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Digit ratio (2D:4D) comparison between competitive age group swimmers and non-athletes

Compararea raportului degetelor (2D:4D) între grupa de vârstă competitivă de înotători și nesportivi

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Abstract

Background. The ratio of the second to the fourth digit length (2D:4D) could have an important role in sport performance.

Aims. The aim of the study was to determine the 2D:4D ratio in age group swimmers and to compare them with non-athletes of both genders.

Methods. 30 female and 35 male age group swimmers and 34 females and 40 male non-athlete volunteers participated in the study. Non-athletic volunteers were selected from the healthy volunteer subjects without sport activities. The lengths of the index and ring fingers of both hands from the proximal bend of the metacarpophalangeal joint up to the fingertips were measured with digital calipers, and the index-ring finger ratio was determined. The height, weight and body mass index of the age group swimmers and non-athlete volunteers were evaluated. Results were processed with SPSS 20.0.

Results. There were significant differences between the age group swimmers and the non-athlete volunteers in terms of the right-hand finger ratio. When the right-hand finger ratio of the female swimmer and non-athlete groups were compared, statistically significant differences were found between the groups.

Conclusion. Right hand 2D:4D ratio was an important indicator of success for swimming performance (especially short-distance sprint performance). This could be used as an additional criterion for talent identification in female swimmers.

Keywords: digit ratio, swimming, age group swimmers, talent identification.

Rezumat

Premize. Raportul dintre lungimea degetului arătător și inelar (2D:4D) ar putea avea un rol important în performanța sportivă.

Obiective. Scopul studiului a fost de a determina raportul 2D:4D în cazul grupei de vârstă competitive de înotători și de a realiza o comparație cu nesportivi de ambele sexe.

Metode. 30 de subiecți de sex feminin și 35 de subiecți de sex masculin au format grupa de vârstă a înotătorilor, iar 34 de subiecți de sex feminin și 40 de subiecți de sex masculin au format grupa de voluntari nesportivi care au participat la studiu. Voluntarii nesportivi au fost selectați dintre subiecții sănătoși fără activități sportive. S-a măsurat lungimea degetelor arătător și inelar de la ambele mâini de la baza articulației metacarpofalangiene până la vârfurile degetelor cu ajutorul caliperilor digitali și s-a determinat raportul arătător-inelar. S-au măsurat înălțimea, greutatea și indicele de masă corporală la grupa de vârstă a înotătorilor și la voluntarii nesportivi. Rezultatele au fost prelucrate cu ajutorul SPSS 20.0.

Rezultate. S-au evidențiat diferențe semnificative între grupa de vârstă a înotătorilor și voluntarii nesportivi în ceea ce privește raportul degetelor de la mâna dreaptă. Când s-a comparat raportul degetelor de la mâna dreaptă la înotătoare și nesportive, s-au constatat diferențe semnificative statistic.

Concluzii. Raportul 2D:4D la mâna dreaptă reprezintă un indicator important al succesului în ceea ce privește performanța la înot (în special performanța la sprintul pe distanță scurtă). Acesta poate fi folosit ca un criteriu suplimentar pentru identificarea talentului înotătoarelor.

Cuvinte cheie: raportul degetelor, înot, grupa de vârstă de înotători, identificare de talente.

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Introduction

The second to fourth digit ratio is the ratio of the lengths of the second and fourth digits (2D:4D). This ratio has been proposed to be related to sports performance. The second to fourth digit ratio of the hand (2D:4D ratio) carries a negative correlation with prenatal testosterone levels (Aksu at al., 2009; Barut et al., 2008; Csathó et al., 2003; Hönekopp et al., 2007; Koehler et al., 2004; Lutchmaya et al., 2004; Manning & Bundred, 2000; Manning et al., 2001; Pokrywka et al., 2005; Paul et al., 2006). This polarity appears as early as the 14th week of intrauterine life and remains stable throughout puberty (Burriss et al., 2007; Fink et al., 2003; Loehlin et al. 2006; Manning et al., 2000; Manning et al., 2004).

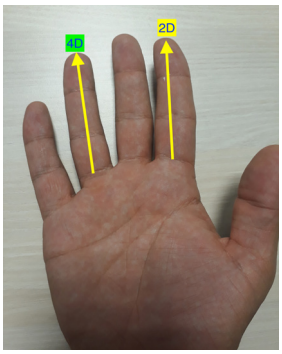

Fig. 1 – Digit ratio (2D/4D).

Moreover, it is claimed that the length of the second digit is related with estrogen, while the length of the forth digit is related with testosterone (Manning et al., 2002).

