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Human Identification: Assessment of Interrelationships between Sex, Handedness and Dermatoglyphics

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ABSTRACT

Humans have numerous forms of diversity ranging from the very fundamental form of gender to inter- and intra-populations forms of diversity. Several methods have been established for identifications of humans; very importantly, gender and dermatoglyphic features, especially thumbprints. Handedness has also been shown to vary among humans. There is however the need to investigate further, the nature of interrelationships between the parameters. This investigation was carried out to observe the prevalence of each of the selected parameters of identification: sex, handedness and thumbprints; and to evaluate the interrelationship between them within the study group. A total of (n = 120) subjects participated, having met the criteria for participation. They completed questionnaires for demographic information and the thumbprints of both hands were obtained with the aid of ink. These were classified primarily as Whorl (W), Arch (A) or Loop (L). Handedness could be Right (R), Left (L) or Both (B). Data obtained from the subjects were subjected to descriptive statistics. Right handedness was the predominant; without left handedness, thus ambidexterity accounts for the remaining 3%. Most right-handed subjects had the Whorl right thumbprint pattern and the Loop left thumbprint pattern. Both handedness and thumbprints patterns vary between sexes, but to varying extents.

Keywords: Thumbprint, Dimorphism, Sex, Handedness.

INTRODUCTION

Gender or sex is arguably the most popular method of classifying people within populations and across the globe generally. Dermatoglyphic feature are however more specific methods of identifying people as it has been reported that no two people have been found to have the same dermatoglyphic features. This explains why it is popularly employed for forensic and other human identification purposes (Girard, 2007). However in addition to this, researchers have explored other peculiar morphological or

anthropological features of humans that can complement the existing major types of identification. Handedness, which is described as an individual's hand of preference (normally naturally) for performing tasks has been found to be peculiar to individuals, hence can serve as a basis of identification and could complement other popular methods of human identification. The importance of exploring the possible link between human specific and peculiar features suitable for human identification will be appreciated when considering the usual need to have a number of features in order to effectively establish an individual's identity relative to others. It is also important to explore the acclaimed links between laterality and inherent abilities as determined by the brain.

The current investigation attempted to explore and evaluate the pattern of distribution of dermatoglyphic patterns and handedness across the subjects, selected at random, as they relate to gender variations; as well as the interrelationship between the features. It is also aimed at studying if there are ways these features can be complementarily combined to help in identifying humans.

Dermatoglyphics are the dermal ridge configurations of digits, palm and sole (Basco *et al.,* 2001). They are characterized by alternating strips of raised friction ridges and grooves present in a variety of patterns (Cummins and Midlo, 1961). The dermal ridges develop in relation to the volar pads, which are formed by the 6th week of gestation and reach a maximum size between 12 and 13 weeks. This means that genetic message contained in the genome (normal or abnormal) is deciphered during this period is also reflected by dermatoglyphics (Schauman, 1991). Since dermatoglyphic traits reflect prenatal development, dermatoglyphic studies have also become part of medical genetics (Wertelecki, 1983).

Dermatoglyphic traits are formed under genetic control early in development but may be affected by the environmental factors (such as viral infection, radiation, alcohol and drug abuse) during the first trimester of pregnancy (Chintaman *et al.,* 2007, Bramon *et al.,* 2005). The dermal patterns once formed remain constant throughout life (Abbasi *et al.,* 2006). Since dermatoglyphic alterations point toward disruption of fetal development, the report by Menser and Purvis-Simth (1969) pointing out that dermatoglyphic alterations were present in childhood leukemia was quite provocative as leukemia was considered to be a postnatal event. These patterns may represent

the genetic makeup of an individual and therefore his or her predisposition to certain diseases.

Furthermore, dermatoglyphics serve as a window of congenital abnormalities and is a sensitive indicator of intrauterine anomalies (Menser and Purvis-Smith, 1969; Matsuyama and Ito, 2006). The importance of these markings to the geneticist was not realized until recent years, they have to be helpful adjunct to other diagnostic method in identifying specific syndromes of a genetic origin (Mustanski *et al.,* 2002). Dermatoglyphics analysis is now a valuable companion to other methods used to detect some genetic diseases. They are considered as markers in single gene disorder: sickle-cell anemia; (Oladipo *et al.,* 2007), phenyloketonuria; (Lapuszanska and Jankowska, 2001), chromosomal abnormality: Down, Turner and Klinefilter syndromes; (Nazarabadi *et al.*, 2007), and multifactorial condition: rheumatoid arthritis; (Ravindranath *et al.,* 2003) and cancers; (Natekar and De Souza, 2006). Since both dermal ridge and brain are derived from the ectoderm, it appears reasonable to use unusual dermatoglyphic patterns to characterize disturbances to brain development in schizophrenic and epilepsy patients (Al-Janaby and Abdullah, 1995). Furthermore, dermatoglyphics are polygenic markers that are useful in studying population dynamic and gender dimorphism (Abdullah and Al-Bakry, 1986; Wang *et al.,* 2008). It has been suggested that human dermatoglyphics and brain asymmetry are influenced by prenatal hormone level (Jamison *et al.,* 1993).

