**RUHUNA JOURNAL OF SCIENCE**
Vol 10(1): 77-87, June 2019
eISSN: 2536-8400
DOI: http://doi.org/10.4038/rjs.v10i1.52



Short paper

# Types and frequency of fingerprint minutiae in individuals of Igbo and Yoruba ethnic groups of Nigeria

U. U. Akpan[1*], T. Awe[1], D. O. Idowu[1, 2] and K. O. Adekoya[1]

[1]*Department of Cell Biology and Genetics, University of Lagos, Lagos Nigeria.*
[2] *Professor Abideen Oluwasola Special Diagnostic Centre, Department of Pathology, University College Hospital, Ibadan, Nigeria.*

*Correspondence: akpanutomobong@gmail.com; https://orcid.org/0000-0002-4062-1034

Received: 27th May 2018, Revised: 8th March 2019, Accepted: 29th April 2019

**Abstract** The population distribution of fingerprint minutiae is necessary to improve efficiency of fingerprints in identifying individuals in a population-specific manner. The objective of the study was to determine the distribution of different types of minutiae fingerprint feature in two Nigerian ethnic populations. Fingerprints from forty-four (44) Igbo individuals and forty-four (44) Yoruba individuals, both of Nigeria were collected using a manual impression method that uses ink pad and paper. Of all the minutiae types considered, bifurcations and convergences accounted for 54.85% of the study's total minutiae counts (TMC). This study shows that the Igbo ethnic group consistently have higher count of all minutiae types and higher total minutiae counts for both hands statistically significant at $P<0.001$. We found association between gender and minutiae distribution in some minutiae types including fragment/point or dot (FP), overlap (OL) and break (BR). This work revealed important variations among individuals from the two ethnic groups on the distribution and variability of minutiae in Nigeria populations.

**Keywords:** Dermatoglyphics, fingerprints, forensic, Igbo, minutiae, Nigeria, Yoruba.

## 1 Introduction

The study of dermatoglyphics in humans involves analyzing the epidermal ridges on the surface of the palms, soles, fingers, and toes of humans (Cummins and Midlo 1943). Dermatoglyphics have been widely employed in areas as anthropology, genetics and evolutionary studies in characterizing populations, analyzing the nature and origin of human variability, population

structure assessment, and the micro-differentiation among populations (Meier 1980, Durham and Plato 1990, Segura-Wang and Barrantes 2009). Previous studies of dermatoglyphics in human populations have hinted on the usefulness of pieces of information obtained from these characteristics in the understanding of the evolution and genetic structure in human populations (Blangero 1990, Crawford and Duggirala 1992), in characterizing syndromes and diseases (Schaumann and Alter 1976), and in personal identification in the field of forensic sciences (Dankmeijer *et al.* 1980, Champod *et al.* 2004, Faigman *et al.* 2008).

Worldwide, only features such as main pattern type, pattern intensity index or ridge count have been widely studied (Aase and Lyons 1971, Karthick *et al.* 2015), whereas other features, such as the minutiae or epidermal ridge breadth have received comparatively less attention, despite being of considerable interest due to their direct relevance in personal identification (Loesch 1983, Dankmeijer *et al.* 1980, Champod *et al.* 2004, Gutierrez-Redomero *et al.* 2007, Gutierrez-Redomero *et al.* 2011). The minutiae representation of the fingerprints has now been adopted by most of the commercially available automatic fingerprint matching systems because it has been relatively demonstrated to be stable (Pankanti *et al.* 2002) and can be extracted from low quality images whereas it is difficult to extract ridge features from low quality images (Iloanusi 2011).

Nigeria is a country of more than 150 million people, and her ethnic landscape is dominated by three major tribes: Hausa, Igbo and Yorubas according to National population commission (NPC) report of 2006. Although there has been considerable amount of dermatoglyphic studies carried out on Nigerian populations, only a few characteristic features have been focused on, while some others have received less or no attention. The earliest works on fingerprint characteristics for individuals of Nigerian origin were performed by Lestrange (1953) and Ojikutu (1964). Jantz and Brehme (1978) performed the first extensive in Yoruba finger and palmar dermatoglyphics, though Lestrange (1953) had reported a small number of females and Ojikutu (1964) had included Yoruba as part of his Nigeria sample.

