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The 2nd:4th Digit Ratio and Shooting Skill Performance in Basketball Players

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Abstract

The aim of this study was to investigate the effect of 2d:4d digit ratio on shooting performance in basketball players. 30 male and 30 female basketball players who have been actively playing basketball for 3 years at the age of 15±04.1.69 participated in the study. Participants were asked to score 5 shots from the free throw line by scoring between 0 and 5 to determine their basketball shooting skill performance. To determine finger length, the second finger (2D) and fourth finger (4D) (Figure 3) were measured using a 0-150 mm (USA, Cocraft) Vernier digital caliper with an accuracy of 0.01 mm in millimeters (mm). In addition, the 20 Meter Shuttle Running Test was applied to measure the endurance of the participants. Independent sample T-Test and Pearson correlation test were used for statistical analysis. There was no significant difference in the participants' shot parameters, Shuttle Run Test and other 2D and 4D parameters ($p>0.05$). There was a negative correlation between the 20 Meter Shuttle Running Test and the left hand 2d:4d variables of the participants ($p<0.05$). There was no significant relationship between the total shot performance of the participants and the parameters of the 20 Meter Shuttle Running Test and 2d:4d digit ratio ($p>0.05$). It was found that there was no effect between 2D: 4D and aerobic performance and shooting in adolescent male and female basketball players. This result may be due to the age, training level and heterogeneity of the sample group.

Keywords: 2nd:4th Digit Ratio, Shooting Skill, Basketball Players

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Basketbolcularda 2D:4D Parmak Oranı ve Şut Beceri Performansı

Öz

Bu çalışmanın amacı basketbolcularda 2d:4d parmak oranının atış performansına etkisini incelemektir. Çalışmaya 15,04±1,69 yaşında 3 yıldır aktif olarak basketbol oynayan 30 erkek ve 30 kadın basketbolcu katılmıştır. Katılımcıların basketbol şut beceri performansını belirlemek için 0 ile 5 arası puanlayarak serbest atış çizgisinden 5 kez atış yapılması istenmiştir. Parmak uzunluğunu belirlemek için Milimetre (mm) cinsinden 0.01 mm hassasiyetle 0-150 mm (USA, Cocraft) Vernier marka dijital kumpas kullanılarak ikinci parmak (2D) ve dördüncü parmak (4D) katılımcıların her iki elinden ölçüm yapılmıştır. Ayrıca katılımcıların dayanıklılığını ölçmek için 20 Metre Mekik Koşu Testi uygulanmıştır. İstatistiki analiz için Bağımsız örneklem T-Testi ve Pearson korelasyon testi kullanılmıştır. Katılımcıların atış parametrelerinde, Shuttle Run Testte ve diğer 2D ve 4D parametrelerinde anlamlı fark bulunmamıştır ($p>0,05$). Katılımcıların 20 Metre Mekik Koşu Testi ile sol el 2d:4d değişkenleri arasında ters ilişki vardır ($p<0,05$). Katılımcıların toplam şut performansı ile 20 Metre Mekik Koşu Testi ve 2d:4d parmak oranı parametrelerinde anlamlı ilişki yoktur ($p>0,05$). Sonuç olarak adölesan erkek ve kız basketbolcularda 2D: 4D ile aerobik performans ve şut arasında bir etkinin olmadığı bulunmuştur. Bu sonuç örneklem grubunun yaşından, antrenman seviyesinden ve heterojenliğinden kaynaklanabilir.

Anahtar kelimeler: 2d:4d, Şut, Beceri, Dayanıklılık

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Introduction

Basketball is a sport that determines the results of the scores and the shooting skill point percentage, so the shooting skill to some extent determines the outcome of a basketball game. Basketball is one of the most popular activities in the world and the main goal is to get a good shot to score a basket. Therefore, shooting is probably the most well-known basic skill in this game, and good shooting requires mainly correct movement of the upper extremity on the dominant side and also balance and jumping strength of the lower extremities (Krause et al., 1999).

Basketball players need to put a lot of effort into improving their shooting skills and do their best to prevent their opponents from scoring a basket in a match. Therefore, the basketball players use more various techniques and tactics to shoot, score and create space. Although there are many factors such as mental state, shot selection and physical level that affect the score percentage, the main factor that determines the score percentage is the shooting technique. Specifically, it is hand movements, basket aiming points, whole body coordination, and index finger that determine whether the shooting technique is reasonable and the percentage of points. But regardless of changes in shooting techniques, the basis of any good shooting action and accuracy is correct and reasonable basic shooting technique (Perperkos et al., 2002; Button et al., 2003; Dougherty et al., 2006; Zhen et al., 2015).

