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Dermatoglyphs in People with Down Syndrome and People with Normal Karyotype: A Comparison of Quantitative Characteristics

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Abstract

Background: All types of chromosomal aberrations have an impact on the development of dermatoglyphs, which changes both their quantitative and qualitative characteristics. This study aims to compare the quantitative characteristics of dermatoglyphs between individuals with Down syndrome and those with normal karyotypes in the Kosova Albanian population.

Methods and Results: The quantitative characteristics of digitopalmar dermatoglyphs were analyzed on 104 individuals (54 men and 50 women) with Down syndrome from Kosova's Albanian population. The dermatoglyphs of 403 Albanians from Kosova with normal karyotypes (the control group) were also analyzed quantitatively. Using the method devised by Cummins and Midlo, dermatoglyph traces were obtained and analyzed. We analyzed the quantitative features of both the dermatoglyphs of the fingers and the dermatoglyphs of the palms of the hands. Moorhead and Seabright's peripheral blood culture technique was utilized to analyze the karyotypes of individuals with Down syndrome.

A total of 40 dermatoglyphic variables were analyzed. When the quantitative dermatoglyphic features of men with Down syndrome and the control group were compared, significant differences were discovered in 20 of the dermatoglyphic variables. Significant differences were discovered in 21 of the dermatoglyphic variables when the features of women with Down syndrome and the control group were compared. One of the most distinctive characteristics of Down syndrome was the breadth of the atd angle, which should be taken into consideration. Compared to the control group's males and females, the males and females with Down syndrome exhibit wider atdT angles (161.91° vs. 92.60° [P<0.0001] and 165.48° vs. 94.75° [P<0.0001], respectively).

Conclusion: The size of atd angles is the factor that most closely identifies people with Down syndrome.(**International Journal of Biomedicine. 2023;13(3):137-142.**)

Keywords: Down syndrome • dermatoglyphs • atd angle • epidermal ridge

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Abbreviations

FRC, finger ridge count; **rc**, ridge count; **PRC**, palmar ridge count; **PIR**, pattern intensity right; **PIL**, pattern intensity left; **TPII**, total pattern intensity index

Introduction

Dermatoglyphics is the study of naturally occurring epidermal ridges found on the fingertips and toes, as well as the palms of the hands and soles of the feet.(1) They begin to form during the sixth or seventh week of intrauterine development, with their final formation occurring between the nineteenth and twenty-first weeks. After their formation, dermatoglyphs do not alter throughout an individual's lifetime. This characteristic elevated the significance of dermatoglyphics in biomedical research.(2-4)

During studies, the most common dermatoglyphic figures are the arc, ulnar loop, radial loop, twist, incidental twist, and triradius, all located near the figures. Always

present on the tips of the digits are dermatoglyphic markings. One can count the epidermal ridges on the ulnar loop, radial loop, pleats, and accidental folds. The digital triradius, marked with the letters a, b, c, and d, is located at the base of digits 2, 3, 4, and 5. During dermatoglyphic analysis, it is possible to enumerate embryonic ridges between the triradius a-b, b-c, and c-d. The axial triradius is located in the proximal portion of the hand's palm and is denoted by the letter t. From the intersection of the triradius a, t, and d with straight lines, the "atd" angle, which represents a distinct dermatoglyphic measurable variable, can be derived.

The quantitative characteristics of dermatoglyphs can be analyzed based on the specifications.[5,6] The quantitative characteristics of dermatoglyphs are investigated by analyzing the epidermal ridges on the digits and palms of the hands. One digit is analyzed for its number of epidermal ridges and triradius. In the palms of the hands, the number of epidermal ridges between the triradius a-b, b-c, and c-d of the right hand and the left hand, as well as the size of the atd angle, are analyzed.[7,8]

