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Distribution of Fingerprint Patterns between Males and Females in a Population in Western Kenya

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ABSTRACT

Fingerprint analysis is a biometric method for individual recognition which has been proven consistent in tests of time. Before that, there have been studies on the link between gender and fingerprint patterns; however, the findings have been inconsistent. The current study intends to explore fingerprint patterns distribution in a Western Kenyan population; particularly analysis of gender differences is conducted. A cross-sectional observational approach was applied and a total of 240 participants were included through cluster sampling. Demographic information was collected using the questionnaire and fingerprints pattern was obtained using the ink pads and classified under Henry's system. Chi-square test were performed to evaluate associations between fingerprint patterns, fingers and gender, with the significance threshold set at $P \leq 0.05$. Results showed no differences in counts of arch, composite, loop and whorl patterns across fingers and genders on both arms ($P > 0.05$). The ulnar loop sub-pattern emerged as the dominant across the fingers and genders followed by plain whorl, radial loop, plain arch, tented arch, central pocket whorl, double whorl, loop arch composite, and whorl arch composite, respectively. Notably, there was substantial similarity in fingerprint patterns across fingers and genders in Western Kenya indicating that fingerprint patterns alone may not reliably distinguish gender within this population.

Key words: Fingerprint, Gender, arch, composite, loop, whorl**.**

INTRODUCTION

Fingerprints are impressions of the friction ridges on fingertips. They are the present unique identifiers because of the specific patterns created by raised pieces of skin (Houck M, 2016; Champod et al., 2017; Sharma et al., 2021). These patterns, set prenatally, remain steady throughout an individual's life (Ravindra et al., 2021). The uniqueness and consistency of the fingerprints warrant their use as identification biometrics (Houck, 2016). Henry's classification system groups fingerprints into arch, loop, and whorl (Sharma et al., 2021). The arch patterns chiefly described by ridgelines entering and exiting without forming loops (Heng et al., 2018). Loops, a very common pattern at worldwide scale, are inverse to the ridgelines curving toward their source. Whorls show either circular or spiral ridges (Shrestha et al., 2016). A combination of two or more different fingerprint patterns is termed as composite.

Studies indicate link between fingerprint pattern and gender. The research outcomes on fingerprint patterns diverge depending on the population. Pattern distribution between the right and left fingers was studied in Bulgarian and Chinese (Heng et al., 2018). In Taiwan and Nigeria, gender dimorphism was shown as males are relatively more likely to have whorls while females are more prone to having loops and arches (Shehu et al., 2018). While Nepal showed varying tendencies, the number of leading radial loops was more in males and the number of ulnar loops in females was more (Anyanwu, 2020). The ethnicity also affects fingerprint patterns; studies in Nigeria and Costa Rica are contradictory, yet conclusive evidence regarding associations between fingerprint patterns and these variables remains elusive.

Thus, this study aims to ascertain the distribution of fingerprint patterns between males and females within a Western Kenyan population, contributing to the ongoing discourse on the relationship between fingerprint patterns and various demographic factors.

METHODOLOGY

The research employed a descriptive cross-sectional approach within Webuye west and Malava sub-counties, Western Kenya. This method combined quantitative data analysis with qualitative themes and an explanatory research design to investigate causal relationships between independent and dependent variables. The questionnaire recorded information on sex, gender, and sibling status.

Study Area and Participants: The study was conducted in Webuye west and Malava sub-counties, Western Kenya. Participants were selected using a cluster sampling technique, a probabilistic method where the population is divided into clusters, and random clusters are chosen as the sample.

Data Collection Procedures: Prior to fingerprinting, individuals' hands were washed, and alcohol was used for moist fingers while cotton was used for dry or flaky hands. Donors were instructed to relax and look away from the fingerprinting device. The investigator held the individual's right hand at the base of the thumb, covering the fingers with their palm, and guided the finger being imprinted from nail edge to nail edge. The fingerprints were recorded on cards by rolling the finger from one side to the other. Four-finger slap prints were taken by pressing all four fingers of the right hand onto an inkpad and then onto the card, followed by the left hand. Two-thumb slap prints were taken simultaneously. Demographic data were recorded, and participants signed the cards.

Ethical Considerations: The study obtained ethical approval from Masinde Muliro University Ethical Review Committee and research permits from NACOSTI. Permission was also obtained from local authorities. The study adhered to the principles of the Helsinki Declaration (Parsa-Parsi et al., 2014), and participants provided written informed consent for questionnaire completion and fingerprint donation. Confidentiality was strictly maintained, and the information collected was solely used for academic research purposes.

RESULTS AND DISCUSSION

The objective of this study was to describe the distribution of fingerprint patterns in a population in Western Kenya. The specific objective was to compare fingerprint patterns between males and females in a population in western Kenya. The study participants were asked to sign the informed consent and their fingerprint patterns were collected. The patterns for each finger were recorded and a chi square test done to determine the significance of the distribution of the pattern in the population.