Accordingly, the 2D:4D ratio in females is higher than in males (Barut et al., 2008; Fink et al., 2003; Manning et al., 2007; Voracek & Dressler, 2007). Several investigations implied that in humans, males classically have shorter second digits compared with fourth digits; however, these fingers are more equal in length in females (Manning et al., 1998; Zhang et al., 2008). Malas et al. (2006) claimed that the 2D:4D ratio was significantly lower in male than in female human fetuses with ages ranging between 9 and 40 weeks of gestation.

The HOXA and HOXD genes affect the differentiation of fingers, toes and gonads, whose products such as testosterone may be displayed in the morphology of fingers (Manning et al., 2003).

Adult body composition and muscle strength have been reported to determine the effect of intrauterine sex hormones (Gale et al., 2001).

There is a strong relationship between a low second to fourth finger ratio in both hands and high performance in sprint and endurance performance-based sports due to high prenatal exposure to testosterone (Bennett et al., 2010; Manning et al., 2002; Manning, Henzi et al., 2001; Pokrywka et al., 2005; Tester & Campbell, 2007; Manning & Hill, 2009). In female and male athletes, the 2D:4D ratio is negatively correlated with exercise performance levels (running associated with physical fitness, skiing, gymnastics and sports such as football, based on the shuttle, repetitive jump test) (Hönekopp et al., 2006; Manning & Taylor, 2001; Manning, 2002).

Despite studies such as those mentioned above on various sports, there are few literature studies investigating the 2:4 digit ratio in swimmers. The aim of this study was to determine the 2D:4D ratio in competitive age group swimmers (AGS) and to compare them with non-athletes of both genders.

Hypothesis

In the present study it was hypothesized that the 2D:4D finger ratio is a performance marker among swimmers. The relationship between the 2D:4D finger ratio and short-distance swimming performance was determined. Gender as well as left and right hand differences were evaluated.

Material and methods

Research protocol

a) Period and place of the research

The study included 30 female and 35 male swimmers competing in the Turkish National Short Course Swimming Championship organized in December 2013.

b) Subjects and groups

Thirty female and 35 male swimmers (aged between 13-18 years) participated in the study. Thirty-four female and 40 male students matched for age participated in the study as non-athletes. The physical characteristics of the swimmers and non-athletes are presented in Table 1. The swimmers were finalists of the 50 and 100 m races in all swimming techniques during the National Short Course Swimming Championship of Turkey. The non-athlete group had no sports activity or regular exercise. Both the participants and their parents were informed about the study and they signed a written consent. All procedures and written forms were controlled and approved by the Ethics Committee of the Dokuz Eylul University.

c) Tests applied

The digit ratio (2D:4D), body weight, height, and body mass index were evaluated as follows:

1. Digit ratio: The 2D:4D ratio was determined by measuring the index and ring fingers of both hands using a digital compass with a sensitivity of 0.01 mm (Mitutoyo, Japan), starting from the proximal baseline on the palmar side of the metacarpophalangeal joint to the fingertip (on the palmar surface). All measurements were made by the same person. Subjects with osteoarthritis or any structural deformity related to a hand injury, and those with a history of hand trauma were excluded from the study. The digit ratio was calculated by dividing the length of the second digit by that of the fourth digit.

2. Body height, body weight and body mass index: The height and body weight of the participants were measured by the Seca 799 Digital Column Scale (USA). The body mass index was calculated using the formula (kg)/ height $(m)^2$.

d) Statistical processing

The results were expressed as mean and standard deviation. The data were analyzed using the Student t-test via SPSS for Windows. The difference was considered statistically significant whenever $p \leq 0.05$.

Results

The physical characteristics of the AGS and non-athletic volunteer groups are shown in Table I. Gender

differences of digit ratios are presented in Table II. There was no significant difference of digit ratios in both hands between females and males in the AGS group. Similarly, no gender difference was observed for digit ratios in non-athletes (Table II).

A comparison between the AGS and non-athletic groups revealed that the 2D:4D ratio in the right hand was significantly lower in the AGS group (p=0.047) (Table III). However, no significant difference was found in the digit ratio for the left hand between AGS and the non-athletic group.

The comparison of the right-hand digit ratio between female AGS and the female non-athletic group revealed a statistically significant difference (p=0.014), whereas the comparison between male AGS and non-athletes was not statistically significant regarding finger ratios (Table IV).

Table I

Physical and anthropometric characteristics according to gender in competitive age group swimmers and the non-athletic volunteer group.

