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Distribution of Fingerprint Patterns in A Population in Western Kenya

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ABSTRACT

Fingerprint is one of the oldest and most reliable biometric tools taken as legitimate proof of identification of an individual. Gender, ethnicity, and relationship-status are used as tools of individual identity and their associations with finger-print patterns have been demonstrated in previous studies but were inconsistent. The objective of this study was to describe the distribution of fingerprint patterns in a population in Western Kenya. The specific objectives were to determine the associations between finger print patterns and sub-patterns with fingers, gender, ethnic group, and sibling status in a population. In a cross-sectional observation study, a total of 240 study participants were recruited via clustered sampling technique. Demographic information was collected using a questionnaire. Fingerprints were collected using fingerprint ink pad and classified according to Henry's classification system. The association of fingerprint patterns with fingers, gender, ethnic groups and relationship-status was determined using the chi-square test. Statistical significance was set at $P \leq 0.05$. The frequency of arch, composite, loop, and whorl patterns were comparable across the five fingers as well as between gender and ethnic group for both the right and left arms ($P > 0.05$). However, there was significant variation in the frequency of arch, composite, loop, and whorl fingerprint patterns for all the fingers between siblings and non-siblings ($P < 0.05$). The ulnar loop was found to be the most occurring fingerprint sub-pattern across the five fingers, between the gender and ethnic group as well as between sibling and non-siblings. Plain whorl, radial loop, plain arch, tented arch, central pocket whorl, double whorl, loop arch composite and whorl arch composite followed respectively. There is similarity in fingerprint patterns across the fingers as well as between gender and ethnic groups but not siblings and non-siblings in Western Kenya. Therefore, fingerprint patterns may not be used to discriminate fingers, gender, and ethnic groups but can be used as a tool to distinguish between siblings and non-siblings in the population.

Key words: Fingerprint, Gender, ethnicity, relationship-status.

INTRODUCTION

Fingerprint is an impression of the friction ridges of the finger-ball found on the fingertips, where friction ridges are raised portions of the epidermis (Houck M, 2016; Champod et al., 2017; Sharma et al., 2021). The skin on human fingertips contains ridges and valleys which together form distinctive patterns. These patterns are fully developed in intra-uterine life and remain unaltered until the death of the individual (Ravindra et al., 2021). The fingerprints are taken as the most reliable criteria for identification, as they are constant and individualistic (Houck, 2016).

There are four main types of fingerprint patterns according to Henry classification system namely the arch, loop, and whorl (Sharma et al., 2021). The Arch patterns are characterized by a ridgeline entering from one side of the finger, rises slightly in the middle, and departs on the other side without generating any loops or recurving patterns. The arch patterns accounts for approximately 5%-15% of fingerprint patterns worldwide (Heng et al., 2018). The arch is further classified into plain arch and tented arches sub-patterns. The Loop patterns are characterized by ridgelines that enter from one side of the finger, form a curve or loop shape, and exit on the same side they entered. Loop patterns are the most common fingerprint pattern accounting for 60-65 percent of the world population (Shehu et al., 2018) and is classified into Ulnar loop which has ridges flowing toward the little finger and Radial loop which has ridges flowing toward the thumb accounting for about. The whorl fingerprint patterns account for about 30–35 (Shrestha et al., 2016) and it has circular or spiral ridges that form concentric patterns. The whorl is sub-patterned into plain whorls, central pocket loops, double loops, and accidental whorls. A combination of two or more different fingerprint patterns is termed as composite.

Previous studies demonstrated association between finger-print patterns with fingers, gender, ethnicity and relationship-status. A study conducted in Bulgaria demonstrated that loop pattern was significantly higher across the right hand fingers (), while another study in China demonstrated that the loop fingerprint pattern was the most dominant pattern across the left hand fingers (Heng et al., 2018). In Northern Taiwan, men have a higher frequency of whorls and women typically exhibiting more loops and arches (Shehu et al., 2018) which is similar to a study in Nigeria which demonstrated that the frequency of whorl and arches was higher in male and females respectively (Anyanwu, 2020). However, higher frequency of radial loops and ulnar loops was reported in males and females, respectively, in Nepal (Shrestha & Malla, 2019). Previous study in Nigeria reported that the frequencies of ulnar loop, whorl, arch and radial loop were similar for the right hand fingers but ulnar loop was higher for the left hand fingers between two ethnic groups (Abimbola et al., 2021). However, a study in Costa Rica concluded that rates of Arch, whorl, and loop fingerprint patterns were similar across six ethnic groups (Heng et al., 2018). Cumulative evidence from the previous studies suggest that there were inconsistent conclusions as to whether there was an association

between fingerprint patterns and sub-patterns with fingers, gender, ethnicity, and relationship-status. Therefore, the present study determined the distribution of fingerprint patterns in a population in western Kenya Population.

