Research Article

A case–control study of fingerprint patterns of both hands in persons with and without schizophrenia

Ashma K A Latiff[1], Arul Saravanan Ramachandran[2], Sundarapandian S[1]

[1]Department of Anatomy, SRM Medical College Research Centre, Kancheepuram, Tamil Nadu, India, [2]Department of Psychiatry, SRM Medical College Research Centre, Kancheepuram, Tamil Nadu, India

Correspondence to: Arul Saravanan Ramachandran, E-mail: arulpsg@gmail.com

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ABSTRACT

Background: Schizophrenia is a complex disorder. Abnormal brain functions and aberrant fingerprint patterns are under study to aid in diagnosing schizophrenia. **Objectives:** The objectives of the study were to study the finger and palm print patterns in patients with schizophrenia, to compare the patterns with those of healthy controls, to find if specific patterns exist in patients with schizophrenia, a cross-sectional comparative case–control study of finger and palm patterns in patients with schizophrenia and age-matched healthy controls was done in a tertiary care teaching hospital in the district of Kancheepuram, Tamil Nadu. **Materials and Methods:** Finger and palm print pattern of 100 patients with schizophrenia and 100 age-matched controls was taken using the standard technique with India ink and studied. Demographic details of both the case and control groups were also collected. Patterns of both the hands of the two groups were analyzed. Descriptive analysis was done. Chi-square test and independent *t*-test were used for analyzing the mean difference between the variables of the two groups. **Results:** The frequency of arches was more in cases than controls. The frequency of radial loops was twice in cases than controls. The ulnar loops were less in cases. The mean total finger ridge count and total A-B ridge count were significantly lower in schizophrenia patients than in controls. The mean atd angle was significantly higher in cases than in controls. **Conclusion:** In our study, the finger and palm print patterns show a statistically significant difference in certain parameters between patients with schizophrenia when compared with controls.

KEY WORDS: Humans; Fingers; Printing; Schizophrenia; Neurodevelopmental disorders; Dermatoglyphics

INTRODUCTION

Since Galton's[1] (1892) pioneering work on fingerprints, a number of research has been made to study the dermatoglyphic correlates of morphological and behavioral traits of humans. Dermatoglyphics of many disorders such as schizophrenia, Down's syndrome, diabetes mellitus, hypertension, epilepsy, and conditions such as obesity have been studied.[2] In such disorders, dermatoglyphics can be utilized along with other clinical signs as a definitive marker.

The second trimester of fetal ectodermal development is an at-risk period.[3] Stress can affect brain development as well as the ectodermal dermatoglyphic ridge development. Thus, dermatoglyphics are of interest as their development is localized to the same period of maturing fetal brain that may be at a higher risk for the later development of schizophrenia.

Ectodermal ridges appear on the fingers and palm during the first and second trimester of pregnancy.[4] Skin and brain develop from the same ectoderm and cells migrate to the cortex in the second trimester.[5] Recent studies now link, the dermatoglyphic profiles of the hands to schizophrenia.[6]

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Schizophrenia is a devastating neurodevelopmental disorder, which is expressed by the interplay of both genetic vulnerability and environmental stress. Recent advances have identified many markers for the disease, though none are pathognomonic. If the robust association can be found between fingerprint features, this can become a noninvasive and inexpensive marker for schizophrenia. Hence, this study was undertaken.

Aim and Objectives

The aim was to study the finger patterns in schizophrenia patients. The objectives were to study the finger and palmar print pattern in schizophrenia patients, to compare the dermatoglyphic patterns of schizophrenia patients and healthy controls, to compare the present findings with the previous workers, and to find out whether the specific dermatoglyphic traits exist in the patients with schizophrenia and whether it is significant.

MATERIALS AND METHODS

The study population consisted of patients visiting the psychiatric department of a tertiary care teaching hospital in the district of Kancheepuram, Tamil Nadu. The study was approved by the Institutional Ethical Committee (IEC clearance number 449/IEC). Informed written consent was obtained from both the patient and the caregiver who had accompanied the patient. Convenient sampling was utilized to select the patients who were under treatment for schizophrenia.

