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Fluctuating Asymmetry in Patients with Down's Syndrome

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The fluctuating asymmetry level of four dermatoglyphic features (palmar ridge count, finger ridge count, *atd* angle and patterns' type on the homologous digits) is studied. The investigation encloses 116 boys and girls with Down's syndrome, as well as a control group of 260 healthy boys and girls. Generalized the Down's patients showed a higher level of fluctuating asymmetry compared to the controls. In boys with Down's syndrome, the highest level of fluctuating asymmetry is established for the ridge count and the type of pattern on the 4th homologous digits. In girls with Down's syndrome the highest level is founded for "b-c" and "c-d" palm ridge count and the pattern's type on the 4th homologous digits. The data obtained can give an interpretation to the results from the disturbances in the ontogenetic development of the individuals with Down's syndrome.

Key words: dermatoglyphic features, fluctuating asymmetry, patients with Down's syndrome.

Introduction

The fluctuating asymmetry of bilateral morphological structures is an indicator of homeostasis in the development of individuals. Basis for this understanding is the idea that the genetical and environmental factors, confusing the normal development of individuals, have a negative effect upon the control in the formation of bilateral structures. Therefore, the disturbances' level in the perfect bilateral symmetry gives possibility for the preciseness of the mechanisms in the homeostatic control, as well as the general capability of the organism to resist the negative genetical and environmental factors to be assessed [2, 3, 4, 5, 6, 7, 10].

The aim of the present study is to evaluate the fluctuating asymmetry level of four dermatoglyphic features (fingerprint patterns and finger ridge counts on pair fingers; palmar *a-b, b-c, c-d* and *a-d* ridge counts, and *atd* angle on pair palms) in patients with Down's syndrome.

Material and Methods

The investigation includes 116 patients (64 boys and 52 girls) with Down's syndrome. The dermatoglyphic prints are taken by the typographical method [9]. The

finger papillar patterns are read by the method of C u m m i n s and M i d l o [1] and the *atd* angle is evaluated by the criterion of S h a r m a [8].

The fluctuating asymmetry level about finger and palm ridge counts and *atd* angle is determined by the coefficient of indetermination ($1-r^2$). The square of the product-moment correlation coefficient (r^2) of the two variables is a measure of their common variance, and the coefficient of indetermination ($1-r^2$) is an estimate of their unshared variance and thus of fluctuating asymmetry [6]. In our study, this unshared variance, regarding the finger and palmar ridge counts and *atd* angle on both hands, determines the fluctuating asymmetry level for the three investigated features. The measure of fluctuating asymmetry for finger patterns is estimated by the degree of pattern discordance [6]. The fluctuating asymmetry level of four dermatoglyphic features in the group of patients is compared to analogical data for a control group of 260 healthy children (129 boys and 131 girls).

Results and Discussion

The mean values of finger ridge count, palmar ridge count and *atd* angle in right and left for the patients with Down's syndrome and the controls are given in Table 1. Summarized the boys from the control group have bigger values of finger ridge count on both hands compared to the patients. Statistical significant are the differences of ridge counts between patients and controls in boys with the exception of those for the III finger in left and II finger in right. The girls from the control group have bigger values for ridge counts on IV and V fingers in left and on I, IV and V fingers in right compared to the girls with Down's syndrome. Statistical significant are only the ridge counts' differences for the V fingers in left and right, as well as for the IV finger on the right hand.

The control boys and girls have greater measures for palmar ridge counts *a-b, b-c, c-d* and the total *a-d* ridge count on both hands compared respectively to the Down's boys and girls. The established differences of palmar ridge counts are statistical significant for the boys of both groups. In girls, statistical significant are only the differences for palmar *a-b* and *c-d* ridge counts and the total *a-d* ridge count on the right hand.

The *atd* angle on the right and left hands in the Down's patients is considerably larger compared to the controls for both sexes. All the established differences are statistical significant.

The correlation coefficients between ridge count on homologous fingers, palmar ridge count and *atd* angle for the right and left hands are given in Table 2. The finger and palm ridge count analyzed shows predominantly smaller values of correlation coefficient in Downs than in the controls for both sexes. The differences between correlation coefficient for both boys and girls, and Down's patients and controls are comparatively great, but statistical significant is only the difference for IV pair fingers in boys.

