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COMPARATIVE STUDY OF DIGIT RATIO IN MEN OF BARU (HUNEDOARA COUNTY) AND ORADEA (BIHOR COUNTY), ROMANIA

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ABSTRACT. The second to fourth digit ratio reflects prenatal estrogen and testosterone exposure and it is established in utero (*Bunevicius et al., 2016*). Digit ratio (2D:4D) denotes the relative length of the second and fourth digits. Many authors considered this ratio to be a biomarker of the balance between fetal estrogen and testosterone in a narrow window of early ontogeny (*Manning et al., 2014*). Males and females generally have different finger proportions. Thus, in men, the 2nd digit is shorter than 4th digit, but in women, 2nd has an equal length or longer than the 4th digit. Our study is particularly about the digit ratio 2D:4D, but 2D:3D and 3D:4D, too in men populations. The research was made in two localities of different counties of Romania: Baru (of Hunedoara county) and Oradea (of Bihor county). Our aim was to identify possible significant differences between the two male populations. The results are important because demonstrate the differences between the two men populations coherently the digit ratio.

Keywords: digit ratio, digit length, biomarker, men populations, fetal sex hormones.

INTRODUCTION:

The 2D:4D ratio is a sexually dimorphic trait (. The digit ratio is the ratio of the lengths of different digits or fingers typically measured from the midpoint of bottom crease (where the finger joins the hand) to the tip of the finger (Mayhew *et al*., 2007). Some scientists said that the ratio of two digits in particular, the 2nd and 4th, is affected by exposure to androgens while in the uterus and that this 2D:4D ratio can be considered a crude measure for prenatal androgen exposure, with lower 2D:4D ratios pointing to higher prenatal androgen exposure (Hönekopp *et al*., 2007, Malas *et al*., 2006, Zheng et Cohn, 2011*)*. The second-to-fourth digit length ratio (2D:4D) is an indicator of prenatal testosterone exposure (Kociuba et al., 2016). Also, Kociuba *et al.* (2016) said that a lower 2D:4D indicates higher PT exposure and vice versa. Males generally have a lower 2D:4D than females. Sensation- and/or thrill-seeking behaviours have also been found to be negatively associated with 2D:4D. They said that boxing and judo are considered to be high-risk sports. Manning is an author who has many investigations about digit ratio and he is a pioneer in this domain. Since 2000, he suggested the following about the 2D:4D digit ratio: a) is fixed in utero; b) is lower in men than in women; c) is negatively related to testosterone and sperm counts; d) is positively related to oestrogen concentrations.

There are more authors who investigated this sex ratio, in different content, such are: Brown *et al*., (2002), Peters *et al*. (2002), Burley and Foster (2004) The 2D:4D ratio is calculated by dividing the length of the index finger of the right hand by the length of the ring finger of the right hand. A longer index finger will result in a ratio higher than 1, while a longer ring finger will result in a ratio of less than 1. The 2D:4D digit ratio is sexually dimorphic: while the second digit is typically shorter in both females and males, the difference between the lengths of the two digits is greater in males than in females.

Many scientists focused on the possibility of using the digit ratio as a marker to early identifying important diseases, personality and behavior traits, artistic and athletic skills. Thus, Sheng *et al.,* (2016), investigated whether there is a possible relationship between 2D:4D ratio and gastric cancer (GCA) in Chinese men. They obtained that in gastric cancer 2D:4D ratios were significantly lower (right hand: $p<0.01$; left hand, mean hand: $p<0.001$) than controls. Also, they observed no association between 2D:4D ratio and tumor staging (neither in tumor size (T) nor in lymph node involvement (N) or distant metastases (M). Kyriakidis *et al*., (2010), investigated the digit ratios and relations for predisposition to myocardial infarction in Greek men and women and suggested that digit ratios that include ring-finger (4th digit) may be useful biomarkers to myocardial infarction in Greek men but not in Greek women. Lu *et a*l., (2015) proposed that sex steroids exposure during human development may influence diseases susceptibility. Also, they found that second to fourth digit ratio is thought to be a putative biomarker for prenatal hormone level during foetal life and their conclusion was that 2D:4D may correlate particularly with risk of coronary heart disease in Chinese men. Other authors, such as Wu *et al*., (2013), investigated the 2D:4D digit ratio in Chinese women and found no significant differences between the coronary artery disease group and control group. Bove *et al.*, (2015), purposed a research to determine whether the 2D:4D ratio (ratio of the second and fourth digit lengths), a proxy for lower prenatal androgen to estrogen ratio, differs in men with and without multiple sclerosis using a case-control study design. They observed that during the prenatal period, low androgens could represent a risk factor for multiple sclerosis. Furuya *et al*., (2015), tried to clarify

