

Study of Fingerprint Patterns in Left-Handed and Right-Handed Bulgarian Individuals

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The aim of the present study is to assess the variability of fingerprint patterns in the individuals of Bulgarian ancestry and establish their relationship with hand dominance. The study includes 390 subjects (277 females and 113 males) aged 19-30 years. Of these, 285 are right-handed, 94 left-handed, and 11 are ambidextrous. The subjects are clinically healthy, of Bulgarian ethnicity.

Rolled fingerprints were obtained by the ink method. Papillary patterns were classified into four main types. The data were analyzed with statistical software SPSS 19.0. A pattern model (U>W>A>Y) of the distribution of papillary fingerprints was found for both hands in left-handers and right-handers. Significant differences were found in the fingerprints of the first ($p = 0.009$), second ($p = 0.008$) and fifth fingers ($p = 0.053$) on the left hand between left-handed and right-handed females. In males the differences did not reach statistical significance ($p > 0.05$).

Key words: fingerprint patterns, handedness, Bulgarian individuals

Introduction

Dermatoglyphic ridges are resistant, permanent throughout life and diagnostically sensitive traits, varying in most cases independently from each other. A large number of modern studies address the relationship between fingerprints and genetically determined tendency for hand dominance [3]. S. Coren [4] suggests a genetic mechanism in the development of hand dominance, which allows differentiation between pathological and natural left-handedness.

In a number of studies, attention is paid to sexual dimorphism in papillary fingerprints of right-handed and left-handed people [16]. According to W. Buchwald [2], in most cases a higher degree of variety of images is found in males, and in terms of fourth finger, diversity is equally valid for both sexes.

A major aim in the studies of many authors is the higher bilateral asymmetry of dermatoglyphic traits in the left-handed subjects. In his paper G. Karev, [7] has found

more expressed fluctuating asymmetry in ulnar loops on the first and fourth fingers of right-handed subjects significantly compared with left-handed and ambidextrous subjects. E. Kobylansky and S. Micle [11] have investigated dermatoglyphic signs of right-handed and left-handed males. In their opinion, fluctuating asymmetry is lower in right-handed persons and the directional asymmetry higher in left-handed persons.

In Bulgaria, dermatoglyphic studies performed have been concerned with ethnicity [8], sexual dimorphism and fluctuating asymmetry [1], clinical application of dermatoglyphics [13, 14, 15]. Less number of studies have examined the differences in the fingerprints between right-handed and left-handed subjects of both sexes [7, 8]. This determined our interest in the present study.

The aim of the present study was to examine the variability of fingerprint patterns in the Bulgarian population and establish their relationship with hand dominance.

Materials and Methods

The study included 390 individuals (277 females and 113 males) aged between 19 and 30 years. Of these subjects 285 were right-handed (73.1%), 94 left-handed (24.1%) and 11 ambidextrous (2.8%). The group of right-handed subjects included 66 males (58.4%) and 219 females (79.1%). The group of left-handed subjects comprised 41 males (36.3%) and 53 females (19.1%). The ambidextrous group included 6 males (5.3%) and 5 females (1.8%).

Potential respondents were excluded from the study in the case of non-Bulgarian ethnicity of one of the parents and grandparents, history of severe neurological disease, history of psychotic disorder, first degree relatives with a history of psychotic disorder, pathological conditions characterized with abnormal dermatoglyphic status: psoriasis, congenital heart disease, diabetes, etc.

The subjects gave their informed consent to participate in the study after the aim, objectives, and procedure of the study had been explained.

Rolled fingerprints were obtained using the ink method and examined with slight magnification (6D). Fingerprint patterns were read as described by Cummins and Midlo [5] and identified as arches (A), ulnar loops (U), radial loops (Y), whorls (W). The whorls group included all varieties of circular images (twin loop, central pocket loop, lateral pocket loop, and accidental).

Hand preference was assessed using the Edinburgh Handedness Inventory [12]. Hand dominance was evaluated on the basis of the laterality index.

The data were analyzed statistically with SPSS 19.0 software. Descriptive statistics was used to summarize the data. Student's t-test was used to test the differences in fingerprints between the groups. The level of significance was set at $p < 0.05$.

Results

Fig. 1 shows the percentage distribution of finger papillary patterns for both hands in females. Ulnar loops are most common patterns both in left-handed (60.8%) and in right-handed (53.9%) subjects. The second most common patterns are the whorls, followed by arches. Radial loops are the least common (4.2% for left-handed, 3.2% for right-handed). The fingerprint pattern frequency formula in females is $U > W > A > R$ for both hands.