These studies established the frequencies of the arch, loop and whorl pattern types in different Nigerian ethnic groups. Several other studies in different ethnic groups reporting frequencies of pattern types include Jaja *et al*. (2011) who studied the dematoglyphics of the Ogoni people focusing on pattern frequencies, ridge count and A-B ridge count and Otobo and Jarimbo-Otobo (2016) who assessed the digital and palmar characteristics in the Ijaw ethnic group with a surprising high radial loop frequency. Eboh studied the digital dermatoglyphics of Anioma and Urhobo people of Nigeria and found no association between ethnicity and pattern while Mohammed (2014) studied digital dermatoglyphics in the Kanuri.

Several other studies assessed the association between different pattern types and health condition/phenotypes and often generated pattern frequencies

as part of it report. Dike *et al*. (2012) performed a comparative dermatoglyphics study of digital pattern, tri-radii and palmar distances in diabetic and hypertensive individuals in Rivers state. An association was observe between ulnar loop and hypertensive subject as well as between whorls and diabetic subject. Ethnicity was not considered. Oladipo *et al*. (2009) studied the association of digital and palmar dermatoglyphics pattern in Nigeria women with malignant mammary neoplasm and obtain significantly high mean DAT and a reduced total right ridge count as being indicative of the condition. Oladipo *et al*. (2010) examined the digital and TFRC as well as DAT and ATD in obese Ibibio individuals and concluded that arch on the first digit was significantly associated with obesity with a greater ATD and DAT in unobese individual.

An association study of dermatoglyphics in cancer patients indicated a 74.9% loop pattern on the right hand and 68.5% on the left hand, both significantly higher than in non-cancer individuals (Umana *et al*. 2013). Adekoya *et al*. (2013) assessed the relationship between dermatoglyphics and multiple intelligence among selected secondary schools students in Nigeria and found significant associations. The Yoruba in Jos were examined by Akingbade *et al*. (2014) while Nigerians of undefined ethnicity were evaluated for association of dermatoglyphics and ABO blood group with no significant associations (Eboh 2013).The association of dermatoglyphics pattern in congenital deaf and mute as well as handedness has been reported (Osunwoke *et al*. 2010, Ogunaike *et al*. 2014).

The type and distribution of minutiae in the fingerprints of Nigerian have received little or no attention. However, Orike *et al* (2016) have reported an effort to explore the forensic applications of fingerprint minutiae for inferring the gender and ethnicity of an individual from fingerprints of an unknown Nigerian origin. Several studies have recently been undertaken on fingerprints from the Hausas of Nigeria. Recent studies by Adamu *et al.* (2016a, 2016b, 2017a, 2017b), Adamu (2017), and Adamu and Taura (2017) have investigated the minutiae in the Hausa population in Kano and estimated its association with sexual dimorphism in epidermal ridges, sex variation in thumb minutiae, estimation of body mass index, and sex estimation.. There is therefore a need to assess the type and frequencies of different fingerprint minutiae in Nigerians of other ethnic origins, including Igbo and Yoruba.

## 2 Material and Methods

The population site for this study was University of Lagos. Samples were collected from staff and students of the University of Lagos, Akoka, Lagos state, Nigeria, who volunteered to participate in the study. The selected participants were verified to be of Igbo and Yoruba ancestry which extends to at least 2-3 previous generations on both parent's genealogies. Consent of the

participant was obtained adequately educating them on what the study aims to achieve and the risk involved in the data collections. Every participant was made to sign an informed consent after reading it to them. The participant's demography including sex and tribal classification were obtained through a designed questionnaire are shown in Table 1. Participants were between the ages of 18-60; 44 Yorubas and 44 Igbos.