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the relationship between midline cyst formation and second to fourth finger length ratio. They obtained that the second to fourth finger length ratio is higher in subjects with midline cyst of the prostate. Also, they said that it can be speculated that the prostatic utricle dilates in cases less exposed to male hormones during fetal development. Xie *et al.*, (2015), investigated the hypothesis that prenatal sex steroids constitute an independent risk factor for adult headaches later in life. Their results suggested that the 2D:4D ratio is a risk factor of migraine and tension-type headache and that the balance of prenatal estrogen and testosterone in utero may impact adult primary headache disorders.

Feily et al., (2016) based on the receiver operating characteristic curve analysis, claimed that 2D:4D does not predict the development of androgenic alopecia. Androgenic alopecia is truly a multifactorial disease. Further, they said that their findings suggest that increased *in utero* exposure to androgens as a fetus does not predispose men to develop androgenic alopecia. Other authors (Bilgic et al., 2016) obtained data that support the anatomical evidence of in utero androgen exposure and/or an individual's sensitivity to androgens in individuals with androgenetic alopecia. Furthermore, according them, the right hand 2D:4D ratio might be an indicator of androgenetic alopecia development.

Ribeiro et al., (2016) concluded that 2D:4D is a negative correlate of strength in challenge situations. According them, this finding may in part explain associations between 2D:4D and sports performance. The results of Li et al., (2016), suggest that a higher R2D:4D (right hand 2D:4D) is a risk factor for phimosis in the early human development. Also, according their research, age is also a significant influence factor of foreskin conditions, but additional research is required to identify pathophysiologic mechanisms and to determine clinical significance.

Hong *et al.*, (2014) found that digit ratio (2D:4D) may correlate with the increased risk of breast cancer. Krishnakumar *et al*., (2014) obtained in their study significant negative associations between myopia and digit ratio favouring a probable causal role of sex steroids on eye growth and development of myopia.

Some of scientists focused on digit ratio in individuals with mental disease. Here we mention the studies of Al-Zaid *et al.*, (2015) who found a significantly lower 2D:4D ratio in Saudi boys with autism, which indirectly suggests that these boys were exposed to high levels of prenatal fetal testosterone. The same subject, autism, is discussed by Masuya *et al.*, (2015) and they said that their findings suggest that high prenatal testosterone could be a risk factor both for Japanese men and women with autism spectrum diseases (ASDs), elucidating one potential etiology of ASDs in women. The results of Lenz et al., (2016), indicated increased risk of suicide following higher prenatal androgen exposure in males. The results of them may improve future efforts to predict and prevent suicides.

There are interesting the studies about Alzheimer disease. Vladeanu *et al*,. (2014) investigated an association between prenatal sex hormone exposure and dementia diagnosis. Their findings suggest that lower levels of prenatal testosterone and higher levels of estrogen exposure are a risk factor for Alzheimer disease in men and that higher levels of prenatal testosterone and lower levels of prenatal estrogen exposure are a risk factor for women.