The patients with Down's syndrome display smaller correlation for palmar ridge counts compared to the controls. Statistical significant differences are not established for the correlation coefficients of palmar ridge count between boys and girls in both studied groups.

Considerably greater are the correlation coefficients for *atd* angle in the patients with Down's syndrome for both sexes compared to the healthy subjects. The difference in boys is statistical significant, and in girls it comes nearby, but is not statistical significant.

T a b l e 1. Finger ridge counts, palmar ridge counts and palmar atd angles of persons with Down's syndrome and controls

Features	Boys						Girls					
	persons with Down's syndrome (n=64)		controls (n=129)		t	P	persons with Down's syndrome (n=52)		controls (n=131)		t	P
	X	SD	X	SD			X	SD	X	SD		
Finger ridge counts												
I left	15.19	5.25	18.03	5.29	3.530	<0.01	13.81	6.01	13.34	5.41	0.491	>0.05
II left	10.59	4.91	12.38	6.27	2.168	<0.05	10.31	5.20	9.05	5.88	1.423	>0.05
III left	11.59	4.67	12.88	5.53	1.697	>0.05	10.90	4.83	9.44	5.73	1.746	>0.05
IV left	10.86	4.69	16.29	5.22	7.289	<0.01	10.29	5.62	11.81	6.31	1.592	>0.05
V left	8.48	4.11	13.33	4.27	7.618	<0.01	8.29	4.21	10.08	4.51	2.541	<0.05
I right	17.16	5.56	20.43	5.14	3.943	<0.01	15.44	6.21	16.06	5.86	0.619	>0.05
II right	11.34	4.86	12.98	6.88	1.912	>0.05	10.93	4.94	10.31	5.89	0.724	>0.05
III right	11.34	4.53	13.35	5.75	2.646	<0.01	10.52	4.23	9.89	5.53	0.829	>0.05
IV right	10.66	4.66	17.15	5.33	8.676	<0.01	11.27	5.25	13.12	5.53	2.117	<0.05
V right	8.75	3.34	13.40	5.07	7.608	<0.01	8.29	4.27	10.63	5.30	3.113	<0.01
I–V left	56.75	19.14	72.94	20.36	5.416	<0.01	53.60	19.99	53.49	21.62	0.033	>0.05
I–V right	59.25	18.13	77.66	21.58	6.225	<0.01	56.44	18.24	59.91	22.21	1.088	>0.05
Palmar ridge counts												
a-b left	30.75	8.36	37.91	7.68	5.622	<0.01	31.46	7.04	33.76	5.95	1.928	>0.05
b-c left	19.43	5.72	24.30	5.72	5.448	<0.01	21.28	5.62	22.11	5.08	0.860	>0.05
c-d left	28.48	8.12	32.91	6.74	3.678	<0.01	30.70	6.28	31.08	6.05	0.347	>0.05
a-d left	78.88	18.50	95.45	15.32	6.041	<0.01	83.91	14.70	86.88	12.47	1.196	>0.05
a-b right	30.98	7.04	39.02	7.60	7.124	<0.01	31.42	5.65	34.64	5.88	3.210	<0.01
b-c right	21.10	5.27	24.85	5.88	4.386	<0.01	21.91	5.49	22.08	5.22	0.178	>0.05
c-d right	30.22	8.25	33.60	6.27	2.818	<0.01	29.67	6.64	32.01	5.64	2.078	<0.05
a-d right	82.30	15.52	97.74	14.99	6.435	<0.01	83.54	12.91	88.65	12.68	2.262	<0.05
atd angles												
left	73.43	18.93	43.91	7.23	12.020	<0.01	72.43	16.48	45.08	9.42	11.083	<0.01
right	73.38	17.96	44.13	7.31	12.493	<0.01	70.18	14.83	44.91	8.64	11.351	<0.01

T a b l e 2. Correlation (r) between the left and right finger ridge counts, palmar ridge counts and palmar *atd* angles of persons with Down's syndrome and controls

