Bulgarian Academy of Sciences

Acta morphologica et anthropologica, 4
Sofia • 1997

Plantar dermatoglyphics in healthy children

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Dermatoglyphic investigation of soles of 806 clinically healthy Bulgarian children and adolescents (406 boys and 400 girls) was carried out. The frequencies and the type of pattern on separate areas of soles (after C u m m i n s, M i d l o, 1961) as well as the longitudinal creases (after M u t a f o v, T o r n j o v a, 1977) were analysed. The data were separately for both sexes and for both soles. Bilateral and intersexual differences about the frequency of pattern types were established on some plantar areas. The results were important for population genetics, on one hand, and, on the other hand, for the clinical practice as a basis for comparison and interpretation of the results from different inborn and inherited diseases.

Key words: plantar dermatoglyphics, healthy individuals, intersexual and bilateral differences.

The plantar dermatoglyphics is less studied in comparison to the dermatoglyphics of hands both in norm and in pathology. On the one hand, it is due to the difficulties with the procedure of print-taking and, on the other hand, the fact that there are not so many variations in the dermatoglyphic features. There are few publications on plantar dermatoglyphic characteristics in studies of separate populations [3, 7, 8, 12], of paternity [9] and of some chromosomal diseases [2, 4, 10]. Some of our publications on plantar dermatoglyphics in some groups of defective children are the only ones in Bulgaria [4, 5].

The aim of the present study is to give a dermatoglyphic picture of the plantar surface of healthy Bulgarian individuals, as well as intersexual and bilateral differences.

The dermatoglyphic plantar prints of 806 clinically healthy childern and adolescents of both sexes (406 boys and 400 girls) were used as material for the present study. The frequency and the type of patterns on the separate areas of the plantar surface are analyzed. The reading of the dermatoglyphic prints is made after the method of C u m m i n s and M i d l o (1961) [1]. The sole areas are after Memorandum on Dermatoglyphic Nomenclature, 1968 [6] (Fig. 1). The intersexual and the bilateral differences are evaluated after the Student's T-criterion.

Results

We analyzed the frequency and the type of patterns, of intersexual and bilateral differences separately for each area of the plantar surface.

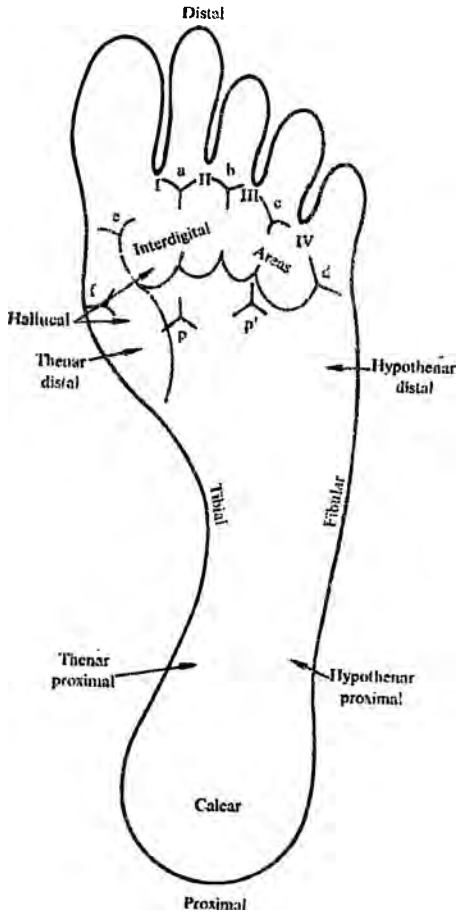

Fig. 1. Dermatoglyphic areas of the sole (by C u m m i n s, M i d l o, 1961)

Hallucal area (Table 1)