Brown *et al.*, (2002) observed masculinized finger length patterns in human males and females with congenital adrenal hyperplasia. Lu *et al.*, (2012) suggested that digit ratio, especially 2D:4D in the left hand may be one of the important markers of infertility in men for early diagnosis. Some studies are related the digit ratio and sexual orientation. Vujovic *et al*,. (2014) found in their researches that male to female transsexuals showed similar 2D:4D of the right hand with control women indicating possible influencing factor in embryogenesis and consequently finger length changes. They also obtained that female to male transsexuals showed the lowest 2D:4D of the left hand when compared to the control males and females. They resumed that their results go in the favour of the biological aetiology of transsexualism. Some authors suggest that personality and behavior traits are linked much stronger with digit ratio of right hand than of left hand (Manning et Robinson, 2003; Williams *et al.*, 2003; Voracek *et al.*, 2005; Honekopp *et al.*, 2006; Barona *et al.*, 2015; Carré *et al*, 2015; Li *et al.*, 2015; Mitsui *et al.*, 2016;).

Manning et al. (2014) discuss the refinement of the 2D:4D paradigm in relation to the links between 2D:4D and sports performance and aggression. Sudhakar *et al*., (2014a) suggested that 2D:4D ratios can be used as reliable additional criteria when screening for prospective kabaddi players to be inducted into the team. Sudhakar *et al*,. (2014b) investigated digit ratio in Indian swimmers and suggested that 2D:4D ratio could be used to identify young sports personnel who have potential to rich high levels of performance.

There are more other interesting studies about artistic and sports performances. Thus, Wang et al., (2016), suggest there seems to be a significant positive correlation between 2D:4D digit ratio and precision of fine motor skill. In addition, there is a negative correlation between 2D:4D ratio and speed of fine motor activity. Other authors studied the correlation between digit ratio and physical skills (Longman *et al.*, 2015; Xu and Zeng, 2016).

MATERIALS AND METHODS:

The studied groups were consisted of 200 individuals of Baru and 200 individuals of Oradea. We measured the length of index (2nd digit), median (3rd digit) and ring (4th digit). The length of the fingers were measured by a single investigator (for best accuracy) using a digital Vernier caliper. Measurements were taken from the bottom crease to the tip of the finger on the palmar surface of hands. The length of the index finger was divided by the length of the ring finger to obtain the 2D:4D ratio. The length of the index finger was divided by the length of the median finger to obtain 2D:3D ratio. The length of median finger was divided by the length of the ring

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finger to obtain the 3D:4D ratio. To compare the digit ratios it was used the Z test. The statistical significance was set at $p<0.05$.

RESULTS AND DISCUSSIONS:

Table 1 and table 2 are showing the statistical results after the measurements of studied fingers were made. In table 1 are described the statistical data of male group of Baru. The variability of the trait is low (all the values are between 5 and 6).

The differences between two hands may be due to prenatal sex hormones exposure and genetic differences. The values of right hand means are higher than left hand.

Table 1.

Statistical processing of the data representing measured finger lengths in male studied group of Baru.

Parameters	Right hand			Left hand		
	index	median	ring	index	median	ring
Average	7.5949	8.2530	7.7750	7.5560	8.2111	7.8010
Standard deviation	0.4326	0.5329	0.4452	0.4452	0.4442	0.5157
Variability coefficient	5.6970	6.4576	5.7268	5.5653	5.4098	6.6108
Variance	0.1871	0.3829	0.1982	0.1768	0.1973	0.2659

In the Oradea male studied group (Table 2), the trait vary very similar with in Baru male group, the values are also under 10 (that means low variability of the trait).

Comparing the finger lengths of the right hands in men of Baru and men of Oradea, we obtained significantly differences in each studied fingers (for index, $z = 2.4132$, for median, $z = 2.3551$ and for ring finger, $z = 3.2915$. These values are between the range of significance corresponding at $p = 0.05$ and $p = 0.01$).

The values of right hand means are lower than left hand in the male group of Oradea, too.

Table 2.

Statistical processing of the data representing measured finger lengths in male studied group of Oradea.