The genes of the human genome govern the development of quantitative dermatoglyphic characteristics. Multiple genes appear implicated, so the inheritance pattern is not straightforward. Numerous studies have demonstrated that people with chromosomal aberrations (Down syndrome, Edwards' syndrome, Turner's syndrome, etc.) have dermatoglyphs that differ significantly from those of healthy individuals.[9-12] Not only do chromosomal aberrations significantly decrease the quality of human life, they also influence the development of quantitative human dermatoglyphic characteristics.[13]

In the general population, Down syndrome (DS) is the most prevalent chromosomal disorder. The incidence of infants born with this syndrome is 1 in 700.[14] Through cytogenetic analysis, it has been determined that there are three cytogenetic forms of Down syndrome. The cytogenetic form of trisomy 21 is found in approximately 94% of patients with Down syndrome. Trisomy 21 with translocation affects approximately 4% of people with Down syndrome. Approximately 2% of individuals with Down syndrome have the mosaic variant of trisomy 21.[15]

When the dermatoglyphs of people with Down syndrome free trisomy of chromosome 21, trisomy 21 with translocation, and the mosaic form of trisomy 21 were compared, no significant differences were found. All three Down syndrome forms possess dermatoglyphs that are characteristic of Down syndrome.[16] However, the dermatoglyphic features in individuals with Down syndrome significantly differ from those in healthy individuals.[17] The ulnar loop is present in approximately 80% of the digits of individuals with Down syndrome, whereas it is present in about 60% of the fingers of healthy individuals. Men with DS have approximately 130 epidermal ridges on their fingertips, whereas healthy men have approximately 145. The sum of the atd angles in both hands of individuals with Down syndrome ranges between 137° and 163°, whereas in healthy individuals, it ranges between 85° and 97°.

In the Albanian population of Kosova, no dermatoglyphic research has been conducted on individuals with Down syndrome. In this study, we investigated the dermatoglyphs of individuals with Down syndrome who are part of the Albanian population of Kosova. We compared them to individuals from the same population without chromosomal abnormalities. Our study concluded that people with Down syndrome in the Albanian population of Kosova have the same quantitative changes in the dermatoglyphs as people with DS in other populations.

This study aims to compare the quantitative characteristics of dermatoglyphs between individuals with Down syndrome and those with normal karyotypes in the Kosova Albanian population.

Materials and Methods

The quantitative characteristics of digitopalmar dermatoglyphs were analyzed on 104 individuals (54 men and 50 women) with Down syndrome from Kosova's Albanian population. The dermatoglyphs of 403 Albanians from Kosova with normal karyotypes were also analyzed quantitatively. This group serves as the control group. Using the method devised by Cummins and Midlo,[18] dermatoglyphic traces were obtained and analyzed.

During the research, the quantitative features of both the dermatoglyphs of the fingers (FRC: Finger Ridge Count) and the dermatoglyphs of the palms of the hands (PRC: Palmar Ridge Count) were analyzed.

The following quantitative characteristics of dermatoglyphs were analyzed in the fingers: Right hand – FRC of Finger 1 (FRR1), Finger 2 (FRR2), Finger 3 (FRR3), Finger 4 (FRR4), and Finger 5 (FRR5); Left hand – FRC of Finger 1 (FRL1), Finger 2 (FRL2), Finger 3 (FRL3), Finger 4 (FRL4), and Finger 5 (FRL5); Total FRC Right (TFRR (1-5)); Total FRC Left (TFRL (1-5)); Total FRC (TFRC); the number of triradius in the fingers of the right hand – Pattern Intensity Right (PIR): PIR1, PIR2, PIR3, PIR4, and PIR5 and the number of triradius in the fingers of the left hand - Pattern Intensity Left (PIL): PIL1, PIL2, PIL3, PIL4, and PIL5; Total PIR (1-5 R) (TPIR1-5R); Total PIL (1-5 L) (TPIL1-5L); the total number of triradius for the 5 fingers of the right hand (TPIR – Total PIR); the total number of triradius for the 5 fingers of the left hand (TPIL– Total PIL), as well as the total number of triradius in all 10 fingers of the right and left hand, i.e., Total Pattern Intensity Index (TPII).

