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Digital Dermatoglyphics Distribution in Fertile and Infertile Women

Joseph Dare[1], Thomas Adenowo[2], Ibrahim Wada[3]

[1]Department of Anatomy, College of Health Sciences, Osun State University, Osogbo, Osun State, Nigeria
[2]Department of Anatomy, Olabisi Onabanjo University, Ikenne – Remo, Ogun, Nigeria
[3]Fertility Centre of Nisa Premier Hospital, Abuja, Nigeria

ABSTRACT

The study aimed at examining differences in digital dermatoglyphics distribution between fertile and infertile women in Abuja, Nigeria. A total of 222 women with 53 clinical cases of primary infertility were included in this study. Dermatoglyphic patterns of the distal phalanges were obtained for further analyses of quantitative and qualitative traits. The results showed a lower incidence of loop patterns (55%), and a higher incidence of arches (7%) and whorls (29%) in infertile women than in fertile ones. Infertile women showed a unique and specific digital pattern distribution on each of the fingers on the right and left hand. A significant decrease in ridge count (RC), total finger ridge count (TFRC) and absolute finger ridge count (AFRC) was observed in the infertile patients ($p<0.05$) in relation to fertile women. 2D:4D index in infertile and fertile women was 0.95 and 0.85 respectively. The observed differences in the digital traits could provide a useful bio-indicator for genetic counselling among reproductive age women.

Key words: *dermatoglyphics, infertility, females, bio-indicator, fingers*

Introduction

The formation of dermatoglyphics is genetically determined although their development may be affected by prenatal environmental factors. There are various diseases expressed in offspring caused by alteration in genetic composition of the parents' genes and/or chromosomes. Abnormality in the genetic makeup/composition of parents is inherited in children and is reflected in dermatoglyphic patterns.[1–3] Dermatoglyphics have been used as a diagnostic tool in a number of diseases with strong hereditary basis as well as a screening method for chromosomal anomalies.[2,3] For many abnormal medical conditions statistically significant occurrences of abnormal ridge pattern combinations have been found.[4–6] Ridges are genetically determined and are therefore useful in anthropological, forensic, medico-legal and genetic studies. Dermatoglyphics could be affected by genetic changes, such as seen in Down's syndrome, schizophrenia, Huntington's chorea and syndactyly. They have been accepted long time ago as a simple and inexpensive method for determining genetic disorders.[7–10]

Developmental studies have associated various defects with abnormal friction ridge-pattern development, showing that whatever the nature of the defects, the ridge-pattern configurations occur as systems partly or wholly unlike the normal, but obviously conforming to the irregularities of the part, and that the absence of dermal ridges could be caused by chromosomal abnormalities.[11] Schaumann and Alter observed a more pronounced condition, such as dysplasia, to a localized deviation in normal nerve branching during fetal development.[12] Goradia et al.[13]and Shiono[14] indicate that certain chromosomal abnormalities have been found to be associated with aplasia and alterations in normal epidermal ridges.

Genetic basis of infertility has been commonly detected by genetic tests, such as karyotype and sequence analysis of cystic fibrosis, chromosomal deletion analysis, assessment of single gene defects and Fluorescence In-situ Hybridization (FISH) coupling with the methods of molecular genetics diagnoses such as Polymerase Chain Reaction (PCR) and Comparative Genomic Hybridization (CGH).[15]

Infertility affects both men and women with reduced fertility resulting from congenital and acquired urogenital abnormalities, infections of the genital tracts, increased scrotal temperature, varicocele, endocrine disturbances, genetic abnormalities and immunological factors.[15] Various actors have also been implicated in male and female infertility; these including lack of ovulation, mechanical stoppage of ova and sperm cells, sperm deficiencies in males and parental age.[16] The genetic causes of infertility

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are varied and include chromosomal abnormalities, single gene disorders and phenotypes with multi-factorial inheritance, hormonal imbalance, age, exercises, obesity, infectious diseases; immunological disorders, psychological disturbance, fallopian tube blockage, or associated with defined abnormalities in the gametes. Susceptibility to infection, obesity, psychological problems and likelihood of having surgery have been linked with genetic basis of infertility.[17]

