Anthrop. Anz. Jg. 65 4 383–390 Stuttgart, Dezember 2007

Qualitative finger and palmar dermatoglyphics: Sexual dimorphism in the Chuvashian population of Russia

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With 5 tables

Summary: Qualitative finger and palmar dermatoglyphics of 547 individuals (293 males, 254 females) belonging to the Chuvashian population of Russia were studied to determine sexual dimorphism. The pattern types are not uniformly distributed on 10 fingers. Sex difference is homogeneous in all fingers whereas palmar patterns reflect the better sex variations for three palmar configurational areas (II, III, and IV). This is perhaps due to embryological development, having a relatively longer growth period compared with fingers (Cummins 1929). The present results of the Chuvashian population are not similar to the results of the five Indian populations of our previous study (Karmakar et al. 2002), perhaps due to a major ethnic difference.

Key words: Qualitative dermatoglyphics, sexual dimorphism, Chuvashian population, Russia.

Introduction

The digital pattern types (polygenic nature) are frequently used to characterize human populations in anthropological research (Cummins & Midlo 1961, Igbigbi & Msamati 1999, 2005, Nagy & Pap 2005, Gasiorowski 2005), because of the prenatal origin of the dermatoglyphic patterns (Babler 1978) that remain unchanged during postnatal life. Qualitative palmar dermatoglyphic traits are considered to be largely under genetic control (Pons 1954, Glanville 1965, Karev 1991). Inter-population variability of palmar dermatoglyphic has also been ascertained (Pons 1952, Plato et al. 1975, Plato & Wertelecki 1972, Malhotra 1979, Vrydagh-Laoureux 1979, Fox et al. 1987, Francis 1991, Gualdi-Russo et al. 1994). Recently, qualitative data on palmar dermatoglyphics alone have been utilized to perform cluster analysis (Kamali et al. 1991, 1992), correspondence analysis (Martin 1991, Arrieta et al. 1992), or correlation analysis to establish inter-population relationships (Sanna & Floris 1995, Sanna et al. 1998). Another well-known important aspect is that dermatoglyphic sexual dimorphism differs in diverse populations. Cummins & Midlo (1961) pointed out that "the usual sexual distinction may be leveled or even inverted

in some populations". Furthermore, Schwidetzky & Jantz (1979) have demonstrated that sexual dimorphism differs in diverse populations associated with race in the context of total finger ridge-count. Females almost universally differ from males as revealed from several studies on dermatoglyphic characters in various racial samples (Cummins & Midlo 1961). Compared to males, females exhibit narrower ridges, lower frequencies of whorls and radial loops, and higher frequencies of arches and ulnar loops on the fingertips. Regarding the palmar features, females have patterns more frequently on the hypothenar and the interdigital areas than males. However, these distinctions may be equal or even reversed in some populations (Cummins & Midlo 1961). The prenatal sex-differences in environmental sensitivity may be significant with respect to dermatoglyphic sexual dimorphism since dermatoglyphics are formed in the early period of the 3–4th fetal months of intrauterine development (Micle & Kobyliansky 1991). Unfortunately, studies on dermatoglyphic sexual dimorphism in the Chuvashian population are hardly available. The present paper is intended therefore of the following three objectives: (a) To provide information on the digital and palmar dermatoglyphics in the Chuvashian population, (b) to analyze the extent of dermatoglyphic sexual dimorphism within this population group, (c) to compare the present result with our previous study (Karmakar et al. 2002) of five Indian populations along with other studies.

Material and methods

Subjects and historical background

The studied individuals of the Chuvashian population reside in several small villages along the Volga River in the Chuvasha and Bashkortostan areas of the Russian Federation. This population, who migrated to these regions during 7th–8th centuries, has an ethnically mixed Caucasian origin. Originally, the Chuvasha ethnic group was formed during the last quarter of the first millennium AD in the forested or hilly portions of the Volga riverside. Their forefathers were most likely Bulgars from the Volga and Kama riverside and intermarried with the local Finno-Ugor tribes (Tischkov 1994). The chosen population is characterized by demographically stable familial structure with traditional relations between family members and is isolated ethnically with a minimal gene flow (El'chinova & Ginter 2001, El'chinova et al. 2002). The sample, which includes 547 individuals, consists of 293 males and 254 females with age ranging from 18 to 91 and 18 to 86 years, respectively. It was collected randomly, through direct contact with all households who agreed to participate in the study. The data were collected by the joint expedition of the Department of Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University, Israel, and the Anthropological Institute and Museum of Moscow State University, Russia.

