



The Relationship of 2D:4D Finger Length Ratio with Biomotoric Characteristics and Sports Performance in Adolescent Basketball Players

Erkan Çetinkaya^{1ABDE}, Halil Tanır^{1ABC} and Furkan Çelik^{3BE}

¹Aydın Adnan Menderes University

²Usak University

³Uludağ University

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Corresponding Author: Halil Tanır, E-mail: tanir.halil@usak.edu.tr

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Abstract

Background. The aim of this study is to determine the relationship of 2D:4D finger length ratio (also known as digit ratio) with biomotoric features and sports performance in adolescent basketball players. 24 male basketball players with a mean age of 14.83 ± 0.71 years and a training age 7.08 ± 1.92 years participated in the study.

Materials and methods. The participants' 2D and 4D finger lengths of both hands, height (cm), body weight (kg), some biomotoric characteristics and sports performances were determined by measurements. The German Heidelberg Basketball Test was conducted to evaluate the basketball-based sports performances of the participants. The SPSS 25.0 package program was performed in the statistical analysis of the obtained data. The Shapiro-Wilk test was used to determine whether or not the data showed a normal distribution. Parametric tests were preferred for statistical analysis as the data were found to have a normal distribution.

Results. It was found that there was no statistically significant relationship between the 2D:4D finger length ratio, some motoric features and basketball-based sports performances of the participants ($p > 0.05$). It was concluded that the ratio of 2D:4D finger lengths in adolescent basketball players did not have an effect on biomotoric features and basketball-based sports performance. When the correlation between 2D:4D finger length ratio and sports performance parameters was examined, no statistically significant relationship was observed ($p > 0.05$).

Conclusions. Although some studies show a significant negative correlation between performance tests and the 2D:4D ratio, it should be noted that the 2D:4D finger ratio is not the only determinant for sports performance.

Keywords: basketball, 2D:4D finger lengths, biomotoric features, sports performance.

Introduction

Tests conducted to identify individuals with a predisposition for sports or a sports-oriented mindset include both physical and psychological assessments, starting from the early years of life. Among these tests, anthropometric measurements play a significant role in determining individuals' physical capacities. The ratio of the length of the index finger (2D) to the length of the ring finger (4D), known as the 2D:4D ratio, is a measurement

frequently used in recent academic studies. The 2D:4D finger length ratio, indicative of the amount of testosterone exposure in the womb, does not change during pregnancy and adulthood (Richards et al., 2022).

The 2D:4D finger length ratio has been used as an indicator of prenatal exposure to testosterone in the fields of health, behavior, and sports science. It has been proposed that prenatal androgens influence the developing brain in later stages of life by increasing sensitivity to testosterone, regulating the structure and function of the brain. It has also been suggested that the 2D:4D finger length ratio could contribute as a reliable indicator of athletic potential (Reed & Meggs, 2017; Alonso et al., 2018). However, this

situation should not be perceived as the sole indicator of performance. When used in conjunction with other analyses, it can be considered as a measure of success or motivation. Additionally, elevated fetal androgen levels have been associated with the development of cardiovascular systems, good visual-spatial abilities, physical endurance, speed, and an inclination towards agile behaviors that may be helpful in sports (Manning & Fink, 2018).

Prenatal testosterone levels can be a fundamental precursor to success in certain sports activities. This is because structural and functional characteristics altered by testosterone activity, such as muscle fiber hypertrophy, increased strength, decreased fat mass, and elevated hematocrit, can contribute to an athlete's success (Moffit & Swanik, 2011). The 2D:4D finger length ratio has been found to impact performance in various individual and team sports, including basketball (Frick et al., 2017), volleyball (Panda et al., 2014), and soccer (Nobari et al., 2021). In a group consisting of judo athletes, Olympic wrestlers, and kickboxers, the 2D:4D finger length ratio was significantly lower compared to a control group that did not engage in sports (Adamczyk et al., 2021).

Basketball, by its characteristic nature, encompasses both aerobic and anaerobic activities, including walking, standing, and moderate to low-intensity runs. In basketball, fundamental skills such as rebounding, blocking, and shooting often involve elements like jumping, quick turns, and dribbling (Pliauga et al., 2015). Due to its complex nature, basketball performance can be influenced by numerous factors such as age, gender, genetics, kinanthropometric characteristics, endocrine system, autonomic nervous system, biological rhythms, psychological state, climate-environmental conditions, injuries, and illnesses. It is believed that one of these factors is the 2D:4D finger length ratio. Therefore, it is considered that this research aims to determine the relationship between the 2D:4D finger length ratio and athletic performance in adolescent basketball players. It is thought that such studies are important for predicting the level of physical development in adolescents based on prenatal sex hormones and can contribute to the selection of qualified athletes.

