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Finger Length Ratio and Body Composition In Chuvashians

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A B S T R A C T

Very few studies that evaluated the association between finger length ratio and body composition in adult population showed very diverse results. We carried out a radiographic study on a large population sample who had participated in a Chuvashian skeletal aging study investigating different aspects of skeletal aging. The aims of this study were to evaluate the association between 2D:4D ratio and various indices of body composition in Chuvashian males and females. The study sample included 802 males (mean age 46.98±17.10 years) and 783 females (mean age 48.65±16.62 years). Single plain radiographs of both hands were taken. Each hand was classified according to whether the index finger was longer (Type 1), equal to (Type 2) or shorter than the ring finger (Type 3) by visual comparison of the soft tissue outline of the finger ends on the radiograph. Anthropometry, including body weight, stature, and six circumferences from the body trunk and extremities were taken from each participant. We found no evidence of substantial associations between visually assessed finger length ratio and adult body mass index, waist, hip and chest circumferences, waist-to-hip ratio and waist-to-chest ratio for men and women. These results suggest that associations between finger length ratio and hormone-related diseases and disorders can be interpreted directly, independent of any mediating effects of adult body composition parameters.

***Keywords*: body** *composition; 2D:4D; finger length ratio; Chuvashian population*

Introduction

The index to ring finger ratio or 2D:4D ratio is thought to be determined by testosterone exposure during early intra-uterine life[1–4]. It has been examined in relation to various physiological processes [5], sporting abilities[6, 7], and diverse health conditions[8–11].

It has been hypothesized, that prenatal androgen exposure may be related to adult anthropometric measures, especially abdominal adiposity[12]. However, very few studies[13–17] evaluated the association between finger length ratio and body composition in the adult population. In a study of 386 university students, Barut et al.[16] found weak inverse associations between both right and left finger length ratio and height and no associations with weight. McIntyre et al.[17] found a weak inverse association between right finger length ratio and waist circumference (WC) in a sample of 42 men between the ages of 31–76 years. Fink et al.[15] in a sample of 50 men and 70 women found moderately strong inverse associations between WC, hip circumference and the waist-to-chest ratio (WCR) and both right and left finger length ratio for women. In this study, body mass index (BMI) was strongly positively associated with the left finger length ratio in men. In another study of 127 men and 117 women by Fink et al.[14], right finger length ratio was inversely associated with hip circumference and positively correlated with waist-to-hip ratio (WHR) in men, but no associations were found between left or right finger length ratio and any anthropometric variables in women. A large Australian cohort study[13] of 8840 women and 6076 men found no association between finger length ratio and anthropometric measures (height, weight, WC, hip circumference, and bioelectrical resistance).

We carried out a radiographic study on a large population sample who had participated in a Chuvashian skeletal aging study investigating different aspects of skeletal aging within a Chuvashian population[18]. The aims of this study were to evaluate the association between 2D:4D ratio and various indices of body composition in Chuvashian males and females.

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Methods

Study design: Cross-sectional observational study.

Sample: The population sampled were native Chuvashians residing in numerous small villages in the Chuvasha and Bashkortostan Autonomies of the Russian Federation. The process described in detail elsewhere[19,20]. Data from 80–90% of the families (including all family members who were living in the area at the time of the expedition) were obtained. Since almost every individual was related to one of the families, we were able to collect data on up to 90% of the population in each village. All studied individuals were recruited randomly, i.e. regardless of the readings of any of the measured variables. Therefore, we believe that the study sample represented the entire rural population of this area.

The Chuvashians are believed to have originated from Turkic-Altaic Bulgar tribes who migrated from Northern Caucasus in the 7th to 8th centuries to the western region of the Middle Volga River. It is likely that they represent an amalgamation of Bulgars and the Finno-Ugric tribes who had previously lived in that area and did not adopt Islam[21]. During the 15th and 16th centuries, the Chuvashians emerged as a single nation, comprised of rural Bulgarians. Present-day Chuvashians are genetically related to Caucasians (Georgians), Mediterraneans, and Mid Easterners, scarcely possessing any indications of the Central Asian-Altaic gene flow[22]. The population was selected due to the homogeneity of the environment and genetic homogeneity. Most of the Chuvashian families live in the rural regions along Volga River and share similar living, economic, and occupational conditions.