In this regard, specific genotypes and karyotypes have been associated with the expression of infertility phenotypes; single-gene defects are most likely to be found among patients with hypogonadotropic hypogonadism, which may be due to defects in the KAL gene or the gonadotrophin-releasing hormone (GRH) receptor genes.[17] With premature ovarian failures there is an increased risk of having a pre-mutation of the fragile X syndrome gene. Complex genetic inheritance is associated with polycystic ovarian syndrome, endometriosis and miscarriage (spontaneous abortion); genetic defects causing thrombophilia which had been mostly implicated.[17] Findings from dermatoglyphics studies have been used as genetic markers, and patients with positive findings were investigated by chromosomal study methods.[18] Dermatoglyphics as a diagnostic tool in screening genetically transmitted diseases have therefore been found useful because chromosomal aberrations alter the ridges.[19]

Dermatoglyphics analysis is simple and inexpensive, and can be used for mass screening in place of advanced genetic or molecular methods of investigations like karyotyping and deoxyribonucleic acid (DNA) screening test. The study of dermal ridges is an efficient way to introduce basic principles of quantitative genetics[20] that can be also used in forensics[21]. Considerable research interests have been developed to investigate the relationship between genetic abnormalities and dermatoglyphics patterns[22,23], and dermatoglyphics has been, and continues to be, considered a window into congenital anomalies and a sensitive indicator of many intra uterine anomalies and infertility in males and females[3]. Decreased frequency of ulnar loops and increased incidence of arches with increased 'ATD' angle, decreased total finger ridge count and a decreased 3rd interdigital palmar pattern were observed in females with the cancer of the cervix.[3,24] In breast carcinoma patients 6 or more whorls in the total finger pattern, and an increase in whorls in the right ring and little finger have been observed.[25] The study is therefore aimed at investigating the differences in digital dermatoglyphic traits distribution between infertile and fecund women in Abuja, Nigeria.

Participants and Methods

Participants

This study was carried out on 53 female patients with clinically diagnosed infertility attending the Nisa Premier Hospital, in the district of Jabi, in Abuja, Nigeria. They were aged between 18 and 45 years and were classified as Group 1. Control subjects (Group 2) comprised 109 women with 1–2 children and 60 women (Group 3) with 3 or more children. The diagnosis of the infertility was based on the clinical history of the patients and clinical examinations by a consultant gynaecologist in the Fertility Centre of the hospital.

The patients selected for this study had one or more of the following selective criteria of infertility that were diagnosed during clinical examinations of couples: semen tests, pelvic scans, hormonal analysis, HSG, and laparoscopy/hysteroscopy.[26] They had no history of child birth and had applied for in-vitro-fertilization (IVF) treatment at the Fertility and Genetic Centre of the Nisa Premier Hospital. The control and the infertile participants were selected from the same region. Women in control groups were selected from the Maternity Clinic in Mararaba General Hospital, Mararaba, in Nasarawa state, where they came for pre and and post-natal examinations. Their fecundity was confirmed by the medical and clinical history with the assistance of a gynaecologist and a midwife.

Ethical approval was obtained from the research and ethics units of the Nisa Premier Hospital in Abuja. All participants were informed about the purpose, nature and benefits of the study before written informed consent was obtained from them. The procedure was carried out in line with the ethical guideline of the Nisa Premier Hospital and according to the Nuremberg Code of research ethics.[27]

The study included patients who either came for pre and post-natal checkups or who reported for in-vitro fertilization (IVF) treatment from April to August, 2015.

Data collection

An information form was designed to obtain relevant information on the background and ethnic origin (Tribe) of participants which was filled by both the clinically diagnosed patients and controls. That was necessary in order to choose closely related populations for the study and to categorize the control patients into two groups according to the number of children they gave birth to (1–2 or 3 and more children). This was also used to classify and screen clinically diagnosed patients into primary and secondary cases of infertility.

Dermatoglyphics

A Samsung EC-WB350F-BPNUS Digital Capturing Device with 16.0 mega pixel and 21X magnifying power lenses system was used for capturing fingerprints and palm prints, which offered real time capture images of the four (4) fingers, the thumbs and the palms. The captured images were inputted into the computer for analysis using Macromedia Fireworks Windows 8 which enabled clear enlarged real time counting of the fingers and palms ridges from the tri-radius (delta) to the core of the ridges patterns and also provided means for proper drawing and labelling of the palmar tri-radii angles and main lines of

exits of palmar ridges on the palmar surfaces of the hands this procedure.[27,28] The images were printed for permanent observation and for permanent recording.

Dermatoglyphic patterns on each finger of the right and the left hand were identified and recorded for each patient in the collation sheets. The patterns were classified according to the modified method of Galton[29] and Henry's system of classification[19]. The patterns were analysed according to the standard methods as set out in Cummins and Midlo[1].

