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Fingerprint Ridge Density in Schizophrenia: A Comparative Study in Kano State, Nigeria

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ABSTRACT

Schizophrenia is a complex neurodevelopmental disorder influenced by genetic and prenatal environmental factors. Dermatoglyphic traits, particularly fingerprint ridge density (RD), are established during early foetal development and may serve as non-invasive markers of developmental disturbances associated with schizophrenia. This study investigated fingerprint ridge density patterns among individuals with schizophrenia and controls in Kano State, Nigeria, and examined sex-related differences. A comparative cross-sectional study was conducted among 109 schizophrenia patients and 111 controls aged 18–60 years. Ridge density was assessed in the ulnar (URD), radial (RRD), and proximal (PRD) regions of all ten digits using a standardized 5 mm × 5 mm counting technique. Females demonstrated consistently higher ridge density values than males across both groups, confirming sexual dimorphism. Compared with controls, schizophrenia patients exhibited significantly lower ridge density values across multiple digits and regions. The reductions were more pronounced among males, particularly in the thumb, ring, and little fingers, and were associated with moderate-to-large effect sizes. Female patients also showed significantly lower ridge density values, especially in the index, middle, ring, and little fingers, although the differences were generally less marked than those observed among males. Bilateral reductions were predominantly evident within the ulnar and radial regions, suggesting altered prenatal epidermal ridge development. These findings provide further support for the neurodevelopmental hypothesis of schizophrenia and indicate that fingerprint ridge density may represent a simple, inexpensive, and non-invasive biomarker of developmental instability associated with the disorder.

Keywords: schizophrenia, fingerprint, ridge density, dermatoglyphics, sexual dimorphism, Nigeria

INTRODUCTION

Schizophrenia is a severe psychiatric disorder that affects about 1 % of the population, and typically has an onset in adolescence or young adulthood, with males being affected more often and more severely than females [1]. In the mainstream psychiatric discourse, schizophrenia is considered a mental disorder that can be diagnosed and classified using the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD). In patients with schizophrenia, decline in mental function and social relationships over time can lead to social isolation, stigma, worse functional and cognitive impairment, reduced quality of life, and poor physical health, which creates burdens not only for individuals with schizophrenia but for their caregivers and families alike. Schizophrenia has also been linked to higher rates of comorbid illnesses, and most excess deaths are due to underlying physical illnesses, especially chronic diseases such as coronary heart disease, stroke, type II diabetes, respiratory diseases, and some cancers. Unnatural causes, including suicide, account for less than 15% of excess deaths [2]. In Nigeria, it is estimated that about 1.1 million people live with schizophrenia [3]. However, mental health data is limited, and the true number may be higher due to underreporting, especially in rural areas where access to mental health care is scarce. The stigma surrounding schizophrenia in Nigeria is high, which often leads to social isolation and discrimination. People with schizophrenia frequently

face rejection by their communities, and many families resort to traditional healers instead of seeking medical treatment, exacerbating the patient's condition. Access to mental health services in Nigeria is limited [4]. Dermatoglyphics analysis has been investigated as a useful diagnostic and research tool in medicine and provides valuable insight into the inheritance and/ or embryology formation of many known clinical disorders [5]. Ridge density (RD) can be defined as the number of digital ridges per unit area [6]. The fingerprint ridge densities differ from finger to finger, even from the upper tip to the bottom of the same finger [7]. In recent decades, medical interest in epidermal ridges has increased considerably following reports that individuals with chromosomal aberrations often exhibit atypical ridge patterns [8-11]. A case and control groups study by Shakibaei and Asadollahi [12] showed a higher statistically significant difference in terms of index finger Ridge densities in patients with schizophrenia.

MATERIAL AND METHODS

This study examined ridge density (Ulna, Radial, and Proximal) of left and right fingerprints of 109 patients with schizophrenia (cases) and 111 in the control group. Cases were randomly selected from patients at Dawanau Psychiatric Hospital, Kano, and Dorayi Rehabilitation Centre, Kano.