Cases

Adults between ages 18 and 60 years were included in the study. The primary diagnosis of schizophrenia made by the psychiatrist according to International classification of diseases-10 was included. The patient must have been diagnosed at least 1 year prior, for the sake of diagnostic stability. No other major psychiatric disorder diagnosis other than nicotine dependence (smoking) was included. The diagnosis was validated using the mini international neuropsychiatric interview schedule.[7] Any person not able to understand the procedure or refusing consent or to give hand impression were excluded from the study. Purposive sampling technique was used to select 100 cases.

Controls

An age-matched sample of controls (n = 100) was selected from the community. Any person not able to understand the procedure or refusing consent or to give hand impression was excluded from the study. They were screened using general well-being schedule to screen for any latent psychological disorder.[8] A score of 73 and above were only included in the study. A semi-structured pro forma was used to collect the relevant demographic and clinical details of the patient and controls.

Procedure

The palm and fingerprints were obtained using a standardized method. The study subjects washed their hands thoroughly with soap and water. Water was dried off using a clean towel. Indian Ink was spread evenly over the palmar surface of both the hands from the wrist above till the fingertips. The impression was placed over white A4 sheet (one for each hand) from wrist to tips direction; gentle pressure was applied over the dorsum of the hand to obtain a clear impression. The prints of the fingertips were taken once again. It was then allowed to dry for 5 min in ambient air and later numbered, labeled, and recorded. The detailed description of the method is given elsewhere.[9] Measurement of the counts and patterns was done manually using a standard magnification lens.

Statistics

Descriptive statistical analysis was performed using IBM SPSS for windows version 12. The fingerprint patterns were studied in all ten fingers for 100 schizophrenia patients and 100 controls. All the parameters were also recorded separately for the right and left hands and were compared between corresponding hands of cases and controls. Data are expressed as number (%) and mean ± standard deviation for continuous variables. Chi-square test and independent t-test were performed to compare the mean scores between schizophrenia patients and controls.

RESULTS

Demographic Data

Table 1 shows the demographic characteristics of the case and the control group. About 44% were male, and 56% were females in the case group, and 64% were males and 36% were females in the control group. The majority (64%) had a primary level of education. About 42% of the patients with schizophrenia were unemployed, and 38% were dependents as against only 20% of them being gainfully employed. The majority was Hindus and most were from rural areas. About 68% of the case were married and 60% of them lived in an extended type of family. The control group was similar in most of the characters. Both the cases and controls were identical with regard to the demographic parameters.

Fingerprint Pattern in Cases

Out of the thousand fingers studied in schizophrenia patients, ulnar loops were the most frequent and were observed in 544 fingers (54.4%). Simple whorls were the second most common and were noted in 284 fingers (28.4%). Radial loops were the least common pattern accounting for 20 fingers

Table 1: Comparison of the Socio-demographic profile of the study group and control group

Variables	Cases *n*=100		Controls *n*=100		X_2 (df=1)	*P*
	n	(%)	*n*	(%)		
Sex						
Male	44	44	64	64	2.2	0.137
Female	56	56	36	36		
Education						
Primary	64	64	50	50	3.9	0.045
Secondary and above	36	36	50	50		
Occupation						
Unemployed	42	42	64	64	5.8	0.054
Employed	20	20	16	16		
Dependants	38	38	20	20		
Socio-economic status						
Lower	20	20	30	30	2.6	0.268
Middle	68	68	60	60		
High	12	12	10	10		
Domicile						
Rural	44	44	50	50	3.5	0.168
Semi Urban	36	36	24	24		
Urban	20	20	26	26		
Religion						
Hindu	62	62	60	60	0.5	0.778
Christian	26	26	30	30		
Muslim	12	12	10	10		
Marital status						
Single	32	32	34	34	0.09	0.763
Married	68	68	66	66		
Family type						
Nuclear	22	22	18	18	0.80	0.669
Extended	60	60	66	66		
Joint	18	18	16	16		

(2.0%). Arches and composite whorls were equal in frequency and were present in 76 fingers each (7.6% each) [Figure 1].

Fingerprint Pattern in Controls

Ulnar loops were the most frequent patterns and were observed in 576 fingers (57.6%). Simple whorls were the second most common patterns which were seen in 287 fingers (28.7%). Radial loops were the least common fingerprint patterns and were present in only 10 fingers (1.0%). Composite whorls were the second least patterns and were present in 55 fingers (5.5%). Arches were observed in 72 fingers (7.2%) [Figure 2].

