SEXUAL DIMORPHISM IN FINGERPRINT PATTERN: A TOOL FOR SEX IDENTIFICATION.

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ABSTRACT

Determination of individuality plays an important part of any medico-legal investigation. One of the most reliable methods of identification is fingerprints. The present study was conducted on 200 healthy adult Egyptian subjects in Assiut Governorate (100 males and 100 females) with age ranged from 18 to 60 years. Rolled impressions of the 10 digits from all participants and their print were recorded after taking their consent to determine the sexual dimorphism by fingertip pattern. Statistical analysis was made. The distribution analysis of fingerprint were (loops, whorls, arches and composite) and their subtypes. It was shown that loops are the most common, arches are the second and whorls the third, and composite are the least common with a very small percentage (3.1%) in both hands. Most loops were ulnar while only 12.4 % of loops were radial .Of the total arches, 86.5% arches were plain arches and 13.5% arches were tented arches. The frequency of the loops was higher in both right and left digits in males and females except the ring finger shows high frequency of whorls. The bimanual differences both in males and females are statistically significant for the occurrence of patterns on the digits of the right and left hands, but the difference between both sexes for the occurrence of patterns is not statistically significant.

Key words: print, fingerprint, dimorphism and identification

I-INTRODUCTION

Determination of individuality is very important in forensic practice. Several parameters usually noted for the purpose of identification these include: race, age, gender, skin texture and features, speech and voice, gait pattern, tattoo marks, footprints, deformities, hair, scars, occupational marks, handwriting, garments and personal articles, fingerprints and DNA profile (Hansi et al,2014). Out of all these parameters which is extensively used Fingerprints which is considered one of the cheapest, best, and legitimate proofs of identification, because they are permanent, individual and unique. (Pillay, 2009).

Dactylography or dactyloscopy is the study of fingerprints as a method of identification and is also known at present, as Henry-Galton system of Identification (Nandy, 2010). The word Dactylography is taken from two Greek words, daktylos meaning finger' and graphein meaning to write (Kumar, 2011). Fingerprints are formed in the human fetus before birth, and remain unchanged all over the life, unless damage or any lesion occurs to the dermal of the finger skin layer. Fingerprints are genotypically determined so they are unique to every single individual (Vij, 2005). It has been estimated that chances of two persons having identical finger impressions is a very rare chance (Modi, 2002). In spite of that the identical twins originating from one fertilized egg share the same DNA profile because they began existence as one entity, yet their fingerprints are characteristic as any unrelated persons (Mozayani, and Noziglia, 2006). The aim of this work was to examine the patterns of fingerprints in both hands as well as in individual digits of some Egyptian samples in Assiut Governorate, and to find if any variation occurs between both sexes for both hands.

III-SUBJECTS AND METHODS

In the present study, 200 persons were taken (100 males and 100 females). The age of subjects ranges from 18-60 years.

III a-Inclusion Criteria:

1-Belonging to Egyptian populations.
3-Healthy subjects.

4-No deformity related to finger print (normal finger print).

III b-Exclusion Criteria:

1- Any type of physical deformity.

2- The subject with a major deformity (congenital/accidental) in the upper extremity (syndactyl, polydactyl).

3-Any trauma or previous surgery of finger that leads to change in the fingerprint pattern,

4- Any subject with gender identity disorder or with leprosy affecting fingers.

III c-Methods:

Fingerprints of the 10 digits are collected after washing the hands with soap and drying. The material used is ink pad. The fingers bulbs are rolled on the plate smeared with ink and then placed on a box of the white paper, with avoiding excessive pressure on the fingers while inking and recording (Nithin et. al, 2009), after the fingerprint is obtained the further details name, sex and age are noted. Digital prints were carefully examined to identify the following patterns, (using a hand lens: magnification 10×)**.** Arches, loops, whorls, and composite based on the outward show of ridge lines delta and core.

III d-Ethical Consideration:

The approval for this study was obtained from the Ethical Clearance Committee of the faculty. Oral informed consent was obtained from all subjects after they were informed about the purpose and nature of the study.

III e-Statistical methodology:

The collected data subsequently entered in a database program. Descriptive statistical organized using SPSS (statistical Package for Social Science) version 20.Chi-square carried out on all cases to demonstrate test any significant gender difference; p-Value <0.05 was considered as significant.

IV-RESULTS

In the present study 200 persons were taken from out of which 100 males and 100 females, among males age group ranged from 18-60 years. Mean age group was 30.87+9.91. In females, age group ranged from 18- 60 years. Mean age was 33.7 +11.76. Highest frequency of fingerprint patterns in both hands were mostly loops (36.3%) followed by arches (31.8%), and whorls (28.8%) (Table1).

