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RESEARCH

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Characterisation of Finger Dermatoglyphics Traits and other Biometric Indices among Health Science Undergraduates of the Osun State University, Nigeria

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Abstract

Background: Finger dermatoglyphics has been useful in diagnosing genetically related diseases and detecting crimes. A cross-sectional study was carried out to establish the relationship between fingerprint traits and biometric indices

Methods: Finger dermatoglyphics data were obtained using the ink method among the Health Sciences Students of Osun State University, Osogbo, Nigeria. Finger pattern intensity, finger pattern distribution, and finger ridge counts were measured and compared. These were done by counting and classifying ridge patterns and pattern configuration of arches, loops, and whorls and counting their ridge densities. The subject's height, weight, and colour of the pupil were measured and recorded, respectively

Results: The ulnar loops and arches were the most predominant finger patterns in females, while males showed significantly spiral whorls. The sex differences between these patterns were not statistically significant ($P>0.05$). Subjects with brown pupils demonstrated higher ulnar loop and elliptical whorl, while those with black pupils possessed significantly well-distributed arches, and were insignificant in pattern width and intensity. Body Mass Index (BMI) polymorphism showed the lowest pattern size (Finger Ridge Counts) demonstrated by significantly reduced total finger ridge count among the subjects with BMI range of 24-26 and predominance of the concentric whorl, radial loop, and arches. However, higher pattern size was observed in subjects with a higher BMI value 27-29 BMI range with corresponding ulanr and spiral whorl respectively.

Conclusion: This study demonstrated the prevalent biometrics measure of finger dermatoglyphics traits, in relations to the biometrics distribution of pupillary colour and body mass index among the Health Sciences Students of Osun State University, Osogbo Nigeria

Keywords: Dermatoglyphic traits, Body mass index, Pupillary Colour, Forensic Anatomy

1.0 INTRODUCTION

Dermatoglyphics is the scientific term used for study of epidermal ridges and configuration on the finger and palmar region of hand and plantar surface of foot and toes [1, 2]. Dermatoglyphics has been used in paediatric medicine, genetic research, criminology, psychiatry, and anthropology [3]. Different diseases associated with genetic alterations have produced different finger patterns. Dermatoglyphics has been used to mass screen genetically altered anomalies and predict individual susceptibility to such disease [4].

The entire human body is covered with the skin, the largest and most important protective organ of the body [5]. It protects and safeguards the body, maintains the body temperature, and protects the internal organs from injuries [5]. The palmar surfaces of the hands and the plantar surfaces of the feet are presented with unique ridge configurations that developed in the womb and remain unchanged throughout life until decomposition in the tomb [6]. Cummins [1] coined the term dermatoglyphics, which is a blend of two words Derma meaning skin, and Glyphe, meaning to carve. The features that constitute dermatoglyphics formed during the 13th-14th week of the development, once formed, persist throughout life [6].

In ancient China (1839), dermatoglyphics was an important tool [7] use in the deed of the land. Land deed carried the impression of the fingerprints as an acknowledgment of the deed. The prints of the palm and soles have been used to safeguard against impersonation [7]. Biometrics measures the morphological characteristics in humans, specifically for identifying individuals using distinctive and measurable characteristics that describe individuals. Such measurable biometric characters include the fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina, and odour/scent. Eye colour and iris pattern of the eye can indicate intelligence, personality traits, and health condition [3]. Dermatoglyphic has been a proven new genetic reference index in selecting athletes, determining zygosity of twins, complimentary establishment of disputed paternity, blood grouping pattern, disease diagnosis and medical jurisprudence. These biometric measures of finger dermatoglyphics traits (FDTs), body mass index (BMI), and pupillary colour (PC) are genetically formed. They are unique anthropological parameters employed in human identification and forensic medicine approaches [7,8,9].

This research work aimed at investigating the digital (Finger) dermatoglyphics traits, body mass index and the pupillary colour distribution among the undergraduate students of the College of Health Sciences, Osun State University.

2.0 METHODOLOGY

2.1 The Subjects

A total of sixty (n=60) Health Sciences Students of Osun State University, Nigeria (male n=18; and female n=42), participated in the study. The student's samples were taken together and later sorted out during analysis. A randomized sample technique was employed for data collection among the participants who must be students of the college of health sciences, Osun State University, presumably normal without presentation of any deformity.