The most frequent pattern on the Hallucal area is the distal loop (L^d) on both soles in boys and girls. The second place is for the whorls (W) (in the sense of Galton), followed by the tibial loops (L^t). The other types of patterns are with relatively rare frequency. As for some patterns there are statistically significant intersexual differences. The distal loops are more frequent in girls on both soles than in boys, while the situation in the whorls is opposite, i. e. they are more frequent in boys ($p<0,05$). There are no statistically significant bilateral differences. However, distal loops in both sexes are with higher frequency on the right sole than on the left one, but the differences are statistically insignificant. There is a tendency showing that tibial loops on the left sole are with higher frequency than on the right one. The distribution of the three basic types of patterns (arches, loops, whorls) shows that the total frequency of the loops (L) is significantly higher in girls than in boys (♂ — 59,73 per cent, ♀ — 67,62 per cent), while the frequency of the whorls (W) is higher in boys (♂ —33,0 per cent, ♀ —24,62 per cent). The arches are with close frequencies in both sexes (♂ —6,53 per cent, ♀ —7,62 per cent). The total frequency of the true patterns (TP) on the Hallucal area (all types of loops, whorls and double patterns) is very high on both soles in boys and girls

T a b l e 1. Frequency (%) of patterns on the Hallucal area (Th^d/I_{IA})

Type of patterns	Boys			Girls		
	Right	Left	Both	Right	Left	Both
A^p	2,46	2,96	2,71	2,25	1,75	2,0
A^t	0,25	0,25	0,25	0,25	0,25	0,25
A^f	2,96	3,20	3,08	5,00	3,75	4,38
T	0,49	0,49	0,49	0,75	1,25	1,00
L^d	51,23*	46,55*	48,89*	61,00*	56,50*	58,75*
L^p	0,25	0	0,12	0	0	0
L^f	0,49	0,25	0,37	0,25	0,25	0,25
L^t	8,62	12,07	10,34	7,25	10,00	8,62
W	31,03*	31,52*	31,28*	21,75*	25,75*	23,75*
DP	1,72	1,72	1,72	1,50	0,25	0,88
V	0,25	0,74	0,50	0	0	0
O	0,25	0,25	0,25	0	0,25	0,12
TP	93,34	92,11	92,72	91,75	92,75	92,25

Note: DP — double patterns; TP — true patterns; * intersexual differences.

(from 91,75 per cent to 93,34 per cent). For these true patterns bilateral and intersexual differences are not established.

S u m m a r y. On the Hallucal area the loops (L) are 59,72 per cent in boys and 67,62 per cent in girls; the whorls (W+DP) are 33,00 per cent in boys and 24.63 per cent in girls; the arches (A+T) are 6,53 per cent in boys and 7,63 per cent in girls. The rest — 0,75 per cent in boys and 0,12 per cent in girls is formed by vestige (V) and open fields (0).

Second interdigital area (Table 2)

Most frequently there are no patterns in both sexes on the right and on the left soles in this area (♂ — 40,89 per cent, ♀— 44,43 per cent). If there are patterns they are from the type of proximal loop (L^p) (♂ —21,42 per cent, ♀ — 20,28 per cent). This proximal loops are more frequent on the left sole in boys, while in girls they are almost with equal frequency on both soles. The comparison between the right and the left soles regarding the tibial arches (A^t) indicates that they are more frequent on the right soles. The difference is significant in boys ($p<0,05$). There is a tendency showing that the fibular arches (A^f) are much more frequent on the left sole than on the right one. The distribution of the main types of papillar patterns (A, L, W) indicates that the whorls are with the lowest frequency (♂ — 5,79 per cent, ♀ — 6,38 per cent). The frequency of the arch patterns and the frequency of the loop patterns are close to one another (A ♂ — 27,22 per cent, ♀ —23,16 per cent; L ♂ — 25,98 per cent, ♀ — 25,40 per cent). There are no bilateral and intersexual differences. The frequency of the true patterns (L, W, DP) on this area is significantly lower than on the Hallucal area with an average of 60 per cent (♂ — 31,77 per cent, ♀ — 31,79 per cent). The true patterns are more frequent on the left sole in boys ($p<0,05$), while they are closer to one another in value on both soles in girls. There are no statistically significant intersexual differences in any pattern on this area.

S u m m a r y. On the second interdigital area the loops are 25,98 per cent in boys and 25,41 per cent in girls; the whorls (W+DP) are 5,79 per cent in boys and 6,38 per cent in girls; the arches (A+T) are 27,22 per cent in boys and 23,16 per cent in girls. The rest — 41,01 per cent in boys and 45,05 per cent in girls is formed by vestiges (V) and open fields (O).