Materials and methods

Study participants

The sample of this study consisted of 24 male basketball players with an average age of 14.83 ± 0.71 years and a training age of 7.08 ± 1.92 in Incirliova district of Aydın province.

Study organization

Height and body weight measurements

The height of the participants was determined by measuring the distance between the heel tip and the top of the head vertically on a flat surface with bare feet with a stadiometer. The body weights of the participants, who were barefoot, were measured with a scale (Lopez-Peralta et al., 2022).

Body mass index

Body Mass Index (BMI) ratios of the participants were calculated using the formula below (Pantanowitz, 2021).

$$\text{Body Mass Index (BMI)} = \text{Weight (kg)} / \text{Height (cm)}^2$$

Determination of age and training age

Personal statements were taken as the basis to determine the age and training age of the participants.

Flexibility

The flexibility of the participants was determined by the sit-and-reach test. Participants were asked to recline the soles of their feet against the sit-down table and keep their legs stretched. While the participants kept their desired positions, they stretched out as far as they could by extending both hands towards the sit-down table. The distance that the participants, who waited for 2 seconds at the last point they could reach, was recorded in cm. After two measurements were performed, the best grades of the participants were recorded in cm (Nokariya et al., 2023).

Static force

The handgrip strength test was conducted to determine the static strength of the participants. A dynamometer was utilised in the application of the test. In the anthropometric stance, the participants positioned the dynamometer appropriately on the thumb palm, and then grasped it to cover the other four fingers. When the participants were ready, they squeezed the dynamometer for 5 seconds with maximum effort. After three trials for each hand were performed, the best result was recorded in kilograms (Kociuba et al., 2019).

Anaerobic power

The standing long jump test was performed to determine the anaerobic power of the participants. In this test, the participants got position on a flat and smooth surface with the feet together behind the marked line and the toes behind the jump line. When the participants felt ready, they tried to jump to the furthest point by throwing their arms forward and pulling their knees towards them. The distance between the starting line and the participant's closest standing to the line after jumping was measured. The test was performed twice for each participant. The best grade of the participants was recorded in centimetres (Laurson et al., 2022).

Abdominal muscle endurance

The participants' abdominal muscle endurance was determined by 30-second push-ups. The test was performed on a flat surface. They positioned their hands and toes on the floor. During the test, they paid attention to keep the feet open, arms shoulder-width apart, and the trunk to be upright. After they kept their back and knees straight, they decreased their chest towards the ground, then they pushed the floor with their hands and lifted the chest up again. The test continued for 30 seconds. They were asked to reach the maximum number of push-ups they could achieve in 30 seconds. The number of completed push-ups in accordance with the test protocol was recorded after the test (Hashim et al., 2018).

Agility

The t-test was utilised to determine the agility of the participants. The test area consisted of four contact areas in the shape of the letter T which was 10 meters long and 10 meters wide. The participants were asked to complete the track, which required movements in different directions, as soon as possible. After the test was performed twice, the best time was recorded in seconds (Raya et al., 2013).

2D and 4D finger length measurement and ratio

The area between the basal line on the proximal part of the finger and the pulp on the palmar surface of the hand

was measured in centimetres with a Vernier caliper that can measure up to 0.05 millimetres. Measurements were performed twice by the same person for reliability. The 2D:4D finger length ratio was determined by dividing the second finger length by the fourth finger length (Wu, 2013).

German Heidelberger Basketball Test

The Heidelberger Basketball Test was developed in 1987 by the collaboration of the scientists of the Sports Institute in Heidelberg and basketball coaches. This test has the capability of evaluating basic basketball-specific skills. The rest periods between measurements to evaluate different technical skills vary between 2 and 3 minutes (Alpullu & Bozkurt, 2018).

Lay up shot

The participants were asked to perform the right layup first, then the left layup for 1 minute, starting from the free throw line, and to bounce the ball to the free throw line after each layup. The participants were given two chances. The score obtained from the attempt in which the most successful shot was performed was recorded (Özçelik & Alpullu, 2019).

Shooting from the Paint

The areas from which shots were performed were divided into 4 equal parts with funnels. The participants started shooting for 1 minute with the command. They were asked to follow their balls for the missed shots, to rebound the ball and to shoot again. The shots that passed through the circle were considered as scores. The participants were given two chances. The best score obtained from the trials was recorded (Özçelik & Alpullu, 2019).

Slalom dribbling

Ten slalom sticks were arranged in intervals of 2m-1m-1m-2m-1m-1m-4m-1m-1m from the starting. The participants were asked to dribble back and forth between slalom bars. They were given three chances. The best score obtained from the trials was recorded (Özçelik & Alpullu, 2019).