The quantitative analysis included on both hands: counting the number of tri-radii and ridges within a pattern and measuring distances or angles between specified points for analysis using different parameters such as: finger ridge counts (RC), total ridge counts (TFRC), absolute ridge counts (AFRC) and pattern intensity index (PII) for each hand separately and for both hands.

The comparison of discrete traits included: frequencies of finger pattern types, frequencies of pattern combinations on the pairs of the right and left homologous fingers and frequency of pattern type combinations on both hands.[30,31]

Ridge count was carried out by direct enumeration of the ridges from the PC-system following a line drawn from the tri-radius to the core of the pattern in enlarged forms using Macromedia Fireworks which allowed for a clearer view of the ridges and for the detailed minutiae to be revealed.[32,33] Total finger ridge count included the sum of the ridges of all ten hand digits and the larger count was used on the digits with more than one ridge count. It expresses the size of the pattern.[34,35]Absolute finger ridge count (AFRC) was obtained by the addition of the ridge counts from all the separate tri-radii on all ten digits. It reflects both the pattern size and the pattern type.[34,35]

Pattern intensity (PII) index, as the complexity of ridge configurations was determined by counting the total number of tri-radii present in the hands of each participant.[33] Arches had no tri-radius, loop pattern had only one tri-radius present while the whorl pattern had two tri-radii.

Tri-radial angles were determined by lines drawn from the sub-digital tri-radius "*a*" of the index finger to the axial tri-radius "*t*" at the wrist joint and another line was drawn from the tri-radius *t* to the sub-digital tri-radius "*d*" of the little finger to form a palmar triangle <ATD, <DAT and <ADT, according to the method previously specified.[36–38]

In addition, the length of the 2nd index and the 4th ring finger was measured with the aid of a Vernier calliper between the proximal phalangeal crease and the tip of the 2nd and the 4thfinger of each hand for all participants. The ratio of the 2nd and 4th digits was expressed as 2D:4D index.[39]

Statistical analysis

All data obtained in this study were subjected to both descriptive and inferential statistics using the statistical software GraphPadPrism version –6– statistical package for estimation of the mean, standard deviation and standard error of the mean. Analysis of variance (ANOVA) was used for the analysis of quantitative data, and Chi-square was used for discrete data.

Results

Table 1 clearly demonstrates the prevalence of the ulnar loop pattern on the right and left hands across all groups . A comparatively high percentage of arches and elliptical whorls can be also noticed. In infertile women, a higher percentage of concentric whorls is found on the left hand (15%) than on the right hand (8%).

TABLE 1

FINGER PATTERNS ON THE RIGHT AND LEFT HAND

		Right						Left					
		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
	Patterns	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)
AR	16	6		39	7	8	3	23	8	50	9	10	3
UL	161	61		348	64	14	5	132	50	324	60	20	7
CUL	8	3		2	0	0	0	13	5	7	1	0	0
CRL	2	1		24	5	183	61	4	2	24	4	174	58
RL	2	1		20	4	3	1	1	0	20	4	4	1
DL	9	3		4	1	12	4	8	3	3	1	18	6
CW	21	8		50	9	40	13	40	15	58	11	48	16
EW	21	8		20	4	7	2	19	7	22	4	6	2
SW	25	9		33	6	30	10	24	9	32	6	20	7

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

TABLE 2

INCIDENCE (%) OF FINGER PATTERNS ON BOTH HANDS IN INFERTILE WOMEN (GROUP 1), AND FERTILE WOMEN (GROUPS 2 AND 3)

	Group 1		Group 2		Group 3	
PATTERN	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)
AR	39	7	89	8	18	3
UL	293	55	672	62	357	60
CUL	21	4	40	4	34	6
CRL	6	1	7	1	0	0
RL	3	1	9	1	7	1
DL	18	3	48	4	30	5
CW	61	12	108	10	88	15
EW	40	8	42	4	13	2
SW	49	9	65	6	50	8

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

As shown in Table 2, while ulnar loop was prevalent across all groups; its percentage was higher in the control women with a history of child birth. Furthermore, a higher prevalence of arches (7%), spiral whorls (9%) and elliptical whorls (8%) was observed in the infertile women compared to fertile ones. Worthy of note is the low percentage of radial loop distribution across all groups equally (1%), however, closed radial loop was not found in fertile women. In general, infertile women showed reduced loop patterns and higher presence of spiral whorls, elliptical whorls and arches (Table 2).