Schizophrenia diagnosis was confirmed by a consultant psychiatrist using the Diagnostic and Statistical Manual of Mental Disorders criteria. Controls were recruited from the School of Hygiene, Kano, and were screened to exclude: history of psychiatric illness, family history of schizophrenia, neurological disorders, congenital hand abnormalities, and dermatological conditions affecting fingerprints. Inclusion Criteria include adults aged 18–60 years, confirmed schizophrenia diagnosis at least six months of onset (case group), and healthy individuals without psychiatric history (control group). Exclusion Criteria: schizophrenia caused by addiction, Finger deformities, a history of major hand trauma, and unclear fingerprint impressions. Ethical approval was sought from the Ethical Committee of Ahmadu Bello University and the Kano State Ministry of Health with ref. no. ABUCUHSR/2024/019 and NHREC/17/03/2018, respectively. Fingerprints were obtained with a direct sensing fingerprint capturing method as described by Adamu [6].

Independent t-tests were performed to compare ridge density parameters between groups. To control for inflation of Type I error due to multiple comparisons, the Bonferroni correction for multiple comparisons was applied separately for the right and left hands. Since 15 comparisons were conducted per hand, the adjusted significance threshold was set at $p<0.003$.

Only p-values less than 0.003 were considered statistically significant after correction.

Effect sizes were calculated using Cohen's d.

Ridge density anthropometry

Ridge density was defined as the number of epidermal ridges intersected by a diagonal line within a standardized 5 mm × 5 mm square placed over a designated area of the fingerprint surface. RD was assessed in three predefined regions of each fingertip: the distal, ulnar distal, and proximal regions (Figure 1). Ridge counts were obtained within the standardized square according to previously validated dermatoglyphic methods [6,13].

RESULTS

The present study evaluated fingerprint ridge density (RD) among schizophrenia patients and controls in Kano State, Nigeria, with emphasis on sexual dimorphism and disease-related differences across the ulnar ridge density (URD), radial ridge density (RRD), and proximal ridge density (PRD) regions of all ten digits.

Table 1 demonstrated generally higher ridge density values among females compared to males in the control population, although only a few parameters reached statistical significance after independent t-test analysis. Significant differences were observed in the left index PRD ($p = 0.012$) and left middle RRD ($p = 0.022$), where females exhibited higher values than males.

Despite the presence of several higher mean values among females, most comparisons were not statistically significant following Bonferroni correction, indicating that sexual dimorphism in the healthy control population was relatively subtle. The Cohen's d effect sizes ranged from negligible to moderate, suggesting small-to-moderate sex-related differences in ridge density patterns among apparently healthy individuals.

Among schizophrenia patients (Table 2), females consistently demonstrated higher ridge density values than males across most digits and ridge regions. The most pronounced differences were observed in the thumb URD of both right and left hands, where females showed significantly higher values compared to males (right: $p < 0.001$, $d = -0.75$; left: $p = 0.002$, $d = -0.62$), while several other variables showed trends toward significance with small-to-moderate effect sizes. These findings suggest stronger sexual dimorphism among schizophrenia patients compared to controls, implying that schizophrenia-related developmental disturbances may interact with sex-linked biological mechanisms affecting epidermal ridge formation.