In the palms of the hands, we analyzed the following patterns: the number of epidermal ridges between the digital triradius a,b,c, and d of the right hand (a-b rc R, b-c rc R and c-d rc R) and of the left hand (a-b rc L, b-c rc L and c-d rc L), the total number of epidermal ridges in the interdigital regions for the right and left hand – Total PRC on the right hand (TPRR), Total PRC on the left hand (TPRL), the total number of epidermal ridges between triradius a and b on both hands (Total Palmar Ridge - TPR 1), the total number of epidermal ridges between triradii b and c on both hands (TPR2), the total number of epidermal ridges between the triradii c and d in both hands (TPR3), the size of the atd angle in the right hand (atd R) and in the left hand (atd L) as well as the size of the atd angle in both hands (atd T).

Moorhead and Seabright's peripheral blood culture technique[19] was utilized to analyze the karyotypes of individuals with Down syndrome.

Statistical analysis was performed using the statistical software package SPSS version 21.0 (SPSS Inc, Armonk, NY: IBM Corp). The normality of distribution of continuous variables was tested by the Kolmogorov-Smirnov test with the Lilliefors correction and Shapiro-Wilk test. For the descriptive analysis, results are presented as mean (M) ± standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. Differences of continuous variables departing from the normal distribution, even after transformation, were tested by the Mann-Whitney U-test. A probability value of $P<0.05$ was considered statistically significant.

The study protocol was reviewed and approved by the Ethics Committee of the University of Prishtina.

Results

Analyses of the quantitative characteristics of dermatoglyphs were conducted on two groups of people. The first cohort consisted of 104 individuals with Down syndrome. The second group consists of 403 individuals with a normal karyotype (the control group).

Three distinct forms of trisomy 21 were present in the karyotypes of individuals with Down syndrome. There were 93 cases of free trisomy of chromosome 21 with 47,XY,+21 karyotype (males) and 47,XX,+21 karyotype (females) (Figure 1), 10 cases of trisomy 21 with translocation (Figure 2), and only one case of trisomy 21 mosaic form.

Among individuals with Down syndrome who had karyotypes with different types of trisomy 21, no significant differences in the quantitative features of the dermatoglyphs were observed; therefore, all these individuals comprised the group of people with Down syndrome.

The quantitative characteristics of the dermatoglyphs of the digits of men with Down syndrome and men with a normal karyotype are compared in Table 1. The results of the Mann-Whitney test (U') indicate a significant difference between men with Down syndrome and the control group for the number of epidermal ridges on FRR2 ($P<0.001$), and on FRR5 ($P<0.011$) of the right hand, while on the left hand for the number of epidermal ridges on FRL1 ($P=0.003$), and for FRL3 ($P=0.0014$), as well as for the TFRL variable of the left hand ($P=0.042$).

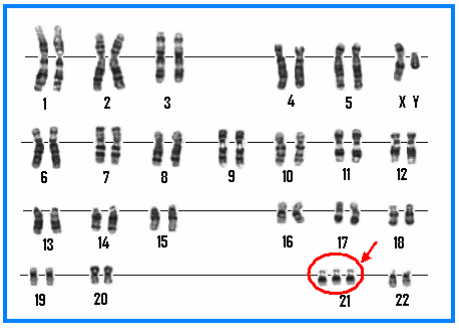

Fig. 1. *Karyotype of the child with free trisomy of chromosome 21 (47,XY,+21).*

Table 1.

The quantitative characteristics of the dermatoglyphs of the fingers between men with Down syndrome and men with a normal karyotype.

