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ORIGINAL RESEARCH

Digit ratio (2D:4D) and physical fitness in early adolescence: A potential criterion for talent identification?

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Abstract

A low digit ratio (2D:4D), as an indicator of prenatal androgen exposure, is assumed to be associated with higher physical fitness and athletic performance. This study aims to examine the relationship between the 2D:4D and certain physical fitness components during early adolescence. The study was conducted as a cross-sectional research. Early adolescents without any prior sports background voluntarily participated in the study. In the study, the participants' right and left hand 2D:4D were measured, and their physical fitness was assessed using tests for handgrip strength, flexibility, agility, speed and power performance. The findings indicated that there was no significant correlation between the 2D:4D and all of the physical fitness components involved in this study in both female and male participants. In the gender-based evaluation, it was determined that the 2D:4D was higher in females. The results show that the 2D:4D is not significantly correlated with handgrip strength, flexibility, agility, speed and power performance in individuals without any prior sports background during early adolescence. In this context, the use of the 2D:4D as a potential biological indicator for talent selection was not supported in this age group and sample.

Introduction

Physical fitness consists of multiple components such as cardiorespiratory fitness, musculoskeletal fitness (muscular strength, power, endurance, and flexibility), agility, speed, balance, coordination, and body composition, which collectively reflect an individual's ability to perform physical activity (Lang et al., 2023). So when physical fitness is assessed, the functional state of all these systems is also assessed. Although physical fitness is partly determined by genetics, it can also be significantly influenced by environmental factors (Ortega et al., 2008). Determining the level of physical fitness is a fundamental element in identifying talent in children and adolescents. It also plays a crucial role in the development of an athletic career (Baj-Korpak et al., 2022).

The identification of talent and the prediction of performance in sport is a complex process characterized by the interplay of biological and environmental factors. An individual's biological potential, such as their genetic makeup, hormone levels, and physiological system capacity, interacts with appropriate environmental conditions, training, and experience to lay the foundation for the development of physical fitness and performance. (Güllich et al., 2022; Ferreira et al., 2024).

Prenatal exposure to androgen hormones is thought to have a decisive impact on the development of physiological systems (Crewther et al., 2022). One of the lasting traces of these hormonal effects is considered to be the ratio between the lengths of the second (2D) and fourth (4D) fingers, known as the digit ratio (2D:4D). It has been suggested that prenatal testosterone and estrogen levels influence the formation of the 2D:4D (Manning, 2002; Hönekopp & Watson, 2010). A low 2D:4D is associated with higher prenatal testosterone exposure, whereas a high ratio is linked to relatively lower testosterone levels (Kasielska-Trojan et al., 2024; Manning & Fink, 2023). Prenatal testosterone exposure exerts long-term organizational effects on the structure and function of numerous bodily systems, including the

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cardiovascular, musculoskeletal, and central nervous systems. All of these systems are critical for physical fitness and performance (Pasanen et al., 2022).

Evidence from studies on adult athletes suggests that a lower 2D:4D may be linked to superior performance across various sports disciplines. Findings, have demonstrated negative associations between the 2D:4D and performance in sports such as rugby (Bennett et al., 2010), basketball (Klapprodt et al., 2018), wrestling (Keshavarz et al., 2017), rowing (Hull et al., 2015), and surfing (Kilduff et al., 2011). Similarly, it has been reported that individuals with a lower 2D:4D achieve higher values in physical performance indicators such as vertical jump (Disterhaupt et al., 2022), handgrip strength (Pasanen et al., 2021), VO_2max (Parpa et al., 2024), and ventilatory threshold (Gower et al., 2025). Furthermore, Olympic athletes participating in sports requiring strength, endurance, and technical skills have been reported to possess lower 2D:4D values compared to sedentary controls (Eklund, 2020).