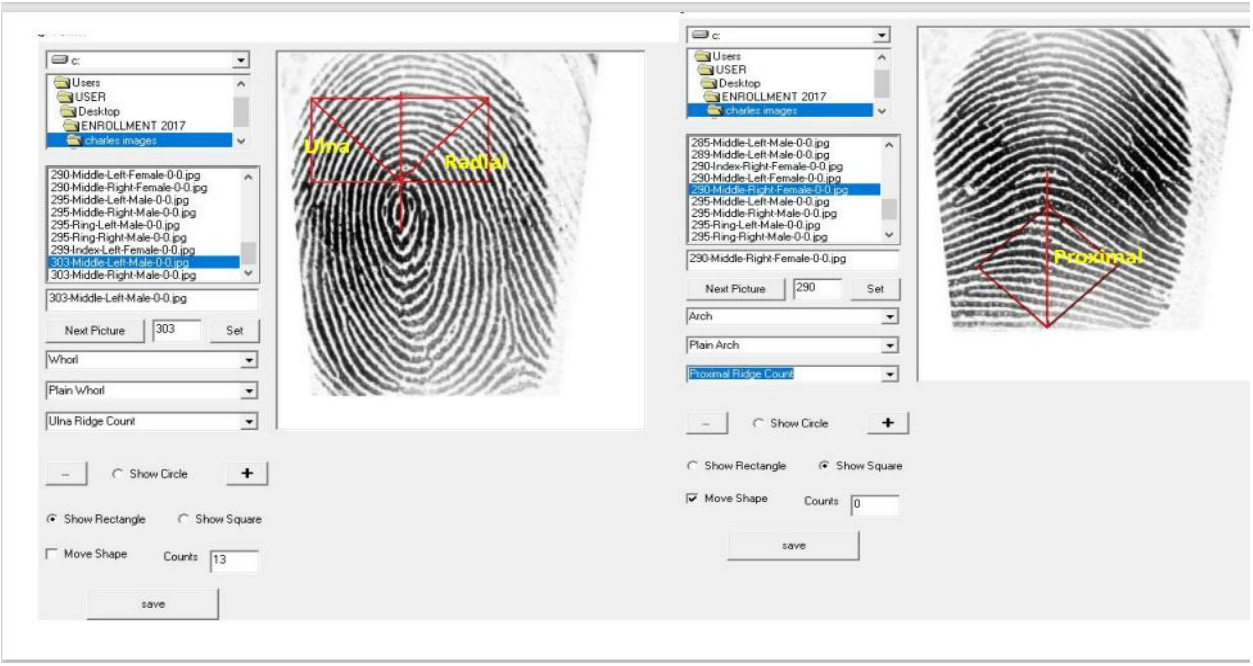

Figure 1: Ulna, radial, and proximal area used for ridge density assessment.

Table 3 revealed markedly reduced ridge density values among male schizophrenia patients compared with male controls across nearly all digits and ridge regions. The strongest reductions were observed in the thumbs, ring fingers, and little fingers of both hands. Significant reductions were particularly evident in: Thumb URD and RRD bilaterally ($p < 0.001$), Index finger RRD and URD, Middle finger RRD, Ring finger RRD, and little finger URD and RRD bilaterally. The effect sizes were predominantly moderate-to-large, with some variables demonstrating very large effects, such as: Right thumb URD ($d = -1.37$), Left ring RRD ($d = -1.21$) and Left little RRD ($d = -1.13$) These findings indicate a substantial reduction in epidermal ridge density among male schizophrenia patients, supporting the hypothesis that abnormal prenatal neurodevelopment contributes to both schizophrenia pathogenesis and altered dermatoglyphic characteristics.

Among females (Table 4), schizophrenia patients also demonstrated lower ridge density values compared with controls, although the magnitude of differences was generally smaller than those observed among males. Significant reductions were especially observed in: Index finger RRD bilaterally ($p < 0.001$), Left middle RRD ($p < 0.001$), Left ring URD and RRD, and Little finger RRD bilaterally ($p < 0.001$). The largest effect sizes among females were observed for: Left little RRD ($d = -1.23$), Left middle RRD ($d = -0.92$), and Left index RRD ($d = -0.82$)

