1. **Type of Manuscript**: Original Article
2. **Title**: Variation in Thumbprint pattern and Ridge Density Count between two major ethnic groups in Nigeria
3. **Authors Names:** Michael E. NANDI\*1, Olaleye A. OLABIYI2 Obun C. OBUN1 and Evare E. UZONG1
4. **Authors Affiliation address**
5. Department of Anatomy and Forensic Anthropology, Faculty of Basic Medical Sciences, Cross River University of Technology, CRUTECH Okuku Campus, Cross River State, Nigeria
6. Department of Anatomy, College of Medicine Idi-Araba, University of Lagos, Lagos State, Nigeria.
7. **Corresponding Author and address:** Mr**.** Michael Ebe Nandi

**Address:** Department of Anatomy and Forensic Anthropology, Faculty of Basic Medical Sciences, Cross River University of Technology, CRUTECH Okuku Campus, Cross River State, Nigeria

1. **Corresponding Email:** **enandi15@gmail.com**

**Abstract**

The uniqueness of fingerprints makes it a valued biometric trait and since the prints are regular and commonly seen physical evidence in many crime scene, forensic investigators usually employ them for sexual and ethnic differentiations as well as apprehension of suspects in criminal related cases. This study was an attempt to discriminate sex and ethnicity using fingerprint pattern and ridge density count among the Igbo and Efik groups of Nigeria.

The sample size for this study includes 173 adults (Efik = 37 males, 44 females) and (Igbos = 61 males, 31 females), randomly selected between the ages of 18-40 years. The subjects were asked to wash and dry their hands to remove dirt and grease. The fingers (thumbs) of both hands were smeared with removable ink and pressed in a white plane paper. Using meter rule, 25mm2 each was measured from radial border, ulnar border, and inferior quadrants respectively for fingerprint ridge density count. This data was analyzed using SPSS Software version 21 Chicago Incorporated.

The results of this study showed that both the males and females of Igbo origin havepredominantly loop fingerprint pattern, at the male to female ratio of 43% and 55% respectively. In the contrary, the male and female of Efik ethnic group recorded more whorl print pattern at the ratio of 54% and 50% respectively. More so, this results recorded sexual dimorphism (P<0.05) in the various ridge density count across the two ethnic groups, even the ethnic comparison of both males to males and females to females, recorded statistical significant difference (P<0.05) between the Igbos and Efiks. Hence, the Igbos, irrespective of sex showed more loop fingerprint pattern, contrary to the whorl fingerprint pattern more frequent amongst the Efiks. Thus, the present results will be of immense relevance in forensic practice by unveiling the peculiarities of finger ridge density associated with gender and ethnic origin.

**Key Words: Fingerprints Pattern, Ridge Density, Sex variation. Ethnic differences**

**INTRODUCTION**

Dermatoglyphic studies are very essential in medical practice as well as in forensic investigations, especially in medical diagnosis of genetically inherited diseases and in crime detection (Ekanem et al. 2009; Sudikahya et al. 2017).

Generally fingers are known to display friction ridge in skin that consist of a series of furrows and ridges called fingerprint (Babler, 1991; Loesch, and Czyzewska, 2011). Fingerprint is an impression left by the friction ridges of a human finger. This is one of the dermatoglyphic traits that can be used for identification of a person. These prints are unique in each individual even in identical twins (Saladin and Miller, 2008).

Friction ridge can be differentiated from the skin of the rest of the body by the presence of raised ridges, the surface is continuously corrugated with narrow minute (friction ridges) ridges and there are neither hairs nor sebaceous (oil) gland. The presence of friction ridges enhances friction for skin used in grasping (Bonnevie, 1924). Also, it has been used to analyze the nature and origin of human variability extensively in bioanthropology, genetics, and evolutionary studies to characterize population (Cummins, 2009). Few areas of dermatoglyphics such as pattern type and ridge count, have received more attention than pattern intensity index (Karmakar et al. 2008).

However, fingerprints are easily deposited on suitable surfaces (such as glass or metal or polished stone) by the natural secretions of sweat from the eccrine glands that are present in epidermal ridges (Ashbaugh, 2008). Deliberate impressions of fingerprints may be formed by ink or other substances transferred from the peaks of friction ridges on the skin to a relatively smooth surface such as a fingerprint card (Ahmed and Osman, 2016). Human fingerprints are detailed, nearly unique, difficult to alter, and durable over the life of an individual, making them suitable as long-term markers of human identity (Huynh et al. 2015).

Fingerprints of an individual have been used as one of the vital parts of identification in both civil and criminal cases because of their unique properties of absolute identity, they have the patterns constituted by the ridges on the surface of fingers and it is peculiar to each person and remains stable for a lifetime (Nandy, 2009). These patterns, types, and various specific characteristics have been utilized worldwide for personal identification (Soanboon et al. 2015).

(Fingerprints are permanent morphological characteristics, and criminal detection based on fingerprints is based on the principle that no two people can have identical fingerprints (Oktem et al. 2015).

The recovery of fingerprints from a crime scene is an important method of forensic science (Åström, 2007). It is also one of the suitable and reliable methods for personal identification and verification and fingerprint do not change from birth to death (Ceyhan et al. 2017). They have a great importance in scientific, criminological, biological and anthropological studies, and are used to properly identify any person or suspect who touches any surface in the crime scene. They are also considered as biometric variables that show manifold utilities in human biology, human morphology, anthropology, and genetics (Ahmed and Osman, 2016). Fingerprint ridge density (FRD) is known to vary according to sex and population, and such variation can be used for forensic purposes (Rivalder et al. 2016).