Handedness is the uneven distribution of fine motor skills between the left and right hands (Raymond and Pontier, 2004). Determination of handedness are important in various aspects of forensic science, including personal identification (Stark, 2001), hence, establishing the relationship between handedness and dermatoglyphics will aid forensic identification. Few studies have investigated whether there is a correlation between handedness and dermatoglyphics. In 1940 Cummins discovered a slight association in the sex differences of asymmetrical occurrence of dermatoglyphic patterns (Cummins, 1940). Cromwell and Rife in 1942 found that left-handers are characterized by slightly less bimanual asymmetry than right-handers among on Caucasian school children in southwestern Ohio (Cromwell and Rife, 1942). In 1943, Rife found association characteristic of

autosomal linkage between the whorl frequencies on the fingers and handedness among descendants from Northern European stock. Coren (1994) reported an increased number of arches, fewer whorls in left-handers as compared to the right-handers among Canadians (Coren, 1994). Cho in 2010 found significant difference of dermatoglyphics patterns on digit 3, 4 and 5 among Koreans. There are however no reported study showing the association between handedness and dermatoglyphics in our population.

MATERIAL AND METHOD

One hundred and twenty subjects (n = 120) who met the criteria for the study participated in the study. The basic criteria included natural handedness (acquired handedness was ruled out) as well as quality corresponding dermatoglyphic prints and adequate demographic information. All subjects were selected from the Nigerian population and were all undergraduates, being within close age range. Structured questionnaires were used to obtain demographic information of subjects. The thumbprints of both hands were obtained with the aid of ink and paper; and classified primarily as Whorl (W), Arch (A) or Loop (L). Handedness could be Right (R), Left (L) or Both (B). Data obtained from the subjects were analysed using descriptive statistics.

RIGHT

Demographic Information

All subjects were Nigerians. The total number of subjects involved in the test was 120: 42(35%) males and 78 females (65%). The mean age of subject is 19 years. Right handedness and ambidexterity were observed, but Left handedness was not. All basic types of thumbprints were observed.

Table 1: Illustration of Handedness Types and Distributions Across Genders; 96.7% of subjects were right-handed and this is also roughly applicable to each sex.

	RH	LH	A [BH]	Total
M	40 (33.3%)	0(0%)	2(1.7%)	42(35%)
F	76 (63.3)	0(0%)	2(1.7%)	78(65%)
Total	116(96.7%)	0(0%)	4(3.3%)	120(100%)

[RH = Right-handedness; LH = Left-handedness; A = Ambidexterity (BH = Both Hands)]

Table 2: Dermatoglyphic Patterns Distribution: Right Thumb; the Ulnar Loop is generally the commonest right thumbprint pattern, followed by the Central Pocket Whorl pattern.

	RW_P (%)	RW_{CP} (%)	RW_{DL} (%)	RW_A (%)	RA_P (%)	RA_T (%)	RL_U (%)	RL_R (%)
M	1 (0.8)	12 (10)	4 (3.3)	0 (0)	3 (2.5)	4 (3.3)	18 (15.0)	1 (0.8)
F	2 (1.7)	22 (18.3)	6 (5.0)	2 (1.7)	12 (10)	6 (5.0)	25 (20.8)	2 (1.7)
T	**3 (2.5)**	**34 (28.3)**	**10 (8.3)**	**2 (1.7)**	**15 (12.5)**	**10 (8.3)**	**43 (35.8)**	**3 (2.5)**
GT	**120**							

[RW_P = Right Thumb Whorl- Plain; RW_{CP}= Right Thumb Who Right Thumb- central Pocket; RW_{DL}= Right Thumb Whorl- Double Loop; RW_A- Right Thumb Whorl- Accidental; RA_P= Right Thumb Arch- Plain; RA_T = Right Thumb Arch- Tented; RL_U = Right Thumb Loop- Ulnar; RL_R = Right Thumb Loop- Radial]

Table 3: Dermatoglyphic Patterns Distribution: Left Thumb; the Ulnar Loop is generally the commonest left thumbprint pattern, followed by the Central Pocket Whorl pattern.

