SEX VARIATIONS IN THUMBPRINT RIDGE COUNT OF A NIGERIAN POPULATION IN CALABAR MUNICIPALITY

ISO ISO USANG[1], MESEMBE OE[1], EWUNONU EO[2].

[1]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, University of Calabar, PMB 1115, Calabar, Cross River State, Nigeria.
[2]Department of Anatomy, Faculty of Basic Medical Sciences, Ebonyi State University, PMB 0053, Abakaliki, Ebonyi State, Nigeria.
Correspondence to Mr. Iso, Iso Usang Phone Number +234803 245 3465, email: usangiso@gmail.com

ABSTRACT

The present study aimed at determining the association between thumbprint ridge count and sex variation among Nigerians in Calabar Municipality. A total number of 300 subjects (150 males and 150 females) aged between 12-35 years participated in the study. Conventional method of using ink pad was used to collect thumbprint of both hands and analysed using magnifying lens. The study confirmed the results of some earlier works done by other researchers on fingerprints. It further established the distribution proportions of thumbprint for both hands in both sexes for the population. The uniqueness of fingerprint to individuals was reaffirmed as no two thumbprints were identical among the 300 subjects under study. These results show that the order of prevalence are as follows; among males, in whatever combination of thumbprint pattern, whorl is the most occurring, followed by loop and arch. Among females, in whatever combination of thumbprint pattern, loop is the most occurring followed by whorl and arch. The result equally showed the mean thumbprint ridge count of females to be lower than that of males (20.91 as against 27.85 respectively). The difference in pattern between left and right hands in females was significant. In conclusion the thumbprint ridge count shows gender dysmorphism in the Nigerian population.

Keywords: Fingers, epidermal ridges, thumbprint ridge count

INTRODUCTION

The fingers of humans possess series of friction ridge skin consisting of a series of furrows and ridges generally referred to as – fingerprints. Fingerprint constitutes a significant biometric variable that have been used in many biometric utilities such as in human biology, morphology, anthropology and in genetics. Their role especially in the field of forensics have become applicable and indispensable based on their reliability and validity of features, easy classification and uniqueness. In determination of identity, adequate and reliable knowledge of sex with certainty reduces the process of identification by 60% (Adamu, 2016) using fingerprint ridge counts and density.

This is possible based on the assumption that the ridge counts, and features remain intact. However, variations in ridge dimensions and sex differences in ridge breadth have been reported (Manish *et al*, 2008; Prateek *et al,* 2009; Ritu 2012; Rijo, 2013; Mulawka, 2014). Ridges and their patterns exhibit

a number of properties that reflect the genetic makeup of individuals.

The uniqueness of a person's fingerprints gave rise to dermatoglyhics and this is because dermatoglyphics is the reflection of DNA and hence, does not change. Fingerprints persist lifelong unless damage to the dermis occurs. Interestingly, as creases develop on the brain during development, they are reflected on the prints (Lakshmi *et al*, 2014) representing the various regions of the brain. These creases or dermal ridges often appear in the third to fifth month of neonatal life and they never change. As such, one can say that dermatoglyphic abnormalities are as a result of genetic or any other factor that expresses itself before the fifth month of neonatal life (Mellor, 1992).

The science of fingerprint has been used generally for the identification or verification of people and for official documentation. Based on the varieties of the information available from the fingerprint its identity can be processed along with gender, age

and ethnicity. As such a host of empirical verifications have been studied and analysed even in Nigeria; however, little or nothing has been done as regards thumbprint ridge analysis. Research concerning thumbprint ridge counts and fingerprints are few in the Nigerian population. Also, the need for a fingerprint database for all individuals within a locality always arises during civil litigations and criminal cases. If this research proves beyond doubt that thumbprint ridge count is influenced by gender, it would be most useful in documentation, matching and database build up as well as reconstruction of thumbprints for criminal investigation and forensic science as the case may be.

METHODOLOGY

A total of three hundred (300) subjects were used for this study. These subjects were all Nigerians residing in Calabar Municipality in a ratio of 50 males to 50 females, making a total of 150 males and 150 females for the research. The subjects were within the age bracket of 12-35 years of age. In order to take the fingerprints of the subjects, the following materials were used: Ink pad, Magnifying lens, White sheet of paper, Hand gloves, Methylated spirit, and Non-sterile cotton wool. Subjects included were Nigerians resident in Calabar Municipality and those whose thumbs were free of inflammation, deformation or pathological changes while subjects without fingers or those who were having inflammatory or pathological changes on their thumbs were excluded. Thumbprints were collected by pressing the thumbs on ink pad with moderate pressure and afterwards, pressing into a white plane sheet.