Passing test

Two squares with 30 centimetres side length were designed on the wall with tapes. The distance between the two squares was 1.80 cm and the height from the ground was 1.50 cm. The tape, which was 2 meters away from the wall, was set up on the floor of the hall. Two funnels were placed at 1-meter intervals on the tape. The participants were asked to throw the ball to the target with the command and to dribble to the other funnel with the outer hand by taking the ball back. They were asked to carry out as many tasks as possible for 30 seconds. The accurate shots within 30 seconds were considered acceptable. They were given two chances. The best score obtained from the trials was recorded (Özçelik & Alpullu, 2019).

Statistical analysis

The data obtained from the measurements and the personal statements of the participants were evaluated at the 0.05 significance level in the SPSS 25.0 package program. The Shapiro-Wilk test was performed to determine whether the data indicated normal distribution or not. Since it was perceived that the data showed a normal distribution, Pearson correlation analysis was conducted to examine the relationship of the 2D:4D finger length ratios of the participants with their biomotoric characteristics and basketball-specific performance values.

Results

Table 1 showed the descriptive statistics of the adolescent basketball players who generated the sample of the research.

Table 1. Descriptive statistics on participants

Variables	n	Mean	SD	Min	Max
Height (cm)	24	1.81	0.06	1.74	1.90
Body weight (kg)	24	76.85	13.71	60	100
Body mass index (kg/cm ²)	24	23.42	4.33	16.74	31.61
Age (years)	24	14.83	0.71	14	16
Training age (years)	24	7.08	1.92	3	9

When Table 2 was examined, it was observed that there was no statistically significant relationship between the right and left hand 2D:4D finger length ratios and biomotoric characteristics of the participants ($p>0.05$).

Table 2. The relationship between 2D:4D finger length ratio and biomotoric features

Variables	Right hand 2D:4D ratio		Left hand 2D:4D ratio	
	r	p	r	p
Flexibility	-0.443	0.149	0.168	0.602
Right static force	-0.334	0.289	0.161	0.617
Left static force	-0.410	0.185	0.016	0.961
Anaerobic power	-0.199	0.536	0.158	0.625
Abdominal muscle endurance	-0.215	0.501	-0.025	0.938
Agility	0.003	0.994	0.112	0.728

Table 3. showed that there was no statistically significant relationship between the right and left hand 2D:4D finger length ratios and basketball-based sportive performances of the participants ($p>0.05$).

Table 3. The relationship between 2D:4D finger length ratio and sportive performance

Variables	Right hand 2D:4D ratio		Left hand 2D:4D ratio	
	r	p	r	p
Lay up shot	-0.499	0.099	-0.258	0.417
Shot	-0.016	0.962	-0.182	0.571
Dribbling	0.123	0.704	0.174	0.588
Pass	-0.453	0.139	-0.233	0.466

Discussion

The study, which was conducted to examine the relationship of 2D:4D finger length ratio with biomotoric characteristics and sportive performance in adolescent basketball players, indicated that there was no significant relationship between 2D:4D finger length ratio and

sportive performance. That condition can be explained by the fact that the participants generating the sample of the study were in the adolescence period and their bone development processes were continuing, as they had not yet completed their adulthood. Because the physical growth and development, which slows down partially in advanced childhood, accelerates again in adolescence and reaches its adult structure at the end of this period. In a similar study, Acar & Eler (2018) suggested that finger length ratio was determined in the mother's womb, and did not have an effect on sportive performance since it did not change during adolescence and adulthood.

This study showed that there was no relationship between the 2D:4D finger length ratio and the static strength of the right and left hands. In the other study supporting this study, Eghbali (2016) suggested that there was no significant relationship between 2D:4D finger length ratio and handgrip strength among master athletes.

In this study, when the relationship between 2D:4D finger length ratio and biomotoric features was examined, no correlation was observed among flexibility, right static strength, left static strength, anaerobic power, abdominal muscle endurance and agility. In another study that has similar characteristics to the findings obtained in this study, Peeters et al. (2013) observed that there was no significant relationship between the left hand 2D:4D finger length ratio and any physical fitness components (balance, limb movement speed, flexibility, explosive strength, static strength, trunk strength, functional strength, running speed / agility and endurance). In his study on basketball players, Güler (2018) indicated that there was no significant relationship between 2D:4D finger length ratio and abdominal muscle endurance (push-ups), vertical jump (cm), anaerobic power (kg/min/sec) and aerobic capacity (ml/kg/min). In their study, in which Mehdizadeh et al. (2013) suggested that there was no significant correlation between 2D:4D finger length ratio and dynamic muscular endurance (pull-ups and chinning bars), they concluded that muscular endurance cannot be predicted by anthropometric dimensions.