In biometrics and forensic sciences, minutiae are the major features of a fingerprint and it is made up of the following features: ridge ending, bifurcation and shorter ridge (dot). The ridge ending is a point at which a ridge terminates. Bifurcations are points at which a single ridge split into two ridges. Short ridges (dot) are ridges which are significantly shorter than the average ridge length on the fingerprint. Minutiae and patterns are very important in the analysis of fingerprint since no two fingerprints have been shown to be identical (Sudesh, 2007). The importance of fingerprint had let to its wide application in the field of forensic sciences, medicine, biological anthropology, ethnology and population genetics for their capabilities to identify racial, ethnic and gender differences as well as congenital malformations (Sudikshya et al. 2018).

If a fingerprint is encountered as evidence, matching of minutiae is the secondary task, the primary task being the classification of the pattern present on the print, which can thereafter be used for narrowing down the suspect from the pool by discriminating the different patterns of prints taken from the crime scene, thereby reducing the burden on the investigating officer (Nandy, 2009).

The distribution of fingerprints pattern has been found to vary amongst various populations and ethnic groups in Nigeria and across the globe (Henry, 2009). Hence, this knowledge becomes crucial in forensic investigations. The relationship between the finger ridge density of the Igbo and Efik ethnic groups of Nigeria, have not been ascertained. This study is an attempt to decipher both sex and ethnic discrepancies between the two tribes.

**MATERIALS AND METHOD**

**Study Design**

This study cohort includes n173 subjects drawn from Efik (Five Efik speaking LGA’s of Southern Cross River State) and Igbo (Enugu and Anambra States) ethnic groups of Nigeria (Efik=37 males, 44=females) and (Igbos=61 males, 31 females). The subjects were randomly selected between the ages of 18-40years, whose parents are of the aforementioned ethnic groups, void of congenital or acquired fingerprint ridge deformities. The overall aim and possible benefits of the study was properly explained to the subjects and subjects consent was taken. They were asked to wash and dry their hands to remove dirt and grease before their fingerprint was taken in the well prepared study proforma.

The materials used for this study includes; Kores quick drying duplicating ink, removable ink. Pencil: To map out various Quadrants, Study proforma containing each subject’s demography, Meter rule: to measure 25mm2 quadrants, a hand magnifying lens, hand sanitizers: use clean dirt, Plain Sheets of papers, thumb tags: to hold the paper firm on the board, white board: Base for the white paper, Methylated Spirit: Solvent to remove the ink after data collection, cotton wool, towel and Water.

**Fingerprint Collection**

The subjects were asked to wash and dry their hands with hand wash sanitizers to remove dirts and grease.

**Protocol:** For collection of fingerprint, the subjects were asked to sit on a chair and each finger starting from the thumb, index finger, middle finger, ring finger, and the little finger was cleaned with a hand sanitizer and uniformly smeared with indelible ink and endorsed on an A4 plain sheet of paper. The procedure was repeated for the 10 fingers of the left and right hands but for the purpose of this study it was restricted to only the left and right thumbs. After taking fingerprints, with the aid of a sharp pencil, a straight line is drawn in the upper portion of the radial and ulna borders of each print to measure radial and ulna quadrants while the inferior quadrant was taken by making a 25mm diagonal across the inferior border to measure the inferior quadrant of the fingerprint.

**Figure 1: Hand Magnifying Lens for finger ridge density count**

****

**Figure 1: Showing left and right handprint data collection procedure from the left and right radial, ulna and inferior quadrants respectively.**

**Statistical Analysis**

The data gotten from fingerprint were entered into Microsoft word Excel spread sheet, which were copied into the Statistical Package for Social Sciences (SPSS) software version 21 Chicago incorporated for analysis. Three basic analysis were done in this research which include; Chi-square was employed for the analysis of frequency distribution of fingerprint pattern and presented in tables and pie charts. The mean, minimum, maximum and range of the dataset as well standard deviation of mean and standard error were analysed using descriptive statistics. Independent sample students t- tests to ascertain sexual dimorphism (differences between the males and females) in fingerprint patterns. Levene’s test for equality of variance and means was used to compare the subjects of the two ethnic groups (Ethnic variation) that's between the Igbo males and Efik males as well as between Igbo females and their Efik counterparts.

**RESULTS**

The results of the present study are presented in tables, pie charts and Bar chart to show the outcome of descriptive statistics, frequency distribution among the print patterns and finger ridge density, sex variation and ethnic differences in print pattern using Levene’s analysis of equality of variance.

**Table 1- Gender wise distribution of print patterns in Igbo Ethnic group of Nigeria**

|  |  |  |
| --- | --- | --- |
| Fingerprints pattern | Males | Females |
| **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** |
| Loop | **26** | **43.0** | **17** | **55.0** |
| Whorl | **21** | **34.0** | **8** | **26.0** |
| Arch | **10** | **16.0** | **6** | **19.0** |
| Composite | **4** | **7.0** | **0** | **0.0** |
| Total | **61** | **100** | **31** | **100** |

Table 1- presents the results of gender wise frequency distribution of print pattern among the Igbos. It can be observed that both male and female of this ethnic decent had predominantly Loop print pattern with a male to female ratio of 43:55% respectively. While the arch and composite prints had lowest percentages of occurrence. Thus, it was observed that both male and female Igbos possess mainly the Loop fingerprint pattern.