**Table 1:** Demography of the participants

| Ethnicity | Gender | | Total |
|---|---|---|---|
| | Male | Female | |
| | Frequency | Frequency | |
| Yoruba | 30 | 14 | 44 |
| Igbo | 36 | 8 | 44 |
| Total | 66 | 22 | 88 |

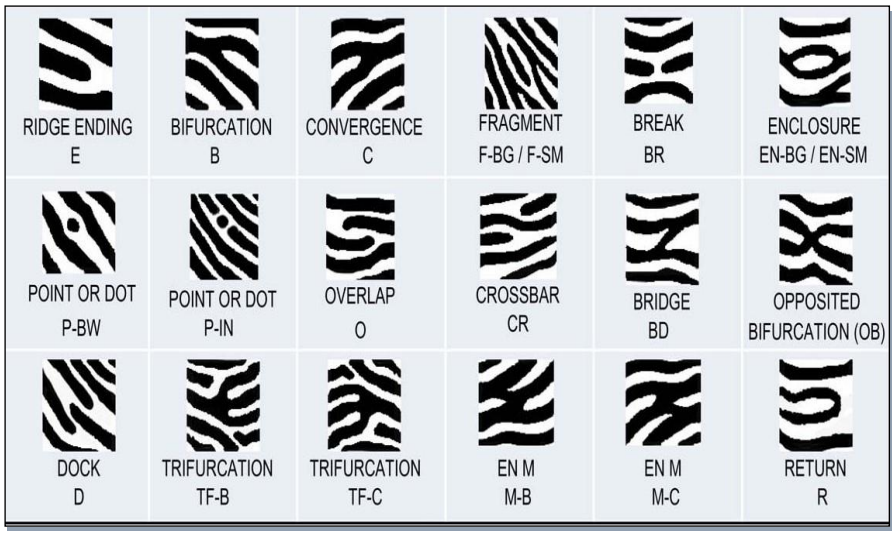


**Fig 1. The types of minutiae considered in this study** (Gutiérrez-Redomero *et al.* 2011)

Plain fingerprint of participants was collected manually using a blue-inked pad and a sheet of paper. Individual participant's fingers were placed on the ink pad and then pressed on the paper which contained spaces for each of the ten fingers and also had provision for obtaining the participants personal and demographic data. The definitions of the minutiae used are according to Gutierrez-Redomero *et al.* (2011) (Figure 1). The fingers/ digits were

designated the following letters: thumb (T), index (I), middle (M), ring(R) and little (L). The hands were designated left (L) and right (R).

The fingerprints were carefully examined with the aid of a hand lens. The occurrence of each type of minutiae were counted and recorded against each fingerprint. The difference in proportions of minutiae between the ethnic groups was tested for statistically significance using Fisher's exact test and Univariate analysis on SPSS 21. The significance level was set at 0.053.

## 3 Results

The comparison made between the frequencies of the different classes of minutiae is also presented in Table 2. Among the study population the most frequent type is the bifurcations and convergence, which accounted for 54.85% of the study's total minutiae counts (TMC). Fragment/point or dot and the bridge type, were the next most frequent representing 12.40% and 10.16% of the study's TMC respectively. Association of the distribution of the minutiae types (MTs) on ethnic group was found for return and bifurcations and convergence at P< 0.01, while those found in overlap and crossbar were at a higher significant level of P<0.001 (Table 2).

**Table 2:** Distribution of different minutiae types in the two populations (total n= 21450).

| Minutiae Type | | Count | |
|---|---|---|---|
| | | Yoruba (n=10,206) | Igbo (n=11,244) |
| | N (%) | Total (%) | Total (%) |
| Bifurcations and Convergence (BC) | 11,764 (54.85) | 5,916 (57.97)* | 5,848 (52.01) |
| Fragment/point or dot (FP) | 2,660 (12.40) | 1,256 (12.3) | 1,404 (12.49) |
| Bridge (BG) | 2,178 (10.15) | 1,066 (10.45) | 1,112 (9.88) |
| Ridge Ending (ER) | 1,328 (6.19) | 556 (5.45) | 772 (6.87) |
| Overlap (OL) | 854 (3.98) | 338 (3.3) | 516 (4.59)** |
| Break (BR) | 808 (3.77) | 292 (2.86) | 516 (4.59) |
| Enclosures (EN) | 758 (3.53) | 338 (3.31) | 420 (3.74) |
| Crossbar (CP) | 628 (2.93) | 288 (2.82) | 340 (3.02)** |
| Return (RT) | 406 (1.89) | 90 (0.88) | 316 (2.81)* |
| Others (OT) | 66 (0.31) | 66 (0.65) | 0 (0) |