Variable	Down syndrome Male (n=54)		Control group Male (n=201)		Mann-Whitney test or T-test	*P*-value
	Mean	SD	Mean	SD		
FRR1	18.24	6.15	17.10	5.72	U'=5939.5	0.287
FRR2	12.37	4.89	9.17	6.16	U'=3860	0.001
FRR3	11.96	3.69	10.17	5.17	U'=4590.0	0.082
FRR4	11.46	4.52	13.09	5.55	U'=4130.0	0.071
FRR5	10.22	4.16	11.16	4.60	U'=4668.0	0.011
TFRR	64.26	17.27	60.70	20.41	t=1.173	0.242
FRL1	16.85	6.80	14.35	5.73	U'=6860.5	0.003
FRL2	11.74	4.93	8.17	5.99	U'=7270.5	0.0001
FRL3	12.59	3.70	9.80	5.46	U'=6961.0	0.0014
FRL4	11.85	4.44	12.91	5.49	U'=6366.0	0.051
FRL5	9.83	4.54	10.95	4.28	U'=6274.0	0.078
TFRL	62.87	16.74	56.18	20.57	U'=6405.5	0.042
TFRC	127.13	32.12	116.88	39.70	t=1.749	0.0816
PIR1	1.17	0.42	1.45	0.56	U'=6961.0	0.0012
PIR2	1.00	0.27	1.22	0.58	U'=6571.0	0.0149
PIR3	1.02	0.14	1.12	0.45	U'=6006.0	0.209
PIR4	1.13	0.34	1.49	0.53	U'=7380.0	<0.0001
PIR5	1.07	0.33	1.18	0.38	U'=5979.0	0.232
TPIR	5.39	0.94	6.46	1.70	U'=7585.5	<0.0001
PIL1	1.09	0.40	1.32	0.56	U'=6613.5	0.0119
PIL2	1.04	0.27	1.21	0.59	U'=6357.0	0.0479
PIL3	1.02	0.14	1.11	0.49	U'=5954.5	0.2554
PIL4	1.24	0.43	1.35	0.51	U'=6030.0	0.2005
PIL5	1.07	0.33	1.19	0.50	U'=5928.5	0.272
TPIL	5.46	1.02	6.18	1.82	U'=6825.5	0.0035
TPII	10.85	1.73	12.64	3.32	U'=7386.5	<0.0001

The TFRC in males with Down syndrome was 127.13, while it was 116.88 in males from the control group. Even though the TFRC of men with Down syndrome was higher than that of men in the control group, the t-test reveals no significant difference ($P=0.0816$).

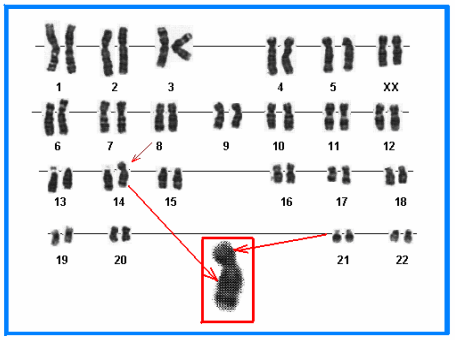

Fig. 2. *Child with trisomy 21 with Robertson's translocation between chromosomes 14 and 21: 46,XX, rob (14;21) (q10;q10), +21 mat.*

The test results (Table 1) reveal significant differences between men with Down syndrome and the control group for the number of triradius on the PIR1(*P*=0.0012), PIR2 (*P*=0.0149), PIR4 (*P*<0.0001), TPIR (*P*<0.0001), PIL1 (*P*=0.0119), PIL2 (*P*=0.0479), TPIL (*P*=0.0035), and for the total number of triradius in both hands TPII (*P*<0.0001).

In Table 2, the quantitative characteristics of palmar dermatoglyphs are compared between men with Down syndrome and men with normal karyotypes. The results of the U' test show a significant difference between men with Down syndrome and the control group for the number of epidermal ridges between the triradius a and b of the right hand (a-b rc R) (*P*=0.0189) and for the number of epidermal ridges between the triradius c and d of the right hand (c-d rc R) (c-d rc R) (*P*=0.0002), as well as for the number of epidermal ridges for the variable TPR3 (*P*=0.025).

In the U′ test between men with Down syndrome and the control group, significant differences were observed for the size of the atd angle right (atd R) (*P*<0.0001) and the atd angle left (atd L) (*P*<0.0001), and the total atd angle for both hands (atdT) (*P*<0.0001) (Table 2).