The data collected included sex, age, anthropometrical characteristics (height, weight), occupation, as well as the nature and extent of their physical activities. Details on chronic morbidity and medical treatment were also requested in the questionnaire compiled for this study and once this information was available all persons with known bone disease, amenorrhea, or with post-traumatic, rheumatoid or psoriatic arthritis, as well as those subjected to hormone replacement therapy or steroid intake, were excluded from the study. X-ray films of both hands were obtained from the study participants in addition to the necessary examinations, measurements, and interviews. All these procedures were consensual. The subjects signed an informed consent form. The entire project was approved by the Helsinki Ethics Committee, Tel-Aviv University.

Hand radiographs*:* Single plain radiographs of both hands were taken in the posteroanterior position with the x-ray source located 60 cm above using a standard roentgenographic technique, as described in detail by Pavlovsky and Kobyliansky[23, 24]. Hands were placed on the same film-containing plate, without pressing arms against the plate, to avoid any film or development variation and exposed for 5–10 sec at 100–150 mA without intensifying screens at 50kV. All x-rays were digitized and the radiographic measurements were performed using digital images.

Visual classification*:* Each hand was classified according to whether the index finger was longer (type 1), equal to (type 2) or shorter than the ring finger (type 3) by visual comparison of the soft tissue outline of the finger ends on the radiograph. Similar to a previous study[25], the x-rays were classified as »definite« or »probable« according to the confidence of the observer. Each x-ray defined as "probable" was assessed by an additional reader and the consensus classification was recorded.

Anthropometric indices definition**:** Anthropometry, including body weight, stature, and six circumferences from the body trunk and extremities were taken from each participant. All the aforementioned measurements were taken by the same experienced investigator, according to a standard technique[26, 27]. Stature was measured with a portable anthropometer with 1 mm accuracy. Subjects were asked to hold their breath and maintain a fully erect position during the measurement. Body weight was measured with a mechanical balance beam scale. Circumferences were measured with a cloth tape measure up to 1 mm.

WC was used as an independent measure of both intra-abdominal fat mass and total fat[28, 29]. WHR was calculated as WHR= waist circumference/hip circumference. WCR was calculated as WHR= WC/chest circumference. BMI was calculated as: BMI= weight/stature^2.

Statistical analysis*:* All statistical computations were performed using SPSS 17.0 for Windows (SPSS, Chicago, IL, USA). Mean and standard deviation for age, BMI. WC, hip and chest circumferences, WHR, and WCR measurements and frequencies of visual classification types were calculated for each sex separately using descriptive statistics. To compare the continues variables between males and females we used one-way ANOVA. To compare the finger ratio types, the Pearson's chi-square test was used.

Pearson correlation analysis was used to test the association between body composition variables and age in each sex separately.

To compare the body composition variables between males and females with different finger length ratio types (after adjustment for age) one-way ANCOVA was used. The analysis was performed four times, separately for males and females and for finger length ratio types of right and left hands.

Results

The study sample (Table 1) included 802 males (mean age 46.98±17.10 years) and 783 females (mean age 48.65±16.62 years) (age difference between males and females was not significant p=0.053). Male BMI (23.19±3.26 kg/m^2) was lower than the females (25.16±4.87 kg/m^2) ($p<0.001$). (Table 1)

Distribution of finger length ratio types in the studied sample is shown in Table 2. It was no significant differences ($p>0.05$) between right and left hand in the prevalence of each type of finger ratio in males and in females. However when the distribution of finger length ratio types

TABLE 1
CHARACTERISTICS OF THE STUDIED SAMPLE (MEAN ± STANDARD DEVIATION).

Characteristic	**Men**	**Women**	**Comparison***
No. of participants	N=802	N=738	
Age (years)	46.98±17.09	48.65±16.62	F=3.74, p=0.053
Height (m)	1.66±0.07	1.54±0.06	**F=1258.38, p<0.001**
Weight (kg)	64.04±10.39	59.97±12.11	**F=49.26, p<0.001**
BMI (kg/m^2)	23.19±3.26	25.16±4.87	**F=86.30, p<0.001**
Waist circumference (mm)	810.40±94.25	793.26±126.02	**F=8.93, p=0.003**
Hip circumference (mm)	897.60±54.16	948.58±86.73	**F=188.03, p<0.001**
Chest circumference (mm)	909.16±67.65	869.97±81.11	**F=103.52, p<0.001**
WHR	0.901±0.07	0.833±0.08	**F=302.48, p<0.001**
WCR	0.890±0.05	0.908±0.07	**F=30.19, p<0.001**

*Results of one-way ANOVA (d.f.=1), Statistically significant differences (p<0.05) marked in bold.