Samples with interrupted ridges were discarded and repeated. To ensure uninterrupted ridges and prints, the subjects' thumbs were wiped with non-sterile cotton wool dipped in methylated spirit. A magnifying lens with the magnification (x10) was used to trace the thumbprints. This is to enlarge the tiny ridges and make them more prominent and easily accessible to the naked eye. In the analysis of these prints, Henry system of classification was adopted.

The collected data were coded and entered in Microsoft Excel 2010 and statistically analysed using Statistical Package for Social Sciences (SPSS) 20.0. Specifically, Chi-square test and student's t-test was used to test for association between the variables. Level of significance was considered at $p<0.05$.

RESULTS

The most predominant thumbprints pattern was loop -46.7%, followed by whorl -40.0% and arch -13.3%). In. the left hand of males, the most predominant thumbprints pattern was Whorl -50.0%, followed by loop -38.0% and arch -12.0%). In the right hand of females, the most predominant thumbprints pattern was loop -45.3%, followed by whorl -36.0% and arch -18.7%). While in the left hand of females the most predominant thumbprints pattern was loop -49.3%, followed by whorl -36.7% and arch -14.0% (Table 1). Females have lower thumbprint ridge count mean values compare to males (Table 2 and 3).

In both left and right combinations, males have more whorl (75) followed by loop (57) and arch (18) [Table 4]. In table 4 Significant differences, as indicated by P<0.05, were found between the thumbprint pattern of both hands.

In both left and right combinations, females have more loop (74) followed by whorl (55) and arch (21) [Table 5]. In table 5 significant differences, as indicated by P<0.05, were found between the thumbprint pattern of both hands in females.

In the right hand of both sexes, loop (68) is the predominant thumbprint pattern followed by whorl (54) and arch (28) [Table 6]. In table 6 no significant difference, as indicated by P<0.05, were found in the right thumbprint pattern of both sexes. In the left hand of both sexes, loop (74) is the most predominant thumbprint pattern followed by whorl (55) and arch (21) (Table 7). In table 7

no significant difference, as indicated by P<0.05, were found in the left thumbprint pattern of both
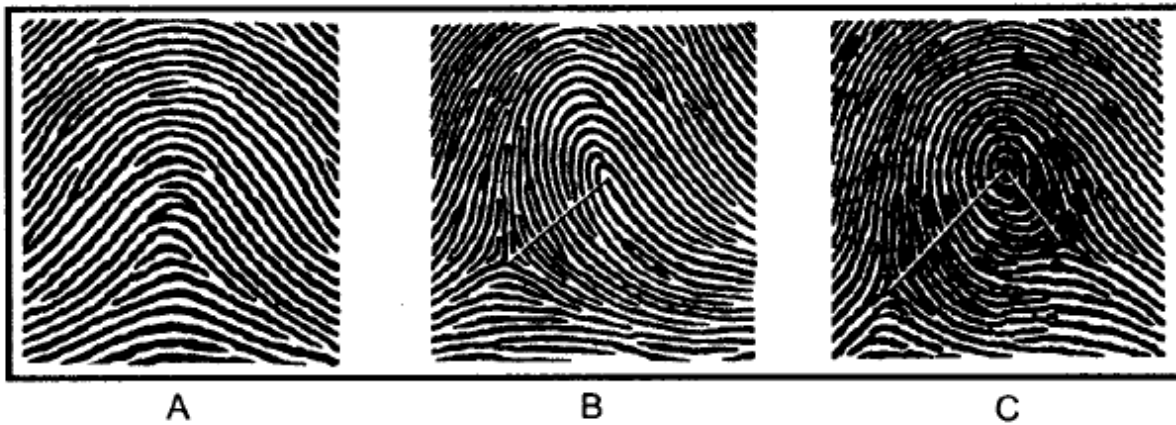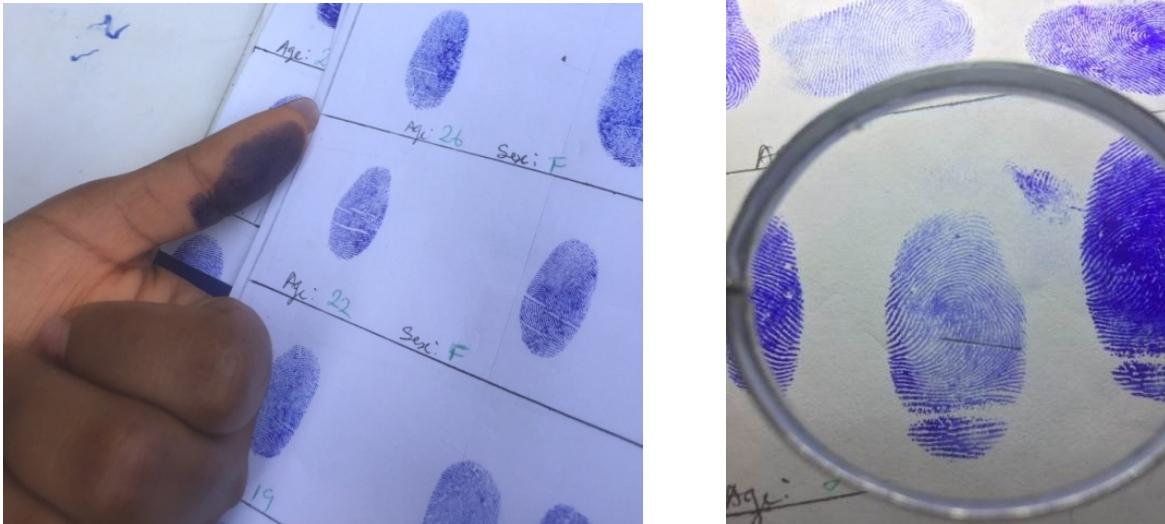