The fingerprint frequency on each finger in left-handed and right-handed females is shown in **Table 1**. Ulnar loops are the most common fingerprint pattern on both hands in the left-handed subjects, excluding the second finger of the right hand on which the

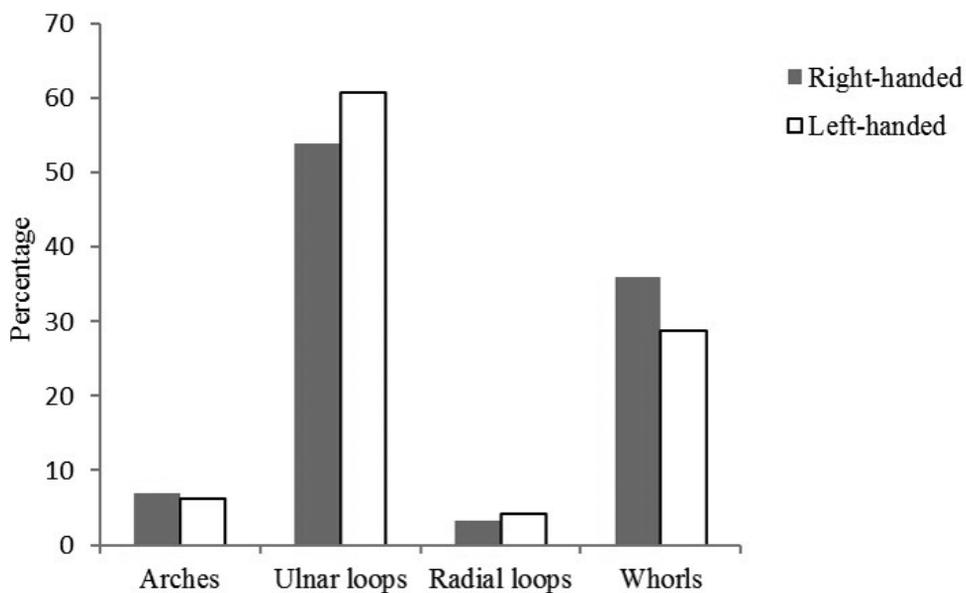


Fig. 1. Finger papillary patterns distribution in both hands of females

Table 1. Percentage of the main papillary pattern types on fingers in right- and left-handed females

Finger	Left-handed females n = 53		Right-handed females n = 219		p value*
	number	%	number	%	
Right hand					
R1					
A	2	3,8	8	3,7	0.652
U	29	54,7	109	49,8	
R	0	0	1	0,5	
W	22	41,5	101	46	
R2					
A	8	15,1	29	13,2	0.078
U	17	32,1	72	32,9	
R	9	17	20	9,1	
W	19	35,8	98	44,8	
R3					
A	1	1,9	18	8,2	0.103
U	45	84,9	151	68,9	
R	0	0	3	1,4	
W	7	13,2	47	21,5	

Continuation of Table 1.

Finger	Left-handed females n=53		Right-handed females n=219		p value*
	number	%	number	%	
R4					
A	0	0	2	0,9	0.249
U	27	50,9	107	48,9	
R	0	0	1	0,5	
W	26	49,1	109	49,7	
R5					
A	2	3,8	5	2,3	0.298
U	43	81,1	171	78,1	
R	1	1,9	1	0,5	
W	7	13,2	42	19,1	
Left hand					
L1					
A	3	5,7	12	5,5	0.009*
U	35	66	105	47,9	
R	0	0	4	1,8	
W	15	28,3	98	44,8	
L2					
A	8	15,1	37	16,9	0.008*
U	21	39,6	67	30,6	
R	10	18,9	28	12,8	
W	14	26,4	87	39,7	
L3					
A	6	11,3	26	11,9	0.548
U	31	58,5	128	58,4	
R	1	1,9	5	2,3	
W	15	28,3	60	27,4	
L4					
A	1	1,9	9	4,1	0.127
U	30	56,6	95	43,4	
R	0	0	3	1,4	
W	22	41,5	112	51,1	
L5					
A	2	3,8	5	2,3	0.053*
U	44	83	175	79,9	
R	1	1,9	4	1,8	
W	6	11,3	35	16	

whorls are most common. Ulnar loops are most frequent patterns on the first, third and fifth finger in the right-handed subjects. Whorls are most common on the second and fourth finger. The frequency of arches and radial loops is low on both hands in left-handed and right-handed subjects. Radial loops show the lowest frequency in right-handed subjects. Similar tendency is observed in left-handed females, with the exception of the second finger of both hands, where the arch rate is the lowest.

