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DIGIT RATIO (2D:4D) AND BODY COMPOSITION IN ATHLETES

WSKAŹNIK PALCOWY (2D:4D) A SKŁAD CIAŁA U SPORTOWCÓW

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Summary

In the course of previous studies it has been established that finger length ratio (2D:4D) can be used as a marker of prenatal androgens exposition. Its low level is connected with a high prenatal and postnatal testosterone level. 2D:4D ratio proves helpful during the evaluation of athletes' predisposition to practice certain disciplines.

The study included a group of athletes – 72 men and 60 women – aged between 18 and 36. Physiotherapy and dietetics students (140) from the Toruń University Collegium Medicum and tourism and recreation students (63) from the Bydgoszcz University were the control group.

Body height and the length of 2nd and 4th finger of right hand were measured in each subject, as well as body composition with the method of segmental bioelectrical impedance analysis (SBIA).

The study concerned the dependence between the digit ratio (2D:4D) and a series of selected features and body composition indicators in athletes of both sexes, as well as the comparison of 2D:4D ratio in athletes and less physically active subjects. In studied female athletes a significant correlation was found between finger length ratio 2D:4D and total and active body mass, and BMI. 2D:4D ratio was not significantly lower when compared to the women who were not athletes. Hormone dependent 2D:4D ratio was finitely predictive in male athletes.

Streszczenie

W toku dotychczasowych badań naukowych ustalono, że wskaźnik palcowy (2D:4D) może być używany jako marker prenatalnej ekspozycji androgenów. Jego niska wartość jest powiązana z wysokim prenatalnym i postnatalnym poziomem testosteronu. Wskaźnik 2D:4D okazuje się pomocny przy ocenie predyspozycji do uprawiania poszczególnych dyscyplin sportowych.

Materiał obejmuje grupę sportowców - 72 mężczyzn i 60 kobiet - w wieku od 18 do 36 lat. Grupę kontrolną stanowią studenci fizjoterapii i dietetyki (140) Collegium Medicum Uniwersytetu w Toruniu oraz studenci turystyki i rekreacji (63) Uniwersytetu w Bydgoszczy.

Badanym osobom zmierzono wysokość ciała oraz długość II i IV palca prawej ręki oraz zbadano skład ciała metodą segmentalnej bioelektrycznej impedancji (SBIA).

Badania dotyczyły zależności między wskaźnikiem palcowym (2D:4D) a szeregiem wybranych cech i wskaźników składu ciała u sportowców obu płci oraz porównanie wskaźnika 2D:4D u sportowców i osób mniej aktywnych fizycznie. U badanych sportsmenek znaleziona została istotna korelacja między wskaźnikiem palcowym (2D:4D) a całkowitą i aktywną masą ciała oraz wskaźnikiem BMI. Wskaźnik 2D:4D był znacząco niższy w stosunku do młodych kobiet nie uprawiających sportu. Zależny płciowo hormonalny wskaźnik 2D:4D miał ograniczoną predykcję u sportowców.

Key words: digit ratio, 2D:4D ratio, body composition, athletes
Słowa kluczowe: wskaźnik palcowy, wskaźnik 2D:4D, skład ciała, sportowcy

INTRODUCTION

In the previous years the interests of scientists in the study of proportion of fingers 2 to 4 has increased [1]. During previous studies it was established that finger length ratio (2D:4D) can be used as a marker of prenatal androgens exposition [2,3,4]. Its low level is connected with high prenatal and postnatal testosterone level, which then influences good visual – spatial skills, sports achievements and increased aggression [3,5,6,7,8]. In general human population 2D:4D ratio in men is lower than in women. Its value differs ethnically. For English population finger length ratio for men is 0.98, while it is 1.00 for women [9]. The development of competitive instinct (rivalry) is associated mainly with the males, which can be connected with high level of androgens. Women practicing sports may have been exposed to high levels of androgens in their natal life. 2D:4D ratio proves helpful in evaluating predisposition to practicing certain spots disciplines [5,8,,10,11,12,13,14].

The aim of the study was to evaluate the correlation between the digit ratio and body composition in athletes and comparing 2D:4D ratio in athletes and less physically active subjects.