Dermatoglyphic prints analyses and statistical application

Finger and palmar prints were collected using the ink and roller method of Cummins & Midlo (1961). Similarly, the dermatoglyphic qualitative characteristics were analyzed according to the criteria and methods of Cummins & Midlo (1961). Mainly four basic pattern types – whorls (W), ulnar loops (UL), radial loops (RL), and arches (A) – were considered in this analysis. In the distribution of pattern types simple and tented arches were considered together, all types of whorls as pattern whorls, and ulnar and radial loops separately. The symmetry of pattern types on homologous fingers and the diversity of finger pattern types present on the ten fingers were analyzed.

Table 1. Frequency of finger pattern types.

Pattern	Left						Right						R+L
Types	I	II	III	IV	V	Total	I	II	III	IV	V	Total	
						Males							
A	3.1	10.9	6.9	3.5	2.4	5.4	1.7	9.7	8.3	1.7	1.0	4.5	4.9
RL	0.3	11.9	1.4	0.0	0.3	2.8	0.0	13.8	1.0	1.0	0.0	3.2	3.0
U	59.4	43.9	66.3	48.3	79.4	59.5	48.1	37.7	66.3	37.5	72.0	52.3	55.9
W	37.2	33.3	25.3	48.3	17.8	32.4	50.2	38.8	24.3	59.7	27.0	40.0	36.2
						Females							
A	4.9	14.2	10.1	2.4	2.4	6.8	3.6	14.2	7.7	1.2	2.0	5.8	6.1
RL	0.0	9.3	2.0	0.4	0.4	2.4	0.0	10.6	1.2	0.4	0.4	2.5	2.5
UL	62.3	41.3	65.6	54.3	79.8	60.6	55.5	39.8	71.5	45.7	78.1	58.2	59.0
W	32.8	35.2	22.3	42.9	17.4	30.1	40.9	35.4	19.5	52.6	19.4	33.6	32.4

Results

Finger patterns

The *frequencies of digital pattern types* are presented in Table 1. The most frequently observed pattern type is the ulnar loop (UL), 55.9 % in males and 59.0 % in females for both hands followed by whorl (W), 36.2 % in males and 32.4 % in females whereas the pattern arch (A) and radial loop (RL) are less frequent than the UL and W. Arches are more frequent (4.9 % in males and 6.1 % in females) than radial loops (3.0 % in males and 2.5 % in females). Thus the order of pattern types is UL > W > A > RL, both in males and females within this population. In males, for the left hand, the highest occurrence of UL was on finger V (79.4 %), followed by III (66.3 %), whereas with pattern W the highest occurrence was on finger IV (48.3 %) followed by I (37.2 %). Similarly for the right hand in males, UL was on finger V (72.0 %) followed by III (66.3 %) and with W it was on IV (59.7 %) followed by I (50.2 %), respectively. In females, for the left hand, the highest occurrence of UL was on finger V (79.8 %), followed by III (65.6 %), whereas with pattern W it was on IV (42.9 %), followed by II (35.2 %). Similarly for the right hand in females, UL was on V (78.1 %) followed by III (71.5 %) and with W it was on IV (52.6 %), followed by I (40.9 %), respectively. The order of pattern frequency decreases from finger to finger in the following order V > III > I > IV > II for UL in the left and right hands in both males and females. Similarly for whorl, it is IV > I > II > III > V with a slight difference in both hands and sexes.