Most existing studies have been conducted on individuals actively participating in a specific sport, and their results have been evaluated based on athletic performance parameters (Bernardino et al., 2025; Hönekopp & Schuster, 2010; Kim & Kim, 2016). Therefore, the findings are insufficient to accurately predict the biological and physical potential associated with the 2D:4D in children lacking any prior sports background. Research on children and adolescents without any prior sports background may allow for the early identification of potential physical fitness traits and could provide valuable insights into the use of biological markers for talent identification. In this regard, the aim of this study is to examine the relationship between the 2D:4D and certain physical fitness components during early adolescence and evaluate its potential use as a biological indicator in talent identification. The main hypothesis of the research is that the 2D:4D during early adolescence will not show a significant relationship with physical fitness components.

Methods

This study was conducted as a cross-sectional study. The data was collected by researchers in October 2023 at a school located in the centre of Elazığ province. The necessary institutional permission for the study was obtained from the Elazığ Provincial Directorate of National Education (dated 20.09.2023 and numbered E-79137285-605.01-84653068). The research protocol was approved by the Fırat University Non-Interventional Research Ethics Committee (25.05.2023/07-35) and was carried out in accordance with the ethical principles of the World Medical Association (Declaration of Helsinki). All participants and their family members were informed about the purpose and protocol of the study in advance and provided written informed consent.

Participants

The G*Power (3.1) program was used to determine the required sample size. In the power analysis, type I error (alpha) 0.05, test power (1-β) 0.80 and medium effect size (r = 0.30) were taken as basis.

The study included males and females in early adolescence (aged 11–14) who lived in the city centre and had without any prior sports background, selected using a criterion sampling method.

The acceleration of physiological, hormonal and motor development during early adolescence supports the maturation of biological and performance characteristics. This process allows abilities to become more distinct and measurable (Lehnert et al., 2024; Leyhr et al., 2018).

The participants were all healthy, with no history of injury in the last six months, and had not previously participated in any sports activities. Individuals whose participation in the study was at risk, who had medical or orthopedic problems, who refused to participate, who had previously been active in any sports activities, and who could not complete the research protocol were excluded from the study.

Procedure

2D:4D

A previously established protocol was followed for the measurement of 2D and 4D finger lengths. Both finger lengths were measured directly from the midpoint of the proximal crease of the proximal phalanx to the distal tip of the distal phalanx. The both left and right hand 2D:4D was calculated by dividing the length of 2D by the length of 4D. A digital caliper with a precision of 0.01 mm was used as the measurement tool (Vernier digital caliper 0-150 mm (USA, Cocraft)). In the study, the 2D:4D was not grouped according to any threshold value (low or high); it was analysed as a continuous variable based on its numerical values (Eklund et al., 2020; Manning et al., 1998). Figure 1 shows the measurement and calculation of the 2D:4D.

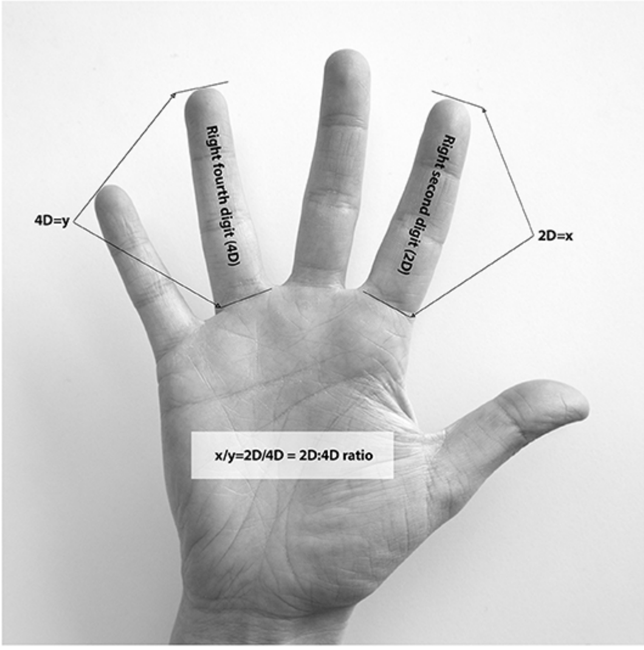

Figure 1. Measurement and calculation of the 2D:4D (Eklund et al., 2020).