MATERIALS AND METHODS

The material includes a group of athletes – 72 men and 60 women – aged between 18 and 36. Sports disciplines practiced by them include football, volleyball, kayaking, rowing and athletics. A few of them practice basketball, swimming and martial arts. Physiotherapy and dietetics students (140) from the Toruń University Collegium Medicum and tourism and recreation students (63) from the Bydgoszcz University were the control group.

The study was conducted in the Anthropology Department of Toruń University Collegium Medicum in 2013. The subjects had their body height and the length of 2nd and 4th finger measured. Anthropometric measurements were taken with Martin technique [15]. The length of fingers in the right hand was measured with linear calipers (GPM, Swiss Made). Body composition was measured with segmental bioelectric impedance analysis (SBIA), utilizing "In Body 3.0" device by Biospace Co. Ltd. SBIA method measures the electric resistance in the organism, which mainly depends on hydration of tissues and concentration of electrolytes [16, 17]. The following features of body composition were studied: protein mass, mineral bone mass, soft lean body mass, lean body mass, segmental lean body mass, waist girth to hip girth (WHR), muscle and total arm circumference.

General lean body mass (LBM) and segmental lean masses of limbs and corpus (sLBM) was estimated basing on general and segmental content of organic water in the body [18,19].

Basic statistical characteristics were calculated (arithmetic mean and standard deviation). Correlation analysis was used to evaluate co-dependence between digit ratio and certain elements of body composition. The differences between the athletes and control group were evaluated with "u" test.

RESULTS

The results of this study are presented in tables I – VII Basic measurements, anthropometric indexes and body composition of studied athletes are presented in tables I and II. The length of 2nd and 4th fingers and the value of digit ratio (2D:4D) in both sexes are shown in table III. In athletes of both sexes 4th finger was longer than the 2nd. In men the digit ratio was 0.974 while in women 0.983. Values of digit ratios in athletes practicing different disciplines are presented in tables IV and V. Among female athletes football players had the lowest value for 2D:4D ratio (0.969), while female kayakers and rowers had the highest value (1.008). In male athletes differences in particular disciplines were not very significant with the lowest values exhibited by those practicing athletics (0.961).

Table I. *Statistical characteristics of anthropometric features of the male and female subjects*

Tabela I. *Charakterystyki statystyczne cech antropometrycznych badanych sportowców*

Feature/cecha	Sex/płeć	
	♂ (n_1=72)	♀ (n_2=60)
	M ± SD	M ± SD
Age/wiek	22.1 ± 3.5	20.9 ± 4.3
Height/wysokość ciała [cm]	182.6 ± 6.8	173.3 ± 8.4
Body mass/masa ciała [kg]	78.3 ± 9.3	65.5 ± 8.9
Body Mass Index/wskaźnik BMI [kg/m^2]	23.41 ± 2.15	21.67 ± 1.66
Rohrer's index/wskaźnik Rohrera [g/cm^3]	1.28 ± 0.13	1.25 ± 0.11

M – mean
SD – standard deviation

Correlations between finger length ratio and selected body composition features were examined (table VI). In men digit ratio correlated significantly only with the length of 4th finger. In women the

correlation concerned protein mass, mineral bone mass, total and lean and part of segmental mass, namely right lower limb.

Table II. *Statistical characteristics of body composition of the subjects*
Tabela II. *Charakterystyki statystyczne składu ciała badanych sportowców*