Features	Correlations (r)							
	Boys				Girls			
	persons with Down's syndrome	controls	t	P	persons with Down's syndrome	controls	t	P
Finger ridge counts								
I	0.7636	0.6715	1.189	>0.05	0.7710	0.6963	0.911	>0.05
II	0.6217	0.7108	1.040	>0.05	0.5979	0.7294	1.403	>0.05
III	0.6304	0.7275	1.201	>0.05	0.7169	0.6455	0.788	>0.05
IV	0.5370	0.7600	2.513	<0.05	0.6937	0.7651	1.026	>0.05
V	0.7480	0.7124	0.550	>0.05	0.7091	0.7969	1.258	>0.05
Palmar ridge counts								
a-b	0.7000	0.7027	0.001	>0.05	0.5120	0.5877	0.635	>0.05
b-c	0.6689	0.7561	1.162	>0.05	0.4663	0.6632	1.561	>0.05
c-d	0.6983	0.6923	0.121	>0.05	0.5148	0.6992	1.682	>0.05
a-d	0.8177	0.8486	0.623	>0.05	0.6260	0.7405	1.154	>0.05
atd angles	0.8187	0.6485	2.419	<0.05	0.7476	0.5650	1.889	>0.05

Table 3. Fluctuating asymmetry measure ($1-r^2$) of finger ridge counts, palmar ridge counts and palmar *atd* angles of persons with Down's syndrome and controls

Features	Coefficient of indetermination ($1-r^2$)					
	Boys			Girls		
	persons with Down's syndrome [D]	controls [C]	difference [D-C]	persons with Down's syndrome [D]	controls [C]	difference [D-C]
Finger ridge counts						
I	0.4169	0.5491	-0.1322	0.4056	0.5152	-0.1096
II	0.6135	0.4948	0.1187	0.6425	0.4680	0.1745
III	0.6026	0.4707	0.1319	0.4861	0.5833	-0.0972
IV	0.7116	0.4224	0.2892	0.5188	0.4146	0.1042
V	0.4405	0.4925	0.0520	0.4972	0.3650	0.1322
Palmar ridge counts						
a-b	0.5100	0.5062	0.0038	0.7379	0.6546	0.0833
b-c	0.5526	0.4283	0.1243	0.7826	0.5602	0.2224
c-d	0.5124	0.5207	-0.1183	0.7350	0.5111	0.2239
a-d	0.3314	0.2799	0.0515	0.6081	0.4517	0.1564
atd angles	0.3297	0.5794	-0.2497	0.4411	0.6808	-0.2397

Table 4. Coincidence of finger patterns of homologous fingers of persons with Down's syndrome and controls

Homologous fingers	Boys						Girls					
	persons with Down's syndrome		controls		*t*	*P*	persons with Down's syndrome		controls		*t*	*P*
	X	SD	*X*	SD			*X*	SD	*X*	SD		
I	0.8308	0.378	0.7132	0.454	1.900	>0.05	0.7647	0.424	0.7752	0.419	0.152	>0.05
II	0.8923	0.312	0.5581	0.499	5.689	<0.01	0.7451	0.436	0.4961	0.502	3.335	<0.01
III	0.7846	0.414	0.7519	0.434	0.508	>0.05	0.7647	0.424	0.7209	0.450	0.619	>0.05
IV	0.6462	0.482	0.7519	0.434	1.482	>0.05	0.6667	0.471	0.7519	0.434	1.128	>0.05
V	0.8769	0.331	0.8295	0.378	0.893	>0.05	0.8235	0.381	0.8605	0.348	0.607	>0.05

Table 5. Discordance of finger patterns of homologous fingers of persons with Down's syndrome and controls

Homologous fingers	Boys			Girls		
	persons with Down's syndrome [D]	controls [C]	difference [D-C]	persons with Down's syndrome [D]	controls [C]	difference [D-C]
I	0.1693	0.2868	-0.1175	0.2353	0.2248	0.0105
II	0.1077	0.4419	-0.3342	0.2549	0.5039	-0.2490
III	0.2154	0.2481	-0.0327	0.2353	0.2791	-0.0438
IV	0.3538	0.2481	0.1057	0.3333	0.2481	0.0852
V	0.1231	0.1705	-0.0474	0.1765	0.1395	0.0370

