsiflexion angles, leg volume, dynamic balance, speed performance, and change of direction performances depending on agility in athletes aged 14–15 who were raised in the infrastructure of various sports clubs and exposed to various training loads during the basic training period. 76 male football players who play football in the amateur league participated in our research at the Cizre Hamit Özalp Stadium, which is under the Cizre Youth and Sports District Services Directorate. Height, weight, body mass index, leg volume, 30 meter speed, Y-balance test, and Illinois test were applied to the performance of changing the direction of the athletes participating in the research. The SPSS package program was used for the analysis of the data obtained in the research. The Kolmogorov-Smirnov test was performed to determine whether the data obtained in the study showed a normal distribution. Spearman Rank Differences the correlation test, which is one of the non-parametric tests, was used to reveal whether there is a relationship between the right and left region measurement values of the athletes participating in the research. In the research findings, the relationship among dorsiflexion and muscle volume ($r=0.301$, $p<0.01$), ($r=0.427$, $p<0.01$), dorsiflexion and dynamic balance anterior ($r=0.497$, $p<0.01$), posterolateral ($r=0.331$), $p<0.01$), posteromedial ($r=0.324$, $p<0.01$), muscle volume and dynamic balance anterior ($r=0.390$, $p<0.01$), posteromedial ($r=0.305$, $p<0.01$), posteromedial ($r=0.365$, $p<0.01$) and balance anterior ($r=-0.493$, $p<0.01$), posterolateral ($r=-0.382$, $p<0.01$), posteromedial and deflection ($r=-0.336$, $p<=.01$) performances were examined. As a result of the research, it has been determined that the muscle volume of the athletes with good dorsiflexion angles is also good, the dynamic balance performance of the athletes with good dorsiflexion angles is also good, the dynamic balance performance of the athletes with good calf volumes is also good, and the direction change performance of the athletes with good speed performance is also good.

**Keywords:** Change of Direction, Dorsiflexion, Football, Range of Motion, Speed

# INTRODUCTION

Football is among the most popular sports branches in the world. For this reason, the interest in football continues to increase on all platforms. The number of football players in the world is considered to be in the millions. Football is an extremely powerful source of prestige both nationally and internationally. As well as these, although the football branch is not easy, it requires being very strong both psychologically and physically.

Football can be defined as a long-term game based on contact, in which all physical and physiological parameters are involved. The reason for this is that in addition to basic motoric features such as speed, strength and endurance, it contains complex movement patterns consisting of all components of force and high-speed changes of direction. However, it reveals the necessity of a good aerobic and anaerobic capacity based on the contraction principles required by muscular strength and endurance. Considering all these features, it is separated from many types of sports. Researchers state that football has an important place in people's lives (Bozkır and Demir, 2022).

Maintaining dynamic balance in athletes depends on the smooth functioning of the postural control system, which protects the pressure center within the body's support area. The balance control process has been an important part of the sport, as various exercise intensities have to be adapted to the prevailing conditions on the field and to various team tactics in combat and sport from the past to the present. Researchers have stated that achieving a high level of skill in sports as an adult athlete depends on the correct development of motor skills at a young age (Sikoro et al., 2020).

Postural balance is defined as the ability of the body to remain stable in positions for static and dynamic balance. In addition, dynamic balance is extremely important for daily life and exercise. Postural balance is a complex process that depends on the interpretation of external stimuli received by sensory information mechanisms, including the visual, vestibular, and proprioceptive systems, which are responsible for bringing information via nerve conduction to the somatosensory cortex. The Y-Balance Test is a functional balance measurement tool for the lower extremity derived from the Star Balance Test. The test is inexpensive to administer and quick and simple to administer. It can be used to assess the dynamic balance of the lower extremity, identify athletes at risk of injury, monitor rehabilitation progress, and perform neuromuscular training. In addition, it can be used in young runners, patients with ankle sprains, and athletes with anterior cruciate ligament injuries (Almeida et al.,2017).

Movement asymmetry has been recognized as a risk factor for initial and recurrent musculoskeletal injuries for individuals. Unfortunately, there is very little information about motion asymmetry in competitive sports. Therefore, the identification and correction of motion asymmetry have been a major concern for sports scientists and scientists in recent years (Cug et al., 2020).

