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The Relationship of Medial Arc Height with Speed Dynamic Balance and Jump Distance in Sports Training Individuals

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Abstract--- Objective:The study was carried out to determine whether the height of the medial longitudinal arch of the foot affects the level of sprint, dynamic balance, standing long jump and vertical jump.
Materials and Methods:Forty-five volunteer athletes with a mean age of 12.53±1.33 years who were trained in skiing, basketball and taekwondo were included in the study. Medial longitudinal arch heights of both feet, standing long jump, vertical jump distances and 20 m running times were measured. Again, the right and left foot Y balance test values of the participants were determined. Descriptives, anova and correlation tests were used in the analysis of the data.
Results:It was determined that there was no significant ($p<0.05$) difference between medial arch height and 20 m running time, standing long jump and vertical jump distances. On the other hand, there was a significant difference at $p<0.01$ level in the balance values of the right foot right cross, left foot right cross and left foot left cross balance. It was revealed that there was a $p<0.05$ difference in the right foot left cross balance value according to the foot arch depth. It was observed that there was no significant ($p<0.05$) difference in the fore balance of the right foot and the fore balance of the left foot. In addition, it was determined that there was a positive ($r=.405$; $p=.006$) correlation between medial arch height and age variable.
In conclusion, it can be said that medial arch height has an effect on dynamic balance. In 20 m running distance, although there is no statistical significance in the right foot fore and left foot fore balance values, it can be said that athletes with higher medial arch height have better averages.

Keywords--- Medial Arch Height, Running Time, Dynamic Balance.

I. Introduction

In general, it is known that in order to demonstrate a high level of performance in all sports branches, it is necessary to have the physical features that are one of the requirements of that branch. The physical and structural characteristics of the individual genetically, the level of participation in training or the high predisposition of the individual specific to the branch are the determining factors. However, it is known that as a result of regular exercise studies, branch-specific differences occur in the physical structure.[1]

One of these features is balance. Muratlı (2003) divided the balance into two as static and dynamic balance. He defined static balance as the state of keeping the physical balance of people in a certain position on a certain ground. Kuşakoğlu (2012), on the other hand, defined static balance with one foot as the ability to stay in balance by keeping the balance of the human body at a minimum level in a fixed position or shape.

In addition to the fact that balance ability in athletes is related to the inter-fibrillar internal coordination of the muscle, proprioceptive sense and total fitness level; It can be said that somatotype characters and physical characteristics have a high effect on the balance level. Equilibrium occurs as a result of the stimulation of the vestibular system, nerves and muscles with visual and sensory feedback, with the motoric ability to position and rebalance against the change of the center point (center of gravity) of the human body.[4]

When the literature is examined; In the context of anthropometric characteristics, balance level is generally considered within the scope of height, body weight, body diameter and circumference measurements.

Foot morphology; It is closely related to many functions such as balance, walking, standing on one or both feet, jumping, squatting.[5,6] The arch of the foot is the area on the bottom of the foot between the heel and heel. The arch consists of three separate arches forming a triangle. Two are longitudinal (medial and lateral) arches and one is transverse arch. These arches are formed by the tarsal and metatarsal bones and are supported by ligaments and tendons in the foot. The arch shape is designed to resemble a bow; It carries the weight of the body and absorbs the shock of movement. The flexibility of the foot provided by the arches is the feature that facilitates daily locomotor functions such as walking and sprinting.[7]

Each human foot consists of twenty-six bones, and they are specialized organs to carry body weight and maintain posture balance during daily tasks such as standing and walking. With the contact of the sole of the foot with the ground, a load of 2-3 times the body weight is accepted by the foot and transmitted upwards to the pelvis and spine through the lower extremities. The arch structure in the foot, especially the medial longitudinal arch, is very important in reducing the load and is considered indispensable for maintaining the strength of the musculoskeletal system even though we move frequently in our daily life. Changes in arch height not only interfere with the function of absorbing plantar impact force from the ground, but have also been reported to induce deflection center of pressure (COP) progression during straight walking and postural movements to maintain balance during standing and walking.[8]

The main arch affecting the foot structure is the medial longitudinal arch (MLA). This provides an elastic connection between the fore and hind legs. This ensures that most of the plantar forces that occur during load-bearing are dissipated before they reach the thigh and leg bones. Problems and malalignment that arise specifically from MLA, such as pes cavus and pes planus, ultimately affect the function of lower extremity muscles and joints.[9,10]

With this study; It was aimed to evaluate the speed and static balance level in terms of MLA depth, sports branch and sports writing.