METHODOLOGY

Study Design; The study employed a descriptive cross-sectional study that targeted a population of Webuye west and Malava sub-counties to gather, analyze, and combine quantitative data with qualitative themes and explanatory research design to explore casual links between the dependent and independent variable. Information on sex, gender, and sibling was recorded on the questionnaire.

Study area and study population; Research was conducted in Webuye west and Malava sub-counties, Western Kenya. The study employed a cluster sampling technique to select the study participants. This is technique of sampling that employs the probability method where the population is divided into clusters, and then some clusters are randomly selected as the sample.

D*ata collection methods and procedure;* Prior to fingerprinting, the individual's hands were washed. For moist fingers, alcohol was used in wiping the hands. For a hand that was dry or flaky, a tiny amount of cotton was used to wipe away any excess. The donors were instructed to relax and gaze away from the fingerprint gadget. With the right hand, the investigator grasped the individual's right hand at the base of the thumb. Then the investigator capped his palm over the individual's fingers, tucking beneath those that are not now being printed. Using the left hand, the investigator guided the finger being imprinted by rolling from nail edge to nail edge, catching the tip of each finger down to the first joint. The side of the finger bulb was put on the card during the rolling imprint process. The finger was then rolled to the other side so that it points in the opposite way. A gentle, steady motion while rolling the finger was applied. The maximum pressure required to capture a clean fingerprint is equal to the weight of the finger. When rolling each finger, the side with the highest resistance was rolled first. Rolling occurred towards the body for the thumbs and away from the body for the fingers. When rolling the right index finger, for example, roll from left to right.

Following the individual fingerprints, the four-finger slap or simple print was recorded. Press the inkpad with all four fingers of the right hand while keeping the fingers together. The four fingers were then pushed at a 45-degree angle into the appropriate area at the bottom of the card to capture all four prints simultaneously. This procedure was repeated for the left hand. The two thumbs slap or simple prints were taken simultaneously by putting both thumbs in the boxes at the bottom of the card. It was ensured that all relevant demographic data is provided in the proper places and that the individual who was fingerprinted signed the card.

Ethical consideration; The ethical approval of the study was obtained from Masinde Muliro University Ethical Review Committee, while the research permit was acquired from NACOSTI. Permission to conduct the study was obtained from the local administration. The study was carried out according to Helsinki's declaration (Parsa-Parsi *et* al., 2014). Written informed consent was obtained from the research participants by filling out the questionnaires and donating fingerprints. Confidentiality of all information was highly maintained and the information was used solemnly for academic research.

RESULTS AND DISCUSSION

The objective of this study was to describe the distribution of fingerprint patterns in a population in Western Kenya. The specific objectives were to determine the associations between finger print patterns and sub-patterns with fingers, gender, ethnic group, and sibling status in a population. 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.

In the analysis, the researcher classified the fingerprint patterns into; arch, composite, loop, and whorl. The research further classified the patterns into sub patterns which included; Plain arch, tented arch, loop arch composite, whorl arch composite, radial loop, ulnar loop, central pocket whorl, double whorl and plain whorl.

The distribution of fingerprint patterns and sub-patterns of the study participants is shown in Table 1. The frequencies of fingerprint patterns were similar across the right-hand digits ($P = 0.736$). Similarly, the distribution was comparable across the left-hand digits ($P = 0.937$). However, the loop pattern had slightly higher occurrence for both hands compared to the rest of the digits. This observation is partly in line with studies in Nigeria (Hirachan et al., 2019), and Thailand (Ojigho et al., 2020) that showed similarity in frequencies of Loop, whorl, and arch patterns across the five fingers. The ulnar loop sub-pattern as the most frequent across the five fingers of the left and right hands and the remainder are Plain arch, Tented arch, Loop arch, Whorl arch, Radial, Ulnar, Central pocket whorl, Double whorls, and plain whorl an observation that mirrors studies in India (Kapoor & Badiye, 2017). However, the findings of this study are contradicted by a study in Costa Rica that reported higher incidences of arches and whorls on the left hand (Segura-Wang & Barrantes, 2009). The similarities and differences observed between this and previous studies may be attributed to maternal environment, blood group, and finger lengths, which vary globally (Shrestha & Malla, 2019) and have been associated with fingerprint patterns. For instance, a number of maternal environmental factors, including the density of the amniotic fluid surrounding the fetus, the size of the fetus, the friction in the womb, and the location in the womb amongst other fetal movement patterns determine the fingerprint pattern in the womb (Singh RK et al, 2018). In addition, people with whorl-shaped fingerprints on both of their little fingers tend to have longer little fingers than those who do not (Li et al. 2022). Most importantly, loop fingerprint patterns are frequently associated with blood group AB while arch and whorl are frequencies identified in blood group A individuals (Saranya Manikandan et al, 2019). Taken together, the common fingerprint pattern distribution in ten fingers varies in different countries. Therefore, the fingerprint patterns of the individuals in Western Kenya may not be used to estimate hand origin together with its digits.