Feature/cecha	Sex/płeć	
	♂ (n_1=72)	♀ (n_2=60)
	M ± SD	M ± SD
Protein mass/ masa proteinowa [kg]	17.56 ± 2.13	13.40 ± 1.81
Bone mass/ mineralna masa kości [kg]	3.60 ± 0.37	2.89 ± 0.31
Soft lean body mass/ miękka szczupła m.ciała[kg]	65.77± 7.99	50.12 ± 6.79
Lean body mass/ szczupła masa ciała[kg]	69.37 ± 8.36	53.01± 7.10
Segmental lean body mass/: $sLBM_{pkg}$	4.09 ± 0.67	2.74 ± 0.48
Segmentalna szczupła m. ciała $sLBM_{lkg}$	4.05 ± 0.65	2.71 ± 0.48
$sLBM_t$	30.66± 4.14	22.90± 2.90
$sLBM_{pkd}$	10.73 ± 1.23	8.36 ± 1.27
$sLBM_{lkd}$	10.69 ± 1.22	8.34 ± 1.27
Total circumference of arm/ obwód całkowity ramienia [cm]	28.74 ± 2.39	26.95 ± 1.55
Muscular circumference of arm/ obwód mięśniowy ramienia [cm]	26.67 ± 2.35	22.45 ± 1.48
Waist hip ratio/ wskaźnik WHR	0.80 ± 0.03	0.76 ± 0.03
Body Fat Mass/Tłuszcz całkowity [kg]	8.81 ±3.22	12.33 ± 2.92
Body Fat Percentage/ względny poziom tłuszczu [%]	11.20 ± 3.46	18.71 ± 3.30

LBM_{pkg} - right upper limb/ prawa kończyna górna
LBM_{lkg} – left upper limb/ lewa kończyna górna
LBM_t – trunk/ tułów
LBM_{pkd} – right lower limb/ prawa kończyna dolna
LBM_{lkd} – left lower limb/ lewa kończyna dolna
M – mean
SD – standard deviation

Table III. *Measurements of right hand fingers of the subjects*
Tabela III. *Pomiary palców prawej ręki badanych sportowców*

Feature/cecha	Sex/płeć	
	♂ (n_1=72)	♀ (n_2=60)
	M ± SD	M ± SD
Length of digit 2/długość palca II [cm]	7.50 ± 0.39	7.05 ± 0.40
Length of digit 4/długość palca IV [cm]	7.69 ± 0.46	7.18 ± 0.44
Digit ratio (2D:4D)/wskaźnik palcowy	0.974 ± 0.027	0.983 ± 0.031

M – mean
SD – standard deviation

Table IV. *Finger ratio in women practicing different sports*
Tabela IV. *Wskaźnik palcowy u kobiet uprawiających różne dyscypliny sportowe*

Discipline/ dyscyplina sportowa	N	M	SD
Football players/ piłkarki	17	0.969	0.026
Volleyball players/ siatkarki	26	0.981	0.027
Kayakers and rowers/ kajakarki i wioślarki	10	1.008	0.038

M – mean
SD – standard deviation

Table V. *Finger ratio in men practicing different sports*
Tabela V. *Wskaźnik palcowy u mężczyzn uprawiających różne dyscypliny sportowe*

Discipline/ dyscyplina sportowa	N	M	SD
Football players / piłkarze	37	0.976	0.027
Athletes/ lekkoatleci	14	0.961	0.029
Kayakers and rowers/ kajakarze i wioślarze	17	0.977	0.023

M – mean
SD – standard deviation

Table VI. *Correlation between the 2D:4D ratio and the examined features*
Tabela VI. *Korelacja między wskaźnikiem 2D:4D a badanymi cechami*

Feature/cecha	Sex/płeć	
	♂ (n_1=72)	♀ (n_2=60)
Heigh/wysokość ciała [cm]	-0.068	-0.166
Body mass/masa ciała [kg]	-0.065	-0.260*
Protein mass/masa proteinowa [kg]	-0.088	-0.267*
Bone mass/mineralna masa kości [kg]	-0.091	-0.257*
Soft lean body mass/miękka szczupła m. ciała [kg]	-0.090	-0.257*
Lean body mass/szczupła masa ciała [kg]	-0.090	-0.257*
Segmental lean body mass/ $sLBM_{pkg}$	-0.093	-0.228
segmentalna szczupła m. ciała $sLBM_{lkg}$	-0.095	-0.232
$sLBM_t$	-0.073	-0.233
$sLBM_{pkd}$	-0.104	-0.257*
$sLBM_{lkd}$	-0123	-0.252
Body Mass Index/wskaźnik BMI [kg/m^2]	0.024	-0.292*
Rohrer's index/wskaźnik Rohrera [g/cm^3]	0.014	-0.156
Waist Hip Ratio (WHR)/obwód pasa do bioder	0.064	-0.141
Muscular circumference of arm/obw. mięśniowy ramienia [cm]	-0.071	-0.189
Total circumference of arm/obw. całkowity ramienia [cm]	-0.020	-0.231
Body Fat Mass/Tłuszcz całkowity [kg]	0.055	-0.212
Body Fat Percentage/ względny poziom tłuszczu [%]	0.099	-0.152
Length of digit 2/długość palca II [cm]	0.039	0.181
Length of digit 4/długość palca IV [cm]	-0.419**	-0.345**