Handgrip Strength Test

It is a simple and commonly used test to assess the isometric strength of the hand and forearm muscles. Participants stand with their arms at their sides and elbows fully extended. The dynamometer is adjusted according to the participant's hand size, and the participant is asked to grip it firmly. The device must be held in a comfortable position, with the index finger flexed at a 90-degree angle. The participants were asked to squeeze the dynamometer with maximum strength for 3 seconds. The participants' hand grip strength was measured twice. The highest value was recorded in kilograms (Akbulut et al., 2020). The measurement tool used was the Takei 5401 hand dynamometer (Takei Scientific Instruments Co. Ltd, Tokyo, Japan).

Sit-and-Reach Test

It is one of the tests used to measure the flexibility of the hamstring muscles, lower back area, and waist. Participants were instructed to sit on the floor with their knees straight, legs together, and the soles of their feet placed against the measurement box. The point where the participant's heel is located is considered the zero point. Participants were then instructed to place their dominant hand over the other with their palms facing downward, lean forward as much as possible while sliding their hands along the box, keep their knees extended, and maintain the maximum flexion position for approximately 5 seconds. The measured distance was recorded in centimeters (Muyor et al., 2014). The sit and reach box (01285A, Lafayette, USA) was used as the measurement instrument.

Pro-Agility Test (5-10-5 shuttle)

The pro-agility test is an effective assessment of change-of-direction speed and is used to measure agility. For the measurement of this test, three cones were placed five yards apart. The participant started in a neutral stance, parallel to the starting line, and upon command, ran toward the right cone (5 yards) and touched it with their right hand. The participant then turned 180° and ran toward the left cone (10 yards) and touched it with their left hand. Then, they turned 180° again and sprinted back to the starting point (5 yards), completing the test (Lazić et al., 2021). The measurement tool used was a photocell device (Smart Speed; Fusion Sport, Australia).

30 m Sprint Test

The 30-meter sprint test is performed to evaluate the speed performance of participants. It is also an assessment tool that provides information about anaerobic power, explosive strength, and fast force performance. For measurement, photocells were placed at the beginning and end of the 30-meter track. Participants were instructed to stand just behind the starting line, begin the sprint from a stationary position without any swinging movement, and run with maximum effort to the finish line. The time spent was recorded in seconds. A photocell device (Smart Speed; Fusion Sport, Australia) was used as the measurement tool.

Squat Jump Test

It is the assessment tool used to determine lower extremity explosive power. For the test, participants started in an upright position with their hands placed on their hips. Then, participants were instructed to bend their knees and maintain an approximately 90° knee angle. The tester counts for a duration of 3 seconds. When the count reaches 3, the individual is instructed to jump as high as possible without any countermovement before the jump. (Glatthorn et al., 2011). The measurement tool used was a jump platform (Smart Jump; Fusion Sports, Australia).

Height Measurement

This measurement is used to determine the head-to-heel distance of an individual. With arms relaxed, legs together, gaze directed straight ahead, and without shoes, the measurement was taken using the Desis B5 height-weight scale device.

Data Analyses

Statistical analyses were performed using SPSS version 22. In the study, descriptive statistics such as minimum, maximum, mean, and standard deviation values were calculated. In the study, the normality assumption of the data set was evaluated using the Shapiro-Wilk test with kurtosis and skewness coefficients. According to Tabachnick and Fidell (2013), kurtosis and skewness coefficients within the range of ±1.5 indicate that the normality assumption is met. The kurtosis and skewness values of the variables in the study were within these limits, and since the p-values obtained from the Shapiro-Wilk test were above 0.05, the normality assumption was met. Since the assumption of normality was met, an independent samples t-test was used for comparisons between the two groups, and Pearson correlation analysis was used to determine relationships. In addition, Cohen's d (δ) formulas were used in calculating the effect size (Cohen, 1988). The significance level for all tests was set at $p < 0.05$.