Parameters	Right hand			Left hand		
	index	median	ring	index	median	ring
Average	7.4460	8.0660	7.5650	7.4410	8.1040	7.6010
Standard deviation	0.4404	0.4989	0.4577	0.4136	0.4819	0.4602
Variability coefficient	5.9156	6.1856	6.0514	5.5594	5.9474	6.0549
Variance	0.1939	0.2489	0.2094	0.1710	0.2322	0.2117

In Table 3 are showed the values of digit ratios in the studied group of male from Baru. Comparing the averages of digit ratio of the two hands, there were no significant differences (2D:4D=1.4074, $p>0.05$; 2D:3D=0.8510, $p>0.05$; 3D:4D=1.35, $p>0.05$). The variability of digit ratio values is low (between 0 and 10).

Table 3.

Statistical processing of data representing the digit ratios in male studied group of Baru.

Parameters	Right hand			Left hand		
	2D:4D index/ ring	2D:3D index/ median	3D:4D median/ ring	2D:4D index/ ring	2D:3D index/ median	3D:4D median/ ring
Average	0.9771	0.9127	1.0622	0.9695	0.9207	1.0541
Standard deviation	0.0337	0.0881	0.0324	0.0445	0.0366	0.0431
Variability coefficient	3.4536	9.6597	3.0532	4.5988	3.9835	4.0925
Variance	0.0011	0.0077	0.0010	0.0019	0.0013	0.0018

In Table 4 are the values of digit ratios founded in Oradea male studied group. Comparing the averages of digit ratio of the two hands, we found no significant differences (2D:4D=0.4758, $p>0.05$; 2D:3D=0.48, $p>0.05$; 3D:4D=1.35, $p>0.05$). The variability of digit ratio values is low (between 0 and 10) and in generally higher than in Baru male studied population (making an exception the values of 2D:4D and 3D:4D in left hand).

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Table 4.
Statistical processing of data representing the digit ratios in male studied group of Oradea.

Parameters	Right hand			Left hand		
	2D:4D index/ ring	2D:3D index/ median	2D:4D index/ ring	2D:3D index/ median	2D:4D index/ ring	2D:3D index/ median
Average	0.9831	0.9157	1.0639	0.9786	0.9098	1.0645
Standard deviation	0.0385	0.0889	0.0418	0.0377	0.0882	0.0307
Variability coefficient	3.9244	9.7174	3.9375	3.8571	9.7003	2.8884
Variance	0.0014	0.0079	0.0017	0.0014	0.0077	0.0009