Table 1: Sexual Dimorphism of Ridge Density Count among the Control Group

		Right					Left				
		Mean±SD					Mean±SD				
Digit	Ridge Density	Male (n=53)	Female (n=58)	t-value	*d*	P-value	Male (n=53)	Female (n=58)	t-value	*d*	p-value
Thumb	URD	13.08±1.12	12.53±1.25	2.405	0.46	0.018	12.38±1.46	12.45±1.54	-0.249	-0.05	0.804
	RRD	12.49±1.37	12.41±1.36	0.296	0.06	0.768	12.74±1.33	12.86±1.50	-0.466	-0.09	0.642
	PRD	9.92±0.94	9.98±0.95	-0.325	-0.06	0.746	10±1.07	10.12±0.90	-0.644	-0.12	0.521
Index	URD	12.30±1.31	12.59±1.4	-1.101	-0.21	0.273	12.19±1.26	12.66±1.64	-1.671	-0.32	0.098
	RRD	12.36±1.32	12.79±1.37	-1.698	-0.32	0.092	12.75±1.29	13.03±1.48	-1.061	-0.20	0.291
	PRD	10.17±1.31	10.5±1.22	-1.375	-0.26	0.172	9.81±1.23	10.43±1.34	-2.546	-0.48	0.012
Middle	URD	12.49±1.22	12.83±1.29	-1.414	-0.27	0.16	12.51±1.44	12.9±1.17	-1.565	-0.30	0.12
	RRD	12.72±1.36	13.03±1.32	-1.244	-0.24	0.216	12.96±1.48	13.66±1.65	-2.332	-0.44	0.022
	PRD	9.92±1.19	9.98±1.25	-0.251	-0.05	0.802	9.81±1.08	10.14±0.95	-1.703	-0.32	0.091
Ring	URD	13.08±1.14	13.24±1.44	-0.668	-0.13	0.506	13.04±1.30	13.38±1.37	-1.342	-0.26	0.182
	RRD	13.17±1.16	12.97±1.69	0.738	0.14	0.462	13.6±1.43	13.45±1.56	0.546	0.10	0.586
	PRD	9.83±1.00	10.05±1.26	-1.02	-0.19	0.31	10.32±1.16	9.97±1.12	1.641	0.31	0.104
Little	URD	13.02±1.22	12.74±1.43	1.094	0.21	0.276	12.57±1.34	12.86±1.34	-1.162	-0.22	0.248
	RRD	12.98±1.49	12.91±1.44	0.242	0.05	0.809	13.51±1.45	13.55±1.62	-0.144	-0.03	0.886
	PRD	9.96±1.00	9.88±1.09	0.416	0.08	0.678	10.04±0.94	9.88±1.03	0.845	0.16	0.4