**Table 2- Gender wise distribution of print patterns in Efik Ethnic group of Nigeria**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fingerprints pattern |  | Males |  |  | Females |  |
|  |  | **Frequency** | **Percentage (%)** |  | **Frequency** | **Percentage (%)** |
| Loop |  | **10** | **27.0** |  | **15** | **34.0** |
| Whorl |  | **30** | **54.0** |  | **22** | **50.0** |
| Arch |  | **5** | **14.0** |  | **6.0** | **14.0** |
| Composite |  | **2** | **5.0** |  | **1.0** | **2.0** |
| Total |  | **37** | **100** |  | **44** | **100** |

The results of table 2 showed that both Efik males and female have predominantly whorl print pattern with the highest percentage of 54 and 50 in males and females respectively. While the arch and composite print patterns had the least frequency print pattern. From the analysis of the frequency distribution, it is obvious that the Efik ethnic decent have abundant of Whorl print pattern ( 54% and 50%) in male and female respectively.

 **Figure 3- Pattern wise frequency distribution of fingerprint among Igbos irrespective of sex**

The result of frequency distribution of the Igbo population irrespective of gender difference is presented in figure 3. It was observed that, the Igbos had more of Loop prints pattern (47%) followed by whorl pattern (32%) while the arch and composite prints recorded the least number of prints. This is a pointer that the Igbos predominantly have Loop pattern of prints.

**Figure 4- Pattern wise frequency distribution of fingerprint among Efiks irrespective of sex**

The results of frequency distribution of the Efik population regardless of sex differences is presented in figure 4. It was observed that, the Efiks had more of Whorl pattern (52)% followed by loop pattern (31%) also the arch and composite prints recorded the least number of prints. This shows that the Efiks had more of whorl prints than other categories.

**Table 3- Descriptive statistics of ridge density (Ridges/25mm2) Quadrant wise among Males Igbos**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  QUADRANTS | N | Range | Minimum | Maximum | Mean | S.D |
| Statistic | Statistic | Statistic | Statistic | Statistic | SEM | Statistic |
| RRQRD | 61 | 6 | 7 | 13 | 10.26 | 0.204 | 1.59 |
| RUQRD | 61 | 7 | 7 | 14 | 10.31 | 0.192 | 1.50 |
| RIQRD | 61 | 5 | 7 | 12 | 9.36 | 0.180 | 1.40 |
| R-TOTAL | 61 | 17 | 21 | 38 | 29.93 | 0.408 | 3.18 |
| LRQRD | 61 | 7 | 8 | 15 | 10.93 | 0.213 | 1.66 |
| LUQRD | 61 | 6 | 8 | 14 | 10.79 | 0.174 | 1.36 |
| LIQRD | 61 | 5 | 7 | 12 | 9.54 | 0.156 | 1.22 |
| L-TOTAL | 61 | 14 | 24 | 38 | 31.26 | 0.401 | 3.135 |

*RRQRD= Right Radial Quadrant Ridge Density; RUQRD=Right Ulnar Quadrant Ridge Density; RIQRD=Right Inferior Quadrant Ridge Density; R-TOTAL=Right Total Ridge count; LRQRD=Left Radial Quadrant Ridge Density; LUQRD=Left Ulnar Quadrant Ridge Density; LIQRD=Left Inferior Quadrant Ridge Density; SEM=Standard Error of Mean; SD=Standard Deviation.*

Table 3-depicts the results of descriptive statistics by quadrant of male Igbo ethnic group, which shows the total number of male Igbos who participated in the exercise, the minimum and maximum values of the ridge count, the average value of ridge count, Standard error of mean and standard error of estimate.

**Table 4- Descriptive statistics of ridge density (Ridges/25mm2) Quadrant wise among Females Igbos**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | N | Range | Minimum | Maximum |  Mean | S.D |
| Statistic | Statistic | Statistic | Statistic | Statistic |  SEM | Statistic |
| RRQRD | 31 | 7 | 8 | 15 | 10.83 | .304 | 1.663 |
| RUQRD | 31 | 4 | 9 | 13 | 10.60 | .212 | 1.163 |
| RIQRD | 31 | 4 | 5 | 9 | 6.90 | .241 | 1.322 |
| R\_TOTAL | 31 | 11 | 24 | 35 | 28.33 | .564 | 3.089 |
| LRQRD | 31 | 6 | 8 | 14 | 10.50 | .279 | 1.526 |
| LUQRD | 31 | 7 | 8 | 15 | 10.40 | .282 | 1.545 |
| LIQRD | 31 | 5 | 5 | 10 | 7.03 | .309 | 1.691 |
| L\_TOTAL | 31 | 14 | 21 | 35 | 27.93 | .686 | 3.759 |

*RRQRD= Right Radial Quadrant Ridge Density; RUQRD=Right Ulnar Quadrant Ridge Density; RIQRD=Right Inferior Quadrant Ridge Density; R-TOTAL=Right Total Ridge count; LRQRD=Left Radial Quadrant Ridge Density; LUQRD=Left Ulnar Quadrant Ridge Density; LIQRD=Left Inferior Quadrant Ridge Density; SEM=Standard Error of Mean; SD=Standard Deviation.*

Table 4-presents the results of descriptive statistics by quadrant of male Igbo ethnic group, which shows the total number of male Igbos who participated in the exercise, the minimum and maximum values of the ridge count, the average value of ridge count, Standard error of mean and standard error of estimate.