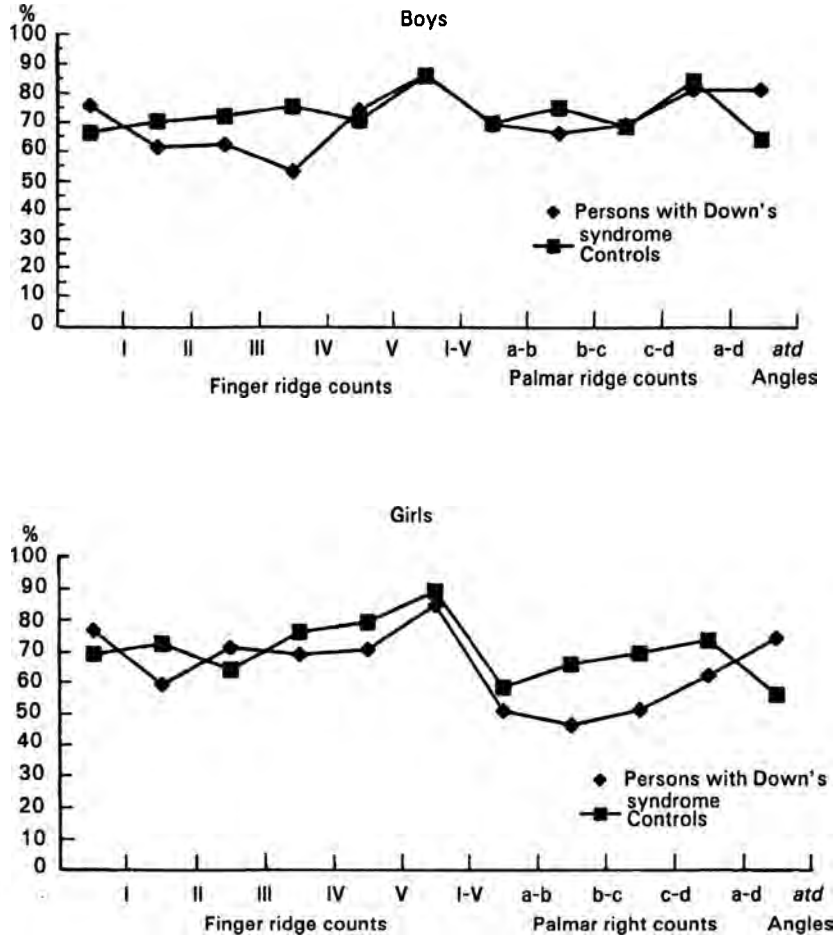

Fig. 1. Correlation between the left and right finger ridge counts, palmar ridge counts and palmar *atd* angles of persons with Down's syndrome and controls

The fluctuating asymmetry of the ridge count on pair fingers, palmar ridge counts and *atd* angle are given in Table 3. The fluctuating asymmetry measures are greater for II, III and IV finger pairs in the Down boys, and for II, IV and V finger pairs in the Down girls compared to the normal children. In the Down boys the fluctuating asymmetry level decrease in the direction IV > II > III > V > I pair fingers, and in the Down girls — II > IV > V > III > I pair fingers. Opposite to the patients' group, the fluctuating asymmetry for the controls decrease in the direction I > II > V > III > IV pair fingers for boys and III > I > II > IV > V pair fingers for girls. Greatest is the differences of fluctuating asymmetry between Downs and controls on the IV digit pairs in boys and on the II digit pairs in girls.

The Down's patients have greater measures of fluctuating asymmetry for palmar ridge count excepting the *c-d* ridge count in boys. Greatest is the difference of fluctuating asymmetry between Downs and controls for the *b-c* ridge count in both sexes.