URD=Ulna Ridge Density, RRD=Radial Ridge Density, PRD=Proximal Ridge Density

Table 2: Sexual Dimorphism of Ridge Density among the Schizophrenia Group

		Right					Left				
		Mean±SD					Mean±SD				
Digit	Ridge Density	Male (n=50)	Female (n=59)	t-value	*d*	p-value	Male (n=53)	Female (n=59)	t-value	*d*	p-value
Thumb	URD	11.38±1.34	12.39±1.34	-3.924	-0.75	<0.001	11.28±1.43	12.19±1.5	-3.223	-0.62	0.002
	RRD	11.42±1.25	11.85±1.24	-1.786	-0.34	0.077	11.68±1.25	12.22±1.38	-2.143	-0.41	0.034
	PRD	9.38±0.88	9.78±0.91	-2.327	-0.45	0.022	9.48±0.95	9.9±0.92	-2.317	-0.45	0.022
Index	URD	11.56±1.22	12±1.33	-1.793	-0.34	0.076	11.42±1.05	11.97±1.46	-2.261	-0.43	0.026
	RRD	11.56±1.43	11.88±1.29	-1.234	-0.24	0.22	11.7±1.07	11.85±1.42	-0.601	-0.12	0.549
	PRD	9.36±1.01	9.76±0.94	-2.152	-0.41	0.034	9.66±1.04	9.78±1.12	-0.575	-0.11	0.566
Middle	URD	11.78±1.35	12.32±1.43	-2.036	-0.39	0.044	11.6±1.4	12.12±1.43	-1.907	-0.37	0.059
	RRD	11.66±1.26	12.44±1.48	-2.983	-0.57	0.004	11.82±1.38	12.22±1.45	-1.468	-0.28	0.145
	PRD	9.58±0.91	9.9±0.92	-1.81	-0.35	0.073	9.6±1.07	9.73±0.89	-0.688	-0.13	0.493
Ring	URD	12.36±1.51	12.53±1.37	-0.595	-0.11	0.553	11.9±1.31	12.41±1.37	-1.964	-0.38	0.052
	RRD	12.14±1.5	12.25±1.5	-0.396	-0.08	0.693	11.9±1.39	12±2.17	-0.281	-0.05	0.779
	PRD	9.48±1.00	9.93±0.85	-2.529	-0.49	0.013	9.32±1.19	9.71±0.87	-1.935	-0.37	0.056
Little	URD	11.62±1.28	12.03±1.43	-1.584	-0.30	0.116	11.66±1.27	12.2±1.45	-2.086	-0.40	0.039
	RRD	11.4±1.34	11.92±1.38	-1.973	-0.38	0.051	12.02±1.19	11.64±1.47	1.451	0.28	0.15
	PRD	9.42±0.91	9.69±0.92	-1.571	-0.30	0.119	9.34±0.75	9.56±0.95	-1.322	-0.25	0.189

URD=Ulna Ridge Density, RRD=Radial Ridge Density, PRD=Proximal Ridge Density

Table 3: Comparison of Ridge Density among Male Study Population

		Right					**Left**				
		Mean±SD					Mean±SD				
Digit	Ridge Density	Schizophrenia (n=50)	Control (n=53)	t-value	*d*	p-value	Schizophrenia (n=50)	Control (n=53)	t-value	*d*	p-value
Thumb	URD	11.38±1.34	13.08±1.12	-6.941	-1.37	<0.001	11.28±1.429	12.38±1.457	-3.857	-0.76	<0.001
	RRD	11.42±1.25	12.49±1.37	-4.155	-0.82	<0.001	11.68±1.253	12.74±1.332	-4.146	-0.82	<0.001
	PRD	9.38±0.88	9.92±0.94	-3.044	-0.60	0.003	9.48±0.953	10±1.074	-2.602	-0.51	0.011
Index	URD	11.56±1.22	12.3±1.31	-2.983	-0.59	0.004	11.42±1.052	12.19±1.257	-3.374	-0.67	<0.001
	RRD	11.56±1.43	12.36±1.32	-2.942	-0.58	0.004	11.7±1.074	12.75±1.285	-4.531	-0.89	<0.001
	PRD	9.36±1.01	10.17±1.31	-3.528	-0.70	<0.001	9.66±1.042	9.81±1.226	-0.673	-0.13	0.502
Middle	URD	11.78±1.35	12.49±1.22	-2.805	-0.55	0.006	11.6±1.4	12.51±1.436	-3.254	-0.64	0.002
	RRD	11.66±1.26	12.72±1.36	-4.095	-0.81	<0.001	11.82±1.38	12.96±1.48	-4.052	-0.80	<0.001
	PRD	9.58±0.91	9.92±1.19	-1.646	-0.32	0.103	9.6±1.069	9.81±1.075	-1.00	-0.20	0.32
Ring	URD	12.36±1.51	13.08±1.14	-2.703	-0.53	0.008	11.9±1.313	13.04±1.3	-4.416	-0.87	<0.001
	RRD	12.14±1.5	13.17±1.16	-3.889	-0.77	<0.001	11.9±1.389	13.6±1.432	-6.129	-1.21	<0.001
	PRD	9.48±1.00	9.83±1.00	-1.786	-0.35	0.077	9.32±1.186	10.32±1.156	-4.333	-0.85	<0.001
Little	URD	11.62±1.28	13.02±1.22	-5.687	-1.12	<0.001	11.66±1.272	12.57±1.337	-3.524	-0.69	<0.001
	RRD	11.4±1.34	12.98±1.49	-5.675	-1.12	<0.001	12.02±1.186	13.51±1.449	-5.72	-1.13	<0.001
	PRD	9.42±0.91	9.96±1.00	-2.889	-0.57	0.005	9.34±0.745	10.04±0.94	-4.187	-0.83	<0.001