Gender wise distribution of fingerprint pattern of the male and female hands (in both hands):

In the male population, frequency were found to be loops (40%) followed by arches (35%) and whorls (22.4%). In the females frequency were found to be whorls (35.2%) followed by loops (32.6%) and arches (28.6%). Least noted pattern among both was composite (Table2).

Subtypes of each of the four fingerprint pattern were identified and their distribution was given below:

-Loops: In both males and females, ulnar loops were the commonest type and radial loops were the least common. (Table3).

-Whorls: In both males and females, Spiral whorls were the predominant type and Elliptical whorls were the least common one. (Table4).

-Arches: In both males and females, Plain arches were the most common, tented arches were the least common one. (Table 5).

-Composites**:** In both males and females the most common type of composite pattern was twinned loop and the least common was central pocket. (Table 6).

The predominant pattern among both males and females was ulnar loop (33.6%) in male and (30%) in female, followed by plain arches (30%) in males and (25%) in females respectively. Central pocket loop whorl in male was (0.02%) and in females was (0.06%) respectively. It has been observed that whorls are more abundant than loops in females .The difference was insignificant (p>0.05) [Table7].

Fingerprint pattern in every digit (on different digits separately:

The frequency of the ulnar loops was higher in both right and left digits in males and females except the ring finger had higher frequency of whorls. Whorls were highly frequent on the, ring, thumb, and middle in that order and they were least on the little fingers in male and female subjects.

A high frequency of arches on the right hands except on the ring finger in females while, males presented a high frequency of arches on the left hands except on the ring finger and there was a bimanual difference in the distribution of the arches was significant in both sexes . Composites were highly frequent in thumb finger in both sexes. The difference was significant (p<0.05). [Table 8, 9].

Table (1): Distribution of different patterns of fingerprints in both hands.

Pattern	Cases	%
Loops	726	36.3
Arches	636	31.8
Whorls	576	28.8
Composites	62	3.1
Total	2000	100

Table (2): Fingerprint patterns and gender distribution in both hands.

Pattern	Males		Females		Total
	No	%	No	%	
Loops	400	40	326	32.6	726
Arches	350	35	286	28.6	636
Whorls	224	22.4	352	35.2	576
Composites	26	2.6	36	3.6	62
Total	1000	100	1000	100	2000

Table (3): Types of loop pattern and gender distribution.

Types of loops	Males	Females	Total
Ulnar	336 (84%)	300(88.2%)	636 (87.6%)
Radial	64(16%)	26(11.8%)	90 (12.4%)
Total	400(100%)	326 (100%)	726(100%)

Table (4): Types of whorl pattern and gender distribution.

Types of Whorls	Males	Females	Total
Spiral	133 (59.4%)	218(61.9 %)	351(60.9%)
Circular	62 (27.7%)	90 (25.6%)	152((26.4%)
Double core	22 (9.8%)	29 (8.2%)	51(8.9%)
Elliptical	7 (3.1%)	15 (4.3%)	22 (3.8 %)
Total	224(%)	352(100%)	576 (100%)

Table (5): Types of arch pattern and gender distribution.

Types of Arches	Males	Females	Total
Plain	300(85.7%)	250 (87.4%)	550 (86.5%)
Tented	50(14.3%)	36 (12.6%)	86(13.5%)
Total	350 (100%)	286 (100%)	636(100%)

Table (6): Types of composite pattern and gender distribution.

Types of composites	Males	Females	Total
Twinned loops	10(38.5%)	15 (41.6%)	25(40.3%)
Lateral pocket loops	8 (30.8 %)	10 (27.8%)	18(29.1%)
Accidental	6 (23.1%)	5 (13.9%)	11(17.7%)
Central pocket loops	2 (7.6%)	6 (16.7%)	8(12.9%)
Total	26 (100%)	36 (100%)	62(100%)

Table (7): Frequencies of fingerprint patterns among males and females in both hands by Chi-square test.

Pattern	Male		Female		Total	*p-value
	Frequency	Percentage	Frequency	Percentage		
Ulnar (loops)	336	33.6%	300	30%	636	>0.05
Plain (arches)	300	30%	250	25%	550	>0.05
Spiral (whorls)	133	13.3%	218	21.8%	351	>0.05
Circular (whorls)	62	6.2%	90	9%	152	>0.05
Radial (loops)	64	6.4%	26	2.6%	90	>0.05
Tented (arches)	50	5%	36	3.6%	86	>0.05
Double core (whorls)	22	2.2%	29	2.9%	51	>0.05
Twinned loops (composites)	10	1%	15	1.5%	25	>0.05
Elliptical (whorls)	7	0.07%	15	1.5%	22	>0.05
Lateral pocket loops (composites)	8	0.08%	10	1%	18	>0.05
Accidental (composites)	6	0.06%	5	0.05%	11	>0.05
Central pocket loops (composites)	2	0.02%	6	0.06%	8	>0.05
Total	**1000	100	1000	100	2000	

NB: *p-value>0.05 is insignificant; The number of cases was 200 cases (100 male, 100 female); **100 casex10 digit= 1000

Table (8): Frequencies of fingerprint patterns in different digits in males by Chi-square test.