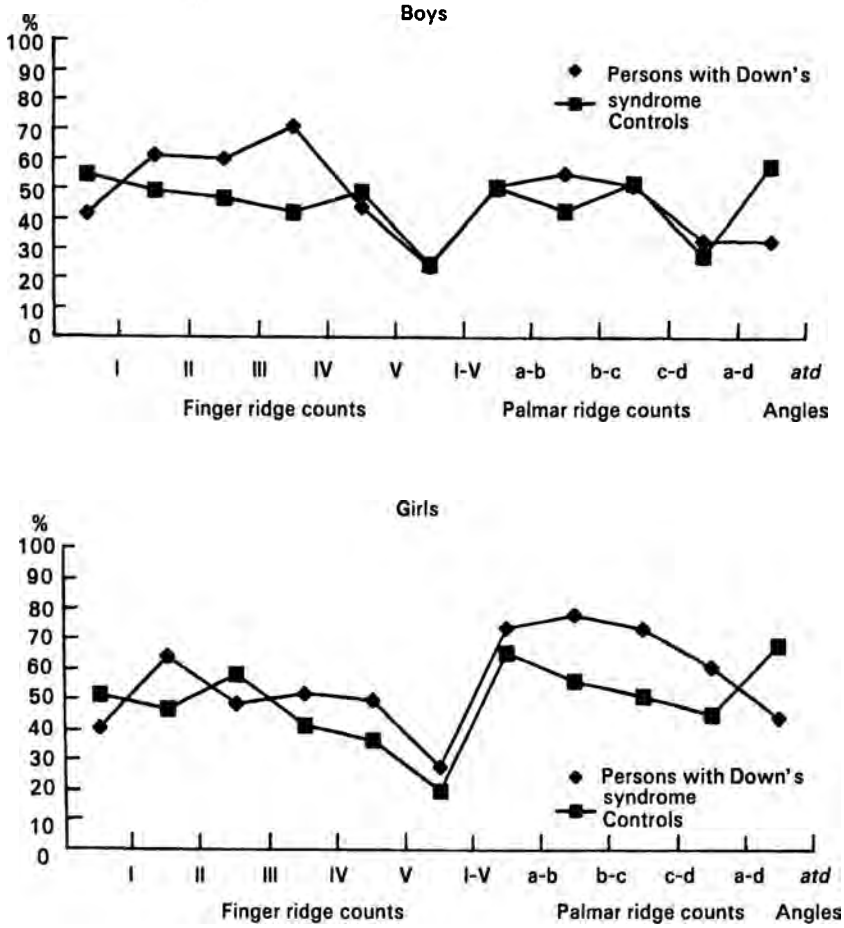

Fig. 2. Fluctuating asymmetry of finger ridge counts, palmar ridge counts and palmar *atd* angles of persons with Down's syndrome and controls

Opposite to the correlation coefficients' data, the fluctuating asymmetry level is smaller for the *atd* angle in both sexes of Downs compared to the controls.

The percentage variability of correlation coefficients and fluctuating asymmetry about finger and palmar ridge counts and *atd* angle are given in Fig. 1 and 2. The comparative analyses of the separate features indicate predominantly greater measures of fluctuating asymmetry for finger ridge count in the Down boys compared to the palmar ridge count and *atd* angle. Different are the findings for the Down girls. In them greater is the fluctuating asymmetry for palmar ridge count compared to the finger ridge count and *atd* angle. For the normal subjects, highest is the fluctuating asymmetry level for *atd* angle in both sexes.

The data about concordance of papillar patterns on homologous fingers for the right and left hand in the patients and controls are presented in Table 4. The proportion of concordant pairs belonging to the Down boys is highest for II and V pair fingers, and belonging to the Down girls — for V, III and I pair fingers. For the controls highest is the concordance for V, III and IV pair fingers in boys and for V