T a b l e 2. Frequency (%) of the patterns on the II interdigital area

Type of patterns	Boys			Girls		
	Right	Left	Both	Right	Left	Both
A^p	0	0	0	0	0	0
A^t	15,52**	7,64**	11,58	11,25	7,52	9,39
A^f	13,79	17,49	15,64	12,00	15,29	13,65
T	0	0	0	0,25	0	0,12
L^d	3,94	5,17	4,56	6,50	3,76	5,13
L^p	19,21	23,64	21,42	21,00	19,55	20,28
L^f	0	0	0	0	0	0
L^t	0	0	0	0	0	0
W	2,96	3,94	3,45	4,00	5,01	4,50
DP	1,48	3,20	2,34	1,25	2,51	1,88
V	0	0,25	0,12	0,75	0,50	0,62
O	43,10	38,67	40,89	43,00	45,86	44,43
TP	27,59**	35,95**	31,77	32,75	30,83	31,79

Note: DP — double patterns; TP — true patterns; ** bilateral differences ($p<0,05$).

T a b l e 3. Frequency (%) of the patterns on the III interdigital area

Type of patterns	Boys			Girls		
	Right	Left	Both	Right	Left	Both
A^p	0	0	0	0	0	0
A^t	0	0	0	0	0	0
A^r	0	0	0	0	0	0
T	0	0	0	0	0	0
L^d	54,68*	49,75*	52,22*	47,75*	42,61*	45,18*
L^p	4,68	5,42	5,05*	7,25	8,02	7,64*
L^r	0	0	0	0	0	0
L^t	0	0	0	0	0	0
W	15,52	11,33	13,42	13,25	10,28	11,76
DP	0,49	1,23	0,86	0	0,75	0,38
V	2,22	1,97	2,10	0,75	1,00	0,87
O	22,41	30,30	26,35	31,00	37,34	34,17
TP	75,37**	67,73**	71,55*	68,25**	61,66**	64,96*

Note: DP — double patterns; TP — true patterns: * intersexual differences; ** bilateral differences.

Third interdigital area (Table 3)

The distal loop (L^d) is the most frequent pattern on both soles in boys and girls (♂ — 52,22 per cent, ♀ — 45,18 per cent). The second place is for the whorls (W+DP) but with significantly lower frequency (♂ — 14,28 per cent, ♀ — 12,14 per cent). The frequencies of the distal loops and of the whorls are higher on the right soles, than on the left ones in both sexes. It is worth noting that there are no cases with any arch pattern type. The total frequency of the true patterns is comparatively higher (♂ — 71,55 per cent, ♀ — 64,96 per cent). The true patterns are more frequent in boys than in girls, and more frequent on the right sole than on the left one ($p<0,05$). This is the only significant bilateral difference in both sexes.

S u m m a r y. On the third interdigital area the loops (L) are 57,27 per cent in boys and 52,82 per cent in girls; the whorls (W+DP) are 14,28 per cent in boys and 12,14 per cent in girls and the arches (A+T) are missing.

Fourth interdigital area (Table 4)

The absence of patterns is typical for this area (from 70,69 per cent to 83,22 per cent). If there is a pattern the most frequent one is the distal loop (L^d) which is with

T a b l e 4. Frequency (%) of the patterns on the IV interdigital area

Type of patterns	Boys			Girls		
	Right	Left	Both	Right	Left	Both
A^p	0,49	0	0,25	0	0,25	0,12
A^t	0,49	0,25	0,37	0,75	0,75	0,75
A^r	0	0	0	0	0	0
T	0	0	0	0	0	0
L^d	20,20*	18,47*	19,34*	13,50*	10,53*	12,01*
L^p	0,74	0,74	0,74	1,75	1,25	1,50
L^r	0	0	0	0	0	0
L^t	2,95	1,23	2,09	2,25	2,50	2,38
W	1,48	0,74	1,11	0,25	0,50	0,38
DP	0,25	0	0,12	0	0	0
V	2,71	1,97	2,34	1,25	1,00	1,13
O	70,69	76,60	73,64	80,25	83,22	81,73
TP	25,62*	21,18*	23,40*	17,75*	14,78*	16,27*

Note: DP — double patterns; TP — true patterns; * intersexual differences.

higher frequency in boys (♂ — 19,34 per cent, ♀ —12,01 per cent). This loop is a little bit more frequent on the right sole in both sexes. The frequency of the tibial loop (L^t) does not exceed 3 per cent while the other types of patterns are very rare, about and under 1 per cent. A double pattern (DP) is established on the right sole of one boy. The total frequency of the true patterns (TP) is relatively low (♂ — 23,40 per cent, ♀ —16,27 per cent). They are more frequent in boys and the difference is significant ($p<0,05$). The true patterns are more frequent on the right sole in both sexes.