Pattern combinations on digital pairs presented in Table 2. The frequency of symmetrical patterns regarding finger pairs is similar between the right and left hands in both sexes. The highest occurrence of UL-UL was followed by the W-W combination among five categories of combinations. Among five pairs of fingers, the maximum frequency of UL, 69.7 % for the V-V pair, was followed by 62.3 % for the 3 % for the III-III pair in males, and was similar for females (76.3 % and 67.3 %), respectively. However, for the W-W combination the frequencies are

Table 2. Frequency of pattern combinations of homologous fingers.

Pairs of fingers	Pattern combination									
	A-A	R-R	U-U	W-W	A-R	A-U	A-W	R-U	R-W	U-W
					Males					
I-I	1.2	0.0	43.6	34.0	0.0	0.4	0.0	0.0	0.4	20.5
II-II	5.7	7.0	28.3	30.4	1.7	3.5	0.4	7.0	1.7	14.3
III-III	4.9	0.0	62.3	19.4	0.4	4.0	0.0	0.8	0.0	8.1
IV-IV	1.5	0.0	33.3	45.8	0.0	0.4	0.4	0.4	0.0	18.2
V-V	0.4	0.0	69.7	14.8	0.0	0.8	0.0	0.0	0.0	14.4
Total	2.6	1.3	47.8	29.0	0.4	1.7	0.2	1.5	0.4	15.2
					Females					
I-I	3.5	0.0	52.8	30.3	0.0	0.0	0.0	0.0	0.0	13.4
II-II	10.4	3.1	29.0	30.6	2.6	4.1	0.0	5.7	1.6	13.0
III-III	5.8	0.0	67.3	17.3	0.0	3.4	0.0	0.5	0.0	5.8
IV-IV	0.9	0.0	41.7	40.8	0.0	0.4	0.0	0.4	0.4	15.4
V-V	1.8	0.0	76.3	11.8	0.4	0.0	0.0	0.4	0.0	9.2
Total	4.2	0.6	54.0	26.2	0.6	1.5	0.0	1.3	0.4	11.4

Table 3. Frequency of pattern combinations of ten fingers.

Pattern	Males		Females	
	N	%	N	%
A only	–	–	–	–
RL only	–	–	–	–
UL only	14	5.1	19	7.8
W only	11	4.0	6	2.5
A + RL	–	–	–	–
A + UL	19	7.0	27	11.1
A + W	–	–	–	–
RL + UL	10	3.7	13	5.3
RL + W	–	–	1	0.4
UL + W	142	52.0	120	49.4
A + RL + UL	5	1.8	7	2.9
A + RL + W	–	–	–	–
A + UL + W	24	8.8	21	8.6
RL+UL+ W	38	13.9	16	6.6
A + RL + UL + W	10	3.7	13	5.3
Total	273	100.0	243	100.0

slightly different between males (45.8 % in pair IV-IV followed by 34.0 % in pair I-I), and females (40.8 % in pair IV-IV followed by 30.6 % in pair II-II). Table 3 presents the frequency of individuals with *monomorphic hands*, i.e. bearing the same pattern on all ten fingers. In males, pattern W (4.0 %) and (RL+UL) Loops were 4.0 % and (3.7 %) whereas in females they were 2.5 % and 5.3 %, respectively. Pattern UL shows a higher frequency (male-5.1 %, female 7.8 %) compared with W. The highest frequency was found (male 52.0 %, female 49.4 %) for the combination UL+W out of 15 combinations.

Table 4. Percent distribution of palmar patterns.

Pattern localization	Palmar configurational areas									
	Hypothenar		Thenar/I		II		III		IV	
	M	F	M	F	M	F	M	F	M	F
Both palms										
Absent	93.1	97.6	53.8	50.6	91.6	99.2	39.9	51.4	35.0	24.5
Present	1.0	0.8	20.6	23.7	2.1	0.0	23.1	13.9	30.4	37.1
Same pattern	1.0	0.4	13.3	15.1	2.1	0.0	23.1	13.9	28.7	36.3
Different pattern	0.0	0.4	7.3	8.6	0.0	0.0	0.0	0.0	1.7	0.8
Bilateral symmetry	94.2	98.0	67.1	65.7	93.7	99.2	62.9	65.3	63.6	60.8
Pattern present										
Left palm	4.8	1.6	10.8	13.5	0.4	0.0	4.5	4.5	26.2	27.3
Right palm	1.0	0.0	14.7	12.2	6.0	0.8	32.5	30.2	8.4	11.0