It is known that lower extremity injuries are common in branches such as football, where bilateral struggle and contact are high. It has been stated that especially the decreased ankle dorsiflexion angles in athletes increase the tension of the tendons in the soleus and gastrocnemius muscles. In the analysis of walking and running, it is stated that the soleus and gastrocnemius muscles absorb the mechanical force before the big toe is lifted, and as a result, the force absorbed by both soleus and gastrocnemius increases if the ankle dorsiflexion angle is limited. In this case, it may increase the risk of injury in the ankle. It is stated that decreasing ankle dorsiflexion angle increases Achilles tendinopathy 2.5-3.6 times (Lagas et al., 2021).

An important feature for athletes is change of direction performance and studies continue on this subject (Baydemir ve Aksoy, 2019). Changing direction performance is also defined as a complex ability that requires power such as maximum power, and reactive power, in which appropriate technique, speed, anthropometric factors, and leg muscle characteristics are at the forefront. Changing direction is defined as an athlete's rapid deceleration from one direction to a new direction and rapid acceleration again. It is known that football is a sports branch with a lot of changes in direction as of gameplay. It is stated that the ability to change direction is extremely important for the performance of the athlete in the match (Kerdaoui et al., 2021).

Another important feature for athletes is speed. Speed, which is one of the basic motoric features, is known to be one of the important motoric features that are at the forefront in football, as in most sports. Sprint training is generally done such as maximal speed, continuity in speed, straight sprint, and acceleration in a straight sprint. Other important parameters in speed, such as maximal speed, acceleration, and agility, have similar biochemical and morphological features such as muscle type, and there are studies supporting that speed and agility performance are interrelated (Vurmaz, 2018).

Overloading in training is about providing optimum stimulation in order to provide physical and physiological adaptation to reveal the desired athlete performance. Overload is exercise and training that goes beyond the normal training performance level. For a workout to be considered overloaded, the intensity, frequency, and duration of the workout must exceed the normal level of physical performance. The intensity of a workout is related to the rate of work done in that workout and the rate of energy burned. The total training volume or scope is related to how much work is done in that unit of training (Stone et al., 2000).

The training should be in accordance with the performance of the athlete in the competition. In order to maximize the performance of the athlete in training, the recommended points to be applied in the training method selections are specified. It is stated that the emphasized regions of force production are the direction of the movement, the dynamics of effort (related to the movement being static and dynamic), the maximum force production rate and duration, and the working regime of the muscle (concentric and eccentric muscle movement) (Stone et al., 2000).

The specificity of the training while doing sports is accepted as an important factor in shaping the training effects. There are two important factors in the personalization of the training. The first of these is the response to the acute effect of the training, while the other is the extent to which the training is similar to the conditions exposed during the matches. The sport-specific training methods are important in terms of seeing the effect of training during the competition. The development of the training experience of the athletes, the specificity of the training, and the physical responses to the training are also affected. For this reason, as the athletes approach professional levels, the specificity of the training will be effective for the athletes. The hereditary characteristics of athletes are also an extremely important parameter for success. The degree to which inherited abilities are transformed into performance during the competition will depend not only on the quality of training but also on the motivation and dedication of the athletes while preparing for the competitions (Gamble, 2013).

It is already known that the physical characteristics of athletes are among the most important factors in terms of their sportive success. In this context, coaches who are sports professionals should use their skills in this field in the best way. Trainers should apply the performance tests appropriate for the branch they have made to their athletes in a planned manner, and monitor the progress of the athletes constantly by comparing them with the studies in the literature. The study aimed to examine the relationship between leg volume, dynamic balance scores, speed performance, and change of direction performance depending on agility by measuring the dorsiflexion angles of athletes aged 14-15 trained in football schools or the infrastructure of different sports clubs and are exposed to various training loads during the basic training period. When the literature was reviewed, many studies were detected evaluating the performance of athletes. However, it was also observed that there are limited studies conducted to learn the relationship of ankle dorsiflexion angles of football players with leg volume, balance, speed, and change of direction performance. For this reason, the purpose was to fill the gap in this field in the literature, as well as to be a source for new studies. One of the main reasons why the study was conducted was that we saw the important results of dorsiflexion angle in sports achievements in football players. Also, we believed that the dorsiflexion angle of the football players determined the performance criteria and could be associated with the balance, speed, and direction change performances of the football players.

## METHOD

### Research Design

The exploratory model, which is one of the relational screening models, was used because the relationship between two or more variables was examined in the research. The research was designed as an experimental study. In addition, it was designed as a relational research that questions at least two relationships and what kind of relationship they are. The study was designed in accordance with the Declaration of Helsinki. It was taken with the decision of Çanakkale 18 Mart University Scientific Research Ethics Committee dated 30.09.2021 and numbered 17/30.