S u m m a r y. On the fourth interdigital area the loops (L) are 22,17 per cent in boys and 15,89 per cent in girls; the whorls (W+DP) are 1,23 per cent in boys and 0,38 per cent in girls and the archess (A+T) are 0,62 per cent in boys and 0,87 per cent in girls.

Hypothenar (distal and proximal), thenar (proximal) and calcar area

Most often there is no pattern on the distal Hypothenar (Hy^d) on both soles in both sexes (♂ right — 68,47 per cent, left — 76,35 per cent; ♀ right — 71,50 per cent, left — 75,19 per cent). If there is a pattern the most frequent one is the tibial loop (L^t) (♂ right — 26,35 per cent, left — 21,18 per cent; ♀ right — 24,25 per cent, left —23,56 per cent). There are neither intersexual nor bilateral differences. A fibular loop (L^f) is established on the right sole of 3 boys and 1 girl while the same type of loop but on the left sole it found in only 1 boy. A whorl pattern (W) is established only on the

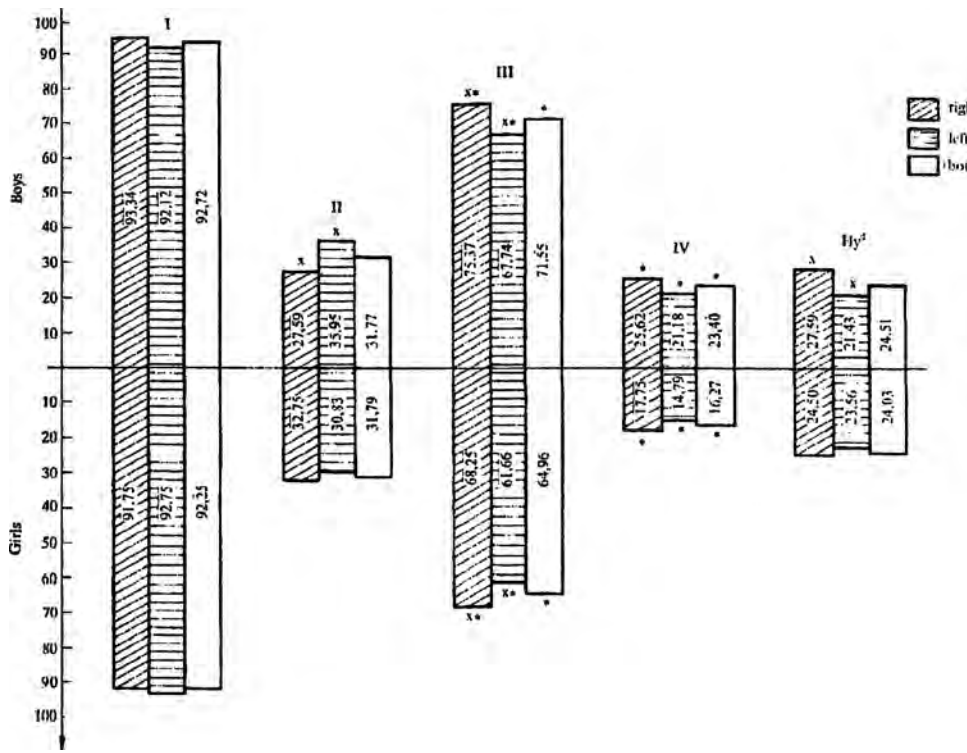

Fig. 2. The frequency of the true plantar patterns
x — bilateral differences; * — intersexual differences

Fig. 3. Plantar print of right sole

right sole of 1 boy. The frequency of the true patterns is equal in both sexes (♂ — 24,51 per cent, ♀ — 24,03 per cent).

