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COMPARATIVE STUDY OF DERMATOGLYPHIC PATTERNS OF STUDENTS WITH LEARNING DISABILITIES AND THEIR NEUROTYPICAL PEERS IN THE SOUTH EASTERN REGION OF NIGERIA

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ABSTRACT
Learning disability is a common problem. Up to 10% of the population are affected by specific learning disability such as dyslexia, dyscalculia and autism, translating to two or three pupils in every classroom. This study sought to investigate and compare fingerprint dermatoglyphic patterns between students diagnosed with learning disabilities and their neurotypical peers, with the aim of identifying distinctive dermatoglyphic markers that may serve as potential diagnostic indicators or correlates of learning disabilities. The study was a descriptive cross-sectional study. A total of three hundred subjects were used, one hundred and fifty (150) students with learning disability and one hundred and fifty(150) students having average intelligence and behavior. The fingerprints were taken with digital scanner connected to a laptop. Qualitative and quantitative analysis were done. The fingerprint parameters included in this study are the total finger ridge count, absolute ridge count, ulnar ridge count and radial ridge count. Higher frequency of whorls and arch in males and higher frequency of ulnar loop and radial loop for females in learning disabled students were observed. Total finger ridge count and radial ridge count were higher in control while absolute finger ridge count and ulnar ridge count were higher in learning disabled students. **Conclusion:** Therefore the study revealed that learning disability has a strong genetic basis.

KEYWORDS: Learning Disability, dermatoglyphic, fingerprint.

1. INTRODUCTION
Fingerprint patterns are formed by the intricate ridge formations or furrows on the fingertips (Soman, 2015). These epidermal ridges begin to develop during the third month of intrauterine life and are fully formed by the fifth month (Penrose, 1969). The pattern of fingerprints is genetically determined and remains unchanged throughout an individual's life, unaffected by developmental or environmental factors. Human fingerprints are unique, providing a reliable and infallible method of personal identification (Bhavana, 2013).

Learning disability refers to a gap between a child's potential to learn and their actual level of achievement. The National Joint Committee on Learning Disabilities (2010) defines it as a diverse group of disorders that result in significant challenges in acquiring and using skills such as listening, speaking, reading, writing, reasoning, or mathematics. These difficulties impact how an individual learns to read, write, speak, and perform mathematical tasks. These disorders are intrinsic to the individual and presumed to be due to atypical central nervous system development with complicated genetic and environmental causes. A fault in the CDK13 gene is associated with learning and communication difficulties in children affected (Bostwick, 2019). Learning disability are often discovered once a child is in school and has learning difficulties that don't improve over time. Current study on learning disability shows that it can't be conclusively diagnosed until the child is about 8 years old (Batshaw, 2007). Learning disability includes dyslexia, dysgraphia, dyscalculia, autism spectrum disorder.

Studies in Europe and America have confirmed that fingerprint patterns are not only unique but also reliable indicators of individual characteristics. Surprisingly, even monozygotic twins, who share identical genetics, have different fingerprint patterns, challenging general genetic principles. Wounds can interfere with fingerprint patterns, but healing typically restores the original pattern unless the cells beneath the skin's surface are severely damaged. This finding suggests that fingerprint patterns remain consistent after healing, offering potential for future research on using fingerprint analysis to predict traits like intelligence (Dholiya et al., 2017).

The classification of fingerprint patterns by Cummins and Midlo (1943), which includes whorl, ulnar loop, radial loop, and arch, lays the foundation for the field of dermatoglyphics.

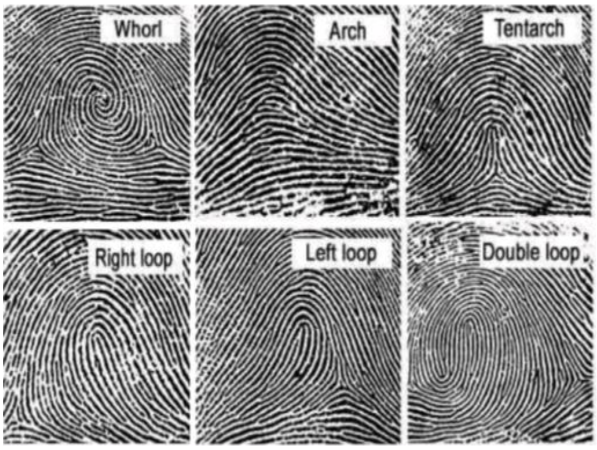

Fig 1: Fingerprint pattern types. Topaloglu, (2013).