2.2 Subject Consents'

All participants were informed about the study's purpose, nature, and benefits before written inform consent was obtained. According to Nuremberg Code of research ethics, the inform/voluntary consents were obtained for studies involving the human subject.

2.3 Demographic Data

The proforma was designed to obtain related information on the background and genetic origin, which were filled. This was necessary in selecting closely related populations for the study and categorizing the students and all data subjects to descriptive and inferential statistics.

2.4 Dermatoglyphics Parameters

2.4.1 Ten Finger Prints

The following steps were taken to obtain a complete imprint of the finger surfaces.

Step 1:- The ink was moderately applied to the distal phalanx of the fingers of both hands using cotton wool

Step 2:- Excess ink was removed with a clean and dry cotton wool

Step 3:- The impressions of the fingers were collected by rolling the fingertip on the space designed for this on the A4 paper, from one side to the other for complete imprints.

2.4.2 Quantitative Analysis

Dermatoglyphics characteristics that were measured and described quantitatively by counting the number of tri-radii or ridges within a pattern and measuring distances or angles between specified points for analysis using different parameters include: finger Ridge Counts (right and left,), Total Ridge Counts (TCR) and Absolute Ridge Counts (AFRC) and Pattern Intensity Index (PI), both hands

Discrete traits that were conceled include: frequencies of finger pattern types and incidence and Frequency of pattern type combinations on both hands

2.4.3 Pattern Type's Identification

Dermatoglyphic pattern types on each finger of the right and the left hands were identified and recorded for each patient in the collation sheets. This study classified fingerprint patterns according to the modified method of Galton Francis [7] and Henry's classification system [8]. The dermatoglyphic characters of the prints were analyzed according to the standard methods as set out in Cummins and Midlo [5]. The pattern on each finger was assigned, to one of the following categories: arch, radial loop, ulnar loop, closed ulnar loop, closed radial loop, whorl, twinned loop or double loop, elliptical whorls, spiral whorls, and concentric whorls.

2.4.4 Qualitative analysis

Dermatoglyphics characteristics were described quantitatively by 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 right and left, Total Ridge Counts (TRC) and Absolute Ridge Counts, Pattern Intensity Index, right and left hand, Pattern Intensity Index, both hands,

Other Dermatoglyphic parameters that were measured include Ridge counts of all patterns. Discrete traits that were compared include: Frequencies of finger pattern types and incidence, frequencies of pattern combinations on the pairs of right and left homologous fingers, Frequency of pattern type combinations on both hands [8, 9].

2.4.4.1 Ridge Counting Method

Ridge count was carried out by direct enumeration of the ridges following a line drawn from the tri-radius to the core of the pattern [10, 11, 12, 13]. Whorl pattern ridge count was determined by the number of intersected ridges between the tri-radius and the core. Arches were defined by having a ridge count of zero. The ridge count of a whorl consisted the higher of the two counts.

2.4.5 Total Finger Ridge Counts (Pattern Size)

This included the sum of ridges of all the ten digits of the hands of a subjects, only the larger count was used on the digits with more than one ridge count. It expresses the size of the pattern [11, 14, 15]. A total ridge count (TRC) is the summation of the ridge counts for all ten fingers. The total ridge counts among the control group and the infertile was obtained by the summation of all the ten-finger ridge counts; the number of ridges intercepting the line from the tri-radius to the core of the centre as it relates to the loop (Ulnar and radial loop) and whorl, no counting was recorded for the arches patterns and the highest counts of the two (2) tri-radii found on the whorls patterns were recorded

2.4.6 Absolute Finger Ridge Counts (AFRC) Method

This was obtained by the addition of the ridge counts from all the separate tri-radii on all ten digits. It reflects the pattern size and pattern type also [14, 15]. Absolute finger ridge counts allow the least count of the two (2) tri -radii found in the whorl pattern to be included in determining the pattern sizes.

2.4.7 Pattern intensity Index (PII)

Pattern Intensity index; the complexity of ridge configurations was expressed by counting the total number of tri-radii present in the hands of each of the subjects [13]. Arches had no zero tri-radius, loop pattern had only one (1) triradius present, while the Whorl pattern had two tri-radius. The number of tri-radius present on each hand of all the ten-finger was summed and estimated for the pattern intensity

2.5 Measurement of the Height and Weight

Measurement of the Height and Weight was done using a height and weight measuring scale. Each candidate's height and weight was accurately taken separately, one after the other, by stepping barefooted on the scale with the head in a Frankfort plane. The essence of this was to determine the actual height and weight without adding that of the shoes. And also, candidates with scarfs and caps while taking their height measurement palpation was involved for actual height.