### Research Group

The population of the research was football players, and the sample comprised male football players playing in the amateur league in Cizre, Şırnak. A total of 76 male football players aged 14-15 playing football in Cizre district of Şırnak province participated in the study. In order to determine the height, weight, body mass index (BMI), leg volume, and sprint performance of the football players, the 30-meter speed test was applied, the Y-Balance Test was applied to determine their dynamic balance performance, and the Illinois test was applied for change direction performance. The obtained data were analyzed with the SPSS program. The correlation between leg volume, speed, balance, and change of direction performances of dorsiflexion angles was examined.

**Table 1.** Descriptive Characteristics of the Athletes Participating in the Research

| | Variables | (n=76) | X | SS | Min | Max |
|---|---|---|---|---|---|---|
| Right | Age (year) | | 14.57 | 0.49 | 14 | 15 |
| | Size (cm) | | 166.21 | 10.12 | 135 | 186 |
| | Body Weight (bw) | | 53.69 | 1.58 | 30.00 | 81.60 |
| | Body Mass İndex (BMI) | | 19.28 | 3.18 | 13.85 | 29.09 |
| | Dorsiflexion (0) | | 32.47 | 2.81 | 24 | 39 |
| | Calf Volume | | 2.068.87 | 439.34 | 1.080.99 | 3.081.60 |
| | Thigh Volume | | 5.335.30 | 1393.25 | 2.760.21 | 8.794.01 |
| | Y-Balance Anterior (cm) | | 61.73 | 7.89 | 45.00 | 77.00 |
| | Y-Balance Posterolateral (cm) | | 98.46 | 10.31 | 63.00 | 119.00 |
| | Y-Balance Posteromedial (cm) | | 95.57 | 10.42 | 59.00 | 112.00 |

| | Variables | (n=76) | X | SS | Min | Max |
|---|---|---|---|---|---|---|
| Left | Dorsiflexion (0) | | 32.53 | 2.84 | 25 | 39 |
| | Calf Volume | | 2.067.24 | 437.28 | 1.075.12 | 3.046.12 |
| | Thigh Volume | | 5.333.26 | 1386.91 | 2.750.10 | 8.57.23 |
| | Y-Balance Anterior (cm) | | 61.73 | 7.29 | 46.00 | 76.00 |
| | Y-Balance Posterolateral (cm) | | 97.85 | 10.52 | 61.00 | 117.00 |
| | Y-Balance Posteromedial (cm) | | 97.42 | 9.77 | 63.00 | 115.00 |
| | Speed (sec) | | 4.88 | 0.57 | 4.11 | 6.99 |
| | Change of Direction (sec) | | 17.52 | 1.21 | 15.21 | 20.76 |

## Data Collection Tools

Anthropometric measurements (height, weight, body mass index) of amateur football players were taken. Leg volumes were measured. 30 meters sprint to determine sprint performance, the Y-Balance test for balance performance test, and the Illinois test to determine direction change performance were applied.

## Applied Tests and Exercises

### *Height Measurement*

The height of the football players was measured with a barefoot accuracy of 0.1 m using a SECA (Germany) branded height scale.

### *Weight Measurement*

The body weight of the players was measured with a SECA (Germany) electronic scale with a precision of 0.5 kg.

### *Calculation of BMI*

The formula below was used to determine the body mass index. Body Mass Index (BMI) = Body Weight / Height2 (Baydemir et al, 2020).

### *Determination of Leg Volume*

Since the volume between the gluteal fold and the sole is determined by the athletes, the gluteal folds of the athletes were determined first in order to take the volume measurements. When the athlete's body was in an upright position, the leg that was measured was placed on the bench in such a way that it was in 90 degrees of flexion and the thigh was at a 90-degree angle with the body. Then, the gluteal fold formed on the leg to be measured was marked with a pencil. Then, while the athlete lowered his leg and stood still with his legs shoulder-width apart, he placed the 50 cm ruler fixed on the spirit level on the marked area, and the scales were brought to the position of balance, and then a line was drawn to determine the determined gluteal fold. While taking the measurements of the athletes, the gluteal fold of the previous leg was taken as a reference in order to have a minimum error in the measurements of both legs. After determining the gluteal crease of one leg with the method mentioned above, the athlete is brought to an upright position, standing still with his legs shoulder-width apart, and the other end of the 50 cm specially prepared spirit level is placed at the determined gluteal crease, and the gluteal fold is balanced on the other leg and its lines were drawn (Işıldak, 2017).

