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# Dermatoglyphic Studies of Fulani and Yoruba Ethnic Groups with Third Generational History in Kwara and Oyo States, Nigeria

***Adetona M.O.[1] and Lawal M.O.[2]**

[1,2.] *Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, University of Ibadan*

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**Abstract**

Dermatoglyphic traits are genetically determined and remain constant until decomposition after death. This study aimed to use dermatoglyphics as a means for ethnic differentiation. The volunteers were Fulani (male 32 and female 28) and Yoruba (male 27 and female 33) from Kwara state and University of Ibadan community respectively. Fingerprints were obtained with Dermalog LF10 fingerprint scanner Hamburg, Germany. Stata was used for T-test and ANOVA. Ulnar loop was predominant in dermatoglyphs of the two ethnic groups (Fulani 38.20%, Yoruba 38.90%). Whorl (Fulani 24.50%, Yoruba 23.50%), Radial loop (Fulani 25.40%, Yoruba 22.60%) and Arch (Fulani 11.90%, Yoruba 15%) were distributed in that order. The gender distribution of patterns in this study were: Arch (male 11.08%, female 16.30%), radial loop (male 24.72%, female 23.5%), ulnar loop (male 39.90%, female 37.50%), whorl (male 24.3%, female 22.7%). Whorl is significantly distributed in both sexes of the two-ethnic group ($P<0.005$). Bifurcation distribution was predominant in both tribes and opposed bifurcation is the least minutiae type in both ethnic groups. Most minutiae revealed significant difference between Fulani and Yoruba except short ridges, dot, ridge ending, and spur. Arch differentiates Fulani and Yoruba, whorl showed sexual dimorphism. Level two details could be a possible marker of ethnic differentiation between Fulani and Yoruba of Nigeria.

**Key Words:** Dermatoglyphics, Forensic, Fingerprint Minutiae, Fulani, Yoruba, Nigeria.

## INTRODUCTION

Dermatoglyphics is the study of the patterns and lines on the skin of the fingers, palms, toes, and soles (Wijerathne *et al*., 2020). These ridges and furrows appear on the hands between the sixth and seventh week of intrauterine development, and are fully formed by the twenty-first week, and then remain essentially unchanged (Scaumann and Alter, 1976). Fingerprint patterns have been reported in various populations around the world, including Nigeria, (Akpan *et al*, 2019. Igbigbi *et al*., 2018. Adetona *et al*., 2008, Lestrange, 1953, Ojikutu 1964, Jantz and Brehme, 1978) which supported ethnic differentiation. Igbigbi *et al*. (2018) reported that the study of skin hieroglyphs in the form of fine ridge patterns on the fingers, palms, and soles is a very valuable tool for identification and paternity. Dermatoglyphics has been used extensively in anthropology, genetics, and medicine as a valuable non-invasive diagnostic instrument and early risk assessment for specific diseases (Wijerathne *et al*., 2016). During the first 14–22 weeks of prenatal development, fingerprints reflect abnormalities in fetal development, hence, dermatoglyphic asymmetry has been utilized to quantify developmental instability during a period of human fetal development. Only in the last few decades have there been widespread medical interest in epidermal ridges, as it became apparent that many patients with chromosomal aberrations had unusual ridge patterns. Inspection of skin ridges promises to provide a straightforward, inexpensive, and non-invasive method of determining whether a given patient may have a specific chromosomal defect. (Sumangala *et al*., 2016). Several studies that have been conducted in different ethnic groups with different pattern types. Jaja *et al*. (2008) studied the fingerprints of Ijaw people relating it to pattern frequency and number of crests while Otobo and Jarimbo-Otobo (2016) examined the palm characteristics of this population. Eboh studied digital skin engravings of the Anioma and Urhobo peoples of Nigeria and found no relationship between ethnicity and design. There is a need to study other ethnic groups in Nigeria and document their fingerprint patterns and minutiae. This study aimed to investigate level 1 (Figure 1) and level 2 details (Figure 2) of Fulani and Yoruba biometrics in Nigeria that can be of significant use for identification.

## MATERIALS AND METHODS

This study was carried out in two states, University of Ibadan community in Oyo state and Banni town in Kwara state, Nigeria. The participant's demography including age, sex and ethnicity were taken through a designed questionnaire. There were 60 Yoruba and 60 Fulani participants comprising of 55 females and 65 males. The fingerprints were obtained by Dermalog LF10, Hamburg, Germany. Participants fingers were wiped with alcohol wet towelette before taking prints. A little pressure was applied to press the fingers on the scanner for adequate contact between the fingers and the scanner.