Results

In Table 1, the demographic information and the min and max values of the physical fitness components for the participants are provided. The average age of the research group was 12.79±1.16 years, height was 1.53±0.10 cm, right handgrip strength 20.83±5.63 kg, left handgrip strength 19.43±5.53 kg, flexibility 22.79±6.99 cm, agility 6.81±0.51 seconds, speed 6.38±0.67 seconds, power 23.59±5.01 cm, right 2D:4D 1.01±0.02, and left 2D:4D 1.01±0.04.

Table 2 shows the right and left 2D:4D by gender. According to the findings, the right 2D:4D is significantly higher in female (1.02±.02) compared to male (1.00±.02) ($p<0.05$). When evaluated in terms of effect size, it was found that the right 2D:4D had a high effect size (δ=1.00) between genders, while the left 2D:4D had a small to medium effect size (δ=0.28).

Table 1
Participant information.

Variables	Gender	n	Min.	Max.	Mean ± SD
Age (years)	Male	95	11	14	12.79 ± 1.19
	Female	87	11	14	12.80 ± 1.13
	Total	178	11	14	12.79 ± 1.16
Height (cm)	Male	95	1.27	1.78	1.53 ± 0.11
	Female	87	1.30	1.70	1.52 ± 0.09
	Total	178	1.27	1.78	1.53 ± 0.10
Right handgrip strength (kg)	Male	95	10.60	50.60	21.68 ± 6.20
	Female	87	11.50	32.60	19.89 ± 4.81
	Total	178	10.60	50.60	20.83 ± 5.63
Left handgrip strength (kg)	Male	95	9.30	52.20	20.32 ± 6.29
	Female	87	9.80	28.50	18.45 ± 4.39
	Total	178	9.30	52.20	19.43 ± 5.53
Flexibility (cm)	Male	95	9.00	39.00	21.40 ± 6.55
	Female	87	11.00	45.00	24.3 ± 7.17
	Total	178	9.00	45.00	22.79 ± 6.99
Agility (sec)	Male	95	6.52	8.00	6.76 ± 0.55
	Female	87	6.95	10.28	6.86 ± 0.47
	Total	178	6.52	10.28	6.81 ± 0.51
Speed (sec)	Male	95	5.00	8.08	6.24 ± 0.65
	Female	87	5.20	8.31	6.54 ± 0.67
	Total	178	5.00	8.31	6.38 ± 0.67
Power (cm)	Male	95	14.50	36.80	24.84 ± 5.38
	Female	87	13.80	34.40	22.23 ± 4.19
	Total	178	13.80	36.80	23.59 ± 5.01
Right 2D:4D	Male	95	0.92	1.06	1.00 ± 0.02
	Female	87	0.94	1.08	1.02 ± 0.02
	Total	178	0.92	1.08	1.01 ± 0.02
Left 2D:4D	Male	95	0.89	1.25	1.01 ± 0.04
	Female	87	0.95	1.18	1.02 ± 0.03
	Total	178	0.89	1.25	1.01 ± 0.04

SD: Standard deviation.

Table 2
2D:4D comparison by gender.

Variables	Gender	n	Mean ± SD	t	Cohen's d	*p*
Right 2D:4D	Female	87	1.02 ± .02	3.102	1.00	0.002*
	Male	95	1.00 ± .02			
Left 2D:4D	Female	87	1.02 ± .03	1.782	0.28	0.077
	Male	95	1.01 ± .04			

$p < 0.05$.

Table 3
Correlation between 2D:4D and physical fitness components.