	LW_P (%)	LW_{CP} (%)	LW_{DL} (%)	LW_A (%)	LA_P (%)	LA_T (%)	LL_U (%)	LL_R (%)
M	0 (0)	8 (6.7)	2 (1.7)	1 (0.8)	6 (5.0)	3 (2.5)	20 (16.7)	2 (1.7)
F	0(0)	17 (14.2)	10 (8.3)	2 (1.7)	11 (9.2)	8 (6.7)	24 (20.0)	4 (3.3)
T	0(0)	25 (20.8)	12 (10.0)	3 (2.5)	17 (14.2)	11 (9.2)	44 (36.7)	6 (5.0)
T	**118 + 2**							

[RW_P = Right Thumb Whorl- Plain; RW_{CP}= Right Thumb Who Right Thumb- central Pocket; RW_{DL}= Right Thumb Whorl- Double Loop; RW_A- Right Thumb Whorl- Accidental; RA_P= Right Thumb Arch- Plain; RA_T = Right Thumb Arch- Tented; RL_U = Right Thumb Loop- Ulnar; RL_R = Right Thumb Loop- Radial]

Table 4: Relationships between Sex, Handedness and Thumbprint Features: Right Handedness; most right-handed subjects had the Whorl right thumbprint pattern and the Loop left thumbprint pattern.

	Right Handedness					
Sex	**RH+RW (%)**	**RH+LW (%)**	**RH+RA (%)**	**RH+ LA (%)**	**RH+RL (%)**	**RH+ LL (%)**
M	16(13.3)	11(9.2)	6(5.0)	8(6.7)	19(15.8)	22(18.3)
F	33(27.5)	29(24.2)	18(15.0)	18(15.0)	27(22.5)	28(23.3)
T	**49(40.8)**	**40(33.3)**	**24(20.0)**	**26(21.7)**	**46(38.3)**	**50(41.7)**

[RH+RW= Right-handedness with Whorl Right Thumb Print; RH+LW= Right-handedness with Whorl Left Thumb Print; RH+RA= Right-handedness with Arch Right Thumb Print; RH+ LA= Right-handedness with Arch Left Thumb Print; RH+RL= Right-handedness with Loop Right Thumb Print; RH+ LL= Right-handedness with Loop Left Thumb Print]

Table 5: Relationships between Sex, Handedness and Thumbprint Features: Ambidexterity.

	Ambidexterity [Both Hands]					
Sex	**A+RW (%)**	**A+LW (%)**	**A+RA (%)**	**A+LA (%)**	**A+RL (%)**	**A+ LL (%)**
M	1(0.8)	1(0.8)	1(0.8)	1(0.8)	0 (0)	1(0.8)
F	0 (0)	1(0.8)	0 (0)	1(0.8)	1(0.8)	0 (0)

[A+RW= Ambidexterity with Whorl Right Thumb Print; A+LW= Ambidexterity with Whorl Left Thumb Print; A+RA= Ambidexterity with Arch Right Thumb Print; A+ LA= Ambidexterity with Arch Left Thumb Print; A+RL= Ambidexterity with Loop Right Thumb Print; A+LL= Ambidexterity with Loop Left Thumb Print]

DISCUSSION

Handedness was predominantly right among the tested subjects (96.7% total; 66.3% out of 65% for females and 33.3% out of 35% for the male) (See Table 1). This shows that both males and females are largely right-handed in the study. Left handedness was not observed. Also, 4.8% of the male subjects (relative to the total number of males) were ambidextrous 2.6% of females were ambidextrous. Altogether only 3.3% of the whole study group were ambidextrous.

For the right thumb prints studied; the Loop pattern of fingerprint accounts for the largest percentage generally and for either sex. Both the Radial and Ulnar Loop patterns were observed; the Ulnar Loop however was by far the largely observed of the two. Of the entire study group, 38.3% had the Loop pattern on their right thumb, of these, 35.8% had the Ulnar Loop while 2.5% had the Radial Loop, indicating that the Ulnar loop was quite more frequently observed. While 42.9% of all males in the study group had the Ulnar Loop, only 2.4% had the Radial Loop. For the females, 32.1% (of the total number of females studied) had Ulnar Loop while 2.6% had Radial loops. While there is just a slight percentage difference of 0.2% between males and females who had the Radial Loop on their thumb; a much larger percentage difference of 10.8 exist between males and females who had the Ulnar loop, the males having the larger percentage resulting in the difference. In other words, males and females generally had large percentage of the Ulnar Loops but relative percentage is much higher in the male than the female. This could be pointer to dimorphism on the basis of sex if found consistently significant within the population.