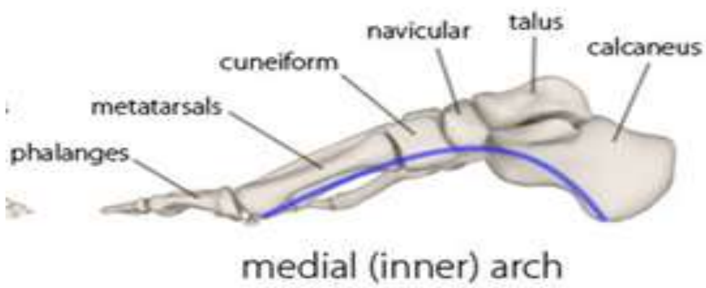

Figure 1: Medial (Inner) Arc[7]

II. Materials and Methods

After the planning phase of the study, the study was put into practice with the decision of Bayburt University Ethics Committee dated 22.02.2022 and numbered 58568.

2.1. Research Group

Forty-five volunteer athletes with a mean age of 12.53±1.33 years, a mean height of 159.20±12.59 cm, and an average body weight of 50.45 ± 15.89 kg, who were trained in skiing, basketball and taekwondo, were included in the study. The average age of the participants in sports is 3.02 ± 1.83 years.

2.2. Measurement Methods

Evaluation or measurement of the medial longitudinal arch has always been a controversial issue. There is not a single globally accepted and agreed method for the clinical or radiological measurement of medial arch height. The clinical examination is dependent on the examiner and is not objective. Numerous methods have been described in the literature for the objective measurement of MLA.[11,12] These can be roughly divided into direct and indirect methods. Direct methods include anthropometric measurements and radiologicalevaluations[11,13] Indirect measurements are footprints and photographic analyzes.[14,15]

2.3. Medial Arch Height Measurement

Participants were seated on a bench with their feet bare. An inflexible plate was extended between the origin of the metatersal of the thumb and the lowest part of the calcaneus bone, with the legs straight and the extended foot in its natural position, so as not to place any pressure on the feet. It was then determined by measuring between the navicula bone and the plate (the highest region).

Y balance Test

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"Y Balance Test" platform was used to measure dynamic postural control. Measurements were tested as the distance between barefoot, 3 directions, ANT reach as farthest from the participant's central toe as PL and PM from the heel. During the experiment, the participants were asked to keep their hands on the iliac and their heels on the floor and to make a light touch with the fingertip of the reaching foot on the farthest point. Before the measurement, a short demonstration was made by the researcher about how to apply the test, and the participants were allowed to experiment at least 6 times in all directions.[16] Between trials, each participant was given a 2-minute rest period and then 3 stretches in each direction.

20m Run

After the track was prepared on a volleyball court, the start and finish lines of which were determined by cones, enough time was given for warm-up and the participants were asked to run the 20 m distance at the highest possible speed. They were then asked to stand one meter behind the photocell at the starting line, wait in the exit position, and start the test when they felt ready. The test was carried out with a Microgate Witty photocell capable of measuring with an accuracy of 0.01 seconds. Participants were only allowed to try twice with a rest period of 5 min. The best performance between two repeated sprint tests was recorded for data analysis.[17]

Standing Long Jump

From the subjects; From a starting point we determined, they were asked to jump forward as far as they could, with their legs shoulder-width apart and parallel to each other. The distance the subjects left behind after their jumps was measured and recorded. Each subject was given three jumps and the best jump grades were taken into account.

Vertical Jump

Athletes made a strong jump upwards with the help of their hands by quickly bending their knees in an upright position on the jump mat with their feet shoulder-width apart. Athletes' jumps from the ground up were recorded in cm. The test was carried out with the Microgate Witty vertical jump device, which can measure with an accuracy of 0.01 cm. Vertical jump tests were performed first as 1 practice and then 2 tests. The test result with a better score than the 2 correct measurements was used in the statistical analysis.