**Table 5- Descriptive statistics of ridge density (Ridges/25mm2) Quadrant wise among Males Efik**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | N | Range | Minimum | Maximum | Mean | S. D |
| Statistic | Statistic | Statistic | Statistic | Statistic | SEM | Statistic |
| RRQRD | 37 | 5 | 7 | 12 | 9.11 | 0.18 | 1.051 |
| RUQRD | 37 | 4 | 7 | 11 | 9.20 | 0.19 | 1.132 |
| RIQRD | 37 | 4 | 7 | 11 | 9.31 | 0.19 | 1.132 |
| R\_TOTAL | 37 | 10 | 21 | 31 | 27.63 | 0.40 | 2.365 |
| LRQRD | 37 | 7 | 7 | 14 | 9.59 | 0.28 | 1.654 |
| LUQRD | 37 | 6 | 6 | 12 | 9.38 | 0.24 | 1.371 |
| LIQRD | 37 | 5 | 7 | 12 | 9.66 | 0.18 | 1.035 |
| L\_TOTAL | 37 | 12 | 23 | 35 | 28.41 | 0.49 | 2.804 |

*LIQRD, Left Inferior Quadrant Ridge Density; LRQRD, Left Radial Quadrant Ridge Density;*

*LUQRD Left Ulnar Quadrant Ridge Density; RIQRD, Right Inferior Quadrant Ridge Density;*

*RRQRD, Right Radial Quadrant Ridge Density; RUQRD, Right Ulnar Quadrant Ridge Density; S.D., Standard Deviation, Standard Error of Mean.*

Table 5-shows the results of descriptive statistics by quadrant of male Efik ethnic group, which shows the total number of male Efiks who participated in the exercise, the minimum and maximum values of the ridge count, the average value of ridge count, Standard error of mean and standard error of estimate.

**Table 6- Descriptive statistics of ridge density (Ridges/25mm2) Quadrant wise among Females Efik**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | N | Range | Minimum | Maximum | Mean | S. D |
| Statistic | Statistic | Statistic | Statistic | Statistic | SEM | Statistic |
| RRQRD | 44 | 7 | 7 | 14 | 9.62 | 0.221 | 1.482 |
| RUQRD | 44 | 6 | 8 | 14 | 9.60 | 0.207 | 1.388 |
| RIQRD | 44 | 7 | 5 | 12 | 8.93 | 0.230 | 1.543 |
| R\_TOTAL | 44 | 18 | 22 | 40 | 28.16 | 0.523 | 3.509 |
| LRQRD | 44 | 7 | 8 | 15 | 10.78 | 0.224 | 1.506 |
| LUQRD | 44 | 8 | 7 | 15 | 10.07 | 0.221 | 1.483 |
| LIQRD | 44 | 5 | 7 | 12 | 9.17 | 0.193 | 1.248 |
| L\_TOTAL | 44 | 17 | 24 | 41 | 30.05 | 0.536 | 3.471 |

*LIQRD, Left Inferior Quadrant Ridge Density; LRQRD, Left Radial Quadrant Ridge Density;*

*LUQRD, Left Ulnar Quadrant Ridge Density; RIQRD, Right Inferior Quadrant Ridge Density;*

*RRQRD, Right Radial Quadrant Ridge Density; RUQRD, Right Ulnar Quadrant Ridge Density; S.D., Standard Deviation, SEM= Standard Error of Mean*

Table 6-presents the results of descriptive statistics by quadrant of the female Efik ethnic group, which shows the total number of the female Efiks who participated in the exercise, the minimum and maximum values of the ridge count, the average value of ridge count, Standard error of mean and standard error of estimate.

**Table 7. Showing results of Levene’s Test for sexual dimorphism in finger ridge density of Igbo ethnic group**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| QUADRANT | T | Df | Sig. (2-tailed) (P-value) | Mean Difference | 95% Confidence Interval of the Difference |
| Lower | Upper |
| RRQRD | 1.586 | 90 | 0.016 | 0.571 | 1.286 | 1.144 |
| RUQRD | 0.925 | 90 | 0.028 | 1.289 | 1.909 | 1.332 |
| RIQRD | 8.013 | 90 | 0.000 | 2.461 | 1.851 | 3.071 |
|  |
| R-TOTAL | 2.275 | 90 | 0.025 | 1.601 | 1.203 | 2.999 |
|  |
| LRQRD | 1.203 |  |  |  |  |  |
| 90 | 0.023 | 0.434 | 1.283 | 1.152 |
| LUQRD | 1.168 | 90 | 0.018 | 1.387 | 1.278 | 1.352 |
|  |
| IQRD | 8.086 | 90 | 0.000 | 2.508 | 1.891 | 3.124 |
|  |
| L-TOTAL | 4.454 | 90 | 0.000 | 3.329 | 1.844 | 4.814 |
|  |

***Values with P<0.05 are significantly different between males and females Igbos.***

The result of Levene’s test for equality of variance and means of gender presented in table 7 showed that all the finger prints quadrants considered recorded statistically significant difference (P<0.05) between the males and females of Igbo ethnic group. This observation further buttress the earlier speculation that no two individuals have the same finger prints qualities. Thus, fingerprint counts have shown from this study that it is sexually dimorphic**.**

**Table 8- Showing the result of Levene’s Test for sexual dimorphism in finger ridge density of Efik tribe**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| RIDGE QUADRANTS | T | Df | Sig. (2-tailed) (P-value) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
| Lower | Upper |
| RRQRD | 1.719 | 79 | 0.00 | 2.508 | 0.296 | 1.096 | 0.080 |
| RUQRD |  |  |  |  |  |  |  |
| 1.383 | 79 | 0.010 | 1.800 | 0.289 | 1.976 | 0.176 |
| RIQRD |  |  |  |  |  |  |  |
| 1.226 | 79 | 0.022 | 1.781 | 0.311 | 0.238 | 1.000 |
| R-TOTAL |  |  |  |  |  |  |  |
| 1.763 | 79 | 0.048 | 1.527 | 0.690 | 1.902 | 0.848 |
| LRQRD |  |  |  |  |  |  |  |
| 3.332 | 79 | 0.001 | 2.090 | 0.357 | 1.900 | 0.479 |
| LUQRD |  |  |  |  |  |  |  |
| 2.097 | 79 | 0.039 | 1.684 | 0.326 | 1.334 | 0.034 |
| LIQRD |  |  |  |  |  |  |  |
| 1.797 | 79 | 0.077 | 1.090 | 0.272 | 1.053 | 1.333 |
| L-TOTAL |  |  |  |  |  |  |  |
| 2.185 | 79 | 0.032 | 1.641 | 0.751 | 2.139 | 3.144 |