Comparison of Fingerprint Patterns of Cases and Controls

Percentage of arches and simple whorls is approximately equal in both cases and controls. Radial loops and composite whorls were significantly high in cases than in controls. Cases tend to possess less ulnar loops than controls [Table 2]. However, this difference was not statistically significant.

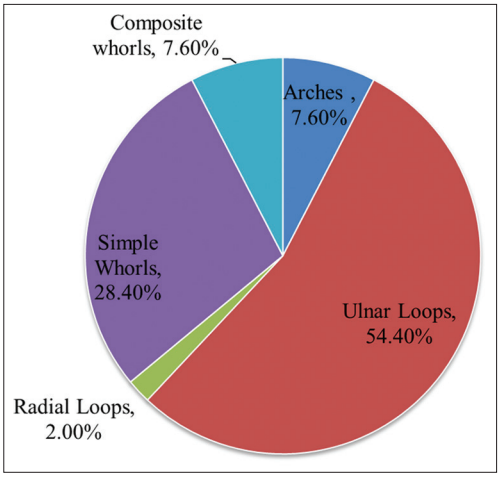

Figure 1: Pie chart showing frequency of fingerprint patterns in cases

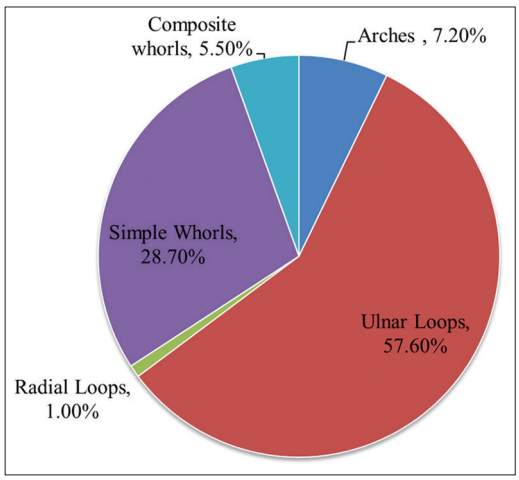

Figure 2: Pie chart showing frequency of fingerprint patterns in controls

Fingerprint Patterns in the Right Hands of Schizophrenia Patients and Controls [Table 3]

Ulnar loops were the most common fingerprint patterns (55.0% in cases and 56.8% in controls). Simple whorls were the second most common patterns (27.2% in cases and 28.2% in controls). Radial loops were the least common patterns present (1.8% in cases and 1.2% in controls). Arches were the second least common patterns observed (7.6% in cases and 8.2% in controls). Composite whorls were present in 8.4% of cases and 5.6% of controls.

Fingerprint Patterns in the Left Hands of Schizophrenia Patients and Controls [Table 3]

Ulnar loops were the most common fingerprint patterns. Simple whorls were the second most common patterns

present. Radial loops were the least common patterns present. Composite whorls were the second least common patterns observed. Arches were present in 6–7%.

Comparison of Fingerprint Patterns in the Right and Left Hand of Cases and Controls

The association between groups (cases and controls) and right-hand patterns (arches, ulnar loops, radial loops, simple whorls, and composite whorls) was not statistically significant ($P = 0.441$).

The association between groups (cases and controls) and left-hand patterns (arches, ulnar loops, radial loops, simple whorls, and composite whorls) was not statistically significant ($P = 0.220$).

Finger ridge count (FRC) was counted separately in the 100 right and 100 left-hand impressions of the cases and was compared with controls. Independent sample *t*-test was performed to test the significance of the difference in the FRC of the right and left hand of cases and controls. The mean FRC in both right and left hands was significantly lower in patients with schizophrenia than in controls [Table 4].

A-B ridge count (ABRC) was counted separately in the 100 right and 100 left-hand impressions of the cases and was compared with controls. The mean FRC in both right and left hands was significantly lower in patients with schizophrenia than in controls [Table 4].

Total FRC (TFRC) was counted in all 10 fingers of 100 schizophrenia patients and 100 controls. The TFRC showed a mean of 110.45 in cases and 143.55 in controls. The mean TFRC is significantly lower in schizophrenia patients when compared with controls [Table 5].

Total a-b ridge count (TABRC) was studied by counting the ridges between the triradius "a" and tri radius "b" in both hands in 100 schizophrenia patients and 100 controls. The mean TABRC in schizophrenia patients was 77.74 and that of controls was 81.95. The mean TABRC is significantly lower in schizophrenia patients when compared with controls [Table 5].