Table 2 shows the topographic distribution of fingerprint patterns in women with different hand dominance. Arches and radial loops are most commonly found on the second finger of both hands in left-handed and right-handed subjects. Whorls are most common on the fourth fingers of both hands. Ulnar loops show a slightly different trend in their distribution. On the left hands in both groups, they are most commonly found on the fifth finger, while in the left-handed subjects they are most common on the third finger of right hand.

Differences in fingerprint patterns reach statistical significance for the first ($p = 0.009$), second ($p = 0.008$) and fifth ($p = 0.053$) fingers of the left hand between left-handed and right-handed females. On the right hand, the differences do not reach statistical significance ($p > 0.05$).

Fig. 2 shows the percentage distribution of the fingerprint patterns for both hands in males. Left-handed and right-handed males have the same model of fingerprint pattern as females. The most common patterns are the ulnar loops (48.3% for left-handed, 53.6% for right-handed subjects), followed by whorls (44.4% for left-handed, 34.8% for right-handed males). Arches and radial loops are observed significantly less frequently in both groups. The formula of fingerprint patterns is $U > W > A > R$ on both hands.

Table 3 shows the frequency of fingerprint patterns on each finger in left-handed and right-handed males. Ulnar loops are the most common pattern on the third and fifth fingers of both hands in left-handed and right-handed subjects. Whorls are most common on the first, second and fourth fingers of the right hand in both groups, and on the left hand only in left-handed subjects. Arches show lower frequency on both hands. Radial loops are the least common pattern on all fingers, except the index one, in the right-handed subjects, and on the index finger of the right hand in the left-handed subjects.

Table 2. Papillary pattern distribution on fingers in left- and right-handed females

Pattern	Left-handed females	Right-handed females
	n = 53	n = 219
	Formulae	Formulae
Right hand		
A	II>I=V>III>IV	II>III>I>V>IV
U	III>V>I>IV>II	V>III>I>IV>II
R	II>V>I=III=IV	II>III>I=IV=V
W	IV>I>II>III=V	IV>I>II>III>V
Left hand		
A	II>III>I>V>IV	II>III>I>IV>V
U	V>I>IV>III>II	V>III>I>IV>II
R	II>III=V>I=IV	II>III>I=V>IV
W	IV>I=III>II>V	IV>I>II>III>V

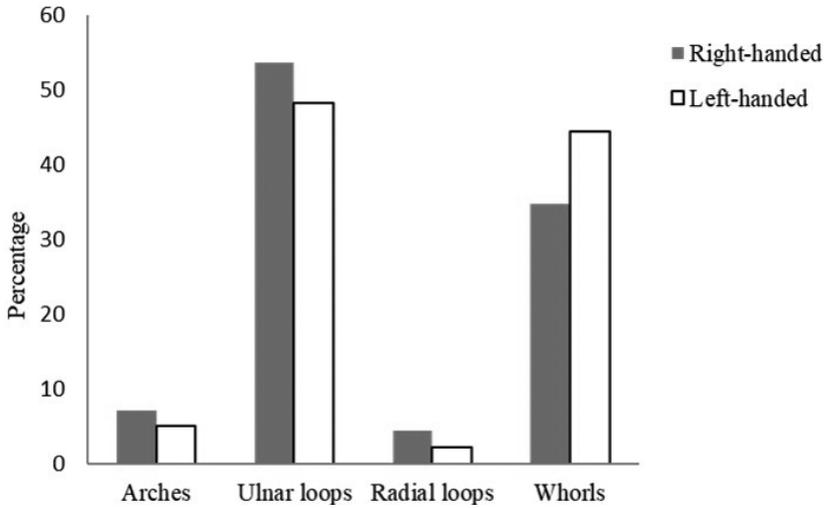


Fig. 2. Finger papillary patterns distribution in both hands of males

Table 3. Percentage of the main papillary pattern types on fingers in right- and left-handed males