The frequencies of fingerprint patterns were similar between the two genders across all ten fingers. (*P* - values = 0.395, 0.857, 0.173, 0.609, 0.461, 0.533, 0.367, 0.376, 0.574, and 0.647) for the RHT, RHI, RHM, RHR, RHP, LHT, LHI, LHM, LHR, and LHP, respectively. These findings on gender are consistent with a study (Heng et al., 2018) conducted in Malaysia that found a similar result for the distribution of male and female fingerprints among young adults and siblings in the community. Moreover, the results also show that the ulnar sub-patterns are the most prevalent in both males and females across the five fingers of the left and right hands the remainder being Plain arch, tented arch, Loop arch, Whorl arch, Radial, Ulnar, Central pocket whorl, Double whorls, and plain whorl, an observation that is consistent with a study in Indian (Badiye et al. 2014). On the contrary, the results of this study are opposed to the study in Nigeria that examined variations in finger dermatoglyphics among the Esan ethnic group of Edo State and found that the arch, loop, and whorl fingerprint patterns differ significantly between the male and female genders (Oguh et al., 2019). The similarities and differences seen in the previous studies and the current study may be due to autosomal dominance inheritance which may vary globally depending on environmental and climatic therefore affecting fingerprint patterns in either gender (Bhat et al. 2014). For instance, if an individual inherits a dominant allele for a gene associated with fingerprint patterns, they will express the trait regardless of their gender. This means that both males and females carrying the dominant allele will exhibit the same fingerprint pattern associated with that particular gene. Taken into consideration, fingerprint pattern distribution varies differently between males and females in different countries. Therefore, the fingerprint patterns of the individuals in Western Kenya may not be used to differentiate between male and female gender.

Table 2. Distribution fingerprint patterns for both male and female

	Right				**Left**		
	Male		**Female**		**Male**	**Female**	
Finger	**Pattern**	**Frequency n = 120 (%)**	**Frequency n = 120 (%)**	**p-value**	**Frequency n=120(%)**	**Frequency n=120 (%)**	**p-value**
Thumb	Arch	15 (12.5)	13 (10.8)		15 (12.5)	13 (10.8)	
	Composite	6 (5.0)	5 (4.2)		4 (3.3)	4 (3.3)	
				0.395			0.533
	Loop	60 (50.0)	73 (60.8)		61 (50.8)	72 (60.0)	
	Whorl	39 (32.5)	29 (24.2)		40 (33.3)	31 (25.8)	
Index	Arch	13 (10.8)	13 (10.8)		12 (10.0)	14 (11.7)	
	Composite	4 (3.3)	4 (3.3)		2 (1.7)	0 (0)	
				0.857			0.367
	Loop	64 (53.3)	70 (58.3)		65 (54.2)	72 (60.0)	
	Whorl	39 (32.5)	33 (27.5)		41 (34.2)	34 (28.3)	
Middle	Arch	12 (10.0)	14 (11.7)		12 (10.0)	13 (10.8)	
	Composite	3 (2.5)	0 (0)		1 (0.8)	4 (3.3)	
				0.173			0.376
	Loop	64 (53.3)	74 (61.7)		65 (54.2)	70 (58.3)	
	Whorl	41 (34.2)	32 (26.7)		42 (35.0)	33 (27.5)	
Ring	Arch	12 (10.0)	13 (10.8)		12 (10.0)	13 (10.8)	
	Composite	4 (3.3)	2 (1.7)		3 (2.5)	3 (2.5)	
				0.609			0.574
	Loop	62 (51.7)	70 (58.3)		63 (52.5)	72 (60.0)	
	Whorl	42 (35.0)	35 (29.2)		42 (35.0)	32 (26.7)	
Pinkie	Arch	12 (10.0)	13 (10.8)		12 (10.0)	13 (10.8)	
	Composite	1 (0.8)	2 (1.7)		4 (3.3)	5 (4.2)	
				0.461			0.647
	Loop	64 (53.3)	73 (60.8)		64 (53.3)	71 (59.2)	
	Whorl	43 (35.8)	32 (26.7)		40 (33.3)	31 (25.8)	