The next most frequently observed right thumb print pattern is the Whorl and all types [Plain, Central Pocket, Double Loop and Accidental] are observed, however, to varying degrees cum percentages. Generally, the Central Pocket Whorl pattern

[RW_{CP} = 28.3%, Table 2] is of the largest percentage. Furthermore, 28.6% of the males involved in the study had this pattern on their right thumb while 28.2% of the females had the pattern; these values are relatively close. Generally, other types of the Whorl pattern observed and in descending order of their percentages include the Double Loop [RW_{DL} = 8.3%]; Plain [RW_P = 2.5%] and Accidental [RW_A = 1.7%] [see Table 2]. A closer look shows that 9.5% and 7.7% of the males and females respectively had the Double Loop; 2.4% and 2.6% of the males and females respectively had the Plain and 0% and 2.6% of the males and females respectively had the accidental. It is important to note that though the accidental pattern is generally least observed; it was not observed at all in the male members.

For the left thumb prints, the loop is the commonest pattern, being 41.7% of the total left thumbprints studied. Out of these the larger percentage of 36.7% was of the Ulnar Loop pattern while the remaining 5.0% were of the Radial Loop. Again, the Ulnar Loop is the quite commoner type of Fingerprint pattern of the two types of Loop. More details would show that for the males 47.6% and 4.8% had the Ulnar and the Radial Loops respectively while the figures are 30.8% and 5.1% for the females. The Whorl patterns altogether account for 33.3%. The Central Pocket Whorl pattern had the largest percentage of 20.8% out of the total 33.3% and there was no Plain Whorl pattern recorded for the left hand as against the total 2.5% recorded for the right thumb print. Variations could be noticed on the basis of sex; that is, percentage of thumb print pattern within each sex. The percentages for each type for the male and female sexes respectively include: Central Pocket Whorl- 19.0% and 21.8%; Double Loop Whorl- 4.8% and 12.8%; Accidental Whorl 2.4% and 2.6%. [See Table 4]

Table 4 presents the distribution of thumbprint patterns among the right-handed subjects. It is important to consider the proportional distribution of thumbprint patterns and to compare the variations between the right and the left thumbprints. Out of the 120 right thumbprints studied [for 120 subjects]: 40.8%, 20.0% and 38.3% had the Whorl, Arch, and Loop respectively. Obviously, most right-handed people in this study had the Whorl thumbprint pattern and the least percentage being of the Arch. For the left thumbprints 41.7%, 33.3% and 21.7% had the Loop,

Whorl and the Arch patterns respectively. This shows that most right-handed people in this study had the highest percentage of Loop [RH+ LL = 41.7%, Table 3] while the least is the Arch [RH+ LA = 21.7%, Table 3]. For both thumbs, the Arch pattern has the least percentage for right-handed people.

Since left handedness was not observed in any subject involved in the study, no fingerprint pattern could be matched with it. Subjects who exhibited ambidexterity [3.3%, Table 1] had all types of thumbprint patterns. For the right thumbprint, a subject- [0.8% of the study group], male and ambidextrous, had the Whorl; another 1 [0.8% of the study group], also male, had the Arch; while a female had the Loop on her right thumb. The left thumb of 2 subjects, a male and a female [1.7% of the total subjects studied] had the Whorl pattern, while another 2, also a male and a female had the Arch. Only a subject, male had a left thumb print of the Loop pattern. There is no clearly defined link between Ambidexterity and any particular type of fingerprint, especially with a quite small percentage of 3.3% of the study group exhibiting ambidexterity.

CONCLUSION

Thumbprint patterns vary among the subjects and this is supposedly representative of the population with the ulnar loop being the commonest pattern for both hands. Right handedness was the predominant; without left handedness, thus ambidexterity accounts for the remaining 3%. While right handedness was well studied, the very low percentage representative of ambidexterity and lack of left handedness limits critical comparative analysis. What is however interesting is the observation of the relative percentage distributions of handedness, thumbprint patterns and gender among the subjects. These results could be compared with other study groups on the basis of nationality and race among other parameters. Another interesting peculiar factor that could influence handedness in the represented population is the cultural discouragement of left handedness, especially in children; an effect that may not change laterality and handedness absolutely, but may result in acquired ambidexterity. Such effects should also be noted if observed in any other research.

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