There are practically no patterns on the proximal Hypothenar (Hy^p) (in more than — 99,00 per cent). Only two cases of tibial loop (L^t) on the right sole in boys are established while there is only vestige of pattern (V) in 1 girl.

Similar is the situation in the proximal Thenar (Th^p). There is no case with true pattern in both sexes. Vestiges of pattern (V) are established only in some children.

Most frequently there is no pattern on the Calcar area on both soles in both sexes. The true patterns are tibial loops (L^t) (♂ right — 1,72 per cent, left — 1,48 per cent; ♀ right — 1,0 per cent, left — 1,75 per cent) and a whorl on the right Calcar area of 1 boy. There are also some cases with vestiges of patterns (V).

Comparative analysis of the frequency of the true patterns on five of the plantar areas is carried out. Hallucal area, second interdigital area, third interdigital area, fourth interdigital area, Hypothenar distal are the areas with relatively more frequent true patterns. The formulae of the frequency patterns are equal in boys and girls on the right and on the left sole (Table 5). The most frequent true patterns are on the Hallucal area (♂ —92,72 per cent, ♀ —92,25 per cent), while they are most scarce on the fourth interdigital area (♂ — 23,40 per cent, ♀ —16,27 per cent) (Figs. 2, 3). Bilateral and intersexual differences are established on some of the plantar areas. For example, on the third interdigital area in both sexes and on the Hypothenar distal in boys only, there are more numerous patterns on the right soles than on the left one ($p<0,25$). On the contrary on the second interdigital area in boys the patterns frequency on the left sole is significantly higher than on the right one. Intersexual differences are related to the third and fourth interdigital areas where the frequency of the true patterns is higher in boys ($p<0,05$).

T a b l e 5. Formulae of the frequency of the true plantar patterns

Sole	Boys	Girls
Right	$Th/I>III>II>Hy^d>IV$	$Th/I>III>II>Hy^d>IV$
Left	$Th/I>III>II>Hy^d>IV$	$Th/I>III>II>Hy^d>IV$
Both	$Th/I>III>II>Hy^d>IV$	$Th/I>III>II>Hy^d>IV$

The frequency and the type of the longitudinal creases on soles are determined after the scheme of M u t a f o v and T o r n j o v a (1977) [4] (Fig. 4). It is established

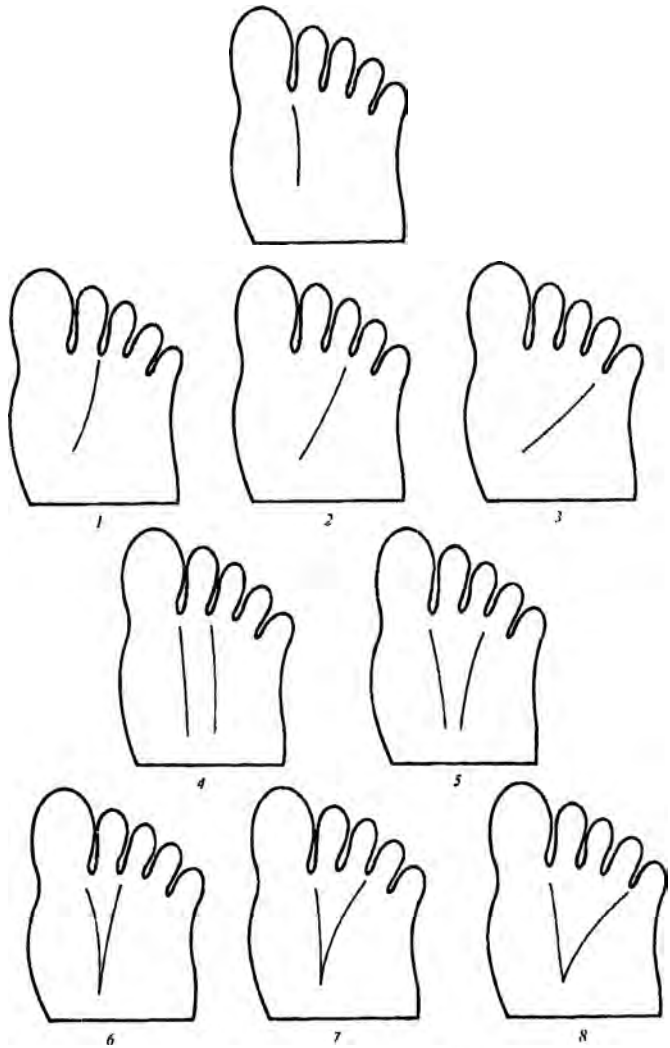

Fig. 4. Most frequent variations (*1–8*) of sole longitudinal creases (by M u t a f o v, T o r n j o v a, 1977)