TABLE 2
DISTRIBUTION OF FINGER LENGTH RATIO (2D:4D) IN STUDIED SAMPLE

Finger length ratio	**Hand**	**Men** N (valid %)	**Women** N (valid %)
Type 1 (2D>4D)	Right	154 (20.5%)	181 (25.2%)
	Left	175 (22.9%)	188 (26.0%)
Type 2 (2D=4D)	Right	109 (14.5%)	132 (17.9%)
	Left	109 (14.3%)	122 (16.9%)
Type 3 (2D<4D)	Right	490 (65.1%)	404 (56.3%)
	Left	479 (62.8%)	412 (57.1%)

compared between males and females, it was a significant difference (d.f.=2, χ^2=11.769, p=0.003) when right hand was compared and no significant differences (d.f.=2, χ^2=5.107, p=0.078) when left hand was compared. Males had a lower prevalence of type 1 and type 2 finger length ratio types and higher prevalence of type 3 finger ratio types. (Table 2)

Associations between body composition parameters (Table 3) and age were all statistically significant in univariate analyses (Pearson correlations). The lowest correlation with age was seen in BMI of males (r=0.085, p=0.017), and highest correlations were of WHR in males (r=0.504, p<0.001) and females (r=0.562, p<0.001**).** Males showed slightly lower correlation coefficients than women in all parameters. (Table 3)

Results of comparisons of body composition parameters individuals with different finger length ratio types (after adjustment for age) are shown in Table 4. Only two parameters showed significant association with finger length ratio types, both of right hand. Males with type 1 (female type) showed lower BMI values (adjusted for age) than ones with type 2 and 3 ratios. Females with type 3 (male type) finger ratio showed significantly lower hip circumference than ones with type 2 ratio. (Table 4)

TABLE 3
RESULTS OF PEARSON CORRELATION ANALYSIS BETWEEN BODY COMPOSITION AND AGE

Body composition parameters	**Men**	**Women**
BMI (kg/m^2)	**r=0.085, p=0.017**	**r=0.275, p<0.001**
Waist circumference (mm)	**r=0.298, p<0.001**	**r=0.424, p<0.001**
Hip circumference (mm)	**r=–0.093, p=0.009**	**r=0.140, p<0.001**
Chest circumference (mm)	**r=0.137, p<0.001**	**r=0.292, p<0.001**
WHR	**r=0.504, p<0.001**	**r=0.562, p<0.001**
WCR	**r=0.394, p<0.001**	**r=0.509, p<0.001**

BMI – body mass index; WHR – waist to hip ratio; WCR – waist to chest ratio; Statistically significant differences (p<0.05) marked bold;

Discussion and Conclusions

The results of this study provide further evidence that the finger length ratio (2D:4D) is a sexually dimorphic trait with men having a significantly higher prevalence of type 3 hands (the male pattern, 2D<4D) than women and women having a significantly higher prevalence of type 1 hands (the female pattern, 2D>4D) than men.

In the present study, sex dimorphism was almost identical for right and left hands, for the visual classification. This symmetry is in accord with previous radiographic studies[7, 25], but with differing results reported in a large study on self-measured finger ratios[30] and a study reporting on direct and indirect measured finger ratios[31]. The variance most likely can be explained by differences in measurement methods or by the diversity of the populations. We believe that further radiographic evidence obtained from a normal population is needed.