2.7 Determination of the Pupillary Colour

The candidate's pupil colour was taken outside in an open place, where there was no darkness as it could alter the

evaluation, thereby making the black pupil look otherwise. Figures 1 and 2 shows two examples each of brown pupil coloured subjects and black pupil coloured subjects.

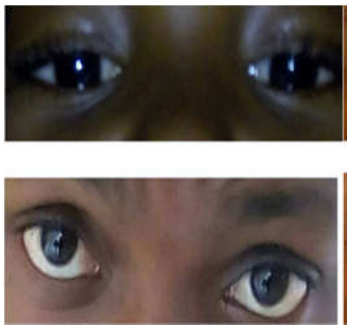

Figure 1. Subjects with Black coloured pupils

Figure 2. Subjects with Brown coloured pupils

2.8 Determination of the BMI

Body Mass Index (BMI) was measured using the standard formula for determining BMI, weight in kilogram (kg) divided by the square of height in meter (m^2). BMI =Weight/Heights^2

2.9 Statistical Analysis

All data were subject to both descriptive and inferential statistics using the statistical software Graph pad prism version -6 for estimation of the Mean, Standard deviation, and Standard error of Mean. Statistical tools used include analysis of variance (ANOVA) for quantitative data, and Chi-square for discrete data.

3.0 RESULTS

The result revealed finger print pattern type distribution among the male and female students of the College of Health Sciences, Osun State University. In both groups of students, the ulnar loop (Plate 1) was higher in percentage distribution, and the double loop was observed lowest in distribution among the male and female students. However, Spiral whorl (Plate 2) was higher in male students while female students showed the highest distribution in arches Table 1

Table 2 revealed the pattern of finger type's distribution among the black and brown pupil coloured subjects. In both groups, the ulnar loop was higher in percentage distribution observed. However, Arches (Plate 3) were significant in black pupil coloured subjects, while in subjects with brown pupil colour, Elliptical whorl (Plate 4) was shown to be significant.

Table 1. Finger Pattern Distributions A mong the Male and Female Students

	MALE		FEMALE	
Finger Pattern	Freq.	(%)	Freq.	(%)
UL	91.0	60.7	263.0	62.6
RL	3.0	2.0	13.0	3.1
DL	3.0	2.0	8.0	1.9
CW	5.0	3.3	24.0	5.7
SW	24.0	16.0	29.0	6.9
EW	9.0	6.0	29.0	6.9
AR	15.0	10.0	54.0	12.9
ACC	0.0	0.0	0.0	0.0

UL- Ulnar loop, **RL**-Radial loop, **DL**-Double loop, **CW**-Concentric whorl **SW**-Spiral whorl, **EW**-Elliptical whorl, **AR**-Arches, **ACC**-Accidental

Table 2. Pupillary Colour and Finger Pattern Distributions

	BLACK		BROWN	
Finger	Freq.	Perc.	Freq.	Perc.(%)
UL	155.0	59.6	199.0	64.2
RL	10.0	3.8	6.0	1.9
DL	6.0	2.3	5.0	1.6
CW	11.0	4.2	17.0	5.5
SW	27.0	10.4	27.0	8.7
EW	10.0	3.8	28.0	9.0
AR	41.0	15.8	28.0	9.0
ACC	0.0	0.0	0.0	0.0

UL- Ulnar loop, **RL**-Radial loop, **DL**-Double loop, **CW**-Concentric whorl **SW**-Spiral whorl, **EW**-Elliptical whorl, **AR**-Arches, **ACC**-Accidental

Table 3 below reveals the Mean ridge count in candidates with black pupil colour (10.30±0.6899) insignificantly different from the mean finger ridge counts of subjects whose pupil colour is brown (10.31±0.5562) with value (10.30±0.6899). More importantly, the total finger ridge count (TFRC) mean distribution was highest in subjects with the brown coloured pupil (99.84±6.277), but the absolute finger ridge count (AFRC) showed an insignificant difference in both classes.