Variables		Right handgrip strength	Left handgrip strength	Flexibility	Agility	Speed	Power
Right 2D:4D	*r*	-0.09	-0.06	-0.03	0.02	0.14	-0.14
	p	0.22	0.42	0.60	0.78	0.05	0.05
	n	178	178	178	178	178	178
Left 2D:4D	*r*	-0.04	0.02	-0.08	-0.08	-0.02	-0.06
	p	0.53	0.74	0.24	0.26	0.74	0.38
	n	178	178	178	178	178	178

Table 4
Correlation between 2D:4D and physical fitness components in female.

Variables		Right Handgrip Strength	Left Handgrip Strength	Flexibility	Agility	Speed	Power
Right 2D:4D	*r*	-0.14	-0.11	-0.07	0.11	0.20	-0.08
	p	0.18	0.31	0.47	0.27	0.05	0.43
	n	87	87	87	87	87	87
Left 2D:4D	*r*	0.04	0.12	-0.17	-0.15	-0.13	0.07
	p	0.71	0.25	0.11	0.14	0.20	0.52
	n	87	87	87	87	87	87

Table 5
Correlation between 2D:4D and physical fitness components in male.

Variables		Right handgrip strength	Left handgrip strength	Flexibility	Agility	Speed	Power
Right 2D:4D	*r*	-0.01	0.02	-0.10	-0.08	0.01	-0.09
	p	0.96	0.81	0.33	0.41	0.94	0.38
	n	95	95	95	95	95	95
Left 2D:4D	*r*	-0.06	0.01	-0.08	-0.06	0.01	-0.09
	p	0.54	0.92	0.44	0.54	0.95	0.39
	n	95	95	95	95	95	95

In Table 3 shows the relationship between the right and left 2D:4D and age, height, right hand strength, left hand strength, flexibility, agility, speed, and power performance. According to the findings, no significant relationship was found between the right and left 2D:4D and the components of physical fitness. The associations between the components of physical fitness and the 2D:4D are presented as follows: right hand strength, (right 2D:4D r=-0.09 and p=0.22; left 2D:4D r=-0.04 and p=0.53), left hand strength (right 2D:4D r=-0.06 and p=0.42; left 2D:4D r=0.02 and p=0.74), flexibility (right 2D:4D r=-0.03 and p=0.60; left 2D:4D r=-0.08 and p=0.24), agility (right 2D:4D r=0.02 and p=0.78; left 2D:4D r=-0.08 and p=0.26), speed (right 2D:4D r=0.14 and p=0.05; left 2D:4D r=-0.02 and p=0.74) and power (right 2D:4D r=-0.14 and p=0.05; left 2D:4D r=-0.06 and p=0.38) performance.

Table 4 shows the relationship between right 2D:4D and right hand strength left hand strength, flexibility, agility, speed and power performance in female. According to the findings, no significant relationship was found between right and left 2D:4D and physical fitness components in female. The associations between the components of physical fitness and the 2D:4D are presented as follows: right hand strength (right 2D:4D r=-0.14 and p=0.18; left 2D:4D r=0.04 and p=0.71), left hand strength (right 2D:4D r=-0.11 and p=0.31; left 2D:4D r=0.12 and p=0.25), flexibility (right 2D:4D r=-0.07 and p=0.47; left 2D:4D r=-0.17 and p=0.11), agility (right 2D:4D r=0.11 and p=0.27; left 2D:4D r=-0.15 and p=0.14), speed (right 2D:4D r=0.20 and p=0.05; left 2D:4D r=-0.13 and p=0.20) and power (right 2D:4D r=-0.08 and p=0.43; left 2D:4D r=0.07 and p=0.52) performance in female.