***Thigh Volume***

The distance between the tibial point and the inguinal fold was measured with an accuracy of ± 1 millimeter at 10% intervals, with the legs shoulder-width apart while the athlete was standing (Marangoz and Özbalcı, 2017).

***Calculation of Thigh Volume***

After measuring the distance between the athlete's tibial point and the inguinal fold at 10% intervals, the volumes of the parts were calculated with a 10% interval as defined by the Frustum sign model method, and then the total volume of the thigh was calculated by adding the volumes of all the parts determined between the tibial point and the inguinal fold (Sukul et al., 1993; Lund et al., 2002; Karges et al., 2003; Carpenter and Özbalcı, 2017).

***Calf Volume***

The distance between the tibial point and the medial malleolus point was measured with an accuracy of 10% ± 1 mm when the athlete was standing and in an open position with his legs shoulder-width apart (Marangoz and Özbalcı, 2017).

***Calculation of Calf Volume***

After measuring the distance between the athlete's tibial point and the medial malleolus point at 10% intervals, the volumes of the parts taken at 10% intervals were calculated as defined by the Frustum sign model method, the volumes of all the parts between the tibial point and the medial malleolus point were summed and the total volume of the calf measurement was calculated. (Sukul et al., 1993; Lund et al., 2002; Karges et al., 2003; Marangoz and Özbalcı, 2017).

***Calculation of Leg Volume***

After determining the volume between the gluteal fold and the sole, the total volume of the leg was calculated by adding the thigh and calf volumes of the athletes (Marangoz and Özbalcı, 2017).

***30-Meter Speed Test***

A 30-meter-long straight track was prepared on an artificial turf ground with sports boots and a photocell was placed at the start and end points. When the athletes waited 0.5 meters behind the starting point and felt ready, they were asked to run through the photocell gate at the finish point at the highest speed.

***Y-Balance Test***

The Y-Balance Test evaluated the ability of the athletes to maintain the dynamic balance of the lower extremity in the anterior, posterolateral, and posteromedial directions (Almeida et al.,2017). Athletes were asked to warm up before the application of the test. The validity and reliability of the Y-Balance test were determined as ICC, the intrarater range of 0.85-0.91, and the interrater range of 0.99-1.00 (Plisky et al., 2009). The application of the test was explained to the athletes and it was demonstrated by the trainer by applying it once. With the Y-Balance test kit, the measurements were taken by asking the individuals to lie down in both the right and left anterior-posteromedial-posterolateral directions. Athletes were asked to stand on one foot at the midpoint of the kit and lie down with the other foot in the anterior-posteromedial-posterolateral directions without losing their balance, and the farthest point where the fingertip reached was recorded. The test was repeated three times and the best performance was recorded in cm.

***Illinois Agility Test***

It is a test consisting of four funnels arranged in a straight line with a width of 5 m, a length of 10 m, and a gap of 3.3 m in the middle. The applied test was performed by performing a slalom run between 30 m straight and 20 m funnels, which includes 180-degree turns in a 10 m straight run. The athlete's track finish time was recorded in seconds. A second repetition was performed 5 minutes after the first test was applied to the athletes and the best score was recorded (Cureton, 1951).

***Dorsiflexion Angle Measurement***

To take this measurement, the iPhone Measure program, which is automatically installed on the iPhone smartphone (iOS 7 and above), was used. This study used an iPhone 11 Pro Max (Apple Inc., Cupertino, CA, USA). Before getting to work, the iPhone Measure app was compared for consistency across three trials on the same, hard flat, and angled surfaces. During the study, measurements were taken and controlled with a goniometer in 20 students for the calibration of the iPhone application. Then, the application was placed on the long axis on the ground and calibrated to zero degrees. For the convenience of the participants, the tests were performed in the planned order. To demonstrate an understanding of preconditioning, and technique, and reduce joint stiffness, participants were asked to perform a Weight-Bearing Lunge Test (WBLT) stance for 30 s three times. A small mark was made behind the heel of the athletes to indicate the one-centimeter superiority of the posterior calcaneal tuberosity as it was the measurement point (Gosse et al., 2021). The WBLT test protocol was used during testing (Bennel et al., 1999). Participants stood with their hands shoulder-width apart, leaning against the wall in front of them. The device was placed on the marked place on the heel of the participants as comfortably as possible, with their right heel on the ground, parallel to the left leg, and perpendicular to the wall for the right leg of the participants. The evaluator was assisted to move the right foot back until the squat position was maintained with the heel remaining on the ground and the knee aligned over the second toe. WBL test measurements were then taken with the knee in extension and knee flexion. At each time point, at each position, the evaluators made a single measurement of each athlete (Bennel et al., 2019).