* Significantly higher at p<0.01, ** significantly higher at p<0.001

**Table 3:** The total count of minutiae (mean ± SD) over whole fingerprint for both hands.

| Hands | Total (n=88) | Ethnic group (n=88) | |
|---|---|---|---|
| | | Yoruba (n=44) | Igbo (n=44) |
| Both Hands TMC | 243.75 ± 61.15 | 232.51 ± 76.16 | 256.20±38.07***** |
| Right hand TMC | 124.02 ± 38.65 | 117.38 ± 40.69 | 131.30± 37.15 |
| Left hand TMC | 119.73 ± 38.03 | 115.20 ± 47.02 | 124.46± 25.27 |

* Significantly higher at p<0.001

In the study population, the counts (TMC) for the right and left hands were unequal between the tribes for both hands (Table 3). However, there was no significant association between tribal classifications and the varying TMCs for the right and left hands. On the other hand, this significant association was discovered for the total TMC.

**Table 4:** Presence or absence of different types of minutiae on all or any of the ten fingers and their descriptive statistics (Mean ± SD).

| Minutiae type | Total (N=88) | | Yoruba | | Igbo | |
|---|---|---|---|---|---|---|
| | Present (%) | Mean ± SD | Present (%) | Mean ± SD | Present (%) | Mean ± SD |
| BC | 88 (100) | 133.68 ± 32.37 | 44 (100) | 134.45 ± 36.48 | 44 (100) | 132.91 ± 27.19 |
| ER | 82 (93.18) | 15.09 ± 14.99 | 38 (86.36) | 12.64 ± 14.55 | 44 (100) | 17.55 ± 15.17 |
| FP | 88 (100) | 30.23 ± 14.12 | 44 (100) | 28.55 ± 13.91 | 44 (100) | 31.91 ± 14.28 |
| OL | 80 (90.91) | 9.70 ± 7.56 | 36 (81.82) | 7.68 ± 8.28 | 44 (100) | 11.73* ± 6.22 |
| CP | 78 (88.64) | 7.14 ± 6.68 | 38 (86.36) | 6.55 ± 7.24 | 40 (90.91) | 7.73 ± 6.10 |
| BG | 88 (100) | 24.75 ± 12.33 | 44 (100) | 24.23 ± 13.57 | 44 (100) | 25.27 ± 11.08 |
| BR | 80 (90.91) | 9.18 ± 8.46 | 40 (9 0.91) | 6.64 ± 7.604 | 40 (90.91) | 11.73 ± 8.59 |
| EN | 86 (97.73) | 8.61 ± 8.11 | 42 (95.46) | 7.68 ± 9.72 | 44 (100) | 9.55 ± 6.08 |
| RT | 68 (77.73) | 4.61 ± 6.08 | 28 (63.64) | 2.05 ± 2.56 | 40 (90.91) | 7.18* ± 7.39 |
| OT | 12 (13.64) | 0.75 ± 3.295 | 12 (27.27) | 1.50¶ ± 4.56 | 0 (0) | 0 |

¶ significantly higher at p<0.001; * significantly higher at p<0.01
Bifurcations and Convergence (BC); Fragment/point or dot (FP); Bridge (BG); Ridge Ending (ER); Overlap (OL); Break (BR); Enclosures (EN); Crossbar (CP); Return (RT); Others (OT)

From our data, we discovered that, not all minutiae types (MTs) were not present in all individuals. The only constant minutiae types (MTs) in the population were the bifurcations and convergence (BC), fragment/point or dot and the bridge types (Table 4), which showed varying levels of presence ranging from 77 - 93%, while the MT with the lowest presence level was the trifurcations; Dock and others types, found in only 13% of the study population. Furthermore, the frequencies of presence or absence of the MTs showed different variations according to the ethnic groups. However, dependence of the level of presence of the MTs on tribal classifications was only statistically significant in the trifurcations; Dock and others MT at $p<0.001$, while the dependence was significant at $p<0.01$ for overlap and return MTs (Table 4). While the tribal classification dependence on gender was not found to be significant for any of the classes of TMC (Figure 2), the analysis of the distribution showed that gender dependence was significant for the distribution of some MTs within the study population.