Table 5 shows the relationship between the right and left 2D:4D of male and age, height, right hand strength, left hand strength, flexibility, agility, speed and power performance in male. According to the findings, no significant relationship was found between the right and left 2D:4D of men and physical fitness components in male. The associations between the components of physical fitness and the 2D:4D are presented as follows: right hand strength (right 2D:4D r=-0.01 and p=0.96; left 2D:4D r=-0.06 and p=0.54), left hand strength (right 2D:4D r=0.02 and p=0.81; left 2D:4D r=0.01 and p=0.92), flexibility (right 2D:4D r=-0.10 and p=0.33; left 2D:4D r=-0.08 and p=0.44), agility (right 2D:4D r=-0.08 and p=0.41; left 2D:4D r=-0.06 and p=0.54), speed (right 2D:4D r=0.01 and p=0.94; left 2D:4D r=0.01 and p=0.95) and power (right 2D:4D r=-0.09 and p=0.38; left 2D:4D r=-0.09 and p=0.39) performance in male.

Discussion

The aim of this study was to examine the relationship between the 2D:4D and certain physical fitness parameters during early adolescence and to evaluate the potential use of this ratio as a biological indicator in talent identification. The findings indicate that there was no significant correlation between the right and left 2D:4D and right-hand grip strength, left-hand grip strength, flexibility, agility, speed or vertical jump performance in in early adolescents without any prior sports background (Table; 3,4,5). This suggests that the 2D:4D may not be a determining factor for all of the physical fitness components involved in this study. Therefore, it can be said that it is still early to use the 2D:4D as a talent identification tool in sports disciplines that require physical fitness components such as handgrip strength, flexibility, agility, speed, and vertical jump performance. The hypothesis of this study was that there would be no relationship between the 2D:4D and physical fitness components, and the obtained results support this hypothesis.

Prenatal exposure to testosterone and oestrogen is effective in determining the 2D:4D ratio, but the effects of these hormones on physical performance may vary depending on age, stage of development and environmental factors (Handelsman et al., 2018). Furthermore, physical fitness is multifactorial in nature and is shaped by many variables, such as genetics, environment, nutrition, and physical activity history (Silventoinen et al., 2021). Therefore, the 2D:4D ratio, which is accepted as a prenatal hormone indicator, may be insufficient to explain all dimensions of physical fitness. The fact that the relationship between the 2D:4D finger ratio and physical fitness components is not always strong and consistent may be due to various physiological and biological mechanisms. Peeters et al. (2013) found no significant correlation between the 2D:4D digit ratio and physical fitness and anthropometric variables such as height, balance, flexibility, vertical jump, static endurance, endurance running, agility, and functional strength in 178 female students aged 13-18 (mean age 15.7±1.3 years) without any sports activity. Başkaya et al. (2018) found no significant relationship between the 2D:4D digit ratio and flexibility, handgrip and leg strength, 10-meter acceleration, 20-meter sprint, vertical jump, standing long jump, and agility parameters in children aged 8–10 years who were not actively participating in any sports discipline. These studies similarly support the view, consistent with the findings of the present research, that the relationship between the 2D:4D digit ratio and physical fitness is not always strong and consistent.

Agha-Alinejad et al. (2019) conducted a study among girls aged 8–12 years and observed no significant associations between the 2D:4D and measures of flexibility, abdominal muscular endurance, upper body strength and endurance, agility, 20-meter sprint performance, or cardiovascular fitness. Consistently, Eghbali et al. (2016) demonstrated the absence of significant correlations between the 2D:4D and aerobic capacity, vertical and horizontal jump performances, 20-meter sprint times, muscular endurance (sit-up and push-up tests), flexibility, agility, and handgrip strength in boys aged 11–13 years. González-Devesa et al. (2024) demonstrated the absence of a significant correlation between the 2D:4D and agility in both children (mean age 9.54 ± 1.36 years) and adolescents (mean age 14.68 ± 1.36 years). It is difficult to compare these studies with our current findings since no information was provided about the participants' sports history. In contrast, the fact that our participants had no prior engagement in sports activities strengthens the significance of our results. Prior sports experience is a crucial factor that can considerably influence children's physical fitness levels. Therefore, evaluating the potential of the 2D:4D digit ratio as an indicator of physical fitness components while considering sports background may offer more meaningful insights into its use as a tool for talent identification and performance prediction.