Contrary to all these studies, some studies reported that there was a negative relationship between sportive performance and 2D:4D finger length ratio among male and female athletes. The ratio of the index finger to the ring finger was negatively related to the amount of testosterone in the blood (Acar & Eler, 2018; Eklund, 2020).

In their study, in which Bilgiç et al. (2016) examined the relationship between 2D:4D finger length ratios and sportive performance among 11-13 year old children from different sports branches, they determined that there was a positive correlation between right and left hand 2D and 4D finger length ratios and anaerobic capacity. In a similar study, Koroğlu et al. (2016) stated that there is a positive correlation between finger length and the dominance of testosterone hormones. They mentioned that athletes with longer 4D finger length exhibit higher anaerobic power performance.

Conclusion

Within the light of these findings, this study concluded that the ratio of 2D:4D finger lengths in adolescent basketball players did not have an effect on biomotoric characteristics and basketball-based sportive performance. However, when

the results obtained in scientific studies that were conducted with the participation of athletes from different age and branch groups were considered, the study predicted that the 2D:4D finger length ratio of adults might affect biomotoric characteristics and sportive performance. Furthermore, the study remarks that the ratio of 2D:4D finger lengths will be insufficient to correlate with sportive performance.

Conflict of interest

The authors state that no commercial or financial ties that might be considered a possible conflict of interest existed during the conduct of the study.

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Взаємозв'язок пальцевого індексу 2D:4D з біомоторними характеристиками та спортивними показниками у баскетболістів підліткового віку

Еркан Четінкая^{1ABDE}, Халіл Танір^{1ABC}, Фуркан Челик^{3BE}

¹Айдинський університет імені Аднана Мендереса

²Ушакський університет

³Улудагський університет в Бурсі

Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 3 табл., 28 джерела.

Вступ. Мета цього дослідження полягає у визначенні зв'язку співвідношення довжини вказівного і безіменного пальців (пальцевого індексу) 2D:4D з біомоторними особливостями та спортивними показниками у баскетболістів підліткового віку. У дослідженні взяли участь 24 баскетболісти чоловічої статі, середній вік яких становив $14,83 \pm 0,71$ років, а вік тренувань — $7,08 \pm 1,92$ років.

Матеріали та методи. За допомогою вимірювань визначали довжину 2-го і 4-го пальців обох рук, зріст (см), масу тіла (кг), деякі біомоторні характеристики та показники спортивної результативності учасників дослідження. Для оцінки спортивної результативності учасників був проведений німецький баскетбольний тест Гайдельберга (Heidelberger Basketball Test). Статистичний аналіз отриманих даних проводився за допомогою програми SPSS 25.0. Для визначення відповідності даних до нормального розподілу використовувався критерій Шапіро-Уїлка. Для статистичного аналізу перевага надавалася параметричним тестам, оскільки було встановлено, що дані мають нормальний розподіл.

Результати. Встановлено, що не було статистично значущого зв'язку між пальцевим індексом 2D:4D, деякими характеристиками рухових якостей та спортивними показниками з баскетболу серед учасників дослідження ($p > 0,05$). Було зроблено висновок, що пальцевий індекс 2D:4D у баскетболістів підліткового віку не впливає на біомоторні особливості та спортивну результативність у баскетболі. При дослідженні кореляції між пальцевим індексом 2D:4D та параметрами спортивної результативності не спостерігалось статистично значущого зв'язку ($p > 0,05$).

Висновки. Незважаючи на те, що деякі дослідження показують значну негативну кореляцію між тестами на продуктивність і співвідношенням 2D:4D, слід зазначити, що пальцевий індекс 2D:4D не є єдиним визначальним фактором для визначення спортивної результативності.

Ключові слова: баскетбол, довжина пальців 2D:4D, біомоторні особливості, спортивна результативність.

Information about the authors:

Çetinkaya, Erkan: erkcetinkaya09@gmail.com; <https://orcid.org/0000-0001-8441-6510>; Faculty of Sport Sciences, Aydın Adnan Menderes University, Zafer, 09010 Efeler/Aydın, Turkey.

Tanır, Halil: halil.tanir@usak.edu.tr; <https://orcid.org/0000-0001-5626-8362>; Faculty of Sport Sciences, Usak University, Ankara İzmir Yolu 8.Km Bir Eylül Kampüsü, Merkez/Uşak, Turkey.

Çelik, Furkan: frkncl9@gmail.com; <https://orcid.org/0000-0001-8881-9843>; Institute of Education Sciences, Bursa Uludağ University, Özlüce Görükle Kampüsü, 16059 Nilüfer/Bursa, Turkey.

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