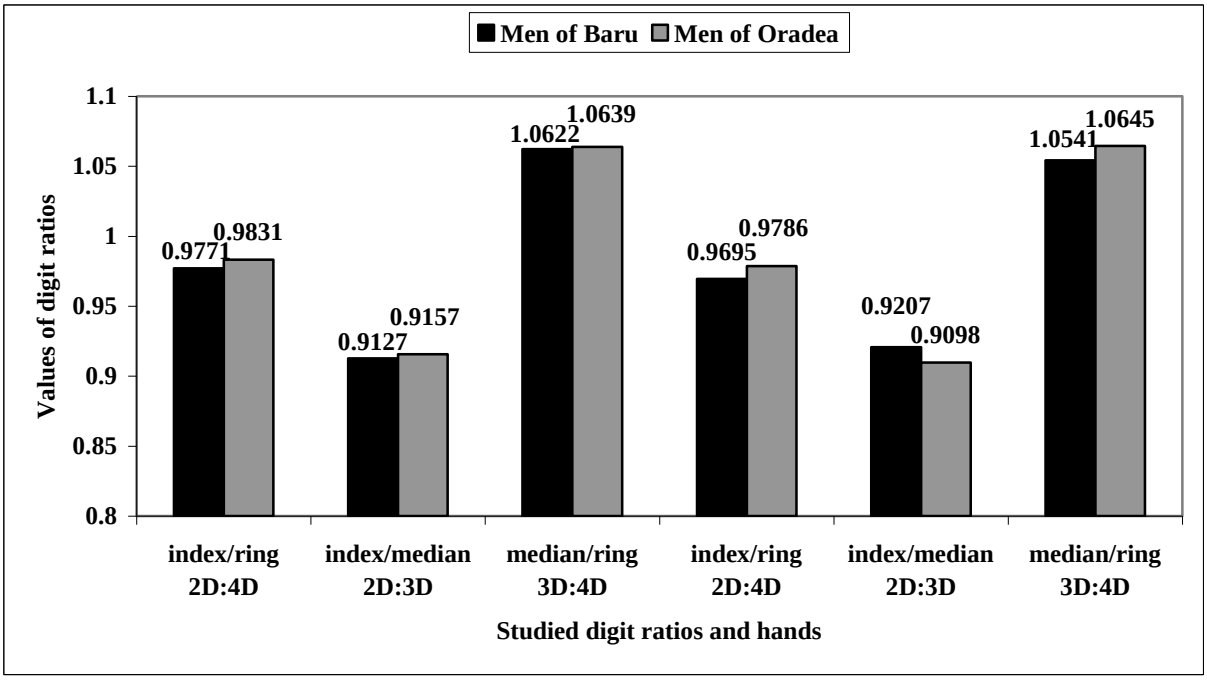

Fig. 1. Comparative graphic representation of digit ratios in the two studied populations.

In Figure 1 is represented a comparison of digit ratio values obtained in the two male populations. We found not significant differences after comparison of digit ratios in the right hands (2D:4D = 1.2, $p>0.05$). 2D:3D = 0.2419, $p>0.05$ and 3D:4D = 0.33, $p>0.05$).

The value of the variability coefficients shows a homogeneity of the finger length character.

Our study is according with other studies on this theme. Thus, Trivers et al. (2006) made a longitudinal study of digit ratio 2D:4D and other finger ratios in Jamaican children. They found that 2D:4D increases slightly with age in children the effect less marked for the right hand. In our study, the age of subjects was over 18 and under 60. Also, in our study we didn't selected the subjects to belong to a certain family.

After Manning et al. (1998) made it clear that this study of gender difference has come to the attention of several researchers suggesting that 2D: 4D be an indicator marker for prenatal androgen and permanent effects on brain and behavior. It is known that these differences that occurred prenatally are not altered during postnatal growth (Malas et al., 2006). Yang *et al*,. (2009) studied 2D:4D digit ratios, sex differences and behavior in Chinese men and women and resumed that within each sex, however, 2D:4D ratios, measures of masculine characteristics and salivary testosterone showed no significant associations with one another.

Manning *et al.*, (2003) investigated 2D:4D digit ratio in three ethnic groups. They obtained strong ethnic differences because were associated with large family size in men. In our research there are no strong differences between the two studied populations because they are heterogenous. Fink *et al*., (2004) tested whether digit ratio is related to the degree of hand skill. Their findings in Caucasian population with high mean 2D:4D suggest that a tendency of improved left-hand performance due to prenatal testosterone may be found across ethnic groups.

Also, in China, Xu and Zheng (2015) made a meta-analysis of 2D:4D digit ratio, and concluded that the sex differences in Chinese 2D:4D are consistent with the results from western studies, and that latitude-related environmental variables do not affect significant the digit ratio. They conclude that genetic pool differences are responsible for the 2D:4D values.

We hope that this study can be useful for future investigations and so, we start to create a database to be able to compare different individuals from different geographic area.

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CONCLUSIONS:

After measurements of 200 individuals of each populations we can conclude that we found significant differences about finger lengths. In digit ratio we didn't observe significant differences. Variability of finger lengths is small either in Baru male group and Oradea male group. Comparing the finger lengths of the two populations, we obtained significant differences between each studied finger of right hands. Also, we observed no significant differences between 2D:4D digit ratio of right hand in the two studied populations and between them. These results are because of genetic pool. The differences are more visible comparing the two populations than comparing the values of the two hand in each population. Differences occur with respect to the average length of fingers on the right hands. The lack of significant differences within the same batch regarding finger lengths and digit ratio may be due to the fact that the two populations are genetically heterogeneous (the Baru locality, although it consists of a population of almost 3000 inhabitants, while Oradea has more than 100,000). Significant can be explained to both genetic dowry and environmental factors (occupations, food habits, life, etc.). For more accuracy of the data and results, we recommend to not mix the methods of measurement in one study. We recommend to use only one method.

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