Pattern	Little finger		Ring finger		Middle finger		Index finger		Thumb		*p-value
	RH	LH	RH	LH	RH	LH	RH	LH	RH	LH	
Ulnar (loops)	34	30	15	12	40	23	25	21	20	27	<0.05
Radial (loops)	2	2	2	0	4	0	0	4	2	0	<0.05
Plain (arch)	2	8	7	3	0	0.75	1	3	0	0	<0.05
Tented (arches)	0	0	0.13	0	0	0	0	3	0.12	0.66	<0.05
Spiral (whorls)	0.3	13	20	30	13	10	15	10	10	15	<0.05
Circular (whorls)	0	0.2	0	2	3	0	0	0	1	0	<0.05
Double core (whorls)	0	0	2	0.3	0	0	0	0	0	0	<0.05
Ellipticl (whorls)	0	0	0.7	0	0	0	0	0	0	0	<0.05
Twinned loops (composite)	1	2	4	0	3.13	0	10	0	10	10	<0.05
Lateral pocket loops (composite)	5	0	0.8	0	1.56	0	0	0.87	2.66	0	<0.05
Accidental (composite)	0.5	0	0.2	0	1.56	0	0	5.57	0	0	<0.05
Central pocket loops (composite)	0	0	0	0.87	0	0	0.56	1	1.56	0	<0.05
Total	100		100		100		100		100		

*p-value<0.05 is significant

Table (9): Percentage distribution of patterns in different digits in females by Chi-square test.

Pattern	Little finger		Ring finger		Middle finger		Index finger		Thumb		p-value
	RH	LH	RH	LH	RH	LH	RH	LH	RH	LH	<0.05
Ulnar (loops)	40	30	20	15	30	29	20	19	25	20	<0.05
Radial (loops)	0.87	2	1	1	0	1	1	2	0	0.71	<0.05
Plain (arches)	5	4	5	10	1	0.45	3	4	0.71	0	<0.05
Tented (arches)	0.45	1	1	1	0	0	4	2	0	0	<0.05
Spiral (whorls)	6	5	30	15	8	7	12	12	14	14	<0.05
Circular (whorls)	0	0	0	0	2	1	0	1	0	1	<0.05
Double core (whorl)	0	0	0	0	1	0	2	1	1	1	<0.05
Elliptical (whorsl)	0	0	0	0	3	2	2	0	0	1	<0.05
Lateral pocket loop (composites)	1	0.45	0	0	1	0.25	0	1	2	3	<0.05
Twinned loop (composites)	0	0	2	2	5	2	3	2	9	3	<0.05
Accidental (composites)	2	1	0.71	0	3	1.3	2	2	1.12	2.6	<0.05
Central pocket loop (composites)	0	0.71	0	0	1	1	2	3	1	0.4	<0.05
Total	100		100		100		100		100		

*p-value<0.05 is significant

V-DISCUSSION

Fingerprints are formed in the human fetus before birth and they are unique to every single individual and fixed does .They don't change throughout life unless damage occurs to the dermis of the finger (Han et al., 2004). The aim of this work was to study various patterns of fingerprints and their distribution in different fingers, and to find if any variation occurs between both sexes for both hands.

In this study, the majority of the patterns observed were loops followed by arches and whorls in the both hands. The least frequently observed pattern in the total population was composites. On analyzing the distribution of fingerprint patterns in either sex, loops were the predominant pattern, followed by arches in males, the third most common pattern was whorls, followed by composites. While in females, the most common pattern was whorls followed by loops then arches.

Owing to the detailed classification and the subtypes used in this study the results of this study vary slightly against most of the other researchers who used general major classification (i.e. loops, arches and whorls). The results of the study are in partial accordance with the other studies who also found that the loop pattern is the most common type in the various populations as Gangadhar and Rajashekara. (1993) ,who reported predominance of loop patterns (57.11%) followed by whorls (27.89%) and arches (15%) in Adikarnataka population of Mysore city of Karnataka State also Igbigbi and Msamati in their study on indigenous black Zimbabweans, in Kenyan and Tanzanian subjects (2002) found that ulnar loops were the most prevalent digital pattern type in most sexes, followed by whorls in males and arches in females, Another study conducted on males of Mundas and Lodhas tribals from Midnapur district in West Bengal by Purkait,(2003) who studied the frequency and variation of fingerprint patterns in the 10 digit classification mentioned that Mundas have higher incidence of whorl and loop patterns whereas the loops were more frequent among Lodhas. Another study by Jaga and Igbigbi in

Ijaw subjects of Southern Nigerians (2008), Nithin et. al.(2009) who reported the most common occurrence of ulnar loops (52.3%) followed by whorl pattern (28.74%) in South Indians of Mysore and by Eboh (2012) who reported that the most common types are ulnar loop followed by whorls and arches patterns, in Anioma and Urhobo population of Southern Nigeria .

