# Fingerprint Pattern of Fulani and Higgi Ethnic Groups in Michika LGA, Adamawa State, Nigeria

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## Abstract

*Developing countries experience surge of insurgency, banditry, cybercrime and other related violence. Criminals often go undetected because of poor forensic capabilities in human detection. Fingerprint features have been very effective in establishment of identity. The aim of this study was to determine fingerprint pattern of Fulani and Higgi ethnic groups of Michika, Adamawa State, Nigeria. A total of 5020 valid fingerprints patterns were captured using live fingerprint scanner. These included; 1230 Fulani male; 1250 Fulani female; 1280 Higgi male; 1260 Higgi female. SPSS version 26.0 statistical software was used for statistical analysis and P < 0.05 was set as a level of significance. Descriptive statistics were employed to determine the frequency of loops whorls and arches in all the fingers of both hands, both sexes and both ethnic groups. Loops were the most frequent pattern in all the observations followed by whorls, and then arches. However, there were relative differences in the percentage proportion across the digits, between left and right, male and female and Fulani and Higgi. The frequency of loop and whorl were equal in right ring (48.8 %) of Fulani male and right thumb (47.7 %) of Higgi male. The frequency of loop was less than that of whorl in left thumb (Loop: 39.8 %; Whorl: 48.8 %) and right thumb (Loop: 43.9 %; Whorl: 48.8 %) of Fulani male. Loops were more frequent in little fingers (85.1 %) followed by middle fingers (73.4 %) and least in thumbs (50.8 %) of left male Higgi; arches more frequent in left hand than right (11.4 % and 7.3 % in Fulani male thumbs respectively). These biological variations might suggest preferential selection of finger as potential predictors of other biological features such as blood group.*

**Keywords**: Arches, Fulani, Higgi, Loops, Whorls.

## INTRODUCTION

Establishment of identity is one of the key processes in forensic sciences (Krogman and Iscan, 1986). Fingerprint is one of the most commonly used features in establishment of identity (Dalrymple *et al.*, 2002). Fingerprint is an impression left by the friction ridges of the finger tips (Cummins & Midlo, 1943). The formation of fingerprint ridges is under the influence of

genetic and environmental factors (Babler, 1991; Omidiora *et al.*, 2012). The variation in fingerprint ridge configuration is unique among individuals including identical twins (Anil *et al.*, 2010). The science of fingerprints has been acclaimed and reputed as a panacea for individualization particularly in forensic investigations. The fingerprint features suggested to have the potential in personal identification include ridge pattern, ridge count, ridge density, ridge thickness, minutiae, ridge pores, ridge contour, ridge shape, white line among others (Gutiérrez-Redomero *et al.*, 2008; Tadurana *et al.*, 2016; Adamu *et al.*, 2019).

In an effort to improve forensic sciences, fingerprints have been studied in different parts of the world; African populations such as Nigerians (Atiku *et al.*, 2018), Sudanese (Ahmed & Osman, 2016), Egyptians (Eshak *et al.*, 2013), Asian populations such as Chinese and Malaysians (Nayak *et al.*, 2010; Vinod *et al.*, 2010), Indian populations (Nithin *et al.*, 2011). Indo-Mauritian populations (Agnihotri *et al.*, 2012), European populations, Spanish Caucasians (Gutierrez-Redomero *et al.*, 2008) Latin American populations, and Argentinean populations (Rivalderia *et al.*, 2016). A study of digital dermatoglyphic pattern was carried out on different ethnic groups of Nigeria, where the results revealed various frequencies of pattern distributions among different ethnic groups; Igbos in South East Nigeria (Anyabolu *at al.*, 2015); Annangs ethnic group in Nigeria (Ekanem *et al.*, 2009); Ijaw of southern Nigeria (Jaja and Igbigbi, 2008); Okrika and Ikwerre ethnic group of Nigeria (Osunwoke, *et al.*, 2008); Hausa ethnic group of Nigeria (Danborno & Idris, 2007) and Yoruba (Igbigbi *et al.*, 1994). Fingerprint friction ridge details have been described in several ways; macro detail such as ridge flow allows pattern classification and ridge counting (Jain *et al.*, 2007). This detail is mainly used by biological anthropologist to differentiate between population (Dorjee *et al.*, 2015) and for the determination of heritability, ethnicity, and sex (Adamu *et al.*, 2016). Ridge density and ridge breadth were used in an attempt to differentiate between sexes and predict age (Atiku *et al.*, 2017; Atiku *et al.*, 2018).