2.4. Analysısof Data

The analyzes of the data obtained with the measurements were made using the SPSS 23 package program. In this package program, descriptives, anova and correlation tests were used.The medial longitudinal arch (MLA) forms the calcaneus, talus, os naviculare, three os cuneiforme, and the first three metatarsal bones. While the muscles actively protect the foot dome, the ligaments protect it passively.[18]The MLA, the main arch that contributes to the foot structure, provides an elastic connection between the forefoot and hindfoot. This ensures that most of the plantar forces that occur during load-bearing are dissipated before they reach the thigh and leg bones. Problems and malalignments that arise specifically from MLA, such as pes cavus and pes planus, ultimately affect the function of lower extremity muscles and joints.[9] These problems can be acquired or structural reasons.[19]

III. Results

Table 1: AnovaResults of Partıcıpants' Short Dıstance Long Jump and Vertıcal Jump Performances Accordıngto Medıal Arc Heıght

Variable	Medial arch height group(mm)	N	Average	S. Deviation	F	p
20 m running time (sec)	<15	3	5,31	,57	,715	,495
	15-18	12	4,93	,62		
	18>	30	4,85	,67		
	Total	45	4,90	,65		
Standing long jump (cm)	<15	3	120,00	63,66	,091	,913
	15-18	12	130,92	39,56		
	18>	30	130,03	39,13		
	Total	45	129,60	39,89		
Vertical jump (cm)	<15	3	31,43	11,99	,036	,965
	15-18	12	32,05	10,98		
	18>	30	31,28	6,86		
	Total	45	31,50	8,23		

When Table 1 was analyzed, it was seen that the medial arch height had no effect on the 20 m running time of the participants (p=.495). It was also found that the medial arch height did not affect the standing long jump distances (p=.913). Another feature that was not affected by the medial arch height was vertical jump (p=.965).

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Table 2: AnovaResults of the Partıcıpants' Balance Levels Accordıngto Medıal Arc Heıght

Variable	Medial arch height group(mm)	N	Average	S. Deviation	F	p
Right Foot Front (cm)	<15	3	56,33	13,65	3,014	,060
	15-18	12	66,17	9,57		
	18>	30	69,73	9,04		
	Total	45	67,89	9,87		
Right Foot Right Cross (cm)	<15	3	54,67	12,66	7,094	,002
	15-18	12	67,50	8,04		
	18>	30	75,17	10,57		
	Total	45	71,76	11,39		
Right Foot Left Cross (cm)	<15	3	58,33	11,93	4,311	,020
	15-18	12	70,58	14,24		
	18>	30	78,63	12,61		
	Total	45	75,13	13,97		
Left Foot Front (cm)	<15	3	57,33	11,24	2,400	,103
	15-18	12	64,50	10,79		
	18>	30	67,93	7,47		
	Total	45	66,31	8,93		
Left Foot Right Cross (cm)	<15	3	58,33	11,15	5,354	,008
	15-18	12	69,75	9,29		
	18>	30	77,13	11,29		
	Total	45	73,91	11,81		
Left Foot Left Cross (cm)	<15	3	56,33	16,01	5,098	,010
	15-18	12	68,42	11,52		
	18>	30	75,63	10,66		
	Total	45	72,42	12,20		

When the balance values in Table 2 were considered according to the medial arch height, a significant difference was found at $p<0.01$ in the balance values of the right foot right cross, left foot right cross and left foot left cross. It was observed that there was a $p<0.05$ difference in the right foot left cross balance value according to the foot arch depth, and there was no significant ($p<0.05$) difference in the right foot fore and left foot fore balance values.

IV. Discussion

When the 20m best running times of the participants included in the study were examined according to the depth of the foot arch, it was observed that the average running time of the participants with a medial arch height of less than 15 mm was 5.31±.57 seconds, and those with a medial arch height of 15-18 mm. It was observed that the mean running time was 4.93±.62 seconds, and the mean running time of those with a medial arch height greater than 18 mm was 4.85 ±.67 seconds. Considering these mean values, it was determined that there was a decrease in running times parallel to the increase in arch height, but this decrease was not statistically significant (p=,495). For an effective run, the foot should be placed as close to the gravity line as possible. If it is placed beyond the gravity line, a reaction force will occur against this forward and downward thrust. Again, there will be a backward and upward force acting to delay the forward motion. [20]Sprint consists of a cycle of ballistic steps in which the body is thrown over and over like a projectile. These forces are largely absorbed by the arches of the foot.[21] The arches of the foot are protected by a combination of bone structure, aponeuroses, ligaments, and tendons. [22]The foot is divided into three categories according to the height of the arch. These are classified as pes planus (PP), normal and pes cavus (PC). Of these, pes planus (PP), normal and pes cavus (PC) foot types. Also known as flatfoot, PP cannot stabilize the body due to excessive pronation at the ankle, which reduces its ability to absorb shock properly, but running speed is not affected. In PC, the arch is higher than normal, causing the toes to claw. There is hypertrophy of the medial portion of the metatarsal head and lateral variation and rotation of the thumb with an overlying bursa that together forms a prominent bunion on the medial side. Lateral variation of the big toe can cause overcrowding, and sometimes overloading of the lateral toes causes an uneven distribution of force, causing shock motion in the legs.[9] Based on the data of their study, Sudhakar et al., (2018) reported that having a high curved foot type is an advantage in sports that require speed performance such as sprinting. Although the findings of the study are not statistically significant, it can be said that the medial arch height provides an advantage in terms of running time in the participants.