sexes.

Figure 1: Examples of fingertip patterns representing an arch (panel A), loop (panel B), and whorl (panel C). Adapted from Holt (1961). The following ridge-counting protocol was used: ridge count = (ridges crossing the longer line) + (1/2 of ridges crossing the shorter line); therefore, the ridge-count values in these examples are A = 0, B = 13, and C = 21 (i.e., 17 + (0.5 × 8)).

Table 1: Respondents' thumbprint patterns

Variable	Group	Frequency	Percent
Male Right Thumbprint pattern	Arch	20	13.3
	Loop	70	46.7
	Whorl	60	40.0
	Total	**150**	**100.0**
Male Left Thumbprint pattern	Arch	18	12.0
	Loop	57	38.0
	Whorl	75	50.0
	Total	**150**	**100.0**
Female Right Thumbprint pattern	Arch	28	18.7
	Loop	68	45.3
	Whorl	54	36.0
	Total	**150**	**100.0**
Female Right Thumbprint pattern	Arch	21	14.0
	Loop	74	49.3
	Whorl	55	36.7
	Total	**150**	**100.0**

Table 2: Descriptive Statistics of thumbprint ridge count

	N	Mean SD
Thumbprint Ridge Count (Male)	150	27.85 14.862
Thumbprint Ridge Count (Female)	150	20.91 13.401

Figure 2: Diagram showing sample collection and thumbprint ridge analysis using magnifying lens

Table 3: One-sample T-test of thumbprint ridge count in both sexes

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Thumbprint Ridge Count (Male)	22.948	149	.000	27.847	25.45	30.24
Thumbprint Ridge Count (Female)	19.113	149	.000	20.913	18.75	23.08

Table 4: Cross tabulation showing the distribution of left and right thumbprint patterns in males

			Left Thumbprint Pattern (male)			Total	X
			Arch	Loop	Whorl		
Right Thumbprint Pattern (male)	Arch	Count	16	4	0	20	
		Expected Count	2.4	7.6	10.0	20.0	165.061
	Loop	Count	2	49	19	70	
		Expected Count	8.4	26.6	35.0	70.0	df = 4
	Whorl	Count	0	4	56	60	
		Expected Count	7.2	22.8	30.0	60.0	Sig = .000
Total		Count	18	57	75	150	
		Expected Count	18.0	57.0	75.0	150.0	

Table 5: Crosstabulation showing the distribution of left and right thumbprint patterns in females

			Left Thumbprint Pattern (female)			Total	χ
			Arch	Loop	Whorl		
Right Thumbprint Pattern (female)	Arch	Count	20	5	3	28	
		Expected Count	3.9	13.8	10.3	28.0	183.827
	Loop	Count	1	62	5	68	
		Expected Count	9.5	33.5	24.9	68.0	df = 4
	Whorl	Count	0	7	47	54	
		Expected Count	7.6	26.6	19.8	54.0	Sig = .000
Total		Count	21	74	55	150	
		Expected Count	21.0	74.0	55.0	150.0	

Table 6: Comparison of right thumbprint patterns in males and females

			Right Thumbprint Pattern (female)			Total	χ
			Arch	Loop	Whorl		
Right Thumbprint Pattern (male)	Arch	Count	2	9	9	20	
		Expected Count	3.7	9.1	7.2	20.0	3.990
	Loop	Count	16	34	20	70	
		Expected Count	13.1	31.7	25.2	70.0	df = 4
	Whorl	Count	10	25	25	60	
		Expected Count	11.2	27.2	21.6	60.0	Sig = .407
Total		Count	28	68	54	150	
		Expected Count	28.0	68.0	54.0	150.0	