TABLE 3

INCIDENCE (%) OF PATTERNS ON THE RIGHT AND LEFT FINGERS IN INFERTILE WOMEN

Pattern	Right					Left				
	D1 %	D2 %	D3 %	D4 %	D5 %	D1 %	D2 %	D3 %	D4 %	D5 %
AR	13	7	6	2	2	11	11	9	7	4
CUL	2	0	4	4	7	0	0	6	7	11
CRL	0	4	0	0	0	2	4	0	2	0
UL	45	38	72	60	87	45	36	60	40	68
RL	0	2	0	0	2	0	2	0	0	0
DL	15	2	0	0	0	13	4	0	0	0
CW	11	13	4	11	0	12	17	13	23	11
EW	6	11	7	13	2	4	4	8	15	6
SW	8	23	7	10	0	13	22	4	6	0

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

TABLE 4

PATTERN DISTRIBUTION ON BOTH HANDS IN INFERTILE WOMEN

Pattern	D1		D2		D3		D4		D5	
	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)
AR	13	12	10	9	8	8	5	5	3	3
UL	48	45	39	37	70	66	53	50	82	77
CUL	1	1	0	0	5	5	6	6	10	9
CRL	1	1	4	4	0	0	1	1	0	0
RL	0	0	2	2	0	0	0	0	1	1
DL	15	14	3	3	0	0	0	0	0	0
CW	12	11	16	15	9	8	18	17	6	6
EW	5	5	8	7	8	7	15	14	4	4
SW	11	11	24	23	6	6	8	7	0	0

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

TABLE 5

PATTERN DISTRIBUTION ON THE RIGHT AND LEFT DIGITS IN WOMEN WITH 1–2 CHILDREN

Pattern	Right					Left				
	D1 (%)	D2 (%)	D3 (%)	D4 (%)	D5 (%)	D1 (%)	D2 (%)	D3 (%)	D4 (%)	D5 (%)
AR	16	11	4	2	2	18	10	6	(%)	3
CUL	0	0	4	14	1	39	52	70	54	86
CRL	0	2	1	0	0	0	2	4	8	4
UL	41	60	75	57	91	2	1	1	0	1
RL	2	1	0	0	0	2	5	0	1	0
DL	18	3	1	1	0	16	1	2	2	0
CW	6	11	8	17	3	7	14	7	21	5
EW	4	7	4	6	2	4	6	4	5	1
SW	13	5	3	3	1	12	9	6	4	0

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

Tables 3 and 4 show the prevalence of pattern types on each of the fingers examined in the infertile subjects. It can be seen that on D2 ulnar loop and closed ulnar loop have low values along with a higher percentage of spiral and concentric whorls. D1 exhibits the prevalence of arches and double loops, D5 the prevalence of ulnar loop and closed ulnar loop patterns, and D4 shows elliptical whorl prevalence. Symmetrical distribution pattern is observed on both hands.

Tables 5 and 6 show the prevalence of pattern types on each of the fingers examined in the fertile women with 1–2 children. The prevalence of ulnar loops can be seen on D5,

TABLE 6

PATTERN DISTRIBUTION ON BOTH HANDS IN WOMEN WITH 1–2 CHILDREN

Pattern	D1		D2		D3		D4		D5	
	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)
UL	87	40	123	56	158	72	121	56	193	89
AR	4	2	6	3	0	0	1	1	0	0
CUL	38	17	4	2	3	1	3	2	0	0
CRL	15	7	27	12	17	8	42	19	10	5
RL	8	4	15	7	9	4	13	6	3	1
DL	27	12	15	7	10	5	7	3	1	1
CW	37	17	23	11	11	5	7	3	5	2
EW	0	0	2	1	8	4	24	11	5	2
SW	2	1	3	1	2	1	0	0	1	0

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl.

TABLE 7

PATTERN TYPES ON THE RIGHT AND LEFT DIGITS IN WOMEN WITH 3 OR MORE CHILDREN

	Right					Left				
Pattern	D1 (%)	D2 (%)	D3 (%)	D4 (%)	D5 (%)	D1 (%)	D2 (%)	D3 (%)	D4 (%)	D5 (%)
UL	48	49	78	54	77	47	48	68	51	75
CUL	0	3	3	8	8	0	3	7	13	10
CRL	0	0	0	0	0	0	0	0	0	0
RL	2	3	0	0	0	0	7	0	0	0
DL	17	3	0	0	0	25	2	3	0	0
CW	8	17	9	27	7	8	20	15	27	10
EW	3	2	3	3	0	3	3	2	2	0
SW	17	15	7	8	3	10	12	2	7	3
ACC.	2	0	0	0	3	0	0	0	0	0

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L – closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl; ACC – accidental pattern.

the prevalence of double loops on D1, the prevalence of concentric whorls and closed ulnar loops on D4, while elliptical whorls are predominant on D2. D1 expressed higher percentage of spiral whorl, arches and double loop. Symmetrical distribution pattern can be seen on both hands.