TABLE 4
ASSOCIATION BETWEEN VISUAL CLASSIFICATION OF FINGER LENGTH RATIO AND BODY COMPOSITION PARAMETERS

	Sex	Visual Classification	Right hand N	Right hand Mean ± SD	Left hand N	Left hand Mean ± SD
BMI (kg/m^2)	Males	Type 1: 2>4	150	22.56 ± 2.97	171	23.04 ± 3.25
		Type 2: 2=4	106	23.62 ± 2.96	106	23.50 ± 3.42
		Type 3: 2<4	481	23.26 ± 3.31	470	23.25 ± 3.231
		One way ANCOVA*	**F=3.525, p=0.030**		F=0.687, p=0.504	
	Females	Type 1: 2>4	177	24.71 ± 5.02	184	24.79 ± 4.60
		Type 2: 2=4	132	25.44 ± 5.12	122	25.36 ± 5.18
		Type 3: 2<4	397	25.31 ± 4.76	401	25.26 ± 4.93
		One way ANCOVA*	F=1.975, p=1.140		F=1.138, p=0.321	
Waist circumference	Males	Type 1: 2>4	146	797.99 ±85.28	168	805.86 ±91.39
		Type 2: 2=4	107	817.76 ± 85.95	105	812.37 ± 93.85
		Type 3: 2<4	477	810.96 ± 96.46	464	812.22 ± 95.95
		One way ANCOVA*	F=1.548, p=0.213		F=0.398, p=0.672	
	Females	Type 1: 2>4	177	817.76 ± 85.95	185	777.10 ± 121.45
		Type 2: 2=4	132	810.96 ± 96.46	121	792.60 ± 132.15
		Type 3: 2<4	396	803.22 ± 125.31	400	800.36 ± 126.34
		One way ANCOVA*	F=1.315, p=0.269		F=1.117, p=0.328	
Hip circumference	Males	Type 1: 2>4	148	896.40 ± 50.36	168	903.87 ± 55.25
		Type 2: 2=4	107	902.66 ± 53.00	106	904.90 ± 55.87
		Type 3: 2<4	476	896.51 ± 54.81	464	895.18 ± 52.77
		One way ANCOVA*	F=0.492, p=0.611		F=1.867, p=0.155	
	Females	Type 1: 2>4	178	945.65 ± 90.24	186	950.42 ± 87.86
		Type 2: 2=4	132	962.15 ± 99.17	121	952.73 ± 93.49
		Type 3: 2<4	393	946.01 ± 80.88	397	946.12 ± 84.37
		One way ANCOVA*	**F=3.948, p=0.020**		F=1.883, p=0.153	
Chest circumference	Males	Type 1: 2>4	148	906.01 ± 61.27	169	909.73 ± 64.25
		Type 2: 2=4	106	913.21 ± 64.75	106	914.28 ± 70.95
		Type 3: 2<4	477	907.66 ± 69.70	464	908.33 ± 68.76
		One way ANCOVA*	F=0.694, p=0.500		F=0.816, p=0.443	
	Females	Type 1: 2>4	178	864.32 ± 84.76	186	866.17 ± 80.96
		Type 2: 2=4	132	873.29 ± 84.35	121	872.17 ± 84.78
		Type 3: 2<4	397	871.30 ± 78.47	401	870.03 ± 79.94
		One way ANCOVA*	F=2.508, p=0.082		F=2.054, p=0.129	
WHR	Males	Type 1: 2>4	146	0.89 ± 0.06	166	0.89 ± 0.07
		Type 2: 2=4	107	0.91 ± 0.07	105	0.90 ± 0.07
		Type 3: 2<4	474	0.90 ± 0.07	462	0.90 ± 0.07
		One way ANCOVA*	F=2.330, p=0.098		F=0.254, p=0.776	
	Females	Type 1: 2>4	177	0.82 ± 0.08	185	0.82 ± 0.08
		Type 2: 2=4	132	0.82 ± 0.07	121	0.83 ± 0.08
		Type 3: 2<4	392	0.84 ± 0.08	396	0.84 ± 0.08
		One way ANCOVA*	F=0.450, p=0.638		F=0.557, p=0.573	
WCR	Males	Type 1: 2>4	146	0.88 ± 0.05	167	0.89 ± 0.05
		Type 2: 2=4	106	0.89 ± 0.06	105	0.89 ± 0.05
		Type 3: 2<4	474	0.89 ± 0.05	461	0.89 ± 0.05
		One way ANCOVA*	F=2.164, p=0.116		F=0.082, p=0.921	
	Females	Type 1: 2>4	177	0.89 ± 0.07	185	0.89 ± 0.07
		Type 2: 2=4	132	0.90 ± 0.07	121	0.90 ± 0.07
		Type 3: 2<4	396	0.92 ± 0.07	400	0.92 ± 0.07
		One way ANCOVA*	F=0.105, p=0.900		F=0.157, p=0.855	

Statistically significant association ($p<0.05$) marked in bold. *adjusted for age.