Table 2.

The quantitative characteristics of palmar dermatoglyphs between males with Down syndrome and men with a normal karyotype.

Variable	Down syndrome Male (n=54)		Control group Male (n=201)		Mann-Whitney test or T-test	*P*-value
	Mean	SD	Mean	SD		
a-b rc R	35.07	7.99	37.29	5.51	t=2.363	0.0189
b-c rc R	24.63	6.16	25.30	5.52	U'=5806.0	0.431
c-d rc R	37.61	8.43	33.83	6.17	U'=7251.5	0.0002
TPRR	97.31	16.90	96.42	12.02	t=0.443	0.657
a-g rc L	38.00	6.79	38.72	5.58	U'=5718.0	0.546
b-c rc L	23.98	6.44	24.82	5.13	U'=6119.0	0.151
c-d rc L	33.26	9.75	32.85	6.19	U'=5834.0	0.3982
TPRL	95.24	17.93	96.39	12.12	t=0.553	0.581
TPRC	192.56	32.92	192.81	23.37	t=0.064	0.949
TPR 1	73.07	13.38	76.01	10.18	t=1.753	0.0808
TPR 2	48.61	11.57	49.86	10.54	t=0.757	0.449
TPR 3	70.87	15.45	66.68	11.18	t=2.242	0.025
atd R	81.07	14.68	46.44	9.03	U'=10492	<0.0001
atd L	80.83	18.96	46.15	8.54	U'=10028	<0.0001
atd T	161.91	30.13	92.60	16.71	U'=10569	<0.0001

In Table 3, the quantitative characteristics of finger dermatoglyphs are compared between women with Down syndrome and women with normal karyotypes. The U' test revealed statistically significant differences between women with Down syndrome and the control group in terms of the number of epidermal ridges on FFF1 (*P*=0.001), FRR3 (*P*=0.0013), and FRR4 of the right hand (*P*=0.019). For the left hand, there were significant differences in the number of epidermal ridges on FRL1 (*P*<0.0001), FRL2 (*P*=0.0005), FRL3 (*P*=0.0003), and the TFRL variable (*P*=0.0045). The TFRC in females with Down syndrome was 126.16, whereas it was 111.37 in the control group (*P*=0.0419). The U' test (Table 3) revealed significant differences between females with Down syndrome and the control group in terms of the number of PIR2 (*P*=0.021) and the TPIR (*P*=0.0278).

Table 3.

The quantitative features of the dermatoglyphs of the fingers between women with Down syndrome and women with a normal karyotype.

Variable	Down syndrome Female (n=50)		Control group Female (n=202)		Mann-Whitney test or T-test	*P*-value
	Mean	SD	Mean	SD		
FRR1	17.46	5.78	14.63	5.50	U'=3540.0	0.001
FRR2	11.74	3.84	9.89	6.11	U'=4309.5	0.108
FRR3	12.18	3.83	9.76	5.00	U'=3567.0	0.0013
FRR4	11.04	5.10	13.04	5.39	U'=3970.0	0.019
FRR5	9.28	4.55	10.47	5.00	U'=5801.0	0.104
TFRR	61.70	15.90	57.78	22.00	U'=5447.0	0.390
FRL1	17.32	5.84	12.85	5.33	U'=7450.5	<0.0001
FRL2	12.24	5.08	8.87	6.35	U'=6645.5	0.0005
FRL3	13.64	4.49	10.01	5.87	U'=6725.5	0.0003
FRL4	12.00	5.29	12.24	5.49	U'=5256.0	0.656
FRL5	9.26	3.89	10.22	4.88	U'=5796.0	0.1062
TFRL	64.46	18.54	54.19	22.67	U'=6363.0	0.0045
TFRC	126.16	32.75	111.37	43.99	U'=5989.5	0.0419
PIR1	1.26	0.53	1.34	0.55	U'=5445.0	0.348
PIR2	1.04	0.35	1.25	0.60	U'=6065.0	0.021
PIR3	1.02	0.25	1.08	0.38	U'=5344.5	0.505
PIR4	1.20	0.45	1.36	0.53	U'=5829.0	0.085
PIR5	1.08	0.44	1.10	0.33	U'=5120.0	0.875
TPIR	5.60	1.39	6.13	1.64	U'=6061.5	0.0278
PIL1	1.24	0.52	1.31	0.56	U'=5386.0	0.459
PIL2	1.08	0.40	1.15	0.67	U'=5430.0	0.403
PIL3	1.08	0.34	1.08	0.45	U'=5088.5	0.9319
PIL4	1.22	0.51	1.29	0.52	U'=5388.0	0.455
PIL5	1.14	0.35	1.12	0.37	U'=5146.5	0.828
TPIL	5.76	1.51	5.95	1.84	U'=5457.5	0.376
TPII	11.36	2.72	12.08	3.27	U'=5827.0	0.0921