The different concentrations of testosterone and estrogen hormones in the uterus determine the proportion of finger lengths of the child to be born (Manning et al., 1998). 2D:4D finger length ratios have been accepted as an indicator of how much testosterone humans are exposed to in the womb. It was stated that the average 2D:4D ratio did not change during pregnancy or even in adulthood (Çelik et al., 2010; Galis et al., 2010). Men have a lower 2D:4D mean than women (ie, the fourth finger is relatively longer than the second finger on both the right and left hands) (Manning et al., 1998; Coates et al., 2009; Van Honka et al., 2011; Frick et al., 2017). Significant differences in 2D:4D have also been observed between different ethnic groups, for example people of African descent typically have lower 2D:4D compared to Caucasians (Manning et al., 2007a). According to many studies, there is a relationship between finger ratio and physiological and psychological characteristics such as fertility, health and sporting ability, aggression (Manning et al., 2002a; Coates et al., 2009).

It has been suggested that finger ratio is related to physical performance (Tester and Campbell, 2007; Hönekopp and Schuster, 2010). Studies have shown that male athletes have a lower 2D:4D ratio than non-athletes (Manning et al., 2001; Manning et al., 2002b; Bennett et al., 2010; Giffin et al., 2012; Baker et al., 2013). However, several studies have investigated finger ratio in female athletes compared to the control group (Pokrywka et al., 2005; Giffin et al., 2012; Baker et al., 2013; Hsu et al., 2015). 2D:4D ratio in female athletes in alpine skiing (Manning et al., 2002b), endurance

running (Manning et al., 2007b), fencing (Voracek et al., 2010) and rowing (Hull et al., 2015). With finger ratio between physical performance was found a relationship in many studies. Similarly, positive correlations were found between 2D:4D ratio and physical fitness (Hönekopp and Muller, 2006) and sportive ability (Paul et al., 2006) among women participating in leisure sports. In the meta-analysis study by Hönekopp and Schuster, contrary to the studies in which right 2D:4D was a stronger predictor than left 2D:4D in sportive ability; they determined that neither the right nor the left 2D:4D is determinative, and the determination of the right and left 2D:4D can vary in different branches (eg, right hand 2D:4D in fencing ability). It is known that there is a relationship between sportive performance and right-left 2D:4D, only right 2D:4D, neither right nor left 2D:4D, or there are many studies examining the relationship only between right 2D:4D and left 2D:4D (Peeters et al., 2013; Acar and Eler, 2018).

Current research has considered relationships between 2D:4D and both closed skill and open skill sports performance. (Wang et al., 2013). Tester and Campbell (2007) reported a moderately negative relationship between 2D:4D and the highest standard of competitiveness achieved in 155 college students playing the outdoor skill sports basketball, football and rugby. Frick et al. (2017) reported differences in average 2D:4D among male basketball players competing in four different competitive standards (club, state, national, and international), with players reaching a higher standard of play tended to have lower 2D:4Ds. They also reported that 2D:4D was not significantly associated with game-related statistics in professional gamers. Dyer et al. (2018) observed that semi-pro female players with low 2D:4D have better game-related stats (especially better defensive stats, for example, higher rebounds and block counts) and are more likely to start as a first team players. Therefore, the aim of this study is to expand the missing literature that Frick et al. (2017), Dyer et al. (2018), and Klapprodt et al. (2018) refer to as suggestions in their studies. The aim of this study is to measure the differences and relationship in 2D:4D in shooting skills on basketball players.

Materials and Methods

Participants

In this study, 30 female and 30 male athletes, who played basketball actively for at least 3 years, voluntarily participated. Pre-study evaluation methods were explained in detail to all individuals participating in the study. Informed consent for their voluntary participation was obtained from the athletes.