**Author for Correspondence:* Tel: +2348033591196 E-mail: *moadetona@com.ui.edu.ng*

Sharp prints of the dermatoglyphs were captured. The patterns were classified according to Penrose (1968) and Cummins and Midlo (1961) Total finger ridge count (TFRC) were estimated. Level 2 details (minutiae) were studied using Automated Fingerprint Identification System (AFIS) (FBI, 1991).


**Figure 1:**
Fingerprint Patterns. A. Arch, B. Loop, C. Whorl

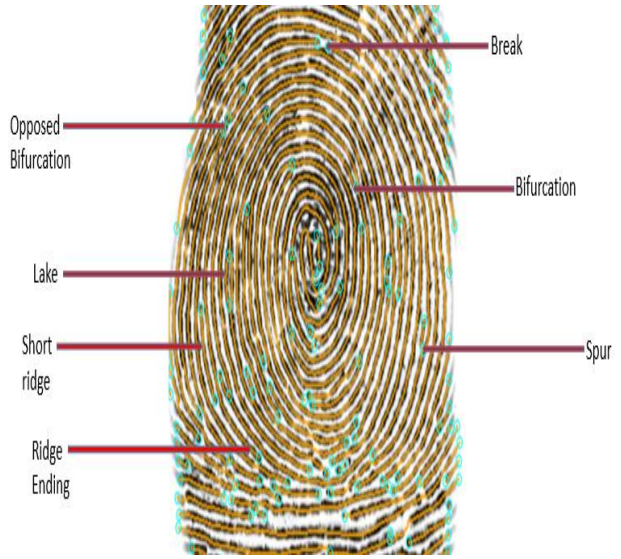


**Figure 2:**
Fingerprint Minutiae

The ethical approval for this study (NHREC/TR/02/06/2007a) was obtained from the UI/UCH Ethical Review Committee in the Institute for Advanced Medical Research and Training (IMRAT), University College Hospital, Ibadan.

**Statistical Analysis:** Descriptive statistics was calculated, and STATA statistical software was used to calculate unpaired student t-test for comparison between the variables. A statistical significance was considered at P<0.05.

## RESULTS

Ulnar loop was predominant between the two ethnic groups (Fulani 38.20%, Yoruba 38.90%). Whorl (Fulani 24.50%, Yoruba 23.50%), Radial loop (Fulani 25.30%, Yoruba 22.70%) and Arch (Fulani 11.9%, Yoruba 15%) were distributed in that order (Figure 3).

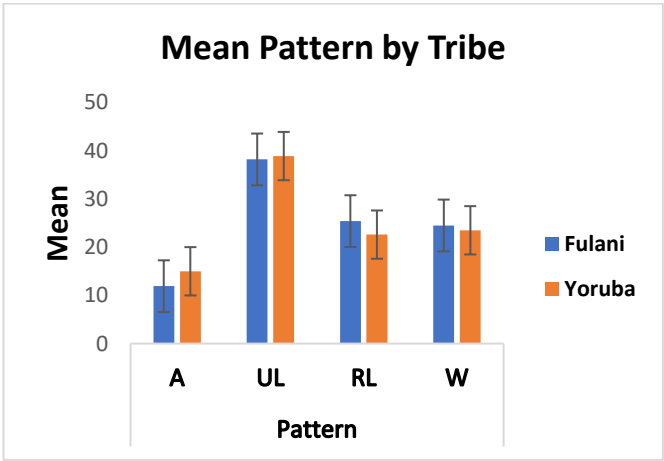


**Figure 3:**
**Pattern percentage by ethnicity**
A - Arch, UL - Ulnar Loop, W - Whorl, RL - Radial Loop

Whorl was the most predominant pattern type among the males between the ethnic groups and it was statistically significant between the genders (P<0.05) (Table 1).

