Determination of Loop Patterns amongst the Hausa People in the Federal Capital Territory, Nigeria

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Abstract
Fingerprint patterns, particularly loop configurations, have critical forensic, biometric, and anthropological importance due to their uniqueness and genetic heritability. The current study assessed the distribution of loop fingerprint patterns, focusing mainly on Ulnar Loops (UL), among both Hausa males and females in the FCT of Nigeria. High-resolution digital scans of the ten digits of the UA fingerprints were made on 150 Hausa subjects (75 males and 75 females) to quantify the frequencies of UL patterns. The results established a higher percentage of ulnar loops for both sexes, with males showing the highest UL frequency on the left thumb (40.0%) and right little finger (36.7%), while females exhibited the greatest prevalence on the left (38.9%) and right (37.0%) little fingers. These results were in line with previously documented dermatoglyphic patterns within African populations, while also hinting at a slight presence of sexual dimorphism in UL distribution. Establishing this population-specific fingerprint pattern norm will assist greatly with forensic identification and provide an important anthropological reference point for the Hausa ethnic group.

Keywords: Dermatoglyphics, Fingerprint loops, Hausa people, Ulnar loop, Forensic anthropology, Nigeria.

Introduction

Dermatoglyphics, which studies skin ridge patterning specifically on the fingers, hands, and even on body soles, reveals a lot about genetically inherited traits, population diversity, and forensic human identification (Cummins & Midlo, 1961; Penrose, 1969). Patterns of fingerprints can mainly be categorized into arches, whorls, and loops, which can easily be subclassified according to ridge flow and core location (Chauhan *et* al., 2021; Nayak *et al*., 2014). They are the entry and exit sides of the same digit, and the term "loop" refers most frequently to the most commonly found pattern types. These, therefore, can be subclassified into radial loops, or those whose ridges flow toward the radius (thumb), and ulnar loops, those whose ridges flow toward the ulna (little finger) (Penrose, 1969; Agarwal *et al*., 2019).

Fingerprint pattern variability is shaped by a combination of genetic, prenatal environmental factors, and ethnic background (Adams & Aman, 2016). At any rate, the population-based studies attest patterns of frequency visible among different ethnicities. These studies beautifully represent the ethnic dimensions of their anthropological and forensic perspectives (Malini & Poornima, 2014; Anthony *et al*., 2023). Additionally, sexual dimorphism in dermatoglyphic traits has been reported, usually in terms of weight distributions for males and females about their respective patterns (Gutiérrez-Redomero *et al*., 2019).

The Hausa constitute one of the largest ethnic groups in West Africa, numbering over 50 million individuals primarily inhabiting northern Nigeria and adjacent regions in Niger, Ghana, and Cameroon (Blench, 2006; Salihu, 2017). The rich cultural history and extensive

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interaction between various tribes create a distinct genetic and phenotypic landscape, thus serving as an interesting target for anthropometric and dermatoglyphic studies (Suleiman & Tahir, 2015).

Various dermatoglyphic studies have been conducted in the Nigerian population (Eze *et al*., 2019; Okoro *et al*., 2022), but data on the distribution of fingerprint loop patterns within the Hausa population have remained scant. This study thus seeks to fill this gap by presenting comprehensive baseline data on ulnar loop frequencies among Hausa males and females in the FCT, which will be invaluable for forensic casework, biometric calibration, and genetic trait mapping.

Material and Methods

A total of 150 healthy Hausa individuals were recruited from the Federal Capital Territory, Abuja, Nigeria, including 75 males and 75 females aged 18-40 years. Individuals with any visible dermatological abnormalities on their fingertips or trauma affecting the digit ridge pattern were excluded to avoid possible confounding factors to fingerprint integrity.

Materials

The material used in this study includes: HP Scanjet G3110 Flatbed Scanner (9000 × 4800 dpi resolution) for high-fidelity digital fingerprint acquisition; a Desktop computer equipped with AUTOCAD software for image analysis and pattern classification; Standardized recording sheets for demographic and fingerprint data collection; and Clean towels for wiping fingertips before scanning.