Table 1. Distribution of fingerprint patterns and sub-patterns

		Right Hand						Left Hand					
		Thumb n (%)	Index n (%)	Middle n (%)	Ring n (%)	Pinkie n (%)	*P*.value	Thumb n (%)	Index n (%)	Middle n (%)	Ring n (%)	Pinkie n (%)	*P*.value
Pattern	Arch	28 (11.7)	26 (10.8)	26 (10.8)	25 (10.4)	25 (10.4)		28 (11.7)	26 (10.8)	25 (10.4)	25 (10.4)	25 (10.4)	
	Composite	11 (4.6)	8(3.3)	3 (1.3)	6 (2.5)	3 (1.3)	0.736	8 (3.3)	2 (0.8)	5 (2.1)	6 (2.5)	9 (3.8)	0.937
	Loop	133 (55.4)	134 (55.8)	138 (57.5)	132 (55.0)	137 (57.1)		133 (55.4)	137 (57.1)	135 (56.3)	135 (56.3)	135 (56.3)	
	Whorl	68 (28.3)	72 (30.0)	73 (30.4)	77 (32.1)	75 (31.3)		71 (29.6)	75 (31.3)	75 (31.3)	74 (30.8)	71 (29.6)	
Sub-pattern	Plain arch	17 (60.7)	16 (61.5)	20 (77.0)	21 (75.0)	14 (56.0)		25 (89.3)	17 (65.4)	18 (72.0)	19 (67.9)	22 (88.0)	
	Tented	11 (39.3)	10 (38.5)	6 (23.0)	4 (25.0)	11 (44.0)		3 (10.7)	9 (34.6)	7 (28.0)	6 (21.4)	3 (12.0)	
	Loop arch	5(45.5)	4 (50.0)	1 (33.3)	5 (83.3)	1 (33.3)		4 (50.0)	1 (50%)	4 (80.0)	3 (50.0)	4 (44.4)	
	Whorl arch	6 (54.5)	4 (50.0)	2 (66.7)	1 (16.7)	2 (66.7)		4 (50.0)	1 (50%)	1 (20.0)	3 (50.0)	5 (55.6)	
	Radial	47 (35.3)	42 (31.3)	44 (31.9)	42 (31.8)	46 (33.6)	------	47 (35.3)	44 (32.1)	42 (31.1)	43 (31.9)	43 (31.9)	-----
	Ulnar	86 (64.7)	92 (68.7)	94 (68.1)	90 (68.2)	91 (66.4)		86 (64.7)	93 (67.9)	93 (68.9)	92 (68.1)	92 (68.1)	
	Central pocket	12 (17.6)	2 (2.8)	1 (1.4)	0(0.0)	2 (2.7)		12 (16.9)	1 (1.3)	0 (0.0)	0 (0.00)	4 (5.6)	
	Double	7 (10.3)	6 (8.3)	1 (1.4)	6 (7.8)	4 (5.3)		5 (7.0)	2 (2.6)	3 (4.0)	2 (2.7)	2 (2.9)	
	Plain whorl	49 (72.1)	64 (88.9)	71 (97.2)	71 (92.2)	69 (92.0)		54 (76.1)	72 (96.0)	72 (96.0)	72 (97.3)	65 (91.5)	

CONCLUSON AND RECCOMENDATIONS

The prevalence of fingerprint patterns for the right and left hands was found to be comparable across the five fingers of the study participants in Western Kenya. The distribution fingerprint patterns of the individuals in Western Kenya should not therefore, be used to estimate hand origin, suggesting a further research 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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