It is a combination of multidimensional biological factors such as gender, anatomy, physiology, genetics and hormones. The effects of hormones on physical fitness may vary depending on gender and pubertal development stage, resulting in different and variable outcomes between genders (Hunter et al., 2023; Hunter & Senefeld, 2024). Contrary to the findings of the present study, some research has suggested that the correlation between the 2D:4D digit ratio and physical fitness may vary according to sex. However, the existing literature presents conflicting results regarding the consistency of this relationship across sexes. For instance, Pruszkowska-Przybylska et al. (2018) reported a negative correlation between the digit ratio and muscle mass percentage in girls aged 6–13 years, whereas no such association was observed in boys. Similarly, Hsu et al. (2018) investigated the relationship between the 2D:4D and lower extremity explosive power (standing long jump performance) in children aged 9–10 years, finding a negative correlation between the 2D:4D and standing long jump scores in boys, but no significant relationship in girls. Ranson et al. (2015) examined the relationship between the 2D:4D and anthropometric measurements (height, weight, BMI, waist circumference), endurance, flexibility, standing long jump, hand grip strength, sprint, and flexibility in a large sample of primary and middle school children aged 8-12 years, identifying sex-based differences. In girls, the 2D:4D showed a significant positive correlation only with anthropometric indices (height, weight, BMI, and waist circumference), whereas in boys, the 2D:4D exhibited significant negative correlations with all fitness tests, except for the standing long jump. Similarly, Zhang et al. (2024) conducted a study involving children and adolescents aged 8-15 years, where they found no significant correlation between the 2D:4D and anthropometric indices in boys, but positive correlations in girls. These findings highlight the need for more controlled studies to better understand the sex-dependent consistency of the relationship between the 2D:4D and physical fitness.

The 2D:4D shows sexual dimorphism. Males typically display lower 2D:4Ds than females, the likely result of the balance between prenatal testosterone and estrogen as the fetal 4D has a higher number of receptors for androgen (Tomkinson & Tomkinson, 2017; Pasanen et al., 2022). The 2D:4D is generally lower in males compared to females, with a slightly larger gender difference observed in the right hand (Richards, et al., 2021). Our findings support this pattern, demonstrating a significant gender difference in the right hand, with males exhibiting lower digit ratios.

This study has several limitations. Due to its cross-sectional design, it does not provide information on the longitudinal changes or causality between the 2D:4D and physical fitness. This also limits the interpretation of the results. Since the study was conducted within a specific age range (10-14 years) and a particular population, the findings cannot be directly generalized to broader age groups or different cultural and socioeconomic backgrounds. This also limits the universality of the results. Field tests were used to assess physical fitness components; however, these tests may be more susceptible to external factors compared to more precise laboratory-based measurements. Furthermore, while only certain components of physical fitness were assessed, other components such as balance, reaction time, or endurance were not included. This has prevented a comprehensive assessment of physical fitness. In light of these limitations, future research is recommended to adopt longitudinal designs, include a broader age range, and incorporate various fitness components and measurement methods to allow for more comprehensive analyses.

Conclusion

In conclusion, our findings indicate that, among early adolescents without any prior sports activity, right and left 2D:4D are not significantly associated with physical fitness components such as age, height, right and left handgrip strength, flexibility, agility, sprint performance, and vertical jump performance. In this context, the validity of using the 2D:4D as a reliable biological marker for talent identification is not supported. Therefore, further research is needed to clarify the applicability of the digit ratio as a tool for talent detection.

Authors' Contribution

Study Design: VÇ, AEY; Data Collection: VÇ, EÇA, AEY; Statistical Analysis: EÇA, VÇ; Manuscript Preparation: VÇ, EÇA; Funds Collection: VÇ, AEY.

Ethical Approval

The study was approved by the Fırat University Non-Interventional Research Ethics Committee (25.05.2023/07-35) and it was carried out in accordance with the Code of

Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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