**Table 1:**
Pattern distribution according to gender

| Pattern | Gender | Mean | SD | P value |
|---|---|---|---|---|
| Arch | Female | 0.49 | 0.1 | 0.06 |
| | Male | 0.28 | 0.06 | |
| Radial Loop | Female | 1.46 | 0.17 | 0.50 |
| | Male | 1.32 | 0.14 | |
| Ulnar Loop | Female | 1.47 | 0.16 | 0.74 |
| | Male | 1.48 | 0.14 | |
| Whorl | Female | 1.56 | 0.14 | *0.03 |
| | Male | 2.0 | 0.14 | |

P<0.05, SD – standard deviation

**Table 2:**
Pattern Distribution of Right and Left Fingers

| Pattern | Fingers | Mean | SD | P Value |
|---|---|---|---|---|
| Arch | Right | | | |
| | Yoruba | 0.28 | 0.1 | 0.699 |
| | Fulani | 0.35 | 0.12 | |
| | Left | | | |
| | Yoruba | 0.32 | 0.08 | 0.15 |
| | Fulani | 0.55 | 0.14 | |
| Radial Loop | Right | | | |
| | Yoruba | 2.18 | 0.23 | 0.218 |
| | Fulani | 2.55 | 0.18 | |
| | Left | | | |
| | Yoruba | 0.77 | 0.18 | * 0.001 |
| | Fulani | 0.03 | 0.02 | |
| Ulnar Loop | Right | | | |
| | Yoruba | 0.83 | 0.19 | *0.001 |
| | Fulani | 0.08 | 0.05 | |
| | Left | | | |
| | Yoruba | 2.3 | 0.23 | 0.449 |
| | Fulani | 2.52 | 0.17 | |
| Whorl | Right | | | |
| | Yoruba | 1.7 | 0.2 | 0.271 |
| | Fulani | 2.02 | 0.2 | |
| | Left | | | |
| | Yoruba | 1.58 | 0.2 | 0.127 |
| | Fulani | 1.9 | 0.19 | |

P<0.05, SD – standard deviation

The presence of radial loop was statistically significant on the left fingers between the ethnic groups while ulnar loop was significant on the right fingers (P<0.05) (Table 2). The gender distribution of patterns in this study were; Arch (male 11.08%, female 16.30%), radial loop (male 24.72%, female 23.50%), ulnar loop (male 39.90%, female 37.50%), whorl (male 24.30%, female 22.70%) (Figure 4).

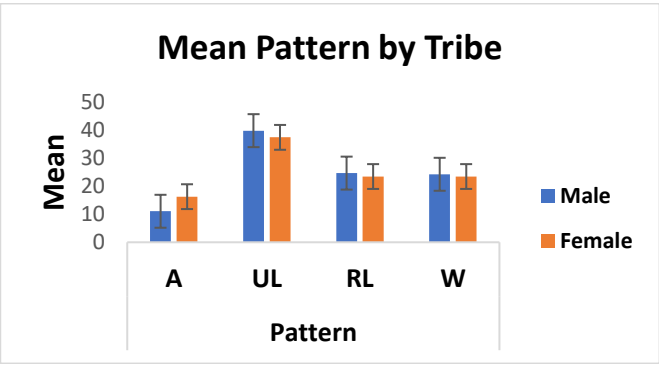


**Figure 2:**
Pattern percentage by gender

A - Arch, UL - Ulnar Loop, W - Whorl, RL - Radial Loop

There is no significant difference in Total Finger Ridge Count and Absolute Finger Ridge Count between the ethnic groups (Table 3) (P<0.05). The comparison in the minutiae between the ethnic groups showed that bifurcation, double bifurcation, bridge, opposed bifurcation, ridge crossing, spur, lake and break were statistically significant (Table 4).

**Table 4:**
Minutiae Ethnic Distribution

| Minutiae | Tribe | Mean | SD | P Value |
|---|---|---|---|---|
| | Fulani | 20.63 | 0.96 | |
| R End | Yoruba | 17.19 | 0.79 | 0.006 |
| Bif | Fulani | 27.79 | 1.21 | |
| | Yoruba | 34.98 | 1.16 | * 0.001 |
| D Bif | Fulani | 4.09 | 0.2 | |
| | Yoruba | 2.41 | 0.2 | * 0.001 |
| Bridge | Fulani | 5.73 | 0.32 | |
| | Yoruba | 7.45 | 0.4 | *0.001 |
| Opp Bif | Fulani | 3.09 | 0.26 | |
| | Yoruba | 1.98 | 0.19 | *0.001 |
| R Cross | Fulani | 2.73 | 0.29 | |
| | Yoruba | 3.9 | 0.29 | *0.005 |
| Shrt R | Fulani | 7.96 | 0.44 | |
| | Yoruba | 7.74 | 0.45 | 0.731 |
| Spur | Fulani | 8.18 | 0.49 | |
| | Yoruba | 13.34 | 0.73 | * 0.001 |
| Dot | Fulani | 4.73 | 0.46 | |
| | Yoruba | 5.45 | 0.38 | 0.232 |
| Lake | Fulani | 11.63 | 0.55 | |
| | Yoruba | 28.09 | 2.02 | * 0.001 |
| Break | Fulani | 7.08 | 0.42 | |
| | Yoruba | 4.57 | 0.35 | * 0.001 |