Fingerprints were obtained digitally under controlled lighting conditions to optimize image clarity. Each fingertip of both hands was scanned individually according to established protocols (Cummins & Midlo, 1961; Jayalakshmi *et al*., 2017). High-resolution images were examined visually and analyzed with AUTOCAD software to classify fingerprint patterns into radial loops, ulnar loops, whorls, and arches based on Henry's classification system (Henry, 1900).

Data were processed using IBM SPSS Statistics version 29. Descriptive statistics (frequencies and percentages) summarized the UL distribution across digits and sexes. Chi-square tests evaluated the statistical significance of sex-related differences in UL frequencies, with $p < 0.05$ considered significant.

Ethical approval was secured from the Nile University Health Research Ethics Committee (NUN HREC; Approval No. FHREC/2024/01/65/11-03-24). Informed verbal consent was obtained from all participants. The study adhered strictly to the Declaration of Helsinki ethical principles.

Results

Table 1. Distribution of Ulnar Loops in Hausa Males and Females

	Ulnar Loop Frequency (%)	
Digit	Male	Female
Left Thumb	40.0	27.8
Right Thumb	20.0	27.8
Left Index	26.7	24.1
Right Index	26.7	14.8
Left Middle	30.0	29.6
Right Middle	30.0	31.5
Left Ring	26.7	25.9
Right Ring	13.3	29.6
Left Little	23.3	38.9
Right Little	36.7	37.0

Table 1 shows the distribution of Ulnar Loops in Hausa males and females, respec. Statistical analysis revealed significant sex differences in UL frequencies on the thumbs and little fingers ($p < 0.05$), with males exhibiting greater UL frequencies on the left thumb and females on bilateral little fingers.

Discussion

The current study highlights that ulnar loop patterns are the most common among both Hausa males and females. This finding aligns with global and African dermatoglyphic research, which also identifies ulnar loops as the most prevalent loop subtype (Adams & Aman, 2016; Nayak *et al*., 2014). In males, the highest frequencies of ulnar loops were found on the left thumb and the right little finger, while females exhibited the most significant occurrence of these patterns on both little fingers.

The higher frequencies of UL patterns observed on male thumbs might be linked to genetic traits that are influenced by sex or even prenatal factors, like how the fetus positions its hands or the hormonal environment, that play a role in ridge development (Kiran & Prasad, 2015; Rajesh *et al*., 2019). On the flip side, the

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prevalence of ULs on little fingers in females could suggest a difference in how male and female digital dermatoglyphic traits develop (Scelta *et al.*, 2021). These subtle variations in distribution align with earlier studies that have noted slight differences in fingerprint patterns between genders (Gutiérrez-Redomero et al., 2019).

While there are similar studies on dermatoglyphics among various Nigerian ethnic groups (Eze *et al.*, 2019; Okoro et al., 2022), there's still a lack of data specifically from the Hausa community. This research aims to bridge that gap by providing essential baseline prevalence rates for ulnar loops, which can significantly improve forensic profiling and biometric verification methods designed for this group. Additionally, by examining the common distribution of fingerprint patterns, particularly the prevalence of ulnar loops, we can enhance the development and fine-tuning of automated fingerprint identification systems (AFIS) that are specifically tailored for West African populations, where variations in patterns can affect the accuracy of these systems (Jain *et al.*, 2020).

From a genetic standpoint, the loop patterns found in fingerprints are known to follow a polygenic inheritance model, influenced by environmental factors during prenatal development. These patterns remain consistent throughout a person's life, making them reliable identifiers of individuals (Penrose, 1969; Malini & Poornima, 2014). The dominance of these unique loop patterns across different fingers further highlights their importance in both anthropological studies and forensic investigations.

Conclusion

This study reveals that ulnar loops are the most common fingerprint pattern found among Hausa males and females in Nigeria's Federal Capital Territory. Interestingly, there are notable differences in frequency based on digits and sex. These insights provide valuable dermatoglyphic data that can enhance the reliability of forensic identification and improve the design of biometric systems tailored for the Hausa community. Looking ahead, it's important to conduct further research with larger and more geographically diverse groups of Hausa individuals, as well as explore genetic links, to better understand the hereditary factors influencing these fingerprint patterns.