***Values with P<0.05 are significantly different between males and females Efiks.***

Table 8- depicts the result of Levene’s test for equality of variance and means of gender between the male and female Efiks. It has been observed that all the finger prints quadrants considered recorded statistically significant difference (P<0.05) between the males and females of Igbo ethnic group.

|  |
| --- |
| **Table 9-showint results of group Statistics of the males of Igbo and Efik ethnic groups** |
| TRIBE | N | Mean | Std. Deviation | Std. Error Mean |
| RRQRD | IGBO | 61 | 10.26 | 1.591 | .204 |
| EFIK | 37 | 9.11 | 1.051 | .178 |
| RUQRD | IGBO | 61 | 10.31 | 1.500 | .192 |
| EFIK | 37 | 9.20 | 1.132 | .191 |
| RIQRD | IGBO | 61 | 9.36 | 1.403 | .180 |
| EFIK | 37 | 9.31 | 1.132 | .191 |
| R\_TOTAL | IGBO | 61 | 29.93 | 3.188 | .408 |
| EFIK | 37 | 27.63 | 2.365 | .400 |
| R\_AV\_TOTAL | IGBO | 61 | 9.984 | 1.0660 | .1365 |
| EFIK | 37 | 9.209 | .7928 | .1340 |
| LRQRD | IGBO | 61 | 10.93 | 1.662 | .213 |
| EFIK | 37 | 9.59 | 1.654 | .284 |
| LUQRD | IGBO | 61 | 10.79 | 1.355 | .174 |
| EFIK | 37 | 9.38 | 1.371 | .235 |
| LIQRD | IGBO | 61 | 9.54 | 1.219 | .156 |
| EFIK | 37 | 9.66 | 1.035 | .183 |
| L\_TOTAL | IGBO | 61 | 31.26 | 3.135 | .401 |
| EFIK | 37 | 28.41 | 2.804 | .496 |
| L\_AV\_TOTAL | IGBO | 61 | 10.418 | 1.0476 | .1341 |
| EFIK | 37 | 9.466 | .9362 | .1655 |

The result of group statistics to outline the mean differences of the finger ridge count of the quadrants between the males of Igbo and Efik ethnic groups is presented in table 9. This outcome is statistically significant different (P<0.05) between the males of both ethnic groups.

**Table 10: Summary of the results of Levene’s Test for equality of variance and means between Igbo and Efik Males**

|  |  |
| --- | --- |
| Levene's Test for Equality of Variances | t-test for Equality of Means |
|  F | Sig. | T | Df | Sig. (2-tailed) P<0.05 | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
| Lower | Upper |
| RRQRD | 7.589 | 0.007 | 3.815 | 94 | 0.000 | 1.148 | 0.301 | 0.550 | 1.746 |
|  |  |  |  |  |  |  |  |  |  |
| RUQRD | 3.554 | 0.062 | 3.802 | 94 | 0.000 | 1.111 | 0.292 | 0.531 | 1.692 |
|  |  |  |  |  |  |  |  |  |  |
| RIQRD | 2.449 | 0.121 | 0.167 | 94 | 0.868 | 0.046 | 0.278 | 0.506 | 0.598 |
|  |  |  |  |  |  |  |  |  |  |
| R-Total | 2.694 | 0.104 | 3.728 | 94 | 0.000 | 2.306 | 0.619 | 1.078 | 3.534 |
|  |  |  |  |  |  |  |  |  |  |
| LRQRD | 0.162 | 0.689 | 3.791 | 94 | 0.000 | 1.346 | 0.355 | 0.641 | 2.051 |
|  |  |  |  |  |  |  |  |  |  |
| LUQRD | 0.000 | 0.983 | 4.822 | 94 | 0.000 | 1.405 | 0.291 | 0.826 | 1.983 |
|  |  |  |  |  |  |  |  |  |  |
| LIQRD | 1.307 | 0.256 | -0.455 | 94 | 0.650 | 0.115 | 0.253 | 0.618 | 0.388 |
|  |  |  |  |  |  |  |  |  |  |
| R-Total | 0.570 | 0.452 | 4.323 | 94 | 0.000 | 2.856 | 0.661 | 1.544 | 4.168 |

The result of the sum total of quadrants for both left and right ridge density count showed statistical significant difference (P<0.05) between the males of Igbo and Efik decent. It is observed from this outcome that both left and right total ridge count of the males of Igbo and Efik ethnic groups showed ethnic difference (P<0.05). also it is observed that only the inferior quadrant ridge density count of both left and right prints does not show ethnic variation but others quadrant showed statistical significant difference (P<0.05). Therefore, it can be deduced from this result that ridge count density is highly ethnic specific.