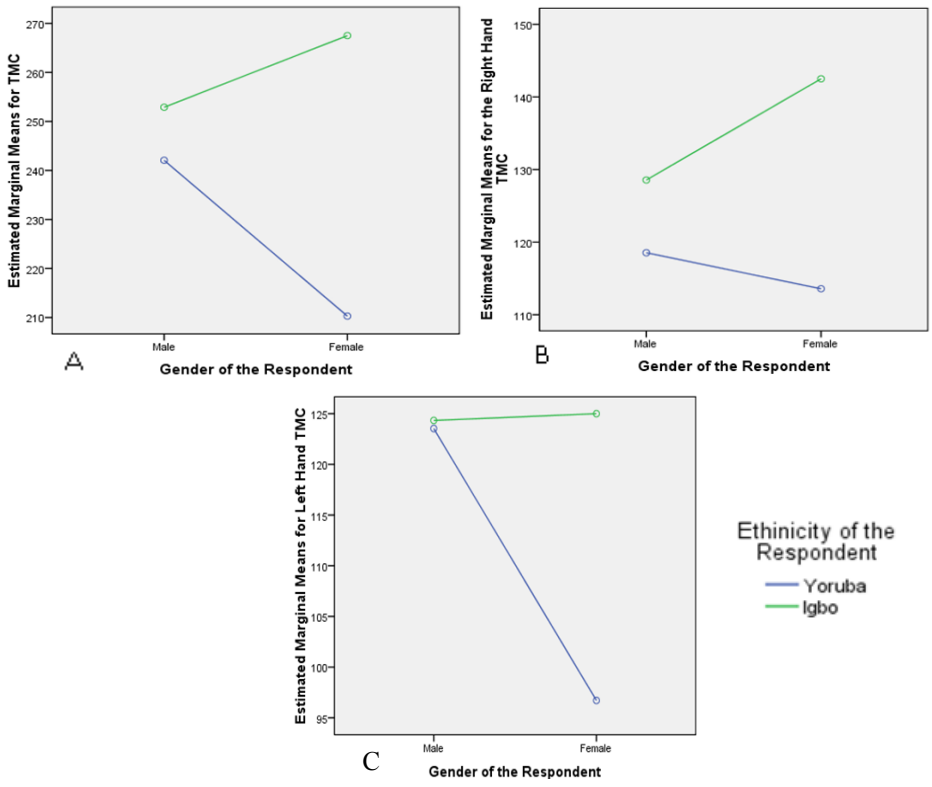


**Fig 2. Profile plot of the interaction of ethnicity and gender in the distribution total minutiae counts (TMC);** for both hands (A), the right hand (B) and the left hand (C).

We went further to check the dependent association between gender classifications and the distribution of the MTs (Table 5). The MTs distributions were found to be gender dependent in the bifurcations and convergence (BC), ridge ending (ER), fragment/point or dot (FP), overlap (OL) and break (BR) MTs. Furthermore, we also checked the tribal distributions of these MTs and their corresponding gender dependent association.

**Table 5.** Distribution of different minutiae types between the genders.

| | MALE | | FEMALE | | P- Value (Fischer's Test) |
|---|---|---|---|---|---|
| | Present (%) | Mean ± SD | Present (%) | Mean ± SD | |
| BC | 100 | 132.36 ± 31.07 | 100 | 138.03 ± 36.17 | 0.008 |
| Igbo BC | 100 | 127.20 ± 25.23 | 100 | 162.05 ± 13.43 | 0.004 |
| ER | 93.94 | 18.30 ± 16.40 | 90.91 | 6.21 ± 5.23 | 0.001 |
| Yoruba ER | 86.67 | 16.12 ± 16.42 | 85.71 | 5.41 ± 4.32 | 0.008 |
| FP | 100 | 30.11 ± 15.08 | 100 | 32.15 ± 11.53 | 0.001 |
| Igbo FP | 100 | 30.34 ± 15.12 | 100 | 39.52 ± 4.23 | 0.003 |
| OL | 93.94 | 11.80 ± 8.22 | 81.82 | 7.21 ± 5.76 | 0.003 |
| Yoruba OL | 86.67 | 10.36 ± 9.68 | 71.43 | 4.72 ± 3.56 | 0.007 |
| BR | 90.91 | 11.01 ± 9.6 | 90.91 | 5.23 ± 4.23 | 0.0001 |
| Igbo BR | 88.89 | 13.03 ± 9.51 | 100 | 8.18 ± 5.44 | 0.004 |
| Igbo EN | 100 | 10.09 ± 6.43 | 100 | 6.61 ± 1.57 | 0.007 |
| Igbo RT | 88.89 | 8.01 ± 8.62 | 100 | 5.72 ± 1.03 | 0.005 |