Dhankar (2015) builds upon this by explaining that the formation and concentration of these ridge patterns can offer insights into an individual’s cognitive processes, such as thinking and reasoning patterns. This understanding not only aids in interpreting a person’s cognitive traits but also suggests that fingerprint patterns could influence career choices. Thus, the study of fingerprint patterns, as outlined by Cummins and Midlo, can serve as a basis for assessing personality and talents, making dermatoglyphics an effective tool for understanding both physical and psychological characteristics. (Dhankar, 2015).

There are variations between the fingerprints of intellectually disabled people and normal persons (Kumari *et al*, 2014). The relationship that exists between the fingerprint pattern and learning Disability is technically literally the most difficult to answer, the least investigated, the least written about and the least often asked about. Also, few works have been done on the relationship between the fingerprint pattern and learning Disability Nigeria, especially in the South East.

Fingerprints are constant and individualistic, they form the most reliable criteria for identification (Kanchan and Chattopadhyay, 2006; Pillay, 2009). There is need for this study because even though few works have been done on this topic, there is little or no research done among the Igbo people. There is also great need to expand the pool of knowledge in this area of students with Learning disability.

So this present study was to compare the fingerprint dermatoglyphics between students with Learning Disability and control students to find out if there are perculiar dermatoglyphic patterns suggestive or diagnostic of the students with learning disability.

2. MATERIALS AND METHOD

HP laptop (manufactured by Hewlett Packard computers in China), Fingerprint Scanner (manufactured by digital persona in China). Stadiometer (Charder & Sohn, India). A4 paper, Hand towel, Soap.

2.1 Ethical clearance

Ethical approval for this study was obtained from the Ethical Committee, Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Nnewi Campus, Anambra State.

2.2 Participants

The sample population involved students from three schools. These schools were all located in either Anambra or Enugu State. The schools used involved two special schools (Therapeutic inclusive Secondary School Abakpa Nike Enugu and School for special education, DCC Nnewi, Anambra State). Samples were also obtained from students of Nnamdi Azikiwe University, College of Health Science Okofia.

2.3 Study location

The study was carried out in two states in the South Eastern part of Nigeria; Anambra and Enugu State. This region has the Igbo tribe as the predominant tribe.

2.4 Inclusion criteria

1. Individuals without deformities of the fingers
2. Subjects must be of Igbo origin aged 5-25 years.
3. For the study group, subjects must have learning disability.

2.5 Exclusion criteria

1. Subjects who are not of Igbo origin
2. Subjects with any hand deformity or permanent scars on the fingertips were excluded from the study.

2.6 Sample size

Sample size was determined using the formula by Daniel (1999)

$$n = \frac{p(1-p)\,z^2}{ME^2}$$

ME = Margin of error (4% =0.04)
Z = Confidence interval (95% = 1.96)
P = level of significance (p=0.8)
n= sample size

$n = 0.5(1-0.8)\times(1.96)^2 = 240.1$

$(0.04)^2$

The minimum number of subjects required for the study according to this formula is two hundred and forty (240) but the sample size of three hundred (300) was used.

2.7 Anthropomorphic parameters

1. Fingerprint pattern
2. Total Finger Ridge Count (TFRC)
3. Absolute Ridge Count (ARC)
4. Radial Ridge Count (RRC)
5. Ulnar Ridge Count (URC)

2.8 Method

Participation in the study was voluntary and informed consent was obtained from the school authority.

Research ethics committee guidelines relating to use of human subjects for research purposes were duly followed.

The procedure was first explained to the subjects through their teacher (study group) and orally for the control group and consent was collected. This prospective study included a total of 300 subjects (150 intellectually disabled and 150 controls) in the age group of 3-25 years .Each group consisted of 75 males and 75 females.