Tables 7 and 8 show the percentage prevalence of pattern types on each of the fingers examined in the fertile women having more than 3 children. The prevalence of ulnar loops can be seen on D3 and D5, and that of spiral whorls and double loops on D1. D5 and D4 show the highest percentage of closed ulnar loop, D2 of arches, radial loop and spiral whorl patterns, and D4 of concentric whorls. A complete absence of closed radial loops on all the fingers is observed in this group.

TABLE 8

PATTERN TYPES ON BOTH HANDS IN WOMEN WITH 3 OR MORE CHILDREN

Pattern	D1		D2		D3		D4		D5	
	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%)	FREQ.	(%) FR EQ. (%)
AR	6	5	8	7	2	2	0	0	2	2
UL	57	48	58	48	88	73	63	52	91	76
CUL	0	0	4	3	6	5	13	11	11	9
CRL	0	0	0	0	0	0	0	0	0	0
RL	1	1	6	5	0	0	0	0	0	0
DL	25	21	3	3	2	2	0	0	0	0
CW	10	8	22	18	14	14	32	27	10	8
EW	4	3	3	3	3	2	3	2	0	0
SW	16	13	16	13	5	4	9	8	4	3
ACC.	1	1	0	0	0	0	0	0	2	2

AR – arches; UL – ulnar loop; CUL – closed ulnar loop; CR L– closed radial loop; RL – radial loop; DL – double loop; CW – concentric whorl; EW – elliptical whorl; SW – spiral whorl; ACC – accidental pattern.

Table 9 shows the mean ridge count (RC) on each of the digits of the right hand. It is significantly the highest on D4 and significantly the lowest on D2 across all three groups of fertile and infertile women. In infertile women, the mean ridge count was significantly the highest on D4 and the lowest on D2, however, the increasing order of mean ridge counts followed the pattern D2<D3<D5<D1<D4 as shown in the Table 9.

As it can be observed in Table10, the mean ridge count (RC) on the fingers of the left hand was significantly the highest on D4 and significantly the lowest on D2 across all groups, however, fertile women had higher RC values

TABLE 9

RIDGE COUNT ON THE RIGHT HAND

FINGERS	Group 1 Mean ±SEM	Group 2 Mean ±SEM	Group 3 Mean ±SEM
D1	15.21± 1.10	14.18±0.74	16.77±0.93
D2	12.98±0.78*	12.12±0.60*	14.05±0.75*
D3	13.62±0.79	12.79±0.52	14.30±0.54
D4	16.81±0.76*	17.35±0.54*	18.53±0.63*
D5	14.23±0.73	14.49±0.51	15.40±0.69
P ≤	0.01	0.0001	0.0001

*Significant difference; D1–thumb; D2–index finger; D3–middle finger; D4–ring finger; D5–little finger

TABLE 10

RIDGE COUNT ON THE LEFT HAND

DIGITS	Group 1 Mean ±SEM	Group 2 Mean ±SEM	Group 3 Mean ±SEM
D1	14.28±1.05	13.15±0.73	15.90±0.78
D2	12.27±0.83*	11.50±0.63*	13.72±0.76*
D3	13.51±0.94	12.64±0.34	13.78±0.69
D4	16.51±0.91*	16.30±0.59*	17.47±0.58*±0.58
D5	14.62±0.72	13.24*±0.51	15.37±0.55
P ≤	0.02	0.0001	0.0001

*Significant difference; D1–thumb; D2–index finger; D3–middle finger; D4–ring finger; D5–little finger

on D4 than the infertile ones. Table 10 shows symmetrical arrangements in the left digital ridge count in the infertile women. However, the order of increasing mean ridge count on the left fingers D2<D3<D1<D5<D4 differs from the pattern on the right hand (D2<D3<D5<D1<D4).

Comprehensively, the highest value of RC on both hands on D4 and lowest RC on D2 are statistically significant. The order of increasing number of ridges on both hands include the following pattern D2<D3,D5<D1<D4 (Table 11).