|  |
| --- |
| **Table 11-showing the result of Group Statistics of the females of Igbo and Efik ethnic groups respectively** |
| TRIBE | N | Mean | Std. Deviation | Std. Error Mean |
| RRQRD | IGBO | 31 | 10.83 | 1.663 | .304 |
| EFIK | 44 | 9.62 | 1.482 | .221 |
| RUQRD | IGBO | 31 | 10.60 | 1.163 | .212 |
| EFIK | 44 | 9.60 | 1.388 | .207 |
| RIQRD | IGBO | 31 | 6.90 | 1.322 | .241 |
| EFIK | 44 | 8.93 | 1.543 | .230 |
| R\_TOTAL | IGBO | 31 | 28.33 | 3.089 | .564 |
| EFIK | 44 | 28.16 | 3.509 | .523 |
| R\_AV\_TOTAL | IGBO | 31 | 9.443 | 1.0338 | .1887 |
| EFIK | 44 | 9.380 | 1.1675 | .1740 |
| LRQRD | IGBO | 31 | 10.50 | 1.526 | .279 |
| EFIK | 44 | 10.78 | 1.506 | .224 |
| LUQRD | IGBO | 31 | 10.40 | 1.545 | .282 |
| EFIK | 44 | 10.07 | 1.483 | .221 |
| LIQRD | IGBO | 31 | 7.03 | 1.691 | .309 |
| EFIK | 44 | 9.17 | 1.248 | .193 |
| L\_TOTAL | IGBO | 31 | 27.93 | 3.759 | .686 |
| EFIK | 44 | 30.05 | 3.471 | .536 |
| L\_AV\_TOTAL | IGBO | 31 | 9.313 | 1.2572 | .2295 |
| EFIK | 44 | 10.024 | 1.1588 | .1788 |

Table 11-depicts the outcome of group statistics which shows mean differences of the fingerprint ridge density count of the quadrants between the females of the two ethnic groups. The analysis of independent sample t-test for ethnic variability employed here showed statistical significant difference (P<0.05).

|  |
| --- |
| **Table 12-Summary of the results of Levene’s Independent Test for equality of variance and means between Igbo and Efik Females** |
|   | Levene's Test for Equality of Variances | t-test for Equality of Means |
| F | Sig. | T | Df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
| Lower | Upper |
| RRQRD | 1.827 | .181 | 3.302 | 73 | .001 | 1.211 | .367 | .480 | 1.942 |
| RUQRD | .722 | .398 | 3.255 | 73 | .002 | 1.000 | .307 | .388 | 1.612 |
| RIQRD | .235 | .630 | -5.911 | 73 | .000 | -2.033 | .344 | -2.719 | -1.348 |
| R\_TOTAL | .053 | .818 | .225 | 73 | .822 | .178 | .789 | -1.395 | 1.751 |
| R\_AV\_TOTAL | .064 | .801 | .241 | 73 | .810 | .0633 | .2631 | -.4610 | .5877 |
| LRQRD | .037 | .847 | -.779 | 73 | .439 | -.278 | .357 | -.989 | .433 |
| LUQRD | .607 | .439 | .938 | 73 | .351 | .333 | .355 | -.375 | 1.042 |
| LIQRD | 3.965 | .050 | -6.163 | 70 | .000 | -2.133 | .346 | -2.824 | -1.443 |
| L\_TOTAL | 1.109 | .296 | -2.462 | 70 | .016 | -2.114 | .859 | -3.827 | -.401 |
| L\_AV\_TOTAL | 1.051 | .309 | -2.476 | 70 | .016 | -.7105 | .2870 | -1.2828 | -.1381 |

The outcome presented in table 12 shows ethnic comparison of fingerprints ridge density count between the females of Igbo and Efik ethnic groups. This result showed statistical significant difference (P<0.05) between the two ethnic groups. This implies fingerprint density count varies between the two ethnic groups and can be used in ethnic groupings.

**DISCUSSION**

Fingerprints are the most dynamic form of evidence in existence. They are unique, permanent and objective (Ekanem et al. 2009). They are impressions left by the friction ridges of a human finger. They are one of the dermatoglyphic traits that can be used for the identification of an individual, these prints are unique in each individual even in identical twins with identical DNA have different fingerprints (Saladin and Miller, 2008). They are also said to be permanent morphological characteristics, and criminal detection based on fingerprints is based on the principle that no two people can have identical fingerprints (Okatem et al. 2015).

In the past, attempts have been made by different researchers (Wang et al. 2007; Ekanem et al., 2009; Soanoboon et al. 2015; Tamil, 2018) to study the distribution of fingerprint patterns in various populations and ethnic divide.

Human fingerprints are detailed, unique, difficult to alter, and durable over the lifespan of an individual, making them suitable as long-term bio-markers of human identity (Huynh et al. 2015). Latent fingerprints are primary physical and biological evidence that investigating officers commonly collect in a crime scene and use for personal identification. The leading step is to decipher the type of fingerprint pattern and ridge density count before any further analysis is done on the prints (Gutierrez-Redomero et al. 2014).

The present research was an attempt to investigate the sex and ethnic variability of fingerprint ridge density amongst the Efik and Igbo population of Nigeria. Table 1- presents the results of gender wise frequency distribution of fingerprints pattern among the Igbos. It was observed from this results that both male and female of the Igbo ethnic descent predominantly had Loop prints pattern with a male to female ratio of 43:55% respectively, although the female values showed higher frequency. Meanwhile the arch and composite prints had the lowest percentages of fingerprints pattern.

The results documented in table 2, outline that both the Efik males and females have predominantly whorl print pattern with the highest percentage of 54% and 50% in males and females respectively. While the arch and composite (multiple) print patterns recorded the least print pattern based on frequency distribution. From the analysis of the frequency distribution, it is obvious that the people of Efik origin have abundant of Whorl print pattern (54% and 50%) in male and female respectively. Studies on gender predictions from fingerprints have gained more popularity in the scientific and judicial fields and some researchers has said the number of ridges on the right hand are more than the number of ridges on the left hand by 20% in most people (Kimura et al. 2008; Tamil, 2018; Soanoboon et al. 2015).