A digital scanner (Digital persona, China) connected to a laptop computer was used to obtain the fingerprints of the 10 fingers of each participant. According to its protocol, finger print reader software was installed to the laptop computer, drivers were installed. The subjects were requested to wash their hands after drying; the finger balls of the subjects were pressed at the center of the sensor of Biometric Scanner. The fingerprints were scanned and saved in the laptop. Every possible care was taken to obtain more clear prints of each subject. The parameters that were studied are the fingerprint pattern, the total ridge count, absolute ridge count, radial ridge count and ulna ridge count.

The quantitative Dermatoglyphic parameters (variables) included in this study include the total finger ridge count (TFRC-sum of the higher ridge counts of the 10 fingers), the Absolute Ridge Count (ARC-sum of all possible ridge counts of the 10 fingers), the Radial Ridge Count (RRC-sumof the ridge counts with a direction of opening towards the radial bone /thumb side/ of the 10 fingers) and the Ulnar Ridge Count (URC-sumof the ridge counts with a direction of opening towards the Ulnar bone /little finger side/ of the 10 fingers) Similarly, the qualitative Parameters (variables) include the pattern types, classified as Loops (with one delta & one core), Whorls (with one/two cores and two deltas), and Arches (with no true core or delta). After collection, the prints were studied to observe the different patterns with the aid of detailed dermatoglyphic analysis and different patterns were identified and classified into whorl, ulnar loop, radial loop, and arch. The total ridge count, absolute ridge count, radial ridge count and ulnar ridge count were also noted.

The whorl patterns have type lines and a minimum of two deltas. The ridge may be spiral, oval or any variant of a circle. Arches do not have type line, deltas or cores while the loops have a ridge entering from one side of the print, reoccurring and exiting from the same side. If the loop opens towards the little finger, it is an ulnar loop why if it opens towards the thumb, it is a radial loop.

For the total ridge count, the tri-radii and the central core were first identified, then using a sharp pencil and ruler, a straight line was drawn connecting the tri-radius to the core. The ridges intervening between the core and the tri-radius were then counted.

The whorl pattern has two tri-radii hence the ridge count having the maximum number is used. The loop has just a single tri-radius while the arch has no tri-radius hence it is assigned a ridge count of zero.

2.9 Statistical analysis

Results obtained were recorded in microsoft Excel spreadsheet and analysed using Statistical package for the social sciences (SPSS) version 23. A p value < 0.05 was considered Statistically significant.

3.0 RESULTS

Table 1: Comparison of Age, Weight, Height and Body Mass Index of Test and Control.

	Test	Mean	±	STD	T	P
Age	Test	12.71	±	6.17	-17.02	0.00
	Control	22.09	±	2.74		
Weight	Test	40.79	±	20.72	-12.42	0.00
	Control	66.61	±	14.81		
Height	Test	143.42	±	22.30	-13.19	0.00
	Control	169.78	±	10.08		
BMI	Test	18.39	±	4.24	-9.49	0.00
	Control	23.02	±	4.21		

Data was analyzed using Independent samples t-test. Result is significant at p<0.05

Table 2: Overall Occurrence of Fingerprint Patterns in Test and Control.

		Frequency	Percent (%)
Test	Whorl	493	32.87
	Arch	291	19.40
	Ulnar loop	398	26.53
	Radial loop	318	21.20
Control	Whorl	404	26.93
	Arch	223	14.87
	Ulnar loop	487	32.47
	Radial loop	386	25.73

Table 2 shows the pattern frequency for the overall occurrence of fingerprint patterns in test group and control group. This table showed that whorl was higher in test and lower in control while ulnar loops were higher in control and lower in test. The radial loop was higher in control and lower in test. The arch was the least frequent pattern in both groups.

Table 3: Comparison of Print Pattern of Test and Control in Right and Left Hands.