The present research provided reference data on fingerprint pattern of the Fulani and Higgi ethnic groups of Michika which might be useful in forensic investigation, and might improve various anthropological techniques used in personal identification. Loops were found to be more frequent in little fingers, followed by middle fingers, then index fingers and were least in thumb fingers of Fulani. Similar observation was noticed in the case of Higgi, except with the ring fingers that replaced the position of the index fingers. Interestingly similar observations were found in both hands and both sexes of each ethnic group. These biological variations might suggest preferential selection of finger as potential predictors of other biological features for a better prediction power. It could also be applied in identification of an individual during natural mass disasters such as earthquakes and floods or in an act of terrorism such as banditry attack, bomb blast and genocides.

## MATERIALS AND METHODS

### Area of Study
This study was conducted in Michika Local Government Area, Adamawa State, Nigeria. Adamawa State derived its name from Madibbo Adama, a Fulani cleric who led the 19th century Jihad in Upper Benue Region under Othman Dan Fodio (Diouf, 2003). Adamawa state is known for its diverse cultural heritage; in addition to the dominant Fulani, the state is inhabited by other minority ethnic groups, such as Margi, Bachama, Mumuye, Higgi, Chamba, Hausa, Kilba, Gude, Wurkum, Jukun, and Bata among others (Heine and Derek, 2008). The Higgi ethnic group lives mainly in the towns of Michika with the GPS coordinates of (10° 37′0.0012″ N and 13° 22′59.9988″ E) and Bazza in Adamawa state. However, another

section of the Higgi ethnic group is located in the Republic of Cameroon. They are called Kapsiki (Van Beek, 2012).
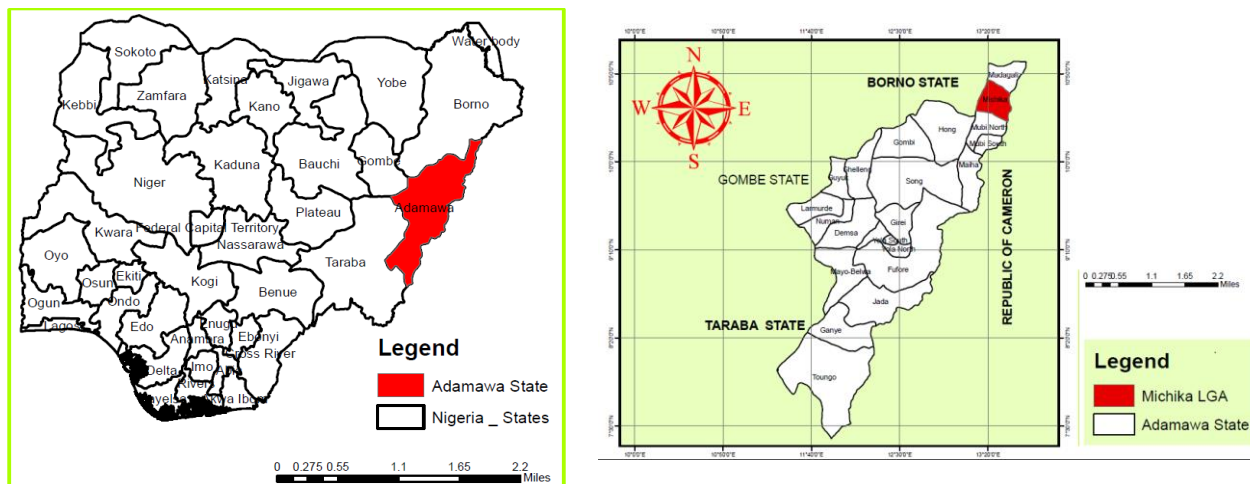