## 4. Discussion

In the application of fingerprinting for forensic identifications, ridge count and pattern type are not the only features in used. The absolute position, direction, and type of minutiae (e.g. termination or bifurcation) are also used. As important as minutiae are, only a few human population studies have been carried out (Gutierrez-Redomero *et al*. 2012) while fewer none has been carried out in Nigeria. The few studies on minutiae in Nigeria did not set out to evaluate the population characteristics of pattern. In the use of minutiae feature of fingerprint in identification, the frequency of appearance in the population is an important factor to consider (Gutiérrez-Redomero *et al*. 2011). This is because the features that are frequent in the population will be less indicative or unique to individuals than the rare features in the population. Gutierrez-Redomero *et al*. (2012) stated that the frequency of minutiae change in relation to population.

The most frequent minutiae type in our study, i.e. bifurcations and convergence, which accounted for more than 54.85% of the study's total minutiae counts (TMC) is way higher than the 28.23 % recorded in a Spanish population (Gutiérrez-Redomero *et al*. 2011) for the same combined minutiae type. We collected our samples manually as against digital collection used in the case of the Spanish population and the dichotomy in the sample sizes. The rarity of the bifurcations and convergence may have also buttressed its value for identification in Spanish population, but not in Nigerian population as they are more frequent. Also ridge ending with a frequency of about 5% contradicts 65% frequency recorded in the same Spanish population. Therefore, further studies should be carried out to establish the variation in minutiae frequency in relation to population, especially using digital tools as used in the earlier minutiae studies.

Although Okajima (1970), Gutierrez-Redomero *et al*. (2007) and Gutierrez-Redomero *et al*. (2011) found basis for statistical association between some minutiae types' distribution and gender, our study was able to find this association for MTs that showed no association in previous studies including fragment/point or dot (FP), overlap (OL) and break (BR) minutiae. Because there has been no work on the distribution study of minutiae on any Nigerian population, the results of this study could not be compared with previous study on Nigerians, hence further studies are still needed if the application of minutiae feature of fingerprint in forensic identification is going to be taken seriously in Nigeria.

## 5 Conclusions

The results of this study have provided us with insights on more morphological differences that exist even between different ethnic populations of the same country especially in dermatoglyphics. This knowledge if well researched on and harnessed can be an efficient and cost effective tool in forensic identifications of individuals of different ethnic groups in developing countries like Nigeria.

## References

Aase JM, Lyons RB. 1971. Technique for recording dermatoglyphics. *Lancet (London, England)* 1(7696): 432–433.

Adamu L. 2017. Sex variation in thumbprint minutiae among Hausa Lineage. *Journal of Anatomical Sciences* 8: 39-47.

Adamu LH, Ojo SA, Danborno B, Adebisi SS, Taura MG. 2016a. Sexual dimorphism in epidermal ridge density and thickness asymmetry indices among Hausa population of Kano State Nigeria. *Nigerian Journal of Experimental and Clinical Biosciences* 4:42-47.

Adamu LH, Ojo SA, Danborno B, Adebisi SS, Taura MG. 2016b. The potential of thumbprint profiles in prediction of body mass index among Hausa ethnic group of Nigeria. *Bayero Journal of Biomedical Science* 1(1):69-77.

Adamu LH, Ojo SA, Danborno B, Adebisi SS, Taura MG. 2017a. Evaluation of facial proportions and their association with thumbprint patterns among Hausa ethnic group. *Journal of Anthropology* 2: 7-18.