Atd angle was measured in the palms of 100 schizophrenia patients and 100 controls. A line was drawn from triradius "a" to tri radius "t," another line was drawn from tri radius "d" to tri radius "t." The angle formed at tri radius "t" between the two lines thus drawn was measured using a protractor. The mean atd angle in cases was 43.97 and that of controls was 39.83.

Table 2: Comparison of fingerprint patterns of cases and controls

Patterns		Groups	
		Case	Control
Arches	Count (%)	76 (7.6)	72 (7.2)
Ulnar loops	Count (%)	544 (54.4)	576 (57.6)
Radial loops	Count (%)	20 (2.0)	10 (1.0)
Simple whorls	Count (%)	284 (28.4)	287 (28.7)
Composite whorls	Count (%)	76 (7.6)	55 (5.5)
Total	Count (%)	1000 (100.0)	1000 (100.0)

Chi-square statistic=7.738; df=4 (P=0.102)

Table 3: Comparison of fingerprint patterns of the right and left hands of cases and controls

Patterns		Right hand		Left hand	
		Case	Control	Case	Control
Arches	Count (% within group)	38 (7.6)	41 (8.2)	38 (7.6)	31 (6.2)
Ulnar loops	Count (% within group)	275 (55.0)	284 (56.8)	269 (53.8)	292 (58.4)
Radial loops	Count (% within group)	9 (1.8)	6 (1.2)	11 (2.2)	4 (0.8)
Simple whorls	Count (% within group)	136 (27.2)	141 (28.2)	148 (29.6)	146 (29.2)
Composite whorls	Count (% within group)	42 (8.4)	28 (5.6)	34 (6.8)	27 (5.4)
Total	Count (%)	500 (100.0)	500 (100.0)	500 (100.0)	500 (100.0)

Table 4: Test of significance for FRC and ABRC in the right and left hands of cases and controls: (n=100)

Parameter	Hand	Group	Mean	Standard deviation	Standard error mean	*P*-value
FRC	Right	Cases	55.2600	2.91849	0.29185	0.000*
		Controls	71.7900	2.94836	0.29484	
	Left	Cases	55.1900	2.86284	0.28628	0.000*
		Controls	71.7600	3.00209	0.30021	
ABRC	Right	Cases	38.8700	3.82088	0.38209	0.000*
		Controls	40.9800	2.65520	0.26552	
	Left	Cases	38.8700	3.80763	0.38076	0.000*
		Controls	40.9500	2.65290	0.26529	

*P<0.0001

Table 5: Test of significance for TFRC, TABRC, and ATD angle in cases and controls: (*n*=100)

Parameter	Group	Mean	Standard deviation	Standard error mean	Confidence interval		*P*-value
					Upper	Lower	
TFRC	Case	110.45	5.739	0.574	109.31	111.59	0.000*
	Control	143.55	5.907	0.591	142.38	144.78	*P<0.001
TABRC	Case	77.74	7.595	0.760	76.23	79.25	0.000*
	Control	81.95	5.240	0.524	80.91	82.99	*P<0.001
ATD-angle	Case	43.97	2.840	0.284	43.37	44.57	0.000*
	Control	39.83	2.432	0.243	39.29	40.37	*P<0.001

The mean atd-angle is significantly higher in schizophrenia patients when compared with controls [Table 5].

DISCUSSION

We studied the d differences in a group of patients with schizophrenia and compared them with the healthy control group. We compared the patterns of the finger and palm prints of both the right and left hands within each group and across the group as well. In the present study, the mean TFRC in cases was 110.45. Our study also showed that the right FRC was 55.26 in schizophrenia patients and 71.79 in controls, which was significant. The mean TABRC in cases was 77.74 and it was 81.95 in controls. The mean right ABRC was 38.87 in cases and 40.98 in controls. The mean left ABRC was 38.87 in cases and 40.95 in controls. Further, the mean left ABRC was 38.87 in cases and 40.95 in controls. In the present study, comparison of mean atd angles of the right and left hands of cases with corresponding hands of controls showed a higher mean atd angle of 43.97 in cases and a lower value of 39.83 in controls for both hands which was significant. There was no significant association between schizophrenia status and fingerprint patterns as *P* value was not significant.