Figure 1: (a) Map of Nigeria with study location          (b) Map of Adamawa with study area

## Collection of Samples

A total of five hundred and two (502) subjects of age range between 5 years and 19 years residing in Michika local government area of Adamawa state were involved in this study. Participants' consent was discussed verbally and obtained in a written form with assurance of confidentiality. For those below the age of 18 years, their participation was approved by their parents or guardians and they were equally contacted verbally and consented before their participation. A total of five thousand and twenty (5020) valid fingerprints patterns were captured and analysed. These constituted all ten (10) fingers of both Fulani and Higgi male and female subjects; 1230 Fulani male; 1250 Fulani female; 1280 Higgi male; 1260 Higgi female.

## Technical Procedures

Fingerprints were captured using live fingerprint scanner device in accordance with the method described by Adamu *et al* (2018). Subjects were asked to clean their fingers and pressed each finger on the scanner, one finger at a time until a clear image appeared on the screen of the laptop. "Save button" was then clicked in other to save the data into the database. Clear button was used to clear the data in other to save another one.

## Data Analysis

The fingerprints were classified into three main categories: arches, loops, and whorls (Drets & Liljenstrom, 1999). Data were expressed in percentages, SPSS version 26.0 statistical software was used for statistical analysis and $P < 0.05$ was set as a level of significance.

## RESULTS

Loops were the most common pattern found in all the observations followed by whorls, and arches were the least. These observations are relatively similar in all fingers of both hands, between males and females as well as between Fulani and Higgi. However, there are relative differences in the percentage proportion across the five (5) digits, between left and right, between male and female and between Fulani and Higgi. The frequency of loop and whorl were found to be equal in right ring (48.8 %) of Fulani male and right thumb (47.3 %) of Higgi male. Also the frequency of loop were found to be less than that of whorl in both left thumb

(Loop: 39.8 %; Whorl: 48.8 %) and right thumb (Loop: 43.9 %; Whorl: 48.8 %) of Fulani male. The frequency of loop was found to be highest in little fingers, followed by middle fingers, then index fingers and was least in thumb fingers. These observations were similar in both hands, and both sexes of Fulani ethnic group. In the case of Higgi, The frequency of loop was found to be highest in little fingers, followed by middle fingers, then ring fingers and was least in thumb fingers. These observations here as well were similar in both hands, and both sexes (Table 1 and Table 2).

Table 1: Frequency distribution of fingerprints pattern in Fulani ethnic group

| | | | Number and Frequency (%) of fingerprints pattern of the five(5) digits | | | | |
|---|---|---|---|---|---|---|---|
| Sex | Side | Pattern | Thumb | Index | Middle | Ring | Little |
| Male | Left | Arch | 14(11.4) | 13(10.6) | 12(9.8) | 3(2.4) | 3(2.4) |
| | | Loop | 49(39.8) | 84(68.3) | 85(69.1) | 72(58.5) | 102(83.7) |
| | | Whorl | 60(48.8) | 26(21.1) | 26(21.1) | 48(39) | 17(13.9) |
| | | Total | 123(100) | 123(100) | 123(100) | 123(100) | 123(100) |
| | Right | Arch | 9(7.3) | 14(11.4) | 11(8.9) | 3(2.4) | 3(2.4) |
| | | Loop | 54(43.9) | 76(61.8) | 86(70.1) | 60(48.8) | 100(81.3) |
| | | Whorl | 60(48.8) | 33(26.8) | 26(20.9) | 60(48.8) | 20(16.3) |
| | | Total | 123(100) | 123(100) | 123(100) | 123(100) | 123(100) |
| Female | Left | Arch | 18(14.4) | 12(9.6) | 14(11.2) | 5(4) | 4(3.2) |
| | | Loop | 59(47.2) | 78(62.4) | 83(66.4) | 72(57.6) | 98(78.4) |
| | | Whorl | 48(38.4) | 35(28) | 28(22.4) | 48(38.4) | 23(18.4) |
| | | Total | 125(100) | 125(100) | 125(100) | 125(100) | 125(100) |
| | Right | Arch | 14(11.2) | 13(10.4) | 9(7.2) | 3(2.4) | 2(1.6) |
| | | Loop | 64(51.2) | 78(62.4) | 97(77.6) | 71(56.4) | 106(84.8) |
| | | Whorl | 47(37.6) | 34(27.2) | 19(15.2) | 52(41.3) | 17(13.6) |
| | | Total | 125(100) | 125(100) | 125(100) | 125(100) | 125(100) |