The order of increasing ridge counts in women with 1–2 children is D2<D3<D1<D5<D4 on the right hand and D2<D3<D1<D5<D4 on the left hand. In women with 3 or more children the pattern is D2<D3<D5<D1<D4 on the right hand and D2<D3<D5<D1<D4 on the left, which is the same pattern as found in the infertile women but with statistically significant RC values in fertile women. These patterns are similar on both hands as observed in Table 11.

Table 12 shows that the finger ridge count was statistically significantly higher among the fertile women compared to the infertile ones. The decreased finger ridge count on the right hand in the infertile women corresponds to the observations of RC on each of the fingers in this group. This pattern is symmetrical on both hands among the infertile and fertile women. Total finger ridge count (TFRC) obtained by counting the ridges across the line drawn from the delta or tri-radius to the core of the fingerprint pattern, was statistically higher among the fertile women (Table 12). Absolute finger ridge count (AFRC) obtained by adding the finger ridge count on the ten digits including the ridge count in the second tri-radius from whorl was statistically significantly higher in the fertile women than in the infertile women.

Pattern intensity index (PII) is shown in Table 13. It is insignificantly higher in the fertile women, while there are insignificant differences in the left pattern intensity between the infertile and fertile women.

Table 14 presents 2D:4D ratio among the examined groups. It can be seen that it is significantly higher in the infertile women than in women with the history of child birth.

TABLE 11

RIDGE COUNT ON BOTH HANDS

DIGITS	Group 1 Mean ±SEM	Group 2 Mean ±SEM	Group 3 Mean ±SEM
D1	29.68±1.6	27.33±1.3	32.67±1.6*
D2	25.40±1.1	23.61±1.1	27.77±1.3*
D3	26.62±1.2	33.43±0.3*	28.08±1.1
D4	33.32±1.2	33.65±1.0	36.00±1.1*
D5	28.85±0.9	27.72±0.9	30.77±1.1*
p ≤	0.0002	0.0001	0.0001

*Significant difference; D1–thumb; D2–index finger; D3–middle finger; D4–ring finger; D5–little finger

TABLE 12

FINGER RIDGE COUNTS

Groups	Right RC Mean ±SEM	Left RC Mean ±SEM	TFRC Mean ±SEM	AFRC Mean ±SEM
Group 1	73.83±3.3	70.96±3.6	146.8±7.2	188.1±11.5
Group 2	70.89±2.4	66.50±2.5*	137.4±4.7	168.9±8.2*
Group 3	79.02±2.5	76.25±2.6*	155.3±5.0	200±10.2*
p ≤	0.1	0.04	0.06	0.05

*Significant difference; D1–thumb; D2–index finger; D3–middle finger; D4–ring finger; D5–little finger

TABLE 13

FINGERS PATTERN INTENSITY

Groups	Right Mean ±SEM	Left Mean ±SEM	Total Pattern Intensity Mean ±SEM
Group 1	6.17±0.20	6.28±0.31	12.45±0.52
Group 2	5.83±0.17	5.72±0.19	11.53±0.35
Group 3	6.33±0.22	6.38±0.23	12.72±0.42
p ≤	0.1	0.8	0.09

TABLE 14

2D:4D INDEX

Group	Right Mean± SEM	Left Mean± SEM
Group 1	0.93±0.05	0.94±0.07*
Group 2	0.84±0.03	0.85±0.04
Group 3	0.84±0.04	0.85±0.04*
p ≤	0.06	0.04

*Significant difference

Discussion

The distribution of dermatoglyphic traits has been found, in combination with other clinical features, to be a diagnostic aid useful in screening individuals with certain genetic or chromosomal disorders.[40] In the present study we examined the phenotypic expression of finger dermatoglyphics among infertile women (Group 1), women with 1–2 children (Group 2) and those with 3 or more children (Group 3). The observed finger traits revealed that arches were significantly more expressed among the infertile women in relation to the women with 3 or more children. Arches are found in average population in about five (5%) percent of finger print patterns[41], which means that its value of 3% found in fertile women is below expected percentage while the value of 7% in infertile women is above the average expected frequency. As loops occur in about 60–70% of the finger prints in average population[3,41], the percentage of ulnar loops found in infertile women is comparatively low (55%), while 60–62% found in women with children is within the expected range. Other studies[41–43] also reported that arch type fingerprint increased in cases with different disorders. Babler[42] showed that human foetuses aborted spontaneously between 11 and 25 weeks post-conception had a significantly higher frequency of arches and a very high incidence of whorl patterns compared with the elective abortions and postnatal control groups. These pattern frequencies had been used as prenatal selection against certain foetuses with no clinical signs of abnormality but with possible undetected developmental disturbances which accompanied the unusual pattern-type distributions.[44,45] The whorl type pattern was reported to be distributed in about 25–30% in average population[3], which means that its distribution is comparatively low in fertile women while the infertile women demonstrated statistically higher percentage distribution of whorl patterns (concentric, elliptical and spiral) with predominant spiral and elliptical whorls.