When the standing long jump values of the participants are evaluated according to the medial arch height, the average standing long jump distance of the participants with an arch height of less than 15 mm is 120.00± 63.66 cm. The average standing long jump distance of the participants with an arc height between 15-18 mm is 130.92 ± 39.56 cm. For those with an arc height of more than 18 mm, the average of standing long jump distances is 130.03 ± 39.13 cm. As a result of statistical comparison of these mean values, it was revealed that the differences between them were not significant (p=.913).

When the vertical jump values of the subjects were considered according to the medial arch height, it was determined that the average of the vertical jump values of the individuals with an arch height of less than 15 mm was 31.43 ± 11.99 cm. The average of the vertical jump values of individuals with an arc height between 15-18 mm is 32.05±10.98 cm. It was determined that individuals with an arch height of more than 18 mm had a jump mean of 31.28±6.86 cm. It was determined that the differences between these mean values were not statistically significant. In their study, Sudhakar et al., (2018) found that those with high arch legs had a jump distance of 49 ± 4.4 cm, those with normal arc heights were 45.9 ± 2.5 cm, and those with low arch heights had a jump of 41.9 ± 3.8 cm. reported their height.

In addition, when the dynamic balance values of the participants were evaluated according to the medial arch height, it was revealed that the average of the right foot anterior balance values of those with a medial arch height less than 15 mm was 56.33±13.65 cm. It was revealed that the mean right forefoot balance values of those with a medial arch height between 15-18 mm, 66.17±9.57 cm, and those with a medial arch height greater than 18 mm, were 69.73±9.04 cm. It would not be wrong to say that these values increase in parallel with the arc height, but this increase is not statistically significant (p=.060). When the mean values of the right foot right diagonal balance values of the groups are considered, those with a medial arch height less than 15 mm have an average of 54.67±12.66 cm, and those with an arch height between 15-18 mm have an average of 67.50 ± 8.04 cm. appeared to be. It was observed that those with a medial arch height of more than 18 mm had a balance mean value of 75.17±10.57 cm. It can be said that there is a significant difference at the p=.002 level between these mean values. In addition, considering the right foot and left diagonal balance values of the participants according to the medial arch height, it was seen that the participants with an arch height of less than 15 mm had an average of 58.33±11.93 cm. It was determined that the mean of those with arch height between 15-18 mm was 70.58±14.24 cm. It was revealed that those with an arc height of more than 18 mm had an average of 78.63±12.61cm. It was determined that the difference between the mean values increasing in parallel with this arc height was significant (p=.020). In the left foot anterior balance values, subjects with a medial arch height of 15 mm had a mean of 57.33±11.24 cm. Those with arch height of 15-18 mm have an average of 64.50±10.79 cm. Those with a medial arch height greater than 18 mm have a mean of 67.93 ± 7.47 cm. Although these mean values increased in parallel with the increase in arch height, it can be said that they were not statistically significant (p=.103). Finally, when the left foot left diagonal balance values of the participants were evaluated according to the medial arch height, it was revealed that the average left foot left diagonal balance values of the participants with an arch height of 15 mm was 56.33±16.01 cm. It was determined that those with a medial arch height of 15-18 mm had an average value of 68.42 ± 11.52 cm. Those with an arc height greater than 18 mm have a balance average of 75.63±10.66 cm. These mean values were found to differ statistically significantly (p=.010). Sudhakar et al., (2018) reported in their study that foot arch types are important for dynamic balance.

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