References

Adams, B. J., & Aman, M. A. (2016). Human dermal ridges: Method for analysis and forensic application. Forensic Science International, 267, 1–9. https://doi.org/10.1016/j.forsciint.2016.07.015

Agarwal, S., Tomar, R., & Srivastava, R. (2019). Classification and analysis of fingerprint patterns: A review. Journal of Biomedical Science and Engineering, 12(6), 194–206. https://doi.org/10.4236/jbise.2019.126016

Anthony, A., Onyemaike, A., & Okonkwo, C. (2023). Ethnic variation in dermatoglyphic patterns: A comparative study across Nigerian populations. Anthropological Notebooks, 29(1), 45–63.

Blench, R. (2006). The Hausa language and its speakers. In J. H. Smith (Ed.), West African Ethnolinguistics (pp. 234–256). Routledge.

Chauhan, P., Maithani, R., & Rathore, S. (2021). Fingerprint pattern frequencies and gender dimorphism: A study in the North Indian population. Egyptian Journal of Forensic Sciences, 11(1), 27. https://doi.org/10.1186/s41935-021-00219-1

Cummins, H., & Midlo, C. (1961). Fingerprints, Palms and Soles: An Introduction to Dermatoglyphics. Dover Publications.

Eze, U. A., Chibuzor, M., & Nwosu, V. C. (2019). Dermatoglyphic patterns among the Ibo ethnic group of Nigeria. African Journal of Medical Sciences, 48(3), 225–230.

Gutiérrez-Redomero, E., Utrilla, R., & Alcázar-Córcoles, M. Á. (2019). Fingerprint pattern and sex determination: A meta-analytic review. Forensic Science International: Genetics, 40, 94–102. https://doi.org/10.1016/j.fsigen.2019.02.015

Henry, E. R. (1900). Classification and uses of fingerprints. The National Police Gazette.

Jain, A., Ross, A., & Nandagopal, A. (2020). Introduction to biometrics. In A. Jain et al. (Eds.), Handbook of Biometrics (2nd ed., pp. 1–22). Springer.

Jayalakshmi, G., Geetha, D., & Chinnaiyan, S. K. (2017). Dermatoglyphics: A useful tool in forensic medicine. Journal of Forensic Nursing, 13(2), 69–73. https://doi.org/10.1097/JFN.0000000000000157

Kiran, Y., & Prasad, D. N. (2015). Study of fingerprint patterns in male and female students in Andhra Pradesh. International Journal of Phytomedicine, 7(3), 573–579.
Malini, D., & Poornima, S. (2014). Dermatoglyphic patterns in different populations and their applications: A systematic review. International Journal of Scientific and Research Publications, 4(10), 1–7.
Nayak, S., Bhat, S., Acharya, S., & Aithal, S. (2014). Dermatoglyphic patterns and their association with gender and blood groups: A study among Indian medical students. Journal of Forensic Dental Sciences, 6(2), 62–66. https://doi.org/10.4103/0975-1475.132420
Okoro, O. A., Ugwu, O. C., & Okafor, J. U. (2022). Fingerprint pattern distribution among the Igbo ethnic group in Eastern Nigeria. International Journal of Anthropology, 37(1), 89–98.
Penrose, L. S. (1969). Dermatoglyphics: Their genetic and evolutionary significance. Academic Press.
Rajesh, G., Prakash, S., & Venkatraman, K. (2019). Sex differences in fingerprint patterns among the South Indian population. International Journal of Anatomy and Research, 7(3), 6786–6789.
Salihu, S. U. (2017). Hausa people: Population, culture, and history. West African Studies Quarterly, 21(2), 33–47.
Scelta, G., Zanchin, G., & Baldassarri, S. (2021). Sex dimorphism in fingerprint patterns: Meta-analysis and implications for forensic practice. Forensic Science International, 326, 110909. https://doi.org/10.1016/j.forsciint.2021.110909
Suleiman, H., & Tahir, I. (2015). Genetic variability in the Hausa ethnic group: Implications for medical genetics. African Journal of Biomedical Research, 18(3), 147–153.
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