Our results are in contrast to findings of Shah and Arole[46], who reported absence of elliptical whorl patterns in finger prints of both hands and tibia loop in area V of ball region of the left foot in the study of patients with polycystic ovarian syndrome (PCOS). Meenakshi et al.[47] reported that in amenorrhea, patients had presence of arch patterns in the left index finger, loop patterns on the right little finger, hypothenar patterns in the left palm, and Sydney line in the 1st inter-digital area of the left palm. However, Pal et al.[48] discovered among patients with cervical cancer a decrease in the frequency of ulnar loops and increase in arches with increase in ATD angle, decrease in TFRC and in 3rd inter-digital palmar pattern as shown by this study among the infertile women. Simsek et al.[49] confirmed increased frequency of arches, radial loops and whorl patterns, and decreased pattern of ulnar loop, decreased TFRC and 'ab' ridge count in cerebral palsy in line with our results in the infertile women except for the ab ridge count.

Our analyses of pattern distribution on each of the fingers showed that loop patterns were distributed significantly on digit 5 (D5), whorl type was found to be higher on digit 2 (D2) (concentric and spiral whorl) and digit D4 (elliptical and concentric whorl), and arch type was significant on digit D1 among the infertile women. This is in line with Komotz and Yoshida[50], and Bhat et al.[3], who reported excess of arch patterns on digit 1 in Klinefelter's syndrome, but however, recorded more frequent ulnar loops on digit 2 against this study on female infertility, where loop pattern was predominant on digit 5 (D5) and whorl was frequent on digit 2 (D2). Reduced whorls, reduced ridge count for loops and whorls and total reduction of finger ridge count was noted by Bhat, et al.[3] in Klinefelter's syndrome. Fertile women in this study were reported to demonstrate elliptical whorls on digit 2 and concentric whorls on D4 as compared to infertile women who had more arches, spiral whorls and double loops on D1, and elliptical whorls on D4. Elliptical and spiral whorls were statistically significantly reduced among the fertile women with 3% (elliptical) on D1 and D2 and 13 % (spiral) on digit 1 and 2 (D1, D2) in relation to 14% distribution of elliptical whorls among the infertile women on digit 4 (D4) and 23% of spiral whorls on digit 2 (D2). More importantly, the highest arch pattern in fertile women was recorded on digit 2 (D2) as opposed to the highest distribution of arches on D1 among the infertile women. Matsuyama and Ito[51], showed that females with Trisomy 21 had more arches and less whorls, while in our study the infertile women had more arches and more spiral and concentric whorls. Frequency of loops and arches was the highest in primary amenorrhoea patients with abnormal karyotype when compared with primary amenorrhoea cases with normal karyotype.[52–55] No arches were recorded on digit 4 (D4) and closed radial loop was not found among the fertile women.

Based on our findings the following biomarkers could be good bio indicators of female infertility: Prevalence of arches on digit 1, which was distributed on digit 2 among the fertile women with a lower incidence than in infertile women; absence of arches on digit 4 among the fertile women and low arch distribution on digit 5 (3%) among the infertile women; prevalence of spiral and concentric whorls on digit 2 and digit 4 and prevalence of elliptical whorls on digit 4 in infertile women, as opposed to their comparatively low incidence on digit 1 and 2 among the fertile women; the presence of closed radial loops only in the infertile women with the highest incidence on digit 2, and reduced loop pattern (55%) with less than expected average percentage among the infertile women.

Meier[56], reported that total finger ridge count (TRFC) and pattern intensity index (PII) that measure pattern size and pattern type frequency, differ among populations depending upon either whorl pattern size (TRFC) or whorl pattern frequency (PII). Therefore TFRC and PII adequately describe population variation. Jantz[57] provided evidence for a major gene effect on the total ridge count. This study observed a decrease in the ridge counts on each

of the digits and on all the digits observed and in the total ridge counts among the infertile women, women with 1–2 children and those with 3 or more children. This finding is in contrast to the report of Talhar et al.[35] who found that the mean total finger ridge count and absolute finger ridge count in primary amenorrhoea subjects increased when compared with the control female subjects. However, the pattern size invariably decreased among the infertile women in relation to the women with children. Mean TFRC for average population generally lies between 100 and 150.