Basketball shooting skill assessment

The free throw shooting task was used to practice and assess basketball shooting skills in this study. Figure 1. depicts the free throw task. In this study, to take into account the effects of fatigue, the shooting position was set at "4,8 meters (m)" from the basket, 1 m less than the free throw line set by the International Basketball Federation (IBF). The height of the ring was "3,05 m", as specified by the IBF. Internationally sanctioned basketballs (BGL7, molten) were used. In order to standardize the shooting behavior of the free throw task for each subject, the following five instructions were given to each subject: (1) stand in front of the ring, (2) hold the ball with the dominant hand with the non-dominant hand along the side of the ball, (3) do not jump, (4) look at the ring for more than 3 s before shooting and (5) try to make the basket without hitting the ring and board. In addition, the participants were asked to watch a video of an experienced player executing a free throw just before the start of the shooting skill training session, so that they fully understood the shooting motion. In this way, the measurement was repeated 5 times. The examiner constantly monitored the participants to ensure that they were following the instructions and performing the shooting motion correctly (for instance, not jumping). Free throw assignments were graded as 5 points if the ball entered the basket without hitting the ring, 4 points if it hit the ring and entered, 3 points if it hit the board and entered, 2 points if it hit the ring and missed, 1 point if it hit the board and missed and 0 points if it hit nowhere and missed (Figure 1.). Performance scores were tallied for final results (Miyaguchi et al., 2022).

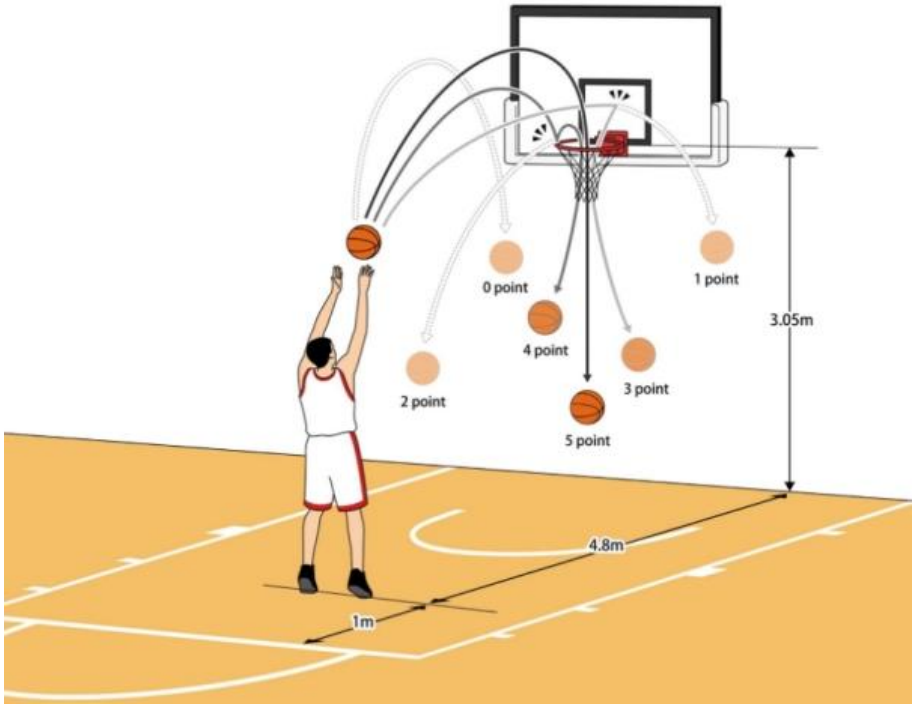

Figure 1. The free throw shooting task. The shooting position was set at 4.8 m from the basket, 1 m in front of the free throw line set by the International Basketball Federation. Free throw shots were graded as 5 points if the ball entered the basket without hitting the ring, 4 points if the ball hit the ring and entered the basket, 3 points if the ball hit the board and

entered the basket, 2 points if it hit the ring and missed, 1 point if it hit the board and missed and 0 points if it hit nowhere and missed. Performance scores were given for the results (Miyaguchi et al., 2022).

20 Meter Shuttle Run Test

The test was applied on the basketball court. A straight track of 20 m was prepared and signs were placed at the beginning and end of the track. Each sound was asked to be within two meters of the start and finish lines. The test was started at 8 km/h and increased by 0.5 km/h every 1 minute. At the end of each shuttle, the volunteers were instructed to press the start and finish lines. Each signal caught by the volunteer was recorded as a shuttle, any shuttle it failed to catch was considered a fault. The test was terminated when the volunteer made three mistakes in a row (Barnard, 2008).