*p ≤ 0.05 ** p ≤ 0.01

Table VII. *Comparison finger ratio in athletes and students*
Tabela VII. *Porównanie wskaźnika palcowego u sportowców i studentów*

Sex/ płeć	Athletes/ sportowcy			Students/ studenci			Test „u"
	N	M	SD	N	M	SD	
♂	72	0.974	0.027	52	0.979	0.036	0.507
♀	60	0.983	0.031	151	0.993	0.031	2.113*

M – mean
SD – standard deviation

Differences between athletes and the control group are presented in table VII. One can conclude from it that male athletes and subjects who do not practice sports professionally do not differ significantly as far as finger length ratio is concerned. However, in females the difference between athletes and students as far as 2D:4D ratio was concerned was significant. The ratio of female athletes was significantly lower (0.983 and 0.993 respectively).

DISCUSSION

The results of our study confirm the sex differentiation of digit ratio, whose values are lower in men. Moreover, such fact was documented in several other publications [9,20,21,22]. 2D:4D ratio, as a marker of prenatal testosterone, was related to sports skills. However it is not absolutely clear whether this index is of greater influence than the most important personal characteristics (body height and mass, years of training). Numerous authors believe that digit ratio negatively correlates with sports skills, particularly in such disciplines as football, skiing, rowing, middle-distance running and endurance running, which depend on the effectiveness of cardio-vascular system [6,7,10,23,24].

In this study, in female athletes practicing various disciplines, the 2D:4D ratio was more differentiated than in males. Football players had the lowest (0.969), while kayakers and rowers (1.008) had the highest ratios. Female football players had even lower digit finger values than male footballers (0.976). It needs to be observed that such results were obtained from a small group. The measurements on which the calculation of finger length ratio (2D:4D) is based are burdened with measurement error and repeatability depending on the measurement technique used by various examiners [25]. As far as male rowers and kayakers are concerned, their digit ratio was much lower than the females (0.977 and 1.008 respectively). The study of Longman et al conducted on rowers proved that the digit ratio was a predictor of rowing skills only in men [6]. But this sport requires great effectiveness of cardio-vascular system and high endurance.

In the analysis of this study, a negative correlation was found between 2D:4D ratio and several examined features in the group of female athletes. They included protein body mass, mineral bone mass, total and lean body mass (particularly of right lower limb). In men no such correlations were found. While analyzing three indexes – BMI, Rohrer's and WHR – only BMI in women correlated significantly with digit ratio. In our previous studies none of the above indexes correlated with digit ratio [20]. Similar results were obtained by Danborno et al. and Neave et al. [21,26]. However, there are authors, who observed a significant correlation between these indexes [22].

Correlative dependency between typically masculinizing features of body composition and 2D:4D noted in the group of studied female athletes with the lack thereof in men suggests that sex dependent 2D:4D ratio has limited predictive properties in men. Similar conclusions were formed when studying a group of young men and women in 2011 [20]. This hypothesis is confirmed by Neave et al and Putz and Gaulin as well [26,27].

During comparison of digit ratio in the group of athletes with the group of students, who as assumed were to be less active physically, it was stated that significant differences occurred only in women. Female athletes were characterized by a significantly lower ratio when compared to the control group (0.983 and 0.993 respectively). It may attest to the fact that female athletes might have been exposed to high levels of androgens in the prenatal period. The lack of significant differences in the 2D:4D ratio between male athletes and male students again confirms a limited predictive property of this ratio in men.

CONCLUSIONS

Finger length ratio correlates with total and active body mass as well as with BMI in female athletes and it is significantly lower when compared with young women who do not practice sports. Sex dependent 2D:4D ratio had limited predictive properties in male athletes.

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