In Table 4, the Mean ridge count (RC) in all the BMI

Plate 1. Ulnar Loop with 1 tri-radius

Plate 2. Spiral Whorl and 2 tri-radii

Plate 3. Showing Arch, no tri-radius

Plate 4. Showing Elliptical Whorl, and 2 tri-Radii

Plate 5. Showing Radial Loop with 1 tri-radius

Plate 6 . Showing Concentric Whorl, with 2 tri-radii

range groups is significantly different. The group with the lowest BMI (18.0-20.0) has the highest AFRC value. Meanwhile, group with the highest BMI, 27.0-29.0, showed significant RC and TFRC. Medium Group (24.0-26.0) BMI demonstrated low value in TFRC.

Table 3. Pupillary Colour and the Ridge Counts

	BLACK	BROWN
	Mean± SEM	Mean± SEM
TPI	10.30±0.6899	10.31±0.5562
TFRC	96.74±8.626	99.84±6.277
AFRC	177.5±11.07	175.0±9.994

P<0.05, * Significant, **TPI**-Total Pattern Intensity, **TFRC**-Total Finger Ridge Counts, **AFRC**-Absolute Finger Ridge counts

Table 4. BMI and Finger Ridge Counts

	TPI	TFRC	AFRC
	Mean± SEM	Mean± SEM	Mean± SEM
18.0-20.0	10.34±0.489	99.28±6.358	158.7±11.47
21.0-23.0	10.14±1.138	95.93±11.76	201.3±18.58
24.0-26.0	10.25±1.130	87.38±11.36	142.5±10.64
27.0-29.0	12.00±0.0	134.0±0.0	16.0±0.0

P<0.05, * Significant, **TPI**-Total Pattern Intensity, **TFRC**-Total Finger Ridge Counts, **AFRC**-Absolute Finger Ridge counts

In Table 5, the percentage ulnar loop was significantly high across all groups; weight range 18.0-20.0 could be identified with arch while weight range 21.0-23.0, showed significantly lower Radial loop (Plate 5) and Double loop distribution.

Percentage distribution of concentric whorl (Plate 6)was highest in the BMI range 24-26, and was not present in subjects with higher BMI range (27-29). Similarly, percentage distribution of elliptical whorl (Plate 4), however, the highest percentage was noticed in BMI range of 21-23

4.0 DISCUSSION

It had been reported that about sixteen genes influence eye colour. These genes equally influence the production, transportation, or storage of a hormone called melanin [16]. Melanin is a brown pigment that determines the colour of the eyes, hair, and skin. These biometric traits are unique for individuals and are means of identification and forensic tools. Finger dermatoglyphics traits are genetically determined and remained unchanged when formed from the womb till after decomposition in the tomb. Therefore it had been employed in heredity studies, human population description, and primate comparisons [17].

Table 5. BMI and Finger Pattern Distributions

BMI Range	18.0-20.0		21.0-23.0		24.0-26.0		27.0-29.0	
	Freq.	Perc.(%)	Freq.	Perc.(%)	Freq.	Perc.(%)	Freq.	Perc.(%)
UL	205.0	64.1	94.0	58.7	46.0	57.7	8.0	80.0
RL	5.0	1.5	4.0	2.5	7.0	8.7	0.0	0.0
DL	7.0	2.2	4.0	2.5	0.0	0.0	0.0	0.0
CW	14.0	4.4	7.0	4.4	9.0	11.3	0.0	0.0
EW	20.0	6.3	13.0	8.1	2.0	2.5	0.0	0.0
SW	34.0	10.6	16.0	10.0	4.0	5.0	2.0	20.0
AR	35.0	10.9	22.0	13.8	12.0	15.0	0.0	0.0
ACC	0.0	00	0.0	0.0	0.0	0.0	0.0	0.0

UL- Ulnar loop, **RL**-Radial loop, **DL**-Double loop, **CW**-Concentric whorl **SW**-Spiral whorl, **EW**-Elliptical whorl, **AR**-Arches, **ACC**-Accidental

Percentage ulnar loop and arch pattern distribution in females (62.6%) was higher than males' (60.7%) on both hands in this study. However, the percentage spiral whorl distribution was higher in males (16.0%) than in females (6.9%). The population distribution of fingerprints among female students was significantly higher in the percentage distribution of ulnar and arches (12.9%). Double-loop, elliptical whorls were observed to have been barely distributed. The trend of finger dermatoglyphics distribution observed followed the Jalali *et al.,* 2002 [18] reported that about 60 to 70% of fingerprints were loop in his studied population, and that arches have been relatively and statistically higher among the female subjects. According to Edward, 1998 the mean ridge count for males is 13.41, and that of the female is 12.04. These figures are the exact opposite of what was reported earlier [19]. The study was done on male and female American Negroes and Caucasian Americans in

2006 and it was found that the mean ridge density in males is more than females [19, 20].