The results of frequency distribution of the Efik population regardless of sex differences is presented in figure 4. It was observed that, the Efiks had more of Whorl pattern (52)% followed by loop pattern (31%) also the arch and composite prints recorded the least number of prints. This shows that the Efiks had more of whorl prints than other categories.

The result of frequency distribution of the Igbo population irrespective of gender difference is presented in figure 3, which shows that, the Igbos had more of Loop prints pattern (47%) followed by whorl pattern (32%) while the arch and composite prints recorded the least number of prints. This is a pointer that the Igbos predominantly have Loop pattern of prints which conforms to the findings of Ekanem et al. (2009) among the Annangs that recorded ulna loop 50.1% and 39.6% for the males and females respectively followed by whorls 42.9% in males then arches 31.1% in the females and radial but contrary to the result of the Efiks from the present study in table 2 that recorded more Whorls print pattern with male to female ratio of 54%a and 50% respectively.

Furthermore, this current data is an evidence that indicates equality of variance and mean of gender of fingerprints quadrants across recorded statistically significant difference (P<0.05) between the males and females of Igbo. This observation further buttress an earlier result by Okatem et al. (2015) that said no two individuals have the same fingerprints features which is applicable to print patterns and ridge density count. Thus, fingerprint density count shown from the present study reveals sexual dimorphism (P<0.05) between the males and females of Igbo and Efik ethnic descent respectively.

The findings of Acree (1999), reports that the mean ridge thickness in males is more than that of the females, this is contrasting with report from Adamu et al (2016), which proves that women tends to have a greater ridge thickness than men but this findings observed that the ridge thickness in males of Efik and Igbo ethnic groups are more than that of their female counterparts which agrees with the report given by Acree (1999). Results from the present study also indicated that all fingerprints quadrants considered in male and female Efiks recorded statistically significant difference (P<0.05) between the Igbo males and their female counterparts, which is in tandem with the works of Acree (1999), Esperanza et al. (2008), Krishan et al. (2013) and Nayak et al. (2010) reported that ridge count is sexual dimorphic (P<0.01) and fingerprint with a ridge density count of 11ridges/25 mm2 or less is most likely to be that of a male. Likewise a ridge density of 12 ridges/25 mm2 or more is likely to be of female origin, regardless of the race, which conforms with the outcome of the present data that recorded statistical significant difference (P<0.05) in the ridge density of females when compared with their male counterparts. Similarly, the research of Sudesh, (2007) speculate that a finger print ridge of < 13 ridges/25 mm2 is more likely of male origin and finger print ridge of > 14 ridges/25 mm2 is more likely of female origin, which are not very similar with the present data.

The current result showed statistical significant difference (P<0.05) in ridge density count of the males of Igbo and Efik ethnic groups when compared with their female counterparts with a male to female ratio of 43:55% and 54:50% for the Igbo and Efik tribes respectively which conforms with the report given by Gutiérrez-Redomero et al. (2013) on the males and females of Argentina and Spain. Similarly, the outcome of ethnic variability of the males of Igbo and Efik are presented in tables 9 and 10 which shows significant differences (P<0.05).

The findings of Gutiérrez-Redomero et al. (2013) on sexual differences in ridge density between Argentinian and Spanish population showed significant difference (P<0.05) in the total ridge density count between the Argentine males and their Spanish counterparts. Meanwhile the female samples drawn from the two countries does not show statistical significant difference (P<05) in the ridge density count of the radial, ulnar and proximal areas. Their report contradicts the present data presented in tables 11and 12, between the females of Igbo and Efik ethnic groups that showed statistical significant difference (P<0.05).

**CONCLUSION**

This research has proven that both the males and females of the Igbo ethnic descent possess mainly the loop fingerprint pattern, although the females recorded more loops than the males. On the contrary, The Efik ethnic group had predominantly whorl fingerprint pattern than the Igbos. The ridge count of the Efiks males and females recorded statistical significant (P<0.05) with consistent higher values recorded among the Efiks than their Igbo counterparts. These similarities observed in fingerprint patterns amongst the males and females of the same ethnic group could be attributed to their close ancestral affinity and location. Moreso, the variation between the two ethnic groups may be traceable to their differences in genetic and environmental factors. This knowledge will help a forensic expert when deciphering sex when tasked with cases relating to human identity

**REFERENCES**

Acree MA. (1999). Is there a gender difference in fingerprint ridge density? Forensic Science

 International 102:35–44.

Adamu, LH, Ojo SA., Danborno, B. and Adebisi, SS. (2016). Sex prediction using ridge

 density among the Hausa Ethnic group of Kano State, Nigeria. Austriallian Journal of

 Forensic Science. 4:264-284.

Afsar, FA and Hussain, M. (2004). Fingerprint Identification and Verification System using

 Minutiae Matching; National Conference on Emerging Technologies. 7:18-28.

Ahmed, AA and Osman, S. (2016). Topological Variability and Sex Differences in Fingerprint

 Ridge Density in a Sample of Sudanese Population. Forensic Leg Med. Khartoum, Sudan;

 42:25-32.

Ashbaugh, D. (2008). Quantitative-Qualitative Friction Ridge Analysis: An Introduction to

 Basic and Advanced Ridgeology. Boca Raton, Florida: CRC Press. 2:11–19.

Åström, P. (2007). "The study of ancient fingerprints". Journal of Ancient Fingerprints 1: 2–3.