**Statistical Analysis**

The SPSS package program was used for the analysis of the data obtained in the research. The Kolmogorov-Smirnov test was performed to determine whether the data obtained in the study were normally distributed. Spearman Rank Differences Correlation test, which is one of the non-parametric tests, was applied to determine whether there is a relationship between the right and left region measurement values and the speed and direction change performances of the athletes participating in the research. In the study, the level of significance was accepted as $p<0.05$.

**Table 2.** Normality Test

| | | **Kolmogorov-Smirnov[a]** | | |
|---|---|---|---|---|
| | **Variables** | **Statistic** | **n=76** | **Sig.** |
| Right | **Age (year)** | 0.374 | | 0.000** |
| | **Height (cm)** | 0.139 | | 0.001** |
| | **Weight (kg)** | 0.088 | | 0.200* |
| | **Body Mass Index (BMI)** | 0.080 | | 0.200* |
| | **Dorsiflexion ($^0$)** | 0.154 | | 0.000** |
| | **Calf Volume** | 0.054 | | 0.200* |
| | **Thigh Volume** | 0.092 | | 0.182** |
| | **Y-Balance Anterior (cm)** | 0.084 | | 0.200* |
| | **Y-Balance Posterolateral (cm)** | 0.079 | | 0.200* |
| | **Y-Balance Posteromedial (cm)** | 0.076 | | 0.200* |

| | Variables | Kolmogorov-Smirnova[a] Statistic | n=76 | Sig. |
|---|---|---|---|---|
| Left | **Dorsiflexion (0)** | 0.111 | | 0.022** |
| | **Calf Volume** | 0.053 | | 0.200* |
| | **Thigh Volume** | 0.087 | | 0.200* |
| | **Y-Balance Anterior (cm)** | 0.078 | | 0.200* |
| | **Y-Balance Posterolateral (cm)** | 0.072 | | 0.200* |
| | **Y-Balance Posteromedial (cm)** | 0.075 | | 0.200* |
| | **Speed (sec)** | 0.226 | | 0.000** |
| | **Change of Direction (sec)** | 0.090 | | 0.200* |

***p>0.05, **p<0.01**

Kolmogorov-Smirnov values were taken into account since the athletes participating in the research were over 30 as a result of the normality test applied to determine whether the data obtained in the study were normally distributed. As a result of the analysis, it was determined that age, height, right dorsiflexion, right thigh volume, left dorsiflexion, and speed values were not normally distributed, while other parameters were found to be normally distributed. (p>0.05). The data obtained are given in Table 2.

## FINDINGS

In this section, the results of correlation analysis of right and left region measurements of football players are given.

**Table 3.** Correlation Analysis of Right Region Measurement Values of Football Players with Speed and Change of Direction

| | | Dorsiflexion | Calf Volume | Thigh Volume | Y-Balance Anterior | Y-Balance Posterolateral | Y-Balance Posteromedial | Speed | Change of Direction |
|---|---|---|---|---|---|---|---|---|---|
| **Dorsiflexion** | **r** | 1.000 | 0.301** | 0.427** | 0.497** | 0.331** | 0.324** | -0.055 | -0.092 |
| | **p** | . | 0.008 | 0.000 | 0.000 | 0.004 | 0.004 | 0.637 | 0.430 |
| **Calf Volume** | **r** | | 1.000 | 0.569** | 0.390** | 0.305** | 0.365** | -0.275* | -0.196 |
| | **p** | | . | 0.000 | 0.001 | 0.007 | 0.001 | 0.016 | 0.090 |
| **Thigh Volume** | **r** | | | 1.000 | 0.237* | 0.222 | 0.292* | -0.141 | -0.077 |
| | **p** | | | . | 0.039 | 0.054 | 0.010 | 0.224 | 0.507 |
| **Y-Balance Anterior** | **r** | | | | 1.000 | 0.675** | 0.641** | -0.431** | -0.493** |
| | **p** | | | | . | 0.000 | 0.000 | .000 | 0.000 |
| **Y-Balance Posterolateral** | **r** | | | | | 1.000 | 0.802** | -0.405** | -0.382** |
| | **p** | | | | | . | 0.000 | 0.000 | 0.000 |
| **Y-Balance Posteromedial** | **r** | | | | | | 1.000 | -0.478** | -0.336** |
| | **p** | | | | | | . | 0.000 | 0.003 |
| **Speed** | **r** | | | | | | | 1.000 | 0.708** |
| | **p** | | | | | | | . | 0.000. |
| **Change of Direction** | **r** | | | | | | | | 1.000 |
| | **p** | | | | | | | | . |