Table 2: Frequency distribution of fingerprints pattern in Higgi ethnic group

| | | | Number and Frequency (%) of fingerprints pattern of the five(5) digits | | | | |
|---|---|---|---|---|---|---|---|
| Sex | Side | Pattern | Thumb | Index | Middle | Ring | Little |
| Male | Left | Arch | 14(10.9) | 16(12.5) | 8(6.3) | 3(2.4) | 3(2.4) |
| | | Loop | 65(50.8) | 71(55.5) | 94(73.4) | 74(57.8) | 109(85.1) |
| | | Whorl | 49(38.3) | 41(32) | 26(20.3) | 51(39.8) | 16(12.5) |
| | | Total | 128(100) | 128(100) | 128(100) | 128(100) | 128(100) |
| | Right | Arch | 6(4.6) | 13(10.2) | 11(8.6) | 1(0.8) | 2(1.6) |
| | | Loop | 61(47.7) | 64(50) | 89(69.5) | 67(52.3) | 104(81.3) |
| | | Whorl | 61(47.7) | 51(39.8) | 28(21.9) | 60(46.9) | 22(17.1) |
| | | Total | 128(100) | 128(100) | 128(100) | 128(100) | 128(100) |
| Female | Left | Arch | 24(19) | 19(15.1) | 15(11.9) | 8(6.3) | 5(4) |
| | | Loop | 53(42.1) | 64(50.8) | 93(73.8) | 79(62.7) | 103(81.7) |
| | | Whorl | 49(38.9) | 43(34.1) | 18(14.3) | 39(31) | 18(14.3) |
| | | Total | 126(100) | 126(100) | 126(100) | 126(100) | 126(100) |
| | Right | Arch | 15(11.9) | 17(13.5) | 6(4.8) | 6(4.8) | 6(4.8) |
| | | Loop | 58(46) | 61(48.4) | 101(80.2) | 80(63.5) | 110(87.3) |
| | | Whorl | 53(42.1) | 48(38.1) | 19(15) | 40(31.7) | 10(7.9) |
| | | Total | 126(100) | 126(100) | 126(100) | 126(100) | 126(100) |

## DISCUSSIONS

In Nigeria fingerprints have been studied on different ethnic groups such as Yoruba (Igbigbi *et al.*, 1994), Hausa (Danborno & Idris, 2007; Adamu *et al.*, 2013; Atiku *et al.*, 2018), Igbo (Anyabolu *et al., 2015*), Okirika and Ikwerre (Osunwoke *et al.*, 2008), Itsekiri and Urhobo (Jaiyeoba-Ojigho *et al.,* 2019) etc. Even though researches have been done on fingerprints using ridge density, ridge thickness and other minutiae in sex determination, age prediction etc; to particularly improve forensic investigation, little is done with regard to the associated secondary epidermal creases of fingerprints, the fingerprint white lines (Adamu *et al.*, 2019;

Taura *et al.,* 2019). More so, no record of research available on Fulani and Higgi ethnic groups as at the time this research was conducted.