Our study did not show a statistically significant association between schizophrenia status and fingerprint patterns. Similar findings were observed in studies done in India and abroad. Karmakar and Sengupta[10] found no association between fingerprint pattern and schizophrenia status of the study groups. In the study done by Chadikovska *et al*.[11] also, there was no association between fingerprint pattern in both study groups. Divakaran *et al*.[12] in their study recorded no association between fingerprint patterns in both cases and controls. Sawant *et al*.[13] found no association between fingerprint pattern and schizophrenia status of the study groups. TFRC appears to be under relatively strong genetic control and little influenced by environmental events.[14] It is the most commonly used measure in dermatoglyphic studies.[15] The mean TFRC in cases was 110.45. This is similar to the following studies. Chok *et al*.[16] (2003) recorded a mean TFRC 108.30, Avila *et al*.[17] observed a mean TFRC of 114.17, and Divakaran *et al*. noted 110.50 as mean TFRC. Karmakar and Malhotra recorded a mean TFRC of 152.49, Fearon *et al*. observed a mean TFRC of 126.4, Francisco *et al*.[18] noted 130.6, Saha *et al*.[19] recorded a mean TFRC of 135.12, and Sawant *et al*. recorded 137.56 as mean TFRC among cases. Studies by Karmakar and Malhotra[20] observed a mean TFRC in controls as 146.09, Avila *et al*.[17] noted a mean TFRC of 140.00 and Divakaran *et al*.[12] recorded a mean TFRC of 144.37. In the present study, the mean TFRC in controls was 143.55. This is comparable to the above studies. Few other studies showed a lower mean TFRC in controls than the present study. Fearon *et al*.[6] recorded a mean TFRC of 126.9, Chok *et al*.[16] noted a mean TFRC of 129.1, Saha *et al*.[19] observed a mean TFRC of 133.71 in controls, Wang *et al*.[21] recorded a mean TFRC 107.84, and Sawant *et al*.[13] recorded a mean TFRC of 127.86. Studies by Francisco *et al*.,[18] Chok *et al*.,[16] Avila *et al*.,[17] Golembo-Smith *et al*.,[22] and Turek[23] also recorded a significantly low TFRC in cases when compared to controls. Divakaran *et al*.[12] recorded reduced mean TFRC in cases than controls. The findings of the present study are consistent with many studies showing a statistically significant difference between cases and controls. The difference between the right FRC of 55.26 in schizophrenia patients and 71.79 in controls was significant. Divakaran *et al*.[12] recorded a mean right FRC of 52.38 in cases and 71.75 in controls. Francisco *et al*.[18] found a mean right TFRC of 65.9 in cases and 81.7 in controls. In the present study, the mean left FRC was 55.19 in cases and 71.76 in controls with a significant *P* value of $P < 0.0001$. Divakaran *et al*.[11] observed a mean left FRC of 58.12 in cases and 72.62 in controls with $P < 0.001$. Francisco *et al*.[18] observed a mean left FRC of 64.7 in cases and 82.2 in controls. Comparison of the right and left hands of cases and controls also showed a similar significant reduction in FRC in the present study. Rose *et al*.[24] believe that the ABRC is more sensitive to environmental stress, arguing that the ridge formation progresses more slowly on the palms than the fingers and ridge differentiation proceeds in a distal radial to the proximal ulnar direction. Thus, the ridges in the second interdigital region, which develop over a longer period, gets exposed longer to potential environmental insults.

In the present study, mean TABRC in cases was 77.74. This is similar to observations by Fañanás *et al*.[25] (1996) who recorded a mean TABRC of 79.2, Fearon *et al*.[6] observed a mean TABRC of 78.0 in cases, Francisco *et al*.[18] noted a mean TABRC of 80.8, and Özyurt *et al*.[26] recorded a mean