Babler WJ. (1991). Embryologic Development of Epidermal Ridges and their Configurations,

 Birth defect, 27:95–112.

Bonnevie, K. (1924): Studies on papillary patterns of human fingers. Journal of Genetics,

 15(5):1-111.

Ceyhan, EB and Sagiroglu, S. (2017). Determining the Relationship between Fingerprint and

 Gender using 10 Finger Attributes, Sakarya University Journal of Science. 21: 740-749.

Cummins, H. (2009). The Topographic History of the Volar pads in the Human Embryo. Contrib

 Embryo1 Carnegie Inst Wash. 20:103-126.

Ekanem, EP, Eluwa, M.A., Udoaffah, GU, Ekanem, TB. and Akpantah, AO. (2009). Digital

 dermatoglyphics pattern of annang ethnic group in Akwa Ibom Nigeria. The internet journal

 of Biological Anthropology. 3:1-5.

Esperanza GR and Varginia, G. (2008). Variability of fingerprint ridge density and its

 application to sex determination. Forensic sci. Int. Spain. 3:17-22.

Gutierrez-Redomero E., Rivaldería, N., Alonso-Rodríguez, C. and Sánchez-Andrés A. (2013). A

 comparative study of topological and sex differences in fingerprint ridge density Argentinian

 and Spanish population. Forensic science Int’l. 48:186-196.

Gutierrez-Redomero E., Rivaldería, N., Alonso-Rodríguez, C. and Sánchez-Andrés, A. (2014).

 Assessment of the methodology for estimating ridge density in fingerprints and its forensic

 application. Science Justice. 54:199-207.

Hale, A. (1949). Breath of epidermal ridges in the human fetus and its relation to the growth of

 the hand and foot. Anat. Rec.105:764-776.

Henry, E. R. (2009). "Classification and Uses of Finger Prints” Rutledge London: 12-21.

Huynh, C., Brunelle, E, Halámková, L. and Agudelo, J. (2015). "Forensic Identification of

 Gender from Fingerprints. Analytical Chemistry 87 (22):15-36.

Karmakar, B., Yakovenko, K. and Kobyliansky, E. (2008). Quantitative Digital and Palmar

 Dermatoglyphics: Sexual Dimorphism in the Chuvashian Population of Russia. HOMO – J.

 Comp. Hum. Biol. 59:317–328.

Kimura, D. and Carson, MW. (2008). Dermatoglyphic asymmetry: relation to sex handedness

 and cognitive pattern, Personality and Individual Differences. 19(4):471-478.

Krishan K, Kanchan T. and Ngangom C. (2013). A study of sex differences in fingerprint ridge

 density in a North Indian young adult population. Forensic Leg Med. (4):217-220.

Loesch, DZ and Czyzewska, J. (2011). Breadth of the dermal ridges in the a–b area in children

 aged 0–14 years Folia Morphol Warsz, 31:249-254.

Nandy A. (2009). Identification. Principles of Forensic Medicine 2nd Edition. New Central

 Book 1. Agency (P) LTD. Calcutta. 1:47-109.

Nayak VC, Rastogi P, Kanchan T, Yoganarasimha K, Kumar G.P. and Menezes R.G. (2010).

 Sex differences from fingerprint ridge density in Chinese and Malaysian population.

 Forensic Sci Int. Kasturba Medical College, Manipal, India. (1- 3):67-69.

Okatem, H, Kurkcuoglu, A, Pelin, I. C, Yaziki, AC. and Aktaay, GA. (2015). Sex

 differences in fingerprint ridge density in Turkish Young Adult Population: A sample of

 Baskent University. Journal of Forensic and Legal Medicine. 32:34-38.

Rivalder, N, Sanchez, A. and Angeles, A. (2016). Fingerprint Ridge Density in Argentinean

 Population and its Application to Sex Interference: A Comparative Study. Internet Journal

 on Physical Anthropology, 14:3-8.

Saladin, KS and Miller, L. (2008). Anatomy physiology: the unity of form and function.

 McGraw-Hill, USA. 12-38.

Somsong, N. and Wibhu, K. (2012). Variability of fingerprint ridge density among Thai

 adolescents. Khon-kaen university Thailand. 2:32-42.

Sudikshya, KC, Niroj M., Nischita, A. and Pragya, S. (2018). Qualitative Analysis of Primary

 Fingerprint Pattern in Different Blood Group and Gender in Neplase. The internet Journal of

 Forensic Science. 2(2):4-7.

Sudesh, G. (2007). Sex Determination from Fingerprint Ridge Density; Internet Journal of

 Medical Update, 2(2):3-2.

Soanoboon, P, Nanakorn, S. and Kutanan W. (2015). Determination of Sex Differences from

 fingerprint ridge density in Northeastern Thai teenagers. The internet Journal of Forensic

 Science, 6(2):185-193.

Sudikshya, KC, Niroj, M., Nischita A. and Pragya S. (2018). Qualitative analysis of primary

 fingerprint pattern in different blood group and gender in Nepalese. Hindawi anatomy

 research international. 1:1-7.

Tamil, N. (2018). Sex differences in fingerprint ridge density of patent thumbprints by ink

 staining method in young adult Indian Tamil population. Internet journal of medical update.

 1:811-819.

Wang, Y, Hu, J. and Phillips, DA (2007).Fingerprint Orientation Model Based on 2D Fourier

 Expansion (FOMFE) and its application to Singular-Point Detection and Fingerprint

 Indexing. Anatomical Medcial Intel. 29(4):573-585.

William, JB. (2009). Development and Configuration of epidermal Ridges. Babylor Collage of

 Dentistry, Dallas Texas. 1:89-109.