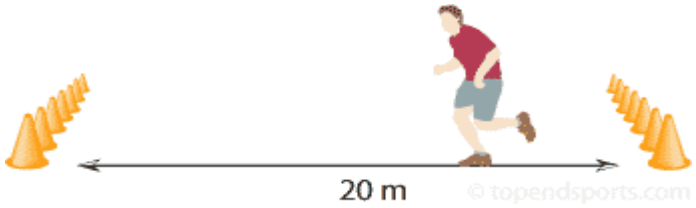

Figure 2. Shuttle Run Test (Barnard, 2008)

2D:4D Ratio Measurement

To determine finger length, the second finger (2D) and fourth finger (4D) (Figure 3) were measured using a 0-150 mm (USA, Cocraft) Vernier digital caliper with an accuracy of 0.01 mm in millimeters (mm). Left and right hand 2D and 4D (9, 15) finger lengths were measured directly from the midpoint of the proximal fold of the proximal phalanx to the distal end of the distal phalanx. The 2D:4D ratio was calculated by dividing the 2D length by the 4D length. Measurements recorded in Millimeters (mm) were converted to Centimeters (cm). Figures were measured independently by researchers (Eklund et al., 2020).

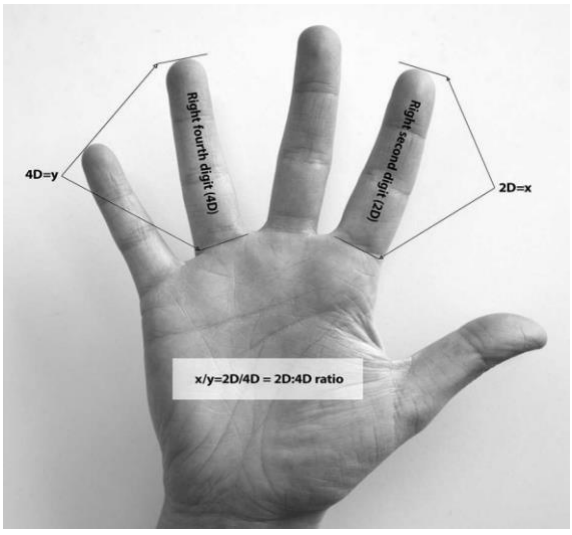

Figure 3. Measurement and calculation of the second to fourth digit (2D:4D) ratio (Eklund et al., 2020).

Statistical Evaluation

The normality distribution test of the data of the shot hit and the deviation angle was made using the Shapiro-Wilk test, and the Pearson Correlation was used to determine the relationship between the deviation angle and the shot hit on the data showing normal distribution, and the Independent Samples T Test was used to determine the difference between Total Hit, Shuttle Run Test and 2nd:4th digit ratio. Independent Samples T Test was used to determine the difference between shooting hits by gender.

Result

Considering the descriptive data of the participants, the age of the participants was 15,04±1,69 years, height 169,37±13,33 centimeters (cm), body weight 58,62±12,23 kg, athlete age 3,78±1,85 years.

Table 1

Evaluation of Shooting, Shuttle Run Test and 2nd:4th Digit Ratio of Participants by Gender

Parameters	Male	Female	t	p
n	30	30		
1st Hit	2,46±1,71	3,40±1,07	-1,514	0,145
2nd Hit	2,53±1,50	2,80±1,03	-0,470	0,644
3rd Hit	2,76±1,30	2,20±1,13	1,098	0,285
4th Hit	2,92±1,60	3,30±1,41	-0,587	0,564
5th Hit	2,69±1,97	2,60±1,42	0,130	0,898
Total Hit (5 Hits)	13,38±4,40	14,30±3,49	-0,538	0,596
Shuttle Run Test (number of repetitions)	36,69±12,43	37,90±12,54	-0,230	0,820
Right Hand 2D (cm)	7,04±0,70	7,04±0,52	0,017	0,987
Right Hand 4D (cm)	7,36±0,43	6,99±0,46	1,967	0,064
2D:4D ratio right	0,95±0,06	1,00±0,02	-2,529	**0,020**
Left Hand 2D (cm)	7,26±0,37	7,01±0,46	1,401	0,176
Left Hand 4D (cm)	7,31±0,45	7,08±0,45	1,193	0,246
2D:4D ratio left	0,99±0,04	0,99±0,01	0,277	0,784

A significant difference was found in the right hand 2D:4D ratio according to gender in the table ($p<0.05$). Right hand 2D:4D ratio is higher in girls than boys. There was no significant difference in shooting parameters of the participants, Shuttle Run Test and other 2D and 4D parameters ($p>0.05$).