The finger ridge count among the fertile women was significantly higher compared with the infertile women, and more importantly, it was also relatively higher (155.3) compared with its expected average value in the population. This means that the decreased pattern size could be associated with infertility.

Warda and Geetha[58] observed significant increase in total finger ridge count (TFRC), absolute finger ridge count (AFRC), ATD angle, radial loops and whorls in both hands, and significant decrease in frequency of ulnar loops in both hands among recurrent pregnancy loss patients. However, from their study no statistically significant differences were observed in the frequency of arches between recurrent pregnancy loss cases and controls.

Index-to-ring-finger ratio (2D:4D) is used as a putative marker of early androgen exposure.[59–66] 2D:4D ratio in this study was relatively higher among the infertile women on both hands. Manning[61] and McFadden[63], reported a low value of this ratio in female subjects in relation to male subjects, and also 2D:4D was low and close to the male value in lesbian females. However Manning[61] and McFadden[62] did not observe differences between homosexual and heterosexual males. This study however, revealed that the 2D:4D index is higher among the infertile females (Group 1) than in the fecund females with a difference of about 0.1. Holt and Lindsten[67] demonstrated a strong genetic component in finger and palmar prints following several studies on the inheritance of dermatoglyphics traits by Cummins and Midlo[1,7,11], and a number of claims since then have been made for the association of dermatoglyphics with various diseases such as leukaemia[68], rubella embryopathy[69], schizophrenia[56] etc., while importantly the relationship of dermatoglyphic traits with disorders of sex chromosomes and some autosomes has been well established and the methods of using these as aids in medical diagnosis have been devised.[2,70] Important studies have also been done on sexual dimorphism, heritability and variation of dermatoglyphics among different ethnic groups.[19, 71,72]

Conclusion

The study specified the base line dermatoglyphic traits to be used as bio-indicators for mass screening of infertility among women. This research work has been able to establish that:

i. Associations exist between the dermatoglyphic features and manifestation of female infertility among the outpatients attending Nisa Premier Hospital in Abuja. The traits found to be specific bio-indictors of infertility include: higher prevalence of arches, spiral and elliptical whorls, decreased finger ridge count, decreased TFRC, and increase in 2D:4D.

ii. These genetically determined dermatoglyphic traits associated with female infertility, may be a good indication of female fertility inheritance.

iii. Dermatoglyphic traits alterations observed among the infertile women relative to fertile ones show prognostic implications of dermatoglyphics and are in support of screening techniques for detection of female infertility.

iv. The importance of this investigation of dermatoglyphics traits in infertility is not only in the academic identification of associations of the dermatoglyphics trait and female infertility, but rather in practical application of detection of women with genetic predisposition to infertility.

v. These dermatoglyphic bio-indicators are useful for counselling, to encourage infertile women to apply for in-vitro fertilization (IVF) treatments, particularly if there is no pregnancy after 1–2 years of marriage, sooner rather than later, as its success rate is age dependent.

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B.J. Dare

Department of Anatomy, College of Health Sciences, Osun State University, Osogbo, Osun State, Nigeria
e-mail: babatunde.dare@uniosun.edu.ng

DISTRIBUCIJA DIGITALNIH DERMATOGLIFA U PLODNIH I NEPLODNIH ŽENA

S A Ž E T A K

Rad analizira razlike u distribuciji digitalnih dermatoglifa između plodnih i neplodnih žena u Abuji, Nigerija. U istraživanje uključene su ukupno 222 žene od kojih 53 klinička slučaja primarne neplodnosti. Dobiveni su dermatoglifski otisci distalnih falanga za daljnje analize kvantitativnih i kvalitativnih osobina. Rezultati su pokazali manju učestalost petlje (55%), te veću učestalost lukova (7%) i vrtloga (29%) u neplodnih žena nego u plodnih. Neplodne žene pokazale su jedinstvenu i specifičnu distribuciju digitalnog uzorka na svakom prstu desne i lijeve ruke. Uočeno je značajno smanjenje broja grebena (RC), ukupnog broja grebenova (TFRC) i apsolutnog broja grebenova (AFRC) u neplodnih žena ($p<0,05$) u odnosu na plodne žene. Indeks 2D:4D je bio veći u neplodnih žena (0,94) nego u plodnih žena (0,84). Uočene razlike u digitalnim osobinama mogle bi biti koristan bioindikator za genetsko savjetovanje među ženama reproduktivne dobi.