In Table 4, the quantitative characteristics of palmar dermatoglyphs are compared between women with Down syndrome and women with normal karyotypes. The U' test showed significant differences between females of the two studied groups for the ridge count of the right hand (b-c rc R, *P*=0.0316; c-d rc R, *P*<0.0001) and the total palmar ridge count of the right hand (TPRR) (*P*=0.016). In the left hand of women, the U' test showed significant differences in the TPRL variable (*P*=0.0199) and the TPRC variable (*P*=0.0043). Significant

differences were also revealed for TPR2 (P=0.0421) and TPR3 (P=0.0008). Through the U' test, significant differences were observed between the women with Down syndrome and the women of the control group for the size of the atd angle right [atdR] (P<0.0001), atd angle left [atdL] (P<0.0001), and total atd angle for both hands (atdT) (P<0.0001) (Table 4).

Table 4.

The quantitative characteristics of palmar dermatoglyphs of women with Down syndrome and women with a normal karyotype.

Variable	Down syndrome Female (n=50)		Control group Female (n=202)		Mann-Whitney test or T-test	*P*-value
	Mean	SD	Mean	SD		
a-b rc R	35.92	5.96	37.00	5.24	U'=5418.5	0.4251
b-c rc R	27.48	6.10	25.41	5.24	U'=6042.5	0.0316
c-d rc R	38.94	7.03	33.70	6.77	U'=7127.5	<0.0001
TPRR	102.34	13.42	96.11	12.09	t=3.192	0.016
a-g rc L	39.28	5.91	37.98	5.13	U'=5838.5	0.087
b-c rc L	26.14	5.48	24.90	5.43	U'=5671.0	0.178
c-d rc L	34.92	7.47	32.78	6.28	U'=5909.0	0.0628
TPRL	100.34	13.86	95.64	12.39	t=2.342	0.0199
TPRC	202.68	25.75	191.75	23.58	t=2.88	0.0043
TPR1	75.20	10.49	74.98	9.48	U'=5324.5	0.5527
TPR2	53.62	10.97	50.30	10.10	t=2.043	0.0421
TPR3	73.86	12.35	66.49	12.23	U'=6606.5	0.0008
atdR	82.02	12.47	47.31	8.50	U'=9828.0	<0.0001
atdL	83.46	13.76	47.45	8.40	U'=9789.5	<0.0001
atdT	165.48	24.40	94.75	16.29	U'=10569.0	<0.0001

Discussion

All types of chromosomal aberrations have an impact on the development of dermatoglyphs, which changes both their quantitative and qualitative characteristics. It is generally believed that autosomal chromosome aberrations alter the frequency of finger folds and the triradius of hands, whereas sex chromosome aberrations alter the number of embryonic ridges.[20-22] Down syndrome is characterized by an increase in the frequency of ulnar folds on the fingers, a widening of the atd angles in both hands (up to 163°), and a decrease in total finger ridge count (TFRC).