The results of the current study are found to be in contrast to some researchers who reported whorls to be the most common pattern, followed by loops and arches in both the hands of both genders as Ching Cho(1998) who reported the predominance of whorls (60.6%) followed by ulnar loops (38.65%) in New Zealand Samoans, and by Singh and Garg.(2004) in Rajputs of Himachal Pradesh, by Banik et. al.(2009) among Rengma Nagas of Nagaland, by Biswas(2011) among Dhimals of North Bengal .These differences may be explained by the developmental variation and heritability among sexes that may account for sexual dimorphism of these patterns. Arches were present more in males than in females in this study. This is contrary to the study of various other authors (Ekanem et al., 2009, Prateek and Keerthi 2010, Eboh ,2012,)

The study of fingerprint patterns on individual digits revealed that there was preponderance of loops on the all fingers except ring finger, whorls on the ring, thumb and index finger and arches on the little and ring fingers in both hands.

Also, the results of this study are found to be in contrast to the studies conducted by Amit and Anjulika. who study the fingerprint patterns among medical students in vidarbha region (2015) in India and observed that the higher majority of loops were present in little and middle finger of both genders and also the ring finger in males showed maximum percentage of whorls, while in little and ring fingers of both genders arches were more which is in accordance with kanchan and Chattopadhyay (2006) , who studied the fingerprint patterns distribution among medical students. The differences in the results of this study from

other studies may be due to regional differences.

VI-CONCLUSION

In this study, distribution of fingerprints patterns as well as their subtypes was made out. Ulnar loops were the most common type of patterns followed by plain arches in both males and females. However, in both genders the frequency of whorl pattern is greater in ring finger. Central pocket loop (subtype of composites) were the least common type in male; accidental (subtype of composites) also was the least common type in females. The bimanual differences both in males and females are statistically significant for the occurrence of patterns on the digits of the right and left hands, but the difference between both sexes for the occurrence of patterns is not statistically significant. Further studies on larger sample sizes are needed to substantiate our findings.

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None.

VIII-Conflict of interest
None.

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التمييز الجنسي في نمط بصمات الأصابع: أداة لتحديد الجنس.
هبة عطية يسي ، صفاء ماهر جورج

قسم الطب الشرعي والسموم الإكلينيكية ، كلية الطب ، جامعة أسيوط

تحديد الهوية يلعب دورا هاما في أي تحقيق طبي. واحدة من أكثر الطرق الموثوقة لتحديد الهوية هي بصمات الأصابع. أجريت الدراسة الحالية على ٢٠٠ شخص مصري بالغ من الأصحاء في محافظة أسيوط (١٠٠ من الذكور و ١٠٠ من الإناث) تراوحت أعمارهم بين ١٨ و ٦٠ سنة. واخذت بصمات الأصابع من جميع المشاركين بعد أخذ موافقتهم و تم إجراء تحليل إحصائي. وتم توزيع أنماط بصمات الأصابع الي (حلقات، دوائر، و مقوسات و مركبات) وأنواعها الفرعية. وقد تبين أن الحلقات هي الأكثر شيوعا و يليها الأقواس ثم الدوائر ، والمركب هي الأقل شيوعا مع نسبة صغيرة جدا (٣.١٪) في جميع السكان، في حين كانت الحلقات الأكثر شيوعا في الذكور و الإناث وكانت معظم الحلقات من النوع الزندي بينما فقط ١٢.٤٪ من الحلقات كانت حلقات شعاعي. من الأقواس الكلية، كان ٨٦.٥٪ من الأقواس كانت الأقواس السهلة و ١٣.٥٪ من الأقواس أقواس خيام. وكان نسية الحلقات أعلى في كل من اليد اليمنى واليسرى في الذكور والإناث باستثناء البنصر . إحصائيا لم تكن هناك اختلافات كبيرة بين الجنسين ($p > 0.05$) في التوزيع الكلي لنماذج بصمات الأصابع في أصابع اليدين بين الذكور والإناث. , ولكن وجد أن الفروق الثنائية بين انواع البصمات في الاصابع وبعضها كانت ذات دلالة احصائية ($p > 0.05$).