Groups	AGS group (n=59)		Non-athletic group (n=74)	
	Female (n=24)	Male (n=35)	Female (n=34)	Male (n=40)
Age (years)	14.08±0.78	14.86±1.44	14.60±0.60	14.53±0.65
Height (cm)	161.42±6.00	172.74±8.55	163.78±6.93	174.98±8.27
Weight (kg)	52.29±5.62	61.17±9.84	58.43±12.79	69.68±12.53
BMI (kg/m^2)	20.06±1.88	20.40±2.12	21.73±4.30	22.79±4.03

Table II

Comparison between female and male finger ratios in swimmers and non-athletes.

Groups	AGS group (n=59)			Non-athletic group (n=74)		
	Female (n=24)	Male (n=35)	P	Female (n=34)	Male (n=40)	P
2D:4D left	0.99±0.04	0.99±0.03	N.S.	0.99±0.06	0.98±0.04	N.S.
2D:4D right	0.99±0.03	0.98±0.05	N.S.	0.99±0.05	0.98±0.06	N.S.

N.S: not significant

Table III

Comparison between swimmers and non-athletic volunteers in terms of finger ratios.

Groups	AGS group (n=59)	Non-athletic group (n=74)	P
2D:4D left	1.00±0.03	1.00±0.04	N.S.
2D:4D right	0.97 ±0.05	0.99 ±0.04	p=0.047

N.S: not significant

Table IV

Comparison between the female and male groups of swimmers and non-athletes in terms of finger ratios

Groups	Female group (n=58)			Male group (n=75)		
	AGS (n=24)	Non-athletic (n=34)	P	AGS (n=35)	Non-athletic (n=40)	p
2D:4D left	0.99±0.03	0.99±0.04	N.S.	0.99±0.03	0.99±0.04	N.S
2D:4D right	0.96±0.05	0.99±0.03	p=0.014	0.97±0.04	0.98±0.05	N.S.

N.S: not significant

Discussions

In the present study, the right-hand finger ratio of swimmers was significantly lower than that of the control group (p=0.047). There are few studies regarding the finger ratios of swimmers. Perciavalle et al. (2014) reported that the 2D:4D ratio of the right hand is associated with the performance of high-level swimmers. Considering other sports, Hsu et al. (2015) stated that elite collegiate tennis athletes have lower 2D:4D values than those of non-athletes, and coaches may use the right-hand 2D:4D ratio as a valid indicator of potential tennis performance when evaluating young tennis players. In their study, all participants had their right-hand second and fourth fingers measured because the right hand may be more sensitive to prenatal testosterone exposure (Hsu et al., 2015; Hönekopp & Watson, 2010). The original finding of this study is that the ratio of the right-hand fingers is significantly different when the groups are compared without considering the gender difference. This result is consistent with the implications of a narrative review about finger ratios and sports performance (Kim & Kim, 2016). Moreover, research suggests that fetal testosterone and fetal estrogen affect the right hand to a greater extent, which also supports this situation (Manning, 2011; Zheng & Cohn, 2011).

According to one of the two literature studies performed on swimmers, Perciavalle et al. (2014) found a relation between right hand 2:4 finger ratios and performance in 21 elite male swimmers. This study reported a significant correlation with performance in the 100-meter race, which is considered a sprint distance. In another important study, Sudakhar et al. (2013) reported that finger ratios in male swimmers were associated with performance, without discriminating sprint from endurance swimmers. The authors argued that low finger ratios in male swimmers may be due to the influence of testosterone in the prenatal period, and 2:4 finger ratios might identify young athletes that could achieve high performance levels. The results of this study are based on research carried out in a single club. Our study was conducted on swimmers finalists in short-distance races at the national championship. The results of the present study show that finger ratios may be an important indicator of sprint performance for female swimmers. Short-distance swimmers have different physiological and anthropometric characteristics (Maglischo, 2003). We also suppose that testosterone may have an impact on some properties in sports that require speed, power and agility, when women are exposed to testosterone during the fetal period.

Some studies in the literature report that finger ratios can also be used to evaluate sports performance in women (Pokrywka et al., 2005; Paul et al., 2006). To support this, there are significant differences in finger ratios between elite female athletes and the control group in the present study. In contrast, not all studies in the literature support these findings. Reports of a recent study evidenced no significant relationship between the 2D:4D digit ratio and the performance level in elite female athletes. In the mentioned study, the lengths of the digits were measured by X-rays only in the left hand, unilaterally (Peeters & Claessens, 2013). In our study and many previous studies, the ratios of the right-hand fingers yielded meaningful results. Measuring 2D:4D finger ratios only in the left hand via X-rays may have led to different results. Probably both hands should be measured in such studies.

Conclusions

1. Right hand 2D:4D ratio was an important indicator of success for swimming performance (especially short-distance sprint performance).

2. This could be used as an additional criterion for talent identification in female swimmers.

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