Palmar patterns

The occurrence of patterns represented in terms of the pattern present and absent in five palmar configurational areas is shown in Table 4. A general trend of a rich frequency at the same was present in males on both palms IV (30.4 %) > III (23.1 %) > Th/I (20.6 %), whereas in females it was present on IV (37.1 %) > Th/I (23.7 %) > III (13.9 %), respectively. The poorer patterns are the hypothenar and the second interdigital areas in both sexes. The frequencies of same pattern are higher in all areas compared with the different types of pattern. The bilateral symmetry of the presence/absence of pattern is more pronounced in the hypothenar and the second interdigital areas, both in males and females. The presence of the palmar pattern only on the left or right hands varies in different palmar areas in both sexes.

Sex comparisons

Finger pattern frequencies between sexes show little variations compared with palmar patterns and thus a sex difference regarding finger patterns on all digits shows homogeneity or no significant differences (Table 5). Out of five digital pairs of pattern combinations, only the I-I pair is significantly (0.044) different between sexes. Compared to finger patterns, the palmar patterns exhibit more variation and thus out of five palmar areas, the II (0.001), III (0.018), and IV (0.045) areas are significantly different. The remaining Hypothenar and Thenar/I areas are homogeneously distributed in both sexes.

Discussion

From the above presentation it appears that there is some variation in the distribution of pattern types regarding the fingers and the palmar configurational areas between sexes and between the right and left sides. However, a trend of similarity is also observed in these areas which may be discussed in light of developmental consid-

Table 5. Sex comparisons by χ^2-test of finger and palmar patterns.

Variables	d.f.	χ^2	p
Finger pattern			
L I	3	2.54	0.468
II	"	2.13	0.546
III	"	1.33	0.722
IV	"	4.14	0.247
V	"	0.12	0.989
All	"	1.73	0.630
R I	"	5.75	0.124
II	"	3.74	0.291
III	"	1.33	0.722
IV	"	3.52	0.318
V	"	6.16	0.104
All	"	2.54	0.468
10 Fingers	"	1.33	0.722
Pattern combination			
I-I	5	11.39	**0.044***
II-II	9	9.38	0.403
III-III	6	3.34	0.765
IV-IV	7	6.56	0.476
V-V	6	10.99	0.089
Pattern comb. 10 fingers	8	15.09	0.057
Palmar patterns			
Hyp	3	6.04	0.110
Th-I	"	1.61	0.657
II	"	17.71	**0.001***
III	"	10.06	**0.018***
IV	"	8.05	**0.045***

* Significant at $p < 0.05$.

eration of dermatoglyphic traits. The Chuvashian population is characterized by having high frequencies of ulnar loops and whorls, and low frequencies of arches and radial loops that are not uniformly distributed on all fingers in both sexes. These findings are corroborated by earlier studies (see among others: Micle & Kobyliansky 1987, Kobyliansky & Micle 1987, 1988, Arrieta et al. 1991, Crawford & Duggirala 1992, Dittmar 1994, Siváková et al. 1995, Karmakar et al. 2002). According to Holt (1968), "certain patterns tend to occur more frequently on some digits than on others, which seems to be constant for any population". Roberts (1982) stated that qualitative dermatoglyphic traits are a complex outcome of a developmental process in which individual digits of the same genetic fields occur but at different locations. In our previous study (Karmakar et al. 2002) in five Indian populations, sex differences were ascertained with respect to digital pattern whereas, the present population does not show any significant sex difference. However, with palmar pattern, both Indian and Chuvasian populations exhibit significant sex differences in some palmar configurational areas. Therefore, palmar pattern may be better discriminator

for inter-population variation than finger (Jantz 1977, Reddy 1990, Reddy et al. 1988, Karmakar 1990, Karmakar et al. 1989, 2002). This difference is due to different duration of growth period during embryological development (Cummins 1929).

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Received August 21, 2006

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