***p<0.05, *p<0.01**

As a result of the Spearman Rank Differences Correlation test conducted to reveal whether there is a relationship between the right region measurement values of the athletes participating in the research and the speed and direction change performance;

A significant positive correlation was determined between dorsiflexion and calf volume ($r=0.301$, $p<0.01$), between dorsiflexion and thigh volume ($r=0.427$, $p<0.01$), between dorsiflexion and Y-Balance anterior ($r=0.497$, $p<0.01$) between dorsiflexion and Y-Balance posteromedial ($r=0.331$, $p<0.01$), and between dorsiflexion and Y-Balance posteromedial ($r=0.324$, $p<0.01$).

There was a significant positive correlation between calf volume and thigh volume ($r=0.569$, $p<0.01$), between calf volume and Y-Balance anterior ($r=0.390$, $p<0.01$), calf volume and Y-Balance posterolateral ($r=0.305$, $p<0.01$) calf volume and Y-Balance posteromedial ($r=0.365$, $p<0.01$).

There was a significant negative correlation between calf volume and speed ($r=-0.275$, $p<0.05$). A positive significant correlation was determined between thigh volume and Y-Balance anterior ($r=0.237$, $p<0.05$), and between thigh volume and Y-Balance posteromedial ($r=0.292$, $p<0.05$).

A significant positive correlation was determined between Y-Balance anterior and Y-Balance posterolateral ($r=0.675$, $p<0.05$), and between Y-Balance anterior and Y-Balance posteromedial ($r=0.641$, $p<0.01$).

A significant negative correlation was determined between Y-Balance anterior and speed ($r=-0.431$, $p<0.01$), and between Y-Balance anterior and change of direction ($r=-0.493$, $p<0.01$).

A significant positive correlation was determined between Y-Balance posteromedial and Y-Balance posteromedial ($r=0.802$, $p<0.01$).

A significant negative correlation was determined between Y-Balance posterolateral and speed ($r=0.405$, $p<0.01$), and between Y-Balance posterolateral and change of direction ($r=-0.382$, $p<0.01$).

A significant negative correlation was determined between Y-Balance posteromedial and speed ($r=-0.478$, $p<0.01$), and between Y-Balance posteromedial and change of direction ($r=-0.336$, $p<=.01$).

A significant positive correlation was determined between speed and change of direction ($r=0.708$, $p<0.01$). The data obtained are given in Table 3.

**Table 4.** Correlation Analysis of Left Region Measurement Values of Football Players with Speed and Change of Direction

| | | Dorsiflexion | Calf Volume | Thigh Volume | Y-Balance Anterior | Y-Balance Posterolateral | Y-Balance Posteromedial | Speed | Change of Direction |
|---|---|---|---|---|---|---|---|---|---|
| **Dorsiflexion** | **r** | 1.000 | 0.317** | 0.438** | 0.479** | 0.203 | 0.290* | -0.023 | -0.063 |
| | **p** | . | 0.005 | 0.000 | 0.000 | 0.079 | 0.011 | 0.843 | 0.589 |
| **Calf Volume** | **r** | | 1.000 | 0.566** | 0.297** | 0.317** | 0.331** | -0.275* | -0.197 |
| | **p** | | . | 0.000 | 0.009 | 0.005 | 0.003 | 0.016 | 0.088 |
| **Thigh Volume** | **r** | | | 1.000 | 0.266* | 0.199 | 0.177 | -0.139 | -0.080 |
| | **p** | | | . | 0.020 | 0.085 | 0.127 | 0.230 | 0.493 |
| **Y-Balance Anterior** | **r** | | | | 1.000 | 0.734** | 0.700** | -0.409** | -0.436** |
| | **p** | | | | . | 0.000 | 0.000 | 0.000 | 0.000 |
| **Y-Balance Posterolateral** | **r** | | | | | 1.000 | 0.814** | -0.454** | -0.403** |
| | **p** | | | | | . | 0.000 | 0.000 | 0.000 |
| **Y-Balance Posteromedial** | **r** | | | | | | 1.000 | -0.444** | -0.440** |
| | **p** | | | | | | . | 0.000 | 0.003 |
| **Speed** | **r** | | | | | | | 1.000 | 0.708** |
| | **p** | | | | | | | . | 0.000. |
| **Change of Direction** | **r** | | | | | | | | 1.000 |
| | **p** | | | | | | | | . |