Contrary to the findings of other authors, our study revealed that the TFRC variable was higher in people with Down syndrome than in people without the condition, for both men (127.13 vs. 116.88, P=0.0816) and women (126.13 vs. 111.37, P=0.0419).

According to the findings of our study, men and women with Down syndrome had wider atdT angles in both hands than men and women in the control group: 161.91° vs. 92.60° in men (P<0.0001) (Table 2) and 165.48° vs. 94.75° in women (P<0.0001) (Table 4).

The findings in our work for the atdR, atdL, and atdT for males and females with Down syndrome are generally similar to the values found in other populations. In our study, significant differences were discovered for 40 dermatoglyphic variables when the quantitative characteristics of cases with Down syndrome and control cases were compared (Tables 1-4). Significant differences were found in 14 dermatoglyphic variables between men with Down syndrome and men with a normal karyotype when comparing the quantitative characteristics of the fingers (FRR2, FRR 5, FRL 1, FRL 2, FRL 3, TFRL, PIR 1, PIR 3, PIR 4, TPIR, PIL 1, PIL 2, TPIL, and the TPII) (Table 1).

Six dermatoglyphic variables (a-b rc R, c-d rc R, TPR 3, atd R, atd L, and atd T) on the palms of the hands of males from the two groups were found to be significantly different (Table 2).

Ten dermatoglyphic variables (FRR 1, FRR 3, FRR 4, FRL 1, FRL 2, FRL 3, TFRL, TFRC, PIR 2, and TPIR) were found to be significantly different between females with Down syndrome and those with a normal karyotype (Table 3).

When the palms of the hands of females in the two groups were compared, 11 of the dermatoglyphic variables (b-c rc R, c-d rc R, TPRR, a-b rc L, TPRL, TPRC, TPR 2, TPR 3, atd R, atd L, and atd T) showed significant differences (Table 4).

It appears that the genes necessary for the development of dermatoglyphs are related to chromosome 21, based on the presence of 40 dermatoglyphic variables with significant differences. The presence of the additional chromosome 21 in the karyotype of people with Down syndrome is the reason for these notable variations in the quantitative characteristics of the dermatoglyphs.

According to our research findings, the size of atd angles is the factor that most closely identifies people with Down syndrome. So, when developing techniques for screening for Down syndrome, the atd angle should be considered.

A diagnosis of Down syndrome can be made with an accuracy of up to 88% when the atd angle is the sole diagnostic criterion.[23] It is possible to make the diagnosis of Down syndrome with a reliability (probability) of up to 90% if the other factors that are distinctive to Down syndrome are also taken into account.[24]

We believe that the dermatoglyphic approach can be utilized as an additional way of diagnosing children with Down syndrome, especially in low-income countries. This would be a quick-to-implement, orienting diagnosis of the child suspected of having Down syndrome for further karyotype analysis that will lead to the establishment of the definitive diagnosis and the identification of the type of trisomy 21. Dermatoglyphic analysis is one of the cheapest, fastest, and non-invasive diagnostic techniques.[25]

Conclusions

The following conclusions were reached after comparing the dermatoglyphs of Down syndrome sufferers with those of the control group:

1. Compared to the control group's males and females, the males and females with Down syndrome exhibit wider atdT angles (161.91° vs. 92.60° [P<0.0001] and 165.48° vs. 94.75° [P<0.0001], respectively).

2. One of the most distinctive characteristics of Down syndrome is the breadth of the atd angle, which should be taken into consideration while developing procedures for detecting the condition.

3. The values of the TFRC variables of the males (127.13) and females (126.16) with Down syndrome were higher than those of the males (116.88) and females (111.37) in the control group.

4. When the quantitative dermatoglyphic features of men with Down syndrome and the control group were compared, significant differences were discovered in 20 of the dermatoglyphic variables. Significant differences were discovered in 21 of the dermatoglyphic variables when the features of women with Down syndrome and the control group were compared. The trisomy 21 condition in people with Down syndrome is the cause of these notable differences.

Competing Interests

The authors declare that they have no competing interests.

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