value of 75.43. The mean TABRC of 81.95 in controls was similar to the following studies. Fañanás *et al*.[25] recorded a mean TABRC of 83.0. Fearon *et al*. [6] observed a mean TABRC of 82.8. Chok *et al*.[16] noted a mean TABRC of 84.4. Saha *et al*.[19] reported a mean TABRC of 82.58. Özyurt *et al*.[26] noted a mean TABRC of 82.87 in controls. Sengupta and Bhuyan[27] recorded a mean TABRC of 74.89 in controls which were lower than the present study. Bramon and Murray[28] also recorded a reduced mean TABRC in cases than controls. Dang *et al*.[29] reported a significantly lower mean TABRC in cases than controls with $P = 0.01$. Golembo-Smith *et al*.[22] found a significantly lower TABRC in cases than controls with $P < 0.01$. Saha *et al*.[19] found that the TABRC was higher in cases than controls, but the results were not statistically significant. Arunpongpaisal *et al*.[30] found no difference in ABRC between cases and controls. Thus in most of the previous studies, statistically significant reduction in TABRC was observed in schizophrenia patients when compared to healthy controls, as in our study. In the present study, the mean right ABRC was 38.87 in cases and 40.98 in controls. Studies by Francisco *et al*.[18] and Özyurt *et al*.[26] showed similar results. Francisco *et al*.[18] recorded a reduced mean right ABRC in cases, but the difference did not reach a statistically significant level. Özyurt *et al*.[26] recorded a mean right ABRC of 37.76 in cases and 40.44 in controls. In the present study, the mean left ABRC was 38.87 in cases and 40.95 in controls. Francisco *et al*.[21] observed that the mean left ABRC was 41.0 in cases and 42.8 in controls. Özyurt *et al*.[26] recorded a mean left ABRC of 37.67 in cases and 42.43 in controls, which was also statistically significant in accordance with the present study.

Penrose (1968) observed that the atd angle is even more sensitive to environmental effects than the ABRC. In the present study, the mean atd angle in cases was observed to be 43.97. This value is similar to the observations made by Sengupta and Bhuyan[27] recorded a mean atd angle of 42.36. Francisco *et al*.[18] observed a mean atd angle of 44.55. Özyurt *et al*.[26] reported a mean atd angle of 38.26. Sawant *et al*.[13] noted a mean atd angle of 43.82 in cases. The mean atd angle in controls of 39.83 was similar to observations by the following authors. Sengupta and Bhuyan[27] noted a mean atd angle of 43.75. Francisco *et al*.[18] reported a mean atd angle of 44.75 in controls. Özyurt *et al*.[26] recorded a mean atd angle of 40.90 in controls. Sawant *et al*.[13] noted a mean atd angle of 40.71 in controls. Sawant *et al*.[13] (2013) found significantly larger atd-angles in schizophrenia patients when compared to controls. Avila *et al*.[17] found no significant difference in atd angles between cases and controls through the mean atd angle was larger in cases when compared to controls. Jhingan and Munjal[31] found a statistically significant smaller atd angle in cases than in controls. Özyurt *et al*.[26] recorded a smaller mean atd angle in cases and larger mean atd angle in controls. Sengupta and Bhuyan[27] also recorded a lower mean atd angle in cases when compared to controls. However, the difference was not statistically significant. Özyurt *et al*.[26] in their study recorded a lower mean right atd angle of 38.69 in cases and higher value of 40.70 in controls. The mean left atd angle was 37.84 in cases and 41.11 in controls. Francisco *et al*.[18] observed a higher mean right atd angle of 43.9 in cases and 42.9 in controls. The mean left atd angle was 45.2 in cases and 46.6 in controls. However, the difference did not reach a statistically significant difference in both.

To the best of our knowledge, there are very few studies that were done in a case–control format before age-matched healthy controls. Furthermore, this is the first study of dermatoglyphics of patients with schizophrenia done in South Indian population. Certain limitations of the current study include that it did not look into the gender differences in the fingerprint pattern. Further subgrouping on the basis of sub-types of schizophrenia was not done, as the diagnostic stability of subtypes is poor and of not much use. The recent Diagnostic and statistical manual -V has altogether done away with sub-typing of schizophrenia. Although the sample size was modest, the findings of the study are in agreement with studies on dermatoglyphics, done both in India and abroad.

CONCLUSION

The present study was done to find the association between finger and palm print parameters and schizophrenia status. On comparing the arches between schizophrenia patients and controls, the frequency of arches was more in cases, the radial loops twice in cases than controls. The ulnar loops were less in cases than controls and were the most frequent of all fingerprint patterns in both cases and controls. The frequency of simple whorls in cases was less in cases than controls. The frequency of composite whorls in cases was the same as arches and was more than that of controls. There was no significant association between fingerprint pattern and schizophrenia status. However, the mean TFRC and TABRC were significantly lower in schizophrenia patients than controls. The mean atd angle was significantly higher in cases than controls. The dermatoglyphic features show differences in certain parameters between those with schizophrenia and healthy controls. Further studies will help fingerprint patterns parameters as a low-cost marker for diagnosing schizophrenia.

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