Table 7: Comparison of left thumbprint patterns in males and females

			Left Thumbprint Pattern (female)			Total	χ
			Arch	Loop	Whorl		
Left Thumbprint Pattern (male)	Arch	Count	0	11	7	18	
		Expected Count	2.5	8.9	6.6	18.0	4.943
	Loop	Count	7	30	20	57	
		Expected Count	8.0	28.1	20.9	57.0	df = 4
	Whorl	Count	14	33	28	75	
		Expected Count	10.5	37.0	27.5	75.0	Sig = .293
Total		Count	21	74	55	150	
		Expected Count	21.0	74.0	55.0	150.0	

DISCUSSION

Dermatoglyphics has become one of the very important topics to be understood by the human society. Day by day, its importance is felt in solving the problem of human crimes and forensic science. It has unlimited application in our problematic society especially in the law enforcing department. In spite of numerous research work in improving the study of its application like complicated finger pattern type classification (Henry's classification), total ridge count, thumbprint ridge count etc. still in-depth and extensive research to know the dermatoglyphics in details are always necessitate.

In this study, 600 thumbprint ridge patterns from 300 individuals were examined. No two prints were the same, indicating the individuality, uniqueness of fingerprints for identification and authentication. In all 600 thumbprint patterns encountered, loop was the dominant ridge pattern, followed by whorl and the least was arch. This is consistent with other studies done in Nigeria, which observed loop pattern to have the highest frequency, followed order by whorl, then arch pattern (Cummins *et al.,* 1943; Ekanem *et al.,* 2009; Jaja *et al.,* 2008). Similar results were reported on the Urhopbos and Hausa by Osunwoke *et al.,* 2008), the Ijaws by Igbigbi *et al.,* 1999; Jaja *et al.,* 2008, Delta State University students by Anibor *et al.,* (2011). Studies in other parts of Africa have also reported characteristic and similar dermatoglyphic patterns like that of Nigerians though with variations in percentages (Odokuma *et al.,* 2005, Igbigbi *et al.,* 1995). Interestingly, our result showed that males have a higher incidence of whorls and females have a higher incidence of loops. Similar results were reported by Prateek Rastogi, *et al.,* (2009).

Acree (1999) confirmed sex differences in fingerprint ridges using quantitative data, with females having finer details, hence, having a higher ridge count. Although, our data shows that female Nigerians in Calabar Municipality have lower thumbprint ridge count than males. These results support the idea of sexual dimorphism in human fingerprint in general and more specifically in thumbprint ridge counts. Our current study shows a trend in thumbprint ridge count regardless of the hand (i.e. left or right hand), and further emphasizes sexual dimorphism based on this thumbprint characteristics and ridge count in Nigeria. This may help in sex discrimination in forensic cases when thumbprints are of unknown

sources. However, Taduran *et al.,* (2017) warned that it should be used with caution because ridge count mean values of the thumb are much lower compared to the other fingers, which could lead to misclassification of a female as a male and vice versa.

Ridge count is the most consistent and reliable measurement for familial investigations and is an inherited metrical character (Verbor, 1970). Its quantitative nature allows for objective characterization of fingerprint, which may be helpful in identification matching. Other fingerprint characteristics where sexual dimorphism may occur, such as ridge breadths, pattern type concordances, and left-right asymmetries, should be explored further. The result of this study as well as future studies on ridge density and fingerprint ridge count maybe correlated with one another to come up with a precise sex discrimination algorithm specific for Nigerians that are based on different thumbprint and fingerprint ridge components. It may be possible to increase the accuracy of sex determination by combining finger and thumbprint techniques and other anthropometric techniques, such as Taduran's (2012) formulae from teeth dimensions.

Although, some similarities were observed in the distribution of thumbprint patterns in both sexes, this might be an indication that they share the same ancestry. The similarities are thus: The distribution of the thumbprints pattern in ascending order in all thumbprints encountered are; Arch > Whorl > Loop. These correspond with the distribution of fingerprint patters of the Africans (Onukwe, 2016). In conclusion, the result showed that in pattern distribution, males have a higher incidence of whorls and females have a higher incidence of loops.

In conclusion, the result showed that in pattern distribution, males have a higher incidence of whorls and females have a higher incidence of loops. The statistical analysis to test for the relationship of the thumbprint ridge count and the differences in sex was highly significant. This study suggests that the males have higher mean thumbprint ridge count than females and therefore thumbprint ridge count can be very instrumental in developing algorithms for sex determination.

COMPETING INTEREST: The authors have no competing interests.

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