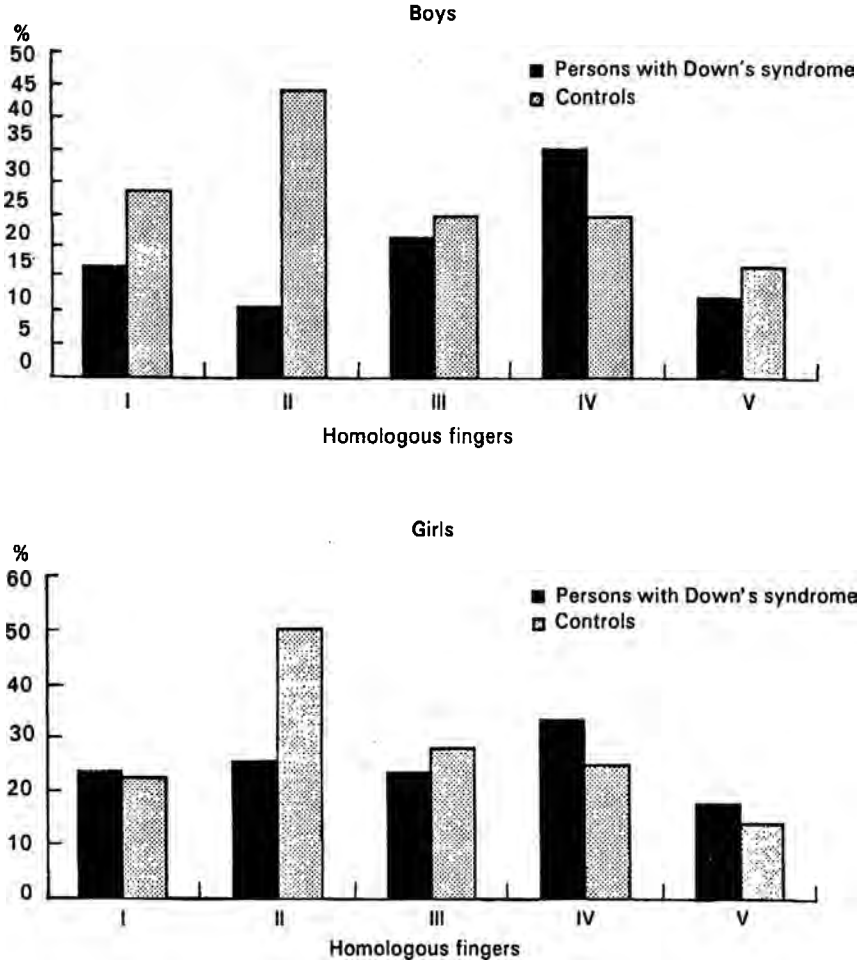

Fig. 3. Fluctuating asymmetry of finger print patterns of homologous fingers of persons with Down's syndrome and controls

and I pair fingers in girls. From all the established differences for the proportion of concordant pairs both for the investigated groups, and sexes statistical significant ($P<0.01$) are only the differences about II-nd homologous digits.

The data about proportions of discordance for finger papillar patterns, as well as the fluctuating asymmetry measures are given in Table 5. For the patients with Down's syndrome, the fluctuating asymmetry decrease in the direction IV > III > I > V > II pair fingers in boys, and in the direction IV > II > I = III > V pair fingers in girls. The fluctuating asymmetry measures for the controls decrease in the direction II > I > III = IV > V pair fingers in boys and in the direction II > III > IV > I > V pair fingers in girls.

The data analyzed about measures of fluctuating asymmetry for the type of finger patterns on the pair fingers in the Down's patients and controls are presented in Fig. 3. Very high is fluctuating asymmetry level for the II pair fingers, as in both investigated groups (patients and normal), so in boys and girls.

Conclusion

The summarized analyzes of the investigation shows considerable differences of fluctuating asymmetry level in the patients with Down's syndrome and the norm.

The fluctuating asymmetry degree is predominantly greater for the Down's girls than it is for the Down's boys, which causes the assumption, that possibly the sexual chromosomes exert some influence on the dermatoglyphic fluctuating asymmetry level.

The fluctuating asymmetry measures are greater for finger and palmar ridge counts then they are for *atd* angle in the patients with Down's syndrome. These data give reason, to be determined approximate correctly the period, during which the Downs gestation development is a subject of enormous disturbances (the formation of finger ridge count is during the period 10.5—13 gestation week, of palmar ridge count — till the 15 gestation week and of *atd* angle — after the 15 gestation week [10]).

The dermatoglyphic fluctuating asymmetry measures are considerably greater for the Down's patients than for the controls. As we know the disorder in the gene fund caused by the gene mutation — trisomie 21 leads to the manifestation of heavy morphological, physiological and neuro-psychological deviations in the individuals with Down's syndrome. The high level of fluctuating asymmetry in the Down's patients laid the assumption that this disorder leads also to an enormous reduction of the common stability in their individual development against the negative environmental factors.

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