		Whorl	Arch	Ulnar loop	Radial loop	Total	X^2	P
R1	Test	64	29	56	1	150	1.905	0.592
	Control	55	27	66	2	150		
L1	Test	48	46	10	46	150	5.047	0.168
	Control	56	31	7	56	150		
R2	Test	43	36	62	9	150	7.672	0.053
	Control	37	25	84	4	150		
L2	Test	57	43	14	36	150	12.675	0.005
	Control	44	30	11	65	150		
R3	Test	44	27	75	4	150	13.481	0.004
	Control	25	17	106	2	150		
L3	Test	36	35	14	65	150	3.604	0.308
	Control	35	31	7	77	150		
R4	Test	60	11	73	6	150	6.743	0.081
	Control	41	8	93	8	150		
L4	Test	52	25	7	66	150	2.347	0.504
	Control	49	23	3	75	150		
R5	Test	50	14	82	4	150	13.376	0.004
	Control	25	10	108	7	150		
L5	Test	39	25	5	81	150	2.160	0.54
	Control	37	21	2	90	150		

Data was analyzed using Chi-square test for association. Result is significant at $p<0.05$.

Table 3 shows the comparison of fingerprint pattern of test and control in right and left hands in the test group and control group. The table showed higher frequency of whorl in both hands in the test and control except in L_1. Test shows higher frequency of arch in both hands while control shows higher frequency of ulnar loops in right fingers. Control shows higher frequency of radial loop in both hands except in right second digit (R_2), right third digit (R_3).

Table 4: Comparison of Print Pattern of Test Male and Female In Right and Left Hands.

		Whorl	Arch	Ulnar loop	Radial loop	Total	X^2	p
L1	Test females	16	21	6	32	75	13.125	0.004
	Test males	32	25	4	14	75		
R1	Test females	28	12	35	0	75	6.362	0.095
	Test males	36	17	21	1	75		
L2	Test females	27	14	9	25	75	11.978	0.007
	Test males	30	29	5	11	75		

R2	Test females	21	10	37	7	75	12.235	0.007
	Test males	22	26	25	2	75		
L3	Test females	16	13	11	35	75	7.715	0.052
	Test males	20	22	3	30	75		
R3	Test females	21	9	44	1	75	6.344	0.096
	Test males	23	18	31	3	75		
L4	Test females	25	8	4	38	75	4.975	0.174
	Test males	27	17	3	28	75		
R4	Test females	27	2	42	4	75	7.379	0.061
	Test males	33	9	31	2	75		
L5	Test females	13	7	2	53	75	17.089	0.001
	Test males	26	18	3	28	75		
R5	Test females	17	3	51	4	75	18.569	0
	Test males	33	11	31	0	75		

Data was analyzed using Chi-square test for association. Result is significant at $p<0.05$.

Table 4 shows the comparison of print pattern of test male and female in right and left hands. The table shows higher frequency of whorl and arch for males in both hands while having higher frequency of ulnar loop and radial loop for females except in left fifth digit (L_5), right first digit (R_1), right third digit (R_3).

Table 5: Comparison of Ridge Counts of Test and Control.

	Pair	Mean	±	STD	T	P
Total ridge count	Test	113.05	±	36.74	-0.29	0.78
	Control	114.17	±	30.52		
Absolute ridge count	Test	151.39	±	64.25	0.63	0.53
	Control	147.11	±	52.73		
Radial ridge count	Test	34.55	±	22.89	-1.72	0.09
	Control	38.55	±	16.88		
Ulnar ridge count	Test	27.45	±	21.36	0.50	0.62
	Control	26.34	±	16.78		

Data was analyzed using Independent samples t-test. Result is significant at $p<0.05$.

Table 5 shows the comparison of ridge counts of test and control. TFRC was found to be higher in control while AFRC manifested highest values in test. RRC was found to be higher in control while URC was higher in test.

Table 6: Comparison of Ridge Counts of Test and Control Females.

	Pair	Mean	±	STD	T	P
Total ridge count	Test females	119.11	±	27.51	2.63	0.01
	Control females	106.91	±	29.40		
Absolute ridge count	Test females	152.41	±	55.20	2.20	0.03
	Control females	133.79	±	48.45		
Radial ridge count	Test females	41.16	±	22.55	0.07	0.94
	Control females	40.92	±	17.62		
Ulnar ridge count	Test females	33.81	±	21.53	3.80	0.00
	Control females	22.20	±	15.59		

Data was analyzed using Independent samples t-test. Result is significant at $p<0.05$.
Table 6: comparison of ridge counts of test and control females.