Adamu LH, Ojo SA, Danborno B, Adebisi SS, Taura MG. 2017b. Evaluation of asymmetry using thumbprint minutiae among Hausa population of Kano State, Nigeria. *Bayero Journal of Pure and Applied Sciences* 10(1): 39 – 46.

Adamu LH, Taura MG. 2017. Application of likelihood ratio and posterior probability density in sex estimation from level two fingerprint features among Hausa ethnic group. *Egyptian Journal of Forensic Sciences* 7:25.

Adekoya KO, Ahmed RA, Oboh BO, Alimba CG. 2013. Relationships between dermatoglyphics and multiple intelligence among selected secondary school students in Lagos State, Nigeria. *Nigerian Society for Experimental Biology (NISEB) Journal* 13 (3& 4): 53-60.

Akingbade AM, Saalu LC, Akunna GG, Anderson LE, Olusolade FS. 2014. Finger and palmar dermatoglyphic study among the Yorubas in Jos, Nigeria. *Annals of Bioanthropology* 2:49-53.

Blangero J. 1990. Population structure analysis using polygenic traits: Estimation of migration matrices. *Human Biology* 62(1): 27–48.

Champod C, Lennard CJ, Margot P, Stoilovic M. 2004. *Fingerprints and other ridge skin impressions*. CRC Press, pp 418.

Crawford MH, Duggirala R. 1992. Digital dermatoglyphic patterns of Eskimo and Amerindian populations: Relationships between geographic, dermatoglyphic, genetic, and linguistic distances. *Human Biology* 64(5): 683–704.

Dankmeijer J, Waltman JM, de Wilde AG. 1980. Biological foundations for forensic identifications based on fingerprints. *Acta Morphologica Neerlando-Scandinavica* 18(1): 67–83.

Dike EU, Oladipo GS, Okoh PD. 2012. A comparative study of the digital pattern, position of triradii, b-c and a-d palmar distances of diabetic subjects and essential hypertensive individuals in River State. *International Journal of Advanced Biotechnology and Research* 3(2): 615-620.

Durham NM, Plato CC. 1990. *Trends in dermatoglyphic research*. 1st ed. eds. N.M. Durham, Plato, C. C. Netherlands: Springer Netherlands. pp724

Eboh DEO. 2013. Fingerprint patterns in relation to gender and blood group. *Journal of clinical Anatomy*, 12(2): 82 – 86.

Faigman DL, Saks MJ, Sanders J. 2008. *Modern Scientific Evidence: Standards, Statistics, and Research Methods*. Thomson/West. pp322.

Gutiérrez-Redomero E, Alonso-Rodríguez C, Hernández-Hurtado LE, Rodríguez-Villalba JL. 2011. Distribution of the minutiae in the fingerprints of a sample of the Spanish population. *Forensic Science International* 208(1): 79–90.

Gutiérrez-Redomero E, Alonso-Rodríguez C, Hernández-Hurtado LE, Rodríguez-Villalba JL. 2012. Are there population differences in minutiae frequencies? A comparative study of two Argentinian population samples and one Spanish sample. *Forensic Science International* 222(1): 266–276.

Gutiérrez-Redomero E, Galera V, Martínez JM, Alonso-Rodriguez C. 2007. Biological variability of the minutiae in the fingerprints of a sample of the Spanish population. *Forensic Science International* 172(2): 98–105.

Iloanusi ON. 2011. Comparison of the minutiae quadruplets and minutiae triplets techniques. *Nigerian Journal of Technology* 30(3): 28-33.

Jaja BNR, Olabiyi O, Noronhhe, CC. (2011) Dermatoglyphics of the Ogoni of Nigeria and its historiographic implications. *Anthropologiseher Anzeyer*, 68 (2): 175-183

Janti RL Breheme H. 1978. Finger and palmar dermatoglyphics of a Yoruba (Nigerian) sample. *Annals of Human Biology* 5: 539-546

Jantz, RL, Brehme, H. 1978. Finger and palmar dermatoglyphics of a Yoruba (Nigeria) sample. *Annals of Human Biology* 5 (6): 539-546

Karthick R. 2015. Dermatoglyphics -A Review. *Biomedical and Pharmacology Journal* 8SE (1905): 417–420.