R End: Ridge Ending, Bif: Bifurcation, D Bif: Double Bifurcation, Opp Bif: Opposed Bifurcation, R Cross: Ridge Crossing, Shrt R: Short Ridge, P<0.05, SD – standard deviation

**Table 3:**
AFRC and TFRC of the right and left fingers

| | Finger | Ethnicity | Mean | SD | P value |
|---|---|---|---|---|---|
| AFRC | Right | Fulani | 54.39 | 1.87 | 0.374 |
| | | Yoruba | 56.90 | 2.10 | |
| | Left | Fulani | 51.80 | 2.21 | 0.124 |
| | | Yoruba | 56.55 | 2.13 | |
| TFRC | Left and Right | Fulani | 106.19 | 3.73 | 0.185 |
| | | Yoruba | 113.45 | 3.97 | |

AFRC - Absolute Finger Ridge Count, TFRC - Total Finger Ridge Count, P<0.05, SD – standard deviation

In the minutiae analysis, the ridge ending, bifurcation, double bifurcation, bridge, break, spur, and lake were statistically significant between the males of the ethnic groups (Table 5) while double bifurcation, spur, lake, and break were statistically significant in the females between the ethnic groups (Table 6).

**Table 5:**
Minutiae Distribution of Yoruba and Fulani Male

| Minutiae | | Mean | Sd | P Value |
|---|---|---|---|---|
| R End | Fulani | 22.42 | 1.5 | |
| | Yoruba | 15.05 | 0.74 | * 0.001 |
| Bif | Fulani | 26.89 | 1.77 | |
| | Yoruba | 36.8 | 1.51 | * 0.001 |
| D Bif | Fulani | 4.11 | 0.3 | |
| | Yoruba | 2.59 | 0.29 | *0.001 |
| Bridge | Fulani | 5.92 | 0.49 | |
| | Yoruba | 8.58 | 0.59 | *0.001 |
| Opp Bif | Fulani | 3.23 | 0.38 | |
| | Yoruba | 1.94 | 0.27 | 0.006 |
| R Cross | Fulani | 3.09 | 0.43 | |
| | Yoruba | 3.95 | 0.42 | 0.154 |
| Shrt R | Fulani | 8.42 | 0.71 | |
| | Yoruba | 7.53 | 0.53 | 0.312 |
| Spur | Fulani | 8.31 | 0.78 | |
| | Yoruba | 14.61 | 1.13 | * 0.001 |
| Dot | Fulani | 5.16 | 0.67 | |
| | Yoruba | 4.83 | 0.44 | 0.684 |
| Lake | Fulani | 11.94 | 0.79 | |
| | Yoruba | 31.74 | 3.07 | *0.001 |
| Break | Fulani | 6.44 | 0.51 | |
| | Yoruba | 4.89 | 0.48 | *0.03 |

R End: Ridge Ending, Bif: Bifurcation, D Bif: Double Bifurcation, Opp Bif: Opposed Bifurcation, R Cross: Ridge Crossing, Shrt R: Short Ridge, P<0.05, SD – standard deviation

**Table 6:**
Showing Minutiae Distribution Yoruba and Fulani Females

| Minutiae | | Mean | SD | P Value |
|---|---|---|---|---|
| R End | Fulani | 18.57 | 1.07 | |
| | Yoruba | 19.81 | 1.44 | 0.489 |
| Bif | Fulani | 28.82 | 1.61 | |
| | Yoruba | 32.76 | 1.78 | 0.103 |
| D Bif | Fulani | 4.07 | 0.26 | |
| | Yoruba | 2.19 | 0.28 | *0.001 |
| Bridge | Fulani | 5.5 | 0.41 | |
| | Yoruba | 6.07 | 0.47 | 0.358 |
| Opp Bif | Fulani | 2.93 | 0.33 | |
| | Yoruba | 2.04 | 0.27 | 0.041 |
| R Cross | Fulani | 2.32 | 0.39 | |
| | Yoruba | 3.83 | 0.38 | 0.007 |
| Shrt R | Fulani | 7.43 | 0.5 | |
| | Yoruba | 8 | 0.76 | 0.528 |
| Spur | Fulani | 8.04 | 0.57 | |
| | Yoruba | 11.8 | 0.82 | * 0.001 |
| Dot | Fulani | 4.25 | 0.62 | |
| | Yoruba | 6.2 | 0.65 | 0.033 |
| Lake | Fulani | 11.27 | 0.76 | |
| | Yoruba | 23.63 | 2.34 | * 0.001 |
| Break | Fulani | 7.8 | 0.66 | |
| | Yoruba | 4.17 | 0.51 | * 0.001 |