The table shows Test females manifested higher values in total finger ridge count (TFRC), absolute finger ridge count (AFRC), radial ridge count (RRC) and ulnar ridge count (URC).

Table 7: Comparison of Ridge Counts of Test and Control Males.

	Pair	Mean	±	STD	t-value	p-value
Total ridge count	Test males	107.00	±	43.44	-2.39	0.02
	Control males	121.62	±	30.03		
Absolute ridge count	Test males	150.37	±	72.54	-0.99	0.32
	Control males	160.78	±	53.76		
Radial ridge count	Test males	27.95	±	21.41	-2.65	0.01
	Control males	36.12	±	15.83		
Ulnar ridge count	Test males	21.09	±	19.32	-3.19	0.00
	Control males	30.59	±	16.99		

Data was analyzed using Independent samples t-test. Result is significant at $p<0.05$.

Table 7 shows the comparison of ridge counts of test and control males.

The table shows higher frequency of total finger ridge count (TFRC), absolute finger ridge count (AFRC), radial ridge count (RRC) and ulnar ridge count (URC) in control males.

4.0 DISCUSSION

Fingerprint patterns are impressions made by the minute ridge formations on the fingertips. The dermal ridges are formed during the 3rd month of intra uterine life. Fingerprint patterns are genetically determined and the pattern once formed doesn't alter with environmental or developmental changes (Soman *et al.*, 2015).

Human fingerprints are unique and they offer an infallible means of personal identification (Bhavana, 2013). Dermatoglyphic patterns have been utilized as a diagnostic tool in disorders which could be either gross chromosomal or localized genetic (Sadanandan and Ushadevi, 2016).

In the present study, the incidence of fingerprint patterns in the students with learning disability was compared with control subjects. The study was done sex wise and side wise. The four fingerprint patterns taken into consideration were ulnar loop, radial loop, whorls and arches.

In this study the percentage frequency of whorls in learning disabled students was higher and lower in control group while that of ulnar loop was higher in control and lower in learning disabled students. This is contrast with the works of Yamuna and Dhanalakshmi (2017) who observed an elevated frequency of ulnar loops noticed in mentally retarded group than any other fingerprint pattern.

Arch pattern was the least frequent pattern in both groups while the radial loop was higher in control and lower in learning disabled students which disagrees with the findings of Sadanandan and Ushadevi (2016) in which radial loop pattern showed the least frequency.

The total finger ridge count (TFRC) and radial ridge count (RRC) were found to be higher in control while absolute finger ridge count (AFRC) and ulnar ridge count (URC) manifested highest values in learning disabled students, this corroborates the work of Yamuna and Dhanalakishma (2017) who reported absolute finger ridge count to be higher in mentally retarded children than control.

A higher frequency of total finger ridge count (TFRC), absolute ridge count (ARC), radial ridge count (RRC) and ulna ridge count (URC) in learning disabled females and control males were observed in this present work.

Higher frequency of whorls in both groups in left and right hands except in L_1 was observed this is not consistent with the findings of Soman *et al*., (2015) who reported higher frequency of ulnar loop in both groups.

Arch shows higher frequency in both hands and ulnar loops in right fingers for the learning disabled students while radial loop shows higher frequency in both hands in control except in R_2 R_3.

A higher frequency of whorl and arch for males and a higher frequency of ulnar loop and radial loop for females except in L_5 R_1 R3 were observed in learning disabled students, this is in line with the findings of Soman *et al.*, (2015) who observed higher frequency of whorls in males and radial loops in females.

5.0 CONCLUSION

Dermatoglyphics, as a non-invasive approach and inexpensive can definitely aid in the early detection of Learning disability in students. Since the dermatoglyphic patterns are established by birth, it can be considered as a diagnostic tool in identifying various genetic abnormalities in individuals. This will help in creating awareness in the parents of such individual. Moreover an early diagnosis will help in framing the rehabilitation programmes.

6.0 RECOMMENDATION

More researches should be done on the relationship between fingerprint patterns and learning disability as there is little amount of data available.

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