Table 2

The Relationship between Participants' Total Hit, Shuttle Run Test and 2nd:4th Digit Ratio Parameters

Parameters		Shuttle Run Test	2D:4D ratio right	2D:4D ratio left
Total Hit	**r**	-0,165	0,191	0,012
	p	0,453	0,384	0,956

	N	60	60	60
Shuttle Run Test	**r**		0,167	-0,508*
	p		0,447	**0,013**
	N		60	60
2D:4D ratio right	**r**			-0,536**
	p			**0,008**
	N			60

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Considering the relationship between the shooting, Shuttle Run Test and 2nd:4th digit ratio parameters of male and female participants, there is an inverse relationship between Shuttle Run Test and left hand 2nd:4th digit ratio variables ($p<0.05$). As one variable increases, the other decreases. A high level of negative correlation was found between the participants' right and left hand 2nd:4th digit ratio ($p<0.01$). There was no significant relationship between Total Hit and Shuttle Run Test and 2nd:4th digit ratio parameters of the participants ($p>0.05$).

Table 3

The Relationship between Total Hit, Shuttle Run Test and 2nd:4th Digit Ratio Parameters of Male Participants

Parameters		**Shuttle Run Test**	**2D:4D ratio right**	**2D:4D ratio left**
Total Hit	**r**	-0,179	0,136	-0,002
	p	0,559	0,657	0,995
	N	30	30	30
Shuttle Run Test	**r**		0,234	-0,519
	p		0,441	0,069
	N		30	30
2D:4D ratio right	**r**			-0,600*
	p			**0,030**
	N			30

* Correlation is significant at the 0.05 level (2-tailed).

When the relationship between shot, Shuttle Run Test and 2nd:4th digit ratio parameters of male participants was examined, a negative correlation was found between right and left hand 2nd:4th digit ratio ($p<0.05$). As one variable increases, the other decreases. There was no significant relationship between Total Hit and Shuttle Run Test and 2nd:4th digit ratio parameters of male participants ($p>0.05$).

Table 4

The Relationship between Total Hit, Shuttle Run Test and 2nd:4th Digit Ratio Parameters of Female Participants

Parameters		**Shuttle Run Test**	**2D:4D ratio right**	**2D:4D ratio left**
Total Hit	**r**	-0,164	0,254	0,097
	p	0,651	0,478	0,790
	N	30	30	30

Shuttle Run Test	**r**	-0,014	-0,576
	p	0,970	0,081
	N	30	30
2D:4D ratio right	**r**		-0,447
	p		0,195
	N		30

There was no significant relationship in Total Hit, Shuttle Run Test and 2nd:4th digit ratio parameters of female participants ($p>0.05$).

Discussion

Physical fitness is an important determinant of success in basketball as in many sports, upper body strength, lower body explosive power, running speed/agility, and cardiorespiratory endurance all correlate positively with game-related statistics, particularly offensive statistics (Castagna, Chaouachi, Rampinini). , Chamari and Impellizzeri, 2009; McGill, Andersen and Horne, 2012; Eraslan et al., 2020; Sarıakçalı et al., 2022).The results of this study reflect the benefits of prenatal testosterone on shooting skills, which have long-term benefits for basketball players. Prenatal testosterone affects the growth and development of the heart, muscles, bones and brain, which are important for athletic success (Geschwind and Galaburda, 1987). According to the results of the study, a significant difference was found in the right hand 2D:4D ratio according to gender ($p<0.05$). Right hand 2D:4D ratio was found to be higher in girls than boys (Table 1). The length of the index finger seen in women depends on the height of the estrogen hormone. In men, the long ring finger is due to high testosterone levels (Manning et al., 2004).

There was no significant difference in the shooting parameters of the participants, Shuttle Run Test and other 2D and 4D parameters ($p>0.05$) (Table 1). As a result of their study, Klapprodt et al. (2018) show that 2D: 4D is significantly associated with sports, athletic and fitness test performance. According to the results of this study, when the relationship between shot, Shuttle Run Test and 2nd:4th digit ratio parameters of male and female participants was examined, there was an inverse relationship between Shuttle Run Test and left hand 2nd:4th digit ratio variables ($p<0.05$). As one variable increases, the other decreases.