R End: Ridge Ending, Bif: Bifurcation, D Bif: Double Bifurcation, Opp Bif: Opposed Bifurcation, R Cross: Ridge Crossing, Shrt R: Short Ridge, P<0.05, SD – standard deviation

## DISCUSSION

The ulnar loop was the most predominant pattern type in both gender and between the tribes (Fulani and Yoruba). The predominance of ulnar loop has been reported in previous studies by other researchers; Adetona *et al*., (2008) among the three major ethnic groups in Nigeria, Ekanem (2009) among the Annang tribe in Nigeria and Shrestha & Malla (2019) among Nepalese. This study showed that whorl pattern can be used for sexual differentiation in the ethnic groups. The predominance of whorl pattern in the male was similar to the reports of Maricq (1972) among the British in an 'all-white' study and Efe *et al*., (2019) in Itsekiri males. Contrarily, Maricq (1972) reported a lower incidence of the pattern in Italian males and Efe *et al*., (2019) in Urhobo males. In line

with this study, significant gender difference in the whorl pattern with a higher distribution in male were reported by Ekanem (2009) in the Annang tribe of Nigeria and Karki and Singh (2014) among the Nepalese. The statistical significance in the radial loop on the left fingers and in the ulnar loop on the right fingers between the two ethnic groups is an indication that these patterns can be used for ethnic differentiation between Yoruba and Fulani.

This study showed that TFRC cannot be used for ethnic differentiation as there was no significant difference between the two tribes, contrary to finding by Adetona *et al*., (2008) among the three major ethnic groups in Nigeria and Igbigbi *et al*., (2005) finding between Tanzanians and Kenyans. Bifurcation, double bifurcation, bridge, opposed bifurcation, ridge crossing, spur, lake, and break were significantly different between the ethnic groups. Bridge was significantly higher in Yoruba ethnic group compared to Fulani contrary to what was reported by Akpan *et al*., (2019) where a lower incidence of the minutia was recorded in Yoruba compared with their Igbo counterpart. Break minutia was lower in Yoruba compared to Fulani. Similar finding was reported by Akpan *et al*., (2019) in their comparison between Yoruba and Igbo. Bifurcation, ridge crossing, spur, and lake have lower mean distribution in Fulani whereas, double bifurcation and opposed bifurcation have higher incidence when compared to Yoruba. Thus, minutiae can be used for ethnic differentiation between Fulani and Yoruba. In this study, the ridge ending was significantly lower in Yoruba male compared to the Fulani. A lower mean distribution of ridge ending in Yoruba ethnic group was also reported by Akpan *et al*., (2019) in their comparison with Igbo ethnic group. Bifurcation was significantly lower in the Fulani male compared to the Yoruba. This is similar to the study by Akpan *et al*., (2019) where the mean distribution of bifurcation was reportedly lower in Igbo male compared to their Yoruba counterpart. In this study, the mean distribution of the bridge, spur, and lake were significantly higher in the Yoruba male compared to their Fulani counterparts, however, double bifurcation was significantly higher in Fulani male compared to the Yoruba.

In the female, the mean distribution of break was significantly lower in Yoruba than in Fulani. When compared with other studies, Akpan *et al*., (2019) also recorded a lower incidence of the minutia in Yoruba when compared with their Igbo counterpart. Double bifurcation was also significantly lower in Yoruba compared with Fulani; however, spur and lake were significantly lower in Fulani compared with their Yoruba counterpart. This study showed that minutiae can be used for sexual differentiation between the ethnic groups.

## CONCLUSION

This study is in conformity with patterns expected in normal indigenous Nigerian and African population. Gender and ethnic disparity existed in both the patterns and minutiae of the two ethnic groups. Therefore, this study can be used as a marker in conjunction with other markers for sexual dimorphism and ethnic differentiation.

***Limitations of study***

*Volunteers were reluctant in participating in this research due to digital fingerprint capturing and its use in other biometric identification procedures. This limits the sample size.*

*This study can be advanced by using the level 3 details for gender and ethnic differentiation.*

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