that these creases are 26,72 per cent in boys and 15,64 per cent in girls. An intersexual difference is obvious ($p<0,05$). The distribution is nearly equal for both soles (♂ right — 26,35 per cent, left — 27,09 per cent; ♀ right — 15,75 per cent, left — 15,54 per cent). The classical form (on the top of the fig. 4) is with highest per cent in girls (44,75 per cent) while in boys No 1 is the most frequent one (51,59 per cent). The other types of longitudinal creases are with relatively low frequency.

As it is mentioned in the beginning of the paper there are no data about the plantar dermatoglyphics in Bulgaria and for this reason it is impossible for a comparison to be made. The comparison of our data is made with data from Polish [11], Slovak [8] and Hungarian [9] populations. In general, our results about the distribution of the frequency and the type of the patterns on the separate plantar areas are close to the above mentioned studies. The only difference is in the frequency

of the patterns on the Hypothenar distal in the work of P o s p i s i l [8] for Slovak population. Probably it is due to methodological differences.

S u m m a r y. The plantar dermatoglyphic status in particular and the general dermatoglyphic status including hands and soles of clinically healthy individuals is important for population genetics, on the one hand, and on the other hand, for the clinical practice as a basis for comparison and interpretation of the results from different inborn and inherited diseases.

References

1. C u m m i n s, H., C. M i d l o. Finger print, palms and soles. An Introduction to Dermatoglyphics. Philadelphia, The Blakinston Company, 1943 and New York, Dover Publications, 1961.
2. H o l t, S. The genetics of dermal ridges. Springfield, Illinois, U.S.A., Charls C. Thomas Publisher, 1968.
3. M a r t i n, R., K. S a l l e r. Lehrbuch der Anthropologie. Vol. 11. Stuttgart, Gustav Fischer Verlag, 1961, 1810—1928.
4. M u t a f o v, S t., S. T o r n j o v a - R a n d e l o v a. Dermatogliphische Untersuchungen bei Kindern mit Syndrom von Langdon Down. — Verh. Anat. Ges., 71, 1977, 659—663.
5. M u t a f o v, St., S. T o r n j o v a - R a n d e l o v a. Dermatoglyphics in Deaf Children. VIII World Congress of the World Federation of the Deaf, 1981.
6. P e n r o s e, L. Memorandum on Dermatoglyphic Nomenclature. — Birth Defects Original Article Series, 4, 1968, No. 3.
7. P o s p i s i l, M., A. L a z a r. Plantar dermatoglyphics in the inhabitants of Moeciu de Sus (Valley of Bran, Romania). — Ann. Rom. D'Anthropol., 7, 1970, 85-102.
8. P o s p i s i l, M. Die Dermatoglyphik der Slowakei III. Dermatoglyphen der Sohle und Zehen. — Acta F. R. N. Univ. Comen. Anthropologia, 17, 1971, 129—169.
9. S u s a, E. Die Dermatoglyphen der Zehen und der Fussohlen im Vaterschaftsgutachten. — Humanbiologia Budapestinensis (Budapest), 1985.
10. T o r n j o v a - R a n d e l o v a, S. Plantar dermatoglyphics in Langdon Down Syndrome. Zb. 1st Nat. Conference of Anthropology, 1991, 28-32.
11. W o j t o w i c z - L e b o i d a, H. Dalse badania nad zroznicowaniem wzorow listewek skornycle w streifie podopalcowej stopy. — Mater. i prace antropol. zakl antropol., PAN, 1967, No 74, 155—172.
12. К о н д и к, В. М. Дерматоглифика популяций *Homo sapiens* в связи с вопросом о первичной дифференциации этого вида на расы. Автореф., Москва, 1985.