***p<0.05, *p<0.01**

As a result of the Spearman Rank Differences Correlation, a significant positive correlation was determined between dorsiflexion and calf volume (r=0.317, p<0.01), between dorsiflexion and thigh volume (r=0.438, p<0.01), between dorsiflexion and Y-Balance anterior (r=0.479, p<0.01), dorsiflexion and Y-Balance posteromedial (r=0.290, o<0.01), between calf volume and thigh volume (r=0.566, p<0.01), between calf volume and Y-Balance anterior (r=0.297, p<0.01), calf volume and Y-Balance posterolateral (r=0.317, p<0.01.) There was a significant positive correlation between calf volume and Y-Balance posteromedial (r=0.331, p<0.01). There was a significant negative correlation between calf volume and speed (r=-0.275, p<0.05). A significant positive correlation was found between thigh volume and Y-Balance anterior (r=0.266, p<0.05).

A significant positive correlation was determined between calf volume and thigh volume (r=0.566, p<0.01), between calf volume and Y-Balance anterior (r=0.297, p<0.01), calf volume and Y-Balance posterolateral (r=0.317, p<0.01) between calf volume and Y-Balance posteromedial (r=0.331, p<0.01). There was a significant negative correlation between calf volume and speed (r=-0.275, p<0.05). A significant positive correlation was determined between thigh volume and Y-Balance anterior (r=0.266, p<0.05).

A significant positive correlation was determined between Y-Balance anterior and Y-Balance posterolateral (r=0.734, p<0.05), and between Y-Balance anterior and Y-Balance posteromedial (r=0.700, p<0.01). A significant negative correlation was determined between

Y-Balance anterior and speed ($r=-0.409$, $p<0.01$), and between Y-Balance anterior and change of direction ($r=-0.436$, $p<0.01$).

A significant positive correlation was determined between Y-Balance posteromedial and Y-Balance posteromedial ($r=0.814$, $p<0.01$). A significant negative correlation was determined between Y-Balance posterolateral and speed ($r=-0.454$, $p<0.01$), and between Y-Balance posterolateral and deflection ($r=-0.403$, $p<0.01$).

A positive significant correlation was determined between Y-Balance posteromedial and speed ($r=-0.444$, $p<0.01$), and between Y-Balance posteromedial and deflection ($r=-0.440$, $p<0.01$).

There was a significant negative correlation between speed and change of direction ($r=0.708$, $p<0.01$). The data obtained are given in Table 4.

## DISCUSSION

It is aimed to examine the relationship between leg volume, dynamic balance scores, speed performance, and change of direction performance depending on the agility by measuring the dorsiflexion angles of the 14-15-year-old athletes who were raised in football schools or the infrastructure of various clubs and were exposed to various training loads during the basic training period.

When the literature is examined; It is possible to find many studies on the subject. People spend most of their daily lives actively standing, so balance is one of the most important points in our lives. While our body is moving, it should be able to make joint movements such as flexion-extension, and these joints should have certain angles. In a study, it is stated that the amount of ankle dorsiflexion required for normal foot function, standing up, and walking should be at least 10 degrees (Weir & Chockalingam, 2007).

In a study, it was determined that there was a positive significant relationship between the dorsiflexion range of motion and dynamic balance performance in the ankle, and it contributed especially in the anterior direction. It is also stated that individuals with chronic ankle instability who have impaired ankle dorsiflexion range of motion performance may experience difficulties in balance performance. In addition, it is stated that before participating in sports, a screening with balance tests can play a preventive role in order to identify individuals at high risk for lower extremity injuries. It is stated that scanning the ankle dorsiflexion range of motion can give an idea about balance performances, as well as provide us with information against the risk of individual injury. In the continuation of the study, it is stated that the musculature of the hip has a strong relationship with the reach distances of the hip and knee flexion, especially the posterolateral and posteromedial aspects in the balance test (Basnett et al., 2013). In another study, it is stated that ankle mobility contributes to the fulfillment of dynamic tasks and can be used to strengthen balance performance as well as help to improve balance performance (Guillen et al., 2021). In their study, Kim and Kim (2018) investigated the effects of ankle dorsiflexion range of motion and lower extremity muscle strength on balance control ability in young adults. As a result of the study, it was found that there was a relationship between balance control ability, ankle range of motion, and lower extremity muscle strength in young adults.