The present study has been conducted to expand the prospect of fingerprints pattern, ridges density, ridges thickness, and white lines of all ten fingers of both children and adolescents of Fulani and Higgi ethnic groups. Loops were the most common pattern found in this study, followed by whorls, and arches were the least. These observations are relatively similar in all fingers of both hands, between males and females and as well as between Fulani and Higgi. This is usually the common trend with regards to fingerprint pattern in most Nigerian ethnic groups as observed in Yoruba (Igbigbi *et al.,* 1994), Okirika and Ikwerre (Osunwoke *et al.,* 2008), Hausa population living in Kano (Adamu *et al.,* 2013), Kanuri population of Borno (Ekanem *et al.,* 2014), South East Igbo (Anyabolu *et al.,* 2015), Itsekiri and Urhobo (Jaiyeoba-Ojigho *et al.,* 2019). Contrary to these, in a study carried out among the Malawians in East Africa, it was reported that arches were the most predominant pattern among sexes (Igbigbi & Msamati, 1999). However, there were relative differences in the percentage proportion across the five (5) digits, between left and right, between male and female and between Fulani and Higgi. Arches were found to be more common in left hands of both sexes of Fulani and Higgi. Only that index fingers of Fulani, middle fingers of male Higgi and little fingers of female Higgi do not conform to that. These peculiarities might suggest forensic relevance in ethnic identification and gender of Higgi ethnic group. Loops were more common in left hand of male individuals of both Fulani and Higgi, but it was more common in right hands of their female counterparts. These suggest sexual dimorphism features in loop pattern distribution. Whorl was generally more common in right hand fingers than left except in female Fulani.

Arches were found to be more common in female than male of both ethnicities except the index finger of Fulani; similar to what was obtained in Yoruba, but contrary to Igbo population where it was found to be more common in male, than in females (Igbigbi *et al.,* 1994). These variations in fingerprint pattern distribution may depend on the finger under the study, but could also be attributed to sex and ethnicity of the subjects as well. Whorls were found to be more common in male than female of both ethnicities except the index finger of Fulani. In Hausa ethnic group of Nigeria however, it was observed that whorls were more common than loop in male right thumb and female left thumb (Atiku *et al.,* 2018). Even though the exact mechanisms behind these variation in percentage proportion between ethnic groups, between sexes of the same ethnic group, and between right and left of the same individual is not clear, it has been documented that these patterns are established during embryogenesis by the ratio of volar pad distances, height to width ratio, among environmental influence and interaction of genes (Mulvihill & Smith, 1969; Wertheim, 2011; Yang *et al.,* 2016). Identical twins exhibit different fingerprints due to the influence of environmental factor (Anil *et al.,* 2010). While these differences were prominent and significant, they cannot stand alone to discriminate ethnicity or sex but at least suggest biological variations, and might also be a potential predictors of other biological features such as blood group; Fathima *et al,* (2022) might have likely presented a significant correlation in some fingers if all the fingers were studied instead of the only thumb considered in correlating ABO blood group with fingerprint. Fingerprint of some fingers were associated with intelligence quotients (Mai *et al.,* 2020), hence the need to identify which finger predict best.

The frequency of loop and whorl were found to be equal in right ring of Fulani male. Similarly also the right thumb of Higgi male. Loops were also found to be less frequent than whorls in both left and right thumb of Fulani male. Similar observation was noticed in Hausa ethnic group of Nigeria where whorls were found to be more common than loop in male right thumb

and female left thumb (Atiku *et al.*, 2018). These variations might be attributed genetically to ethnicity and gender, therefore suggest forensic relevance in gender and ethnic identification. Loops were found to be more frequent in little fingers, followed by middle fingers, then index fingers and were least in thumb fingers of Fulani. Similar observation was noticed in the case of Higgi, except with the ring fingers that replaced the position of the index fingers. Interestingly, these observations were similar in both hands and both sexes of each ethnic group. They might be potential variations that support preferential selection of finger in prediction power of some biological features as earlier stated.

## CONCLUSION
Loops were the most common pattern found in all the observations followed by whorls, and arches were the least. However, there were relative differences in the percentage proportion across the five digits, between left and right, male and female and Fulani and Higgi.

## ACKNOWLEDGEMENTS

## CONFLICTS OF INTEREST
There are no conflicts of interest.

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