Significant correlations were found between age and body composition parameters in men and women. In all parameters, correlation coefficients were higher in women than in men. In men, BMI, hip, waist and chest circumferences showed low, WCR showed moderate and WHR high correlation with age. In women, BMI, hip, and chest circumferences showed low, WC showed moderate, and WHR and WCR high correlation with age.

Associations between body composition parameters and visual classification of finger length ratio (adjusted for age) were significant only in two out of 24 analyses. Right-hand visual classification of finger ratio significantly associated with BMI in males, and with a hip circumference in females. Left-hand visual classification of finger ratio showed no associations with body composition parameters. These results are in accord with ones of a large Australian cohort study[13] that found no association between finger length ratio and height, weight, WC, hip circumference, and bioelectrical resistance. On the other hand, several smaller studies showed different results. McIntyre et al. [17] in a sample of 42 males found a weak inverse association between right finger length ratio and WC. Fink et al.[15] in a sample of 50 males and 70 females found moderately strong inverse associations between right and left finger length ratio and WC, hip circumference and WCR in females. BMI was strongly positively associated with left finger length ratio in males. In another study of 127 men and 117 women by the same group[14], right finger length ratio was inversely associated with hip circumference and positively correlated with WHR in men, but no associations were found between left or right finger length ratio and any anthropometric variables in women. Because two large studies found no or weak associations between body composition parameters and finger length ratio and taking into consideration the inconsistent results of previous small studies we can that there are no substantial associations between 2D:4D and the assessed body composition measures. Subsequently, it is unlikely that adult body composition measures mediate any association between 2D:4D finger length ratio and risk of adult diseases and disorders.

The primary advantage of this study is its large sample size, second only to one of Muller et al[13], which allows the detection of very small associations. Another advantage is that anthropometrical measurements were made by same trained and experienced investigator, so any measurement error or bias is minimized.

In summary, we found no evidence of substantial associations between visually assessed finger length ratio and adult BMI, WC, hip and chest circumferences, WHT and WCR for men and women. These results suggest that associations between finger length ratio and hormone-related behaviors, diseases and disorders can be interpreted directly, independent of any mediating effects of adult body composition parameters.

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OMJER DULJINE PRSTIJU I SASTAVA TIJELA KOD STANOVNIKA ČUVAŠKE

S A Ž E T A K

Vrlo je malo studija koje su procjenjivali povezanost omjera dužine prstiju i sastava tijela u odrasloj populaciji, a pokazale su vrlo različite rezultate. proveli smo radiografička istraživanja na velikom uzorku populacije, koji su sudjelovali u studiji koštanog starenja koja istražuje različite aspekte koštanog starenja. Ciljevi ovog istraživanja bili su procijeniti povezanost između 2D: 4D omjera i raznih pokazatelja u sastavu tijela u kod čuvaških mužjaka i ženki. Uzorak istraživanja uključuje 802 muškaraca (prosječna dob 46,98 ± 17,10 godina) i 783 žene (prosječne dobi 48,65 ± 16,62 godina). Pojedinačne rendgenske snimke obje ruke su uzeti u obzir. Svaka ruka je klasificirana prema tome je li kažiprst bio duži (Tip 1), jednaka (Tip 2) ili kraći od prstenjaka (Tip 3) vizualne usporedbe obrisa meko tkivo prsta završava na snimkama. Antropometrija, uključujući tjelesne težine, stas, a šest kružnica iz tijela trup i ekstremitete su uzeti kod svakog sudionika. Nismo našli dokaze o značajnim povezanosti vizualne ocjene omjera dužine prstiju i BMI-a odraslih, WC-a, hip i prsima kružnica, WHT i WCR za muškarce i žene. Ovi rezultati sugeriraju da povezanost između omjera duljine prstiju i bolesti i poremećaja vezanih uz hormone može se tumačiti izravno, neovisno o bilo kojem posrednom učinaku odraslih parametara sastava tijela.