Table 3. Distribution fingerprint sub-patterns for both male and female

Right Hand					**Left Hand**		
	Male		**Female**		**Male**	**Female**	
Finger	**Sub - Pattern**	**Frequency n (%)**	**Frequency n (%)**	p-value	**Frequency (%)**	**Frequency (%)**	**P-value**
Thumb	Central pocket	5 (4.2)	7 (5.8)		5 (4.2)	7 (5.8)	
	Double	6 (5.0)	1 (0.8)		4 (3.3)	1 (0.8)	
	Loop/Arch	3 (2.5)	2 (1.7)	-----	2 (1.7)	2 (1.7)	----
	Plain arch	10 (8.3)	7 (5.8)		13 (10.8)	12 (10.0)	
	Plain whorl	28 (23.3)	21 (17.5)		31 (25.8)	23 (19.2)	
	Radial	22 (18.3)	25 (20.8)		22 (18.3)	25 (20.8)	
	Tented	5 (4.2)	6 (5.0)		2 (1.7)	1 (0.8)	
	ulnar	38 (31.7)	48 (40.0)		39 (32.5)	47 (39.2)	
	whorl/Arch	3 (2.5)	3 (2.5)		2 (1.7)	2 (1.7)	
Index	Central pocket	1 (0.8)	1 (0.8)		0 (0)	1 (0.8)	
	Double	3 (2.5)	3 (2.5)		2 (1.7)	0 (0)	
	Loop/Arch	1 (0.8)	3 (2.5)	----	1 (0.8)	0 (0)	----
	Plain arch	8 (6.7)	8 (6.7)		7 (5.8)	10 (8.3)	
	Plain whorl	35 (29.2)	29 (24.2)		39 (32.5)	33 (27.5)	
	Radial	19 (15.8)	23 (19.2)		19 (15.8)	25 (20.8)	
	Tented	5 (4.2)	5 (4.2)		5 (4.2)	4 (3.3)	
	ulnar	45 (37.5)	47 (39.2)		46 (38.3)	47 (39.2)	
	whorl/Arch	3 (2.5)	1 (0.8)		1 (0.8)	0 (0)	
Middle	Central pocket	0 (0)	1 (0.8)		0 (0)	0 (0)	
	Double	0 (0)	1 (0.8)		3 (2.5)	0 (0)	
	Loop/Arch	1 (0.8)	0 (0)		1 (0.8)	3 (2.5)	----
	Plain arch	9 (7.5)	11 (9.2)	-----	9 (7.5)	9 (7.5)	
	Plain whorl	41 (34.2)	30 (25.0)		39 (32.5)	33 (27.5)	
	Radial	19 (15.8)	25 (20.8)		19 (15.8)	23 (19.2)	
	Tented	3 (2.5)	3 (2.5)		3 (2.5)	4 (3.3)	
	ulnar	45 (37.5)	49 (40.8)		46 (38.3)	47 (39.2)	
	whorl/Arch	2 (1.7)	0 (0)		0 (0)	1 (0.8)	
Ring	Central pocket	0 (0)	0 (0)		0 (0)	0 (0)	
	Double	4 (3.3)	2 (1.7)		1 (0.8)	1 (0.8)	
	Loop/Arch	3 (2.5)	2 (1.7)	-----	2 (1.7)	1 (0.8)	-----
	Plain arch	10 (8.3)	11 (9.2)		9 (7.5)	10 (8.3)	
	Plain whorl	38 (31.7)	33 (27.5)		41 (34.2)	31 (25.8)	
	Radial	19 (15.8)	23 (19.2)		19 (15.8)	24 (20.0)	
	Tented	2 (1.7)	2 (1.7)		3 (2.5)	3 (2.5)	
	ulnar	43 (35.8)	47 (39.2)		44 (36.7)	48 (40.0)	

	whorl/Arch	1 (0.8)	0 (0)		1 (0.8)	2 (1.7)		
Pinkie	Central pocket	2 (1.7)	0 (0)		3 (2.5)	1 (0.8)		
	Double	2 (1.7)	2 (1.7)		2 (1.7)	0 (0)		
	Loop/Arch	1 (0.8)	0 (0)	----	2 (1.7)	2 (1.7)		-----
	Plain arch	5 (4.2)	9 (7.5)		10 (8.3)	12 (10.0)		
	Plain whorl	39 (32.5)	30 (25.0)		35 (29.2)	30 (25.0)		
	Radial	21 (17.5)	25 (20.8)		20 (16.7)	23 (19.2)		
	Tented	7 (5.8)	4 (3.3)		2 (1.7)	1 (0.8)		
	ulnar	43 (35.8)	48 (40.0)		44 (36.7)	48 (40.0)		
	whorl/Arch	0 (0)	2 (1.7)		2 (1.7)	3	(2.5)	

CONCLUSON AND RECCOMENDATIONS

In summary there is a similar distribution of fingerprint patterns between the male and female genders for both the right and left hands of the study participants in Western Kenya. Therefore, the fingerprint patterns of the individuals in Western Kenya should not be used to differentiate between male and female gender, therefore, further research needs to be done with a wider population to confirm the findings.

Conflict of interest

The author declares no conflicts of interest regarding the publication of this paper.

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