Finger	Left-handed males n = 41		Right-handed males n = 66		p value*
	number	%	number	%	
Right hand					
R1					
A	4	9,8	1	1,5	
U	9	22	29	43,9	0.411
R	0	0	0	0	
W	28	68,2	36	54,6	
R2					
A	4	9,8	7	10,6	
U	9	22	22	33,3	0.139
R	7	17,1	11	16,7	
W	21	51,1	26	39,4	
R3					
A	2	4,9	8	12,1	
U	29	70,7	44	66,7	0.968
R	0	0	0	0	
W	10	24,4	14	21,2	
R4					
A	0	0	2	3	
U	12	29,3	21	31,8	0.238
R	0	0	1	1,5	
W	29	70,7	42	63,7	
R5					
A	0	0	3	4,5	
U	28	68,3	47	71,2	0.118
R	0	0	0	0	
W	13	31,7	16	24,3	

Finger	Left-handed males		Right-handed males		p value*
	n = 41		n = 66		
	number	%	number	%	
Left hand					
L1					
A	2	4,9	3	4,5	0.102
U	19	46,3	39	59,1	
R	0	0	0	0	
W	20	48,8	24	36,4	
L2					
A	6	14,6	7	10,6	0.134
U	15	36,6	26	39,4	
R	2	4,9	15	22,7	
W	18	43,9	18	27,3	
L3					
A	1	2,4	10	15,2	0.117
U	30	73,2	43	65,2	
R	0	0	0	0	
W	10	24,4	13	19,6	
L4					
A	0	0	3	4,5	0.565
U	16	39	32	48,5	
R	0	0	2	3	
W	25	61	29	44	
L5					
A	2	4,9	3	4,5	0.796
U	31	75,6	51	77,3	
R	0	0	0	0	
W	8	19,5	12	18,2	

In **Table 4** is shown the fingerprint pattern formulas in males with different hand dominance. Two images - radial loops and whorls - have the same topographic distribution on both hands for left-handed and right-handed subjects. Radial loops are the most common on the second finger, and whorls on the fourth finger. As for the other two images - ulnar loops and arches, there are differences between left and right hand in both groups. Ulnar loops are most often found on the fifth finger of the left hand in both groups, and on the right hand only in right-handed subjects. Arches are most often found on the first and second finger of left-handed subjects and on the third finger of right-handed subjects.

In our study, the differences in the distribution of fingerprint patterns on both hands in males do not reach statistical significance.

Table 4. Papillary pattern distribution on fingers in left- and right-handed males

Pattern	Left-handed males	Right-handed males
	n = 41	n = 66
	Formulae	Formulae
Right hand		
A	I=II>III>IV=V	III>II>V>IV>I
U	III>V>IV>I=II	V>III>I>II>IV
R	II>I=III=IV=V	II>IV>I=III=V
W	IV>I>II>V>III	IV>I>II>V>III
Left hand		
A	II>I=V>III>IV	III>II>I=IV=V
U	V>III>I>IV>II	V>III>I>IV>II
R	II>I=III=IV=V	II>IV>I=III=V
W	IV>I>II>III>V	IV>I>II>III>V

Discussion

The results of our study show well-established differences in fingerprint patterns between left-handed and right-handed females on the first, second and fifth fingers of the left hand. These differences could be due to a greater genetic pressure during the prenatal period. Similar pattern has been observed by B. Wijerathne and G. Rathnayake [16], who found statistically significant differences in fingerprints on the first and second fingers of the left hand between left-handed and right-handed females. The authors have also reported significant differences between left-handed and right-handed males which are not present in our study.

S. Coren, [4] has found significant dermatoglyphic differences in four of the five fingers of the left hand in males and females. In our sample, statistically significant differences are found in three of the five fingers of the left hand only in females.

G. Karev, [7] has examined the frequency of typographic images in men and women with different dominant hand. The author finds that whorls are less and ulnar loops are more common in right-handed than in left-handed subjects from both sexes. Our results support these data, but only for males. In our study in females, the pattern is reversed.

Of all types of patterns in our study, the least represented on both hands are the arches and radial loops. In comparison between left-handed and right-handed, we find a lower incidence of arches in left-handed subjects. The results obtained by K. Cho and S. Kim [3] are slightly different; they notice a lower frequency in right-handed subjects. This may be due to racial peculiarities in fingerprint pattern.

Conclusions

1. There is a similar model of distribution of the fingerprints patterns on both hands (U>W>A>R) in left-handed and right-handed subjects. Differences are expressed by their percentage representation on each finger individually.
2. The distribution of the least represented images (arches and radial loops) on the fin-

gers of the two groups is normal, whereas the higher-frequency images (ulnar loops) show a higher topographic diversity.

3. Statistically significant differences in fingerprint patterns on the first, second and fifth fingers of the left hand are found between females with different hand dominance but not between males.

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