A high level of negative correlation was found between the participants' right and left hand 2nd:4th digit ratio ($p<0.01$). There was no significant relationship between Total Hit and Shuttle Run Test and 2nd:4th digit ratio parameters of the participants ($p>0.05$) (Table 2). A review of the literature showed that a study of 64 Australian female basketball players had moderate negative correlations in blocks for both 2D:4D right hand and 2D:4D left hand, also showing that women with lower 2D:4D recorded more blocks.In the 2D:4D right hand parameter, there was a weak negative correlation in field goal percentage and rebounds. In the 2D:4D left hand parameter, however, a weak negative correlation of rebounds was found, suggesting that women with lower 2D:4D were more efficient scorers and recorded more rebounds (Dyer et al., 2018).In other words, female players with

lower 2D:4D tended to perform statistically better on defense in basketball games, particularly in terms of accumulating more blocks and rebounds and being more efficient scorers regardless of their age and body size (Dyer et al., 2018). It is stated that low 2D:4D ratio is important in sportive success. (Manning et al., 2007; Ellis et al., 1992). They found that the 2D:4D ratio was associated with parenetal Testosterone and endurance running in men and women.In the same study, he states that the ratio of parenetal Testosterone is important in determining aerobic exercise adequacy (Manning et al., 2007 (b)). Tester and Campbell found that 2D:4D was negatively associated with performance in both male and female amateur football, rugby and basketball players. Therefore, the study on subjects shows that performance in many sports branches is related to 2D:4D (Tester and Campbell, 2007).With the conclusion drawn from this study, it is important to understand that physical measurements such as 2D:4D are generally not positively correlated with shooting performance in basketball, because many factors that affect shooting performance are involved in open skill sports such as basketball.When the relationship between shot, Shuttle Run Test and 2nd:4th digit ratio parameters of male participants was examined, a negative correlation was found between right and left hand 2nd:4th digit ratio ($p<0.05$). As one variable increases, the other decreases. There was no significant relationship between Total Hit and Shuttle Run Test and 2nd:4th digit ratio parameters of male participants ($p>0.05$) (Table 3).Finding 2D:4D not significantly associated with game-related statistics in professional male players, Frick et al. Contrary to (2017), Klapprodt et al. (2018) found in their study on male basketball players that male basketball players with low 2D:4D tend to perform better offensively in professional and semi-professional matches, especially by scoring more points and scoring assists. In 2D:4D men, cardiorespiratory endurance, running speed in VO2max and peak blood lactate concentration, muscle strength, upper and lower body explosive power and speed were positively associated with both short and long distance running speed (Fink et al., 2006; Manning et al., 2007; Manning and Hill, 2009; Hill, Simpson, Millet, Manning and Kilduff, 2012; Tomkinson and Tomkinson, 2017; Klapprodt et al., 2018).

There was no significant relationship in Total Hit, Shuttle Run Test and 2nd:4th digit ratio parameters of female participants ($p>0.05$) (Table 4). In a study in which the 2D:4D ratio of elite and non-elite female athletes was found to be low, it was assumed that a low 2D:4D ratio could be a positive indicator of sports potential in women. Therefore, the low 2D:4D ratio of sportive performance is important in determining sportive success (Ellis et al., 1992). Eler et al. (2020) found that 2D:4D, an indicator of prenatal testosterone, has a very strong relationship with VO2max in female handball players. Ranson et al. (2015), on the other hand, found a strong relationship between 2D:4D and resilience in men in a study conducted on 922 male and 835 female students. In girls, 2D:4D showed a significant positive correlation with height, mass, BMI and waist circumference. However, in different studies, they found that there was no significant relationship between maximal

oxygen uptake and right and left 2D:4D in young girls and boys (Peeters et al., 2013; Hill et al., 2012; Eghbali, 2016).

As a results were evaluated, it was found that there was no effect between 2D: 4D and aerobic performance and shooting in adolescent male and female basketball players. This result may be due to the age, training level and heterogeneity of the sample group. It can be recommended to researchers who will work on this subject to work on measuring the skills of athletes in a larger sample group and different sports branches in order to estimate the effect of 2D:4D ratio on sports performance.

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Authors' contributions

Author Levent CEYLAN, Tülay CEYLAN, Hamza KÜÇÜK and author Murat ELİÖZ have given substantial contributions to the conception or the design of the manuscript, author Levent CEYLAN, Tülay CEYLAN, Hamza KÜÇÜK and author Murat ELİÖZ to acquisition, analysis and interpretation of the data. All authors have participated to drafting the manuscript, author Levent CEYLAN revised it critically. All authors read and approved the final version of the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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