Lestrange, MD. 1953. Les crates papillaires digitales de 1.491 Noirs d'Afrique occidentale. *Bulletin de l'Institut Franeais d'Afrique noire*, 15: 1278-1315.

Loesch DZ. 1983. *Quantitative Dermatoglyphics: Classification, Genetics, and Pathology*. Oxford University Press. Pp 134

Meier RJ. 1980. Anthropological Dermatoglyphics: A Review. *American Journal of Physical Anthropology* 23(1 S): 147–178.

Midlo H, Cummins C. 1943. *Finger Prints, Palms and Soles; an Introduction to Dermatoglyphics*. Philadelphia: Blakiston. pp: 332

Mohammed B, Garba SH, Adeyemi LB. 2014. Digital dermatoglyphics patterns of the Kanuri ethnic group of North Eastern Nigeria. *International Journal of Innovation and Applied Studies* 9(2): 985-988.

National Population Commission (NPC). 2006. *Report on the final census result.* NPC Press 2006. From: http://www.population.gov.ng accessed on March 22, 2018.

Ogunnaike PO, Owolabi JO, Ogunsola AO, Olanrewaju JA. 2014. Human identification: Assessment of interrelationships between sex, handedness and dermatoglyphics. *Journal of Medical and Applied Biosciences* 6 (2): 44 – 54.

Ojikutu RO. 1964. A qualitative and quantitative analysis of finger and palmar cutaneous dermatoglyphics in the Nigerian population. *Homo* 15: 160-164.

Okajima M. 1970. Frequency of forks in epidermal-ridge minutiae in the finger print. *American Journal of Physical Anthropology* 32(1): 41–48.

Oladipo GS, Afolabi EO, Esomonu C. 2010. Dermatoglyphic patterns of obese versus normal weight in Nigerian individuals. *Biomedicine International* 1: 66-69.

Oladipo GS, Osogbe LG, Bobmanuel I, Ugbonna HAA, Sapira MK, Ekeke ON. 2010. Palmer dermatoglyphics in essential hypertension amongst Rivers indigenes. *Australian Journal of Basic and Applied sciences*, 4(12): 6300 -6305.

Oladipo GS, Paul CW, Bob-Manuel IF, Iboroma AD, Fawehinmi H, Edibamode E. 2009. Study of digital and palmar dermatoglyphic patterns of Nigerian women with malignant mammary neoplasm. *Journal of Applied Biosciences* 15: 829 - 834.

Orike S, Anireh VIE, Ademuyiwa, SI .2016. A gender and ethnicity identification system in Nigeria using the fingerprint technology. *Proceedings of the World Congress on Engineering* 1:1-5.

Osunwoke EA, Amah-Tariah FS, Sapiraand MK, Onosigho A. 2010. Dermatoglyphic patterns in congenital deaf and mute in South-South Nigeria. *African Journal of Medicine, Physiology, Biomed Engineering & Science* 2: 98 – 101.

Otobo TM, Tarimobo-Otobo, R. 2016. Digital and palmer dermatoglyphic characteristics of the Ijaw ethnic group. *International Journal of Forensic Medical Investigation*. 2(1)25-30.

Pankanti S, Prabhakar S, Jain AK. 2002. On the individuality of fingerprints. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 24(8): 1010–1025.

Schaumann B, Alter M. 1976. *Dermatoglyphics in Medical Disorders*. 1st ed. BERLIN: Springer-Verlag Berlin Heidelberg, pp 1075.

Segura-Wang M, Barrantes R. 2009. Dermatoglyphic traits of six Chibcha-speaking Amerindians of Costa Rica, and an assessment of the genetic affinities among populations. *Revista de Biologia Tropical* 57(SUPPL. 1): 357–369.

Umana UE, Ahunna CO, Timbuak, JA, Ibegbu AO, Musa SA, Hamman WO. 2013. Dermatoglyphics and Cheiloscopic patterns in cancer patients; A study in Ahmadu Bello University Teaching Hospital (ABUTH), Zaria, Nigeria. *Current research journal of biology sciences, 5(5): 220.*