URD=Ulna Ridge Density, RRD=Radial Ridge Density, PRD=Proximal Ridge Density

Table 4: Comparison of Ridge Density among Female Study Population

		Right					Left				
		Mean+SD					Mean+SD				
Digit	Ridge Density	Schizophrenia (n=59)	Control (n=58)	t-value	*d*	p-value	Schizophrenia (n=59)	Control (n=58)	t-value	*d*	p-value
Thumb	URD	12.39±1.34	12.53±1.25	-0.605	-0.11	0.546	12.19±1.50	12.45±1.54	-0.932	-0.17	0.353
	RRD	11.85±1.24	12.41±1.36	-2.346	-0.43	0.021	12.22±1.38	12.86±1.50	-2.405	-0.44	0.018
	PRD	9.78±0.91	9.98±0.95	-1.183	-0.22	0.239	9.9±0.92	10.12±0.90	-1.319	-0.24	0.19
Index	URD	12.00±1.33	12.59±1.4	-2.323	-0.43	0.022	11.97±1.46	12.66±1.64	-2.399	-0.44	0.018
	RRD	11.88±1.29	12.79±1.37	-3.703	-0.68	<0.001	11.85±1.42	13.03±1.48	-4.428	-0.82	<0.001
	PRD	9.76±0.94	10.5±1.22	-3.67	-0.68	<0.001	9.78±1.12	10.43±1.34	-2.856	-0.53	0.005
Middle	URD	12.32±1.43	12.83±1.29	-2.01	-0.37	0.047	12.12±1.43	12.9±1.17	-3.232	-0.60	0.002
	RRD	12.44±1.48	13.03±1.32	-2.291	-0.42	0.024	12.22±1.45	13.66±1.65	-4.992	-0.92	<0.001
	PRD	9.90±0.92	9.98±1.25	-0.416	-0.08	0.678	9.73±0.89	10.14±0.95	-2.413	-0.45	0.017
Ring	URD	12.53±1.37	13.24±1.44	-2.753	-0.51	0.007	12.41±1.37	13.38±1.37	-3.838	-0.71	<0.001
	RRD	12.25±1.50	12.97±1.69	-2.407	-0.45	0.018	12±2.17	13.45±1.56	-4.158	-0.77	<0.001
	PRD	9.93±0.85	10.05±1.26	-0.602	-0.11	0.548	9.71±0.87	9.97±1.12	-1.366	-0.25	0.175
Little	URD	12.03±1.43	12.74±1.43	-2.676	-0.49	0.009	12.2±1.45	12.86±1.34	-2.551	-0.47	0.012
	RRD	11.92±1.38	12.91±1.44	-3.824	-0.71	<0.001	11.64±1.47	13.55±1.62	-6.655	-1.23	<0.001
	PRD	9.69±0.92	9.88±1.09	-0.99	-0.18	0.324	9.56±0.95	9.88±1.03	-1.748	-0.32	0.083

URD=Ulna Ridge Density, RRD=Radial Ridge Density, PRD=Proximal Ridge Density

DISCUSSION

The present study investigated variations in fingerprint ridge density between patients with schizophrenia and controls in Kano State, Nigeria. The findings demonstrated significantly lower ridge density values among schizophrenia patients, particularly in the ulnar and radial regions of several digits, thereby supporting the hypothesis that dermatoglyphic abnormalities may serve as markers of disturbed prenatal neurodevelopment in schizophrenia.