Cummins [1] have established that females have a higher mean ridge count (23.3) than males (20.7), similar to the result of the present student. It was observed that the total pattern intensity (TP), total finger ridge count (TFRC) in brown pupil coloured (10.31±0.5562 and 99.84±6.277) subjects were higher than subjects with black pupil colour (10.30±0.6899 and 96.74±8.626). In contrast, absolute ridge count (AFRC) was higher in black pupil coloured candidates (177.5±11.07) than in brown pupil coloured subjects (175.0±9.994). This study established finger print characteristics among the black and brown pupillary colour individuals, eye colours do not followed normal pattern of hereditary from parent to offspring. Many genes are at play from each parent, independent assortment but mainly dependent on the amount and distribution of a brown pigment called melanin in the iris. Therefore, it can be deduced that increased finger pattern diameter as measured by the ridge counts could be attributed to the brown eye colour individuals while the pattern intensity that measured the numbers of triradius present is associated with the black colour inherent subjects.

It was observed that total pattern intensity (TP) insignificantly higher in the BMI range group 27.0-29.0 (12.00±0.0) with a percentage ulnar distribution of 80% and spiral whorl 20%. BMI range of 21-23 showed reduced pattern intensity (10.14±1.138) with percentage ulnar distribution of 58.7%, arch 10.9%, and spiral whorl 10.6%. Studies have identified variants in several genes that contribute to obesity by increasing hunger and food intake, which could be traced to genetic origin. The finger dermatoglyphics trait distribution in relation to BMI status was examined, and it was discovered that the total finger ridge count (TFRC) was significantly higher in BMI range of 27.0-29.0 (higher BMI). The different ranges of BMI as observed in this study produce a characteristic dermatoglyphic trait-specific for the identification as well as bioindicator. Dermatoglyphics had been used in a number of diseases as diagnostic tools with a strong hereditary basis [21,22,23], therefore, higher pattern intensity and increased ridge diameter as measured

by ridge count is statistically associated with the higher risk of BMI as equally observed in the previous studies.

The ridge density is a characteristics parameter to determine sex, height, pupil colour, BMI, and weight from fingerprint. The pattern of the fingerprint is most likely to be a specific parameter. From the present study, the dermatoglyphics parameters can be used as a bio-indicator among populations to know the risk of obesity, weight, pupil color, and height. This findings followed several studies that reported total finger ridge count (TRFC) and pattern intensity index (PII) measured the pattern size and pattern type frequency, because these two parameters differ among populations for example, whorl pattern size determine the total finger ridge count (TRFC) while the whorl pattern frequency determine the pattern intensity (PI) [24]. Therefore TFRC and PI adequately describe population variation [23] as observed in this study. Likewise, in another studies, evidences for major genes effect on total ridge count was provided and the practical application of the ridge pattern and ridge counts in identification and as bioindicator of intelligent quotient among undergraduate [25, 26].

Conclusively, the proposed method looks promising for gender, height, BMI weight, and pupil colour determination using these dermatoglyphics traits: high pattern intensity, high Ulnar Loop distribution, lower radial loop distribution in the obese individuals, higher total finger ridge Count (TFRC) and Absolute Finger Ridge Count (AFRC). Ulnar loop distribution is higher in brown pupil coloured individuals and Arch distribution is higher in black pupil coloured individuals. Also, tall individual shows higher spiral whorl distribution than short individuals.

The study had established finger dermatoglyphics traits attributed to the pupillary color and BMI biometric parameters for practical application in identification, forensic uses and medical jurisprudence.

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Conflict of Interest

Authors declare that there is no conflict of interest.

Authors‘ Contributions

JBD conceived and designed the study and contributed to manuscript writing. **OOO, AAA, ADA** performed data collection and contributed to data analysis tools. **TAA, AAO** performed data analysis. All authors approved the final version of the manuscript .

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