There are many studies that show parallelism with our study on the relationship between muscle volume and balance that athletes have. In a study, it was determined that the mass and volume of the lower extremities positively affected the balance performance of the athletes. In addition, they argued that the mass and volume of the lower extremity should be developed sufficiently in branches where balance performance is at the forefront (Akil et al., 2016). It has been determined that there is a significant relationship between the balance performances of young elite football players and their change of direction performance. In addition, it is stated that dynamic balance angle performance is important for its contribution to the change of direction performance and individualized special dynamic balance exercises should be performed to improve direction change performance (Rouissi et al., 2018). In another study, they found that balance training positively improved static and dynamic balance and agility performance. In addition, it has been stated that it has no effect on speed performance (Rüçhan et al., 2018). In another study, a statistically significant positive correlation was determined between agility performance and balance performance of male tennis players (Okudur & Sanioğlu, 2012).

Speed and change of direction are as important parameters for the performance of athletes as other motor features. In our study, a positive and significant relationship was determined between speed and direction change performances. When the literature is examined, different studies can be found. In a study, they found a significant difference between speed and change of direction performances. In the study, it is thought that speed and agility training may be effective in improving the performance of athletes in addition to the training specific to football players (Yaman & İpek, 2021). It has been determined that male elite rugby athletes perform lower than their maximum speed performance compared to female rugby athletes. In addition, it is stated that a more inclusive training plan that includes acceleration-deceleration exercises and direction-changing techniques for athletes will improve their ability to change direction and make their performance more efficient in changing direction (Freitas et al., 2021).

The relationship between the angles of dorsiflexion and injuries is mostly encountered. It is known that sports injuries adversely affect athletes financially and morally. For this reason, sports professionals need to minimize the risk of injury and prevent injury while creating training programs. In a previous study, it was reported that people with a greater dorsiflexion range of motion had more knee flexion. It was also found that athletes with low dorsiflexion joint range of motion may increase the risk of anterior cruciate ligament rupture, and also more knee Varus in single-leg squats (Dill et al., 2014).

In another study, they stated that army soldiers with limited ankle dorsiflexion angle increased the risk of lower extremity injuries and especially ankle sprains. In addition, it was stated in the study that the average ankle dorsiflexion angle taken from army soldiers was 45, and the lowest ankle dorsiflexion angle was 34 degrees. According to these values, it was stated that the risk of injury to soldiers below the average values is approximately 2.5 times higher. It has been stated that soldiers with low ankle dorsiflexion angle have a higher risk of suffering one of 5 lower extremity injuries, such as stress fracture, tibial periostitis, ankle sprains, Achilles tendinitis, and anterior tibial compartment syndrome, compared to soldiers with flexible ankle dorsiflexion angle. In a similar study, it was stated that decreased ankle dorsiflexion angle may increase the risk of patellar tendon injury. It has been stated that this type of injury, which is common among athletes, will negatively affect our competitive performance (Malliaras et al., 2006; Pope et al., 1998). In the study, it was determined that the muscle volume and dynamic balance performance of the athletes with good dorsiflexion angles were also good. In addition, it has been determined that the dynamic balance performance of the athletes with good calf volumes is also good, and the direction change performance of the athletes with good sprint performance is also good. The results obtained and the presence of biomotor features such as joint range of motion, strength, balance, change of direction, speed, quickness, and agility in football movement patterns reveal the necessity of increasing the basic movement patterns of football players to the highest level. Also, coaches who are sports professionals should include different types of stretching in their training. When the literature was reviewed, it was reported in a study that stretching movements were effective in increasing the ankle dorsiflexion range of motion. It was also stated in the study that the most commonly used stretching type is static stretching. Using PNF and similar stretching types during the workouts is important (Medeiros & Martini, 2018).

As a result, it is thought that there is a relationship between ankle dorsiflexion angle, balance performance, muscle volume, speed, and change of direction performances and that trainers or coaches include these combined exercises while designing football-specific training will bring the athletes to a high athletic performance level in terms of performance. In addition to these, it is thought that in addition to the training of the athletes, different stretching movements for the lower extremities and exercises that increase muscle flexibility will be effective in increasing the ankle dorsiflexion angle and improving biomotor characteristics.

## Recommendations

It is considered that the results of the study will contribute to the literature and can be applied in different branches and contribute to the diversity of studies. Also, studies to be conducted with female athletes and different age groups can contribute to the literature.

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