Dermatoglyphic structures are formed during early foetal development between the 10th and 19th weeks of gestation and remain unchanged throughout life. Consequently, any disturbance occurring during this critical developmental window may be permanently reflected in fingerprint characteristics. Since schizophrenia is widely regarded as a neurodevelopmental disorder, abnormalities in ridge density may reflect disruptions in foetal growth and morphogenesis associated with the disease process.

An important finding of the present study was the presence of sexual dimorphism in ridge density. Females generally exhibited higher ridge density values than males in both control and schizophrenia groups. These findings are consistent with previous literature demonstrating sex-based differences in dermatoglyphic patterns, where females generally exhibit higher ridge density than males, possibly due to hormonal influences during foetal development [14-16]. Prior studies have documented these differences and attributed them to genetic and prenatal hormonal factors influencing epidermal ridge formation [17,18]. Females with schizophrenia exhibited higher ridge density than males across multiple digits, reinforcing evidence of sexual dimorphism in dermatoglyphic traits and suggesting sex-specific developmental influences on schizophrenia susceptibility [19,20]. The lower ridge density observed among male patients, particularly in the thumb regions, is consistent with reports linking reduced ridge density to perturbations in prenatal development during periods critical for epidermal ridge formation [21,22]. Because epidermal ridges and the central nervous system develop concurrently during early gestation, dermatoglyphic deviations may reflect shared developmental insults underlying schizophrenia [23]. The moderate-to-large effect sizes observed further indicate that these differences are not only statistically significant but also biologically meaningful, supporting the potential utility of ridge density as a marker of neurodevelopmental instability in schizophrenia. The comparison between male schizophrenia patients and male controls revealed substantial reductions in ridge density among schizophrenia patients across almost all digits and ridge regions. The most significant reductions were observed in the thumb, ring, and little fingers, particularly within the ulnar ridge density (URD) and radial ridge density (RRD) regions.

The large effect sizes reported in several comparisons, such as right thumb URD, left ring RRD, and left little RRD, indicate that the observed differences were not only statistically significant but also biologically meaningful. The consistent bilateral reduction in ridge density further suggests generalised developmental abnormalities rather than localised variation. These reductions support a neurodevelopmental basis for dermatoglyphic abnormalities in schizophrenia and are consistent with the neurodevelopmental hypothesis of the disorder. Similar findings have been reported previously, with reduced ridge density proposed as a potential marker of prenatal developmental disturbances associated with schizophrenia [24,25].

Female schizophrenia patients also demonstrated lower ridge density values compared with female controls, although the reductions were generally less extensive than those observed among males. The persistence of reduced ridge density among female schizophrenia patients further supports the association between schizophrenia and prenatal developmental disturbances. However, the comparatively smaller effect sizes among females suggest that females may experience less severe developmental disruption than males. The left-hand digits showed more pronounced abnormalities among females, particularly the left little finger RRD, which demonstrated a very large effect size. The reduced ridge density observed in female schizophrenia patients may reflect impaired foetal epidermal development associated with schizophrenia susceptibility genes or prenatal environmental insults. Nevertheless, the milder abnormalities compared to males reinforce the possibility of sex-specific protective mechanisms. In contrast, no significant differences in dermatoglyphic ridge density were observed between female schizophrenia patients and controls in a previous study, suggesting that ridge density may not be a consistent biomarker of schizophrenia in females and that its expression may be influenced by population-specific genetic factors [12].

CONCLUSION

This study demonstrates significant reductions in dermatoglyphic ridge density in schizophrenia, with more pronounced effects in males, supporting a neurodevelopmental contribution to the disorder and suggesting potential utility as a low-cost, non-invasive indicator of early developmental instability in resource-limited settings. However, ridge density alone lacks diagnostic specificity, and future integrative studies combining dermatoglyphic, genetic, neuroimaging, and clinical data are required to better elucidate schizophrenia pathogenesis and improve early risk stratification.

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