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Exploration of sexual dimorphism and Bilateral asymmetry in finger print patterns of North Indian population: A cross sectional study

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Abstract---Introduction- The fingerprints are most dependable and acceptable dermatoglyphic traits for personal identification. The current study is an attempt to observe the percentage frequency distribution of patterns of fingerprint bilaterally as well as digit wise, to assess the predominant pattern type, besides, evaluating the statistically significant gender variations. This study may enhance the authenticity of finger print patterns in identifications of suspects. Material & method- The study sample was consisting of fingerprints of 600 medical students of Punjab, India. The subjects were aged between 17–25 years and male female ratio was 1:1. Fingerprints were recorded by the ink and roller method of Cummins and Midlo and analysed manually by using Henry's classification. Appropriate statistical tests were applied to achieve aim of study. Result- This cross-sectional study revealed that the most common finger print pattern of both hands was Loops (L-51.6%, R-53.3%), followed by whorls (L-38.6%, R-38.2%), arches (L-8.8%, R- 6.7%) and composites (L-1.0%, R-1.8%) respectively. Each digit shows preferences for

specific patterns. Discussion- The current study showed insignificant bilateral difference and significant sexual dimorphism in the distribution frequency of the finger print which might be caused by differences in heritability and developmental variation among sexes.

Keywords--finger print patterns, gender differences, bimanual differences.

Introduction

Fingerprints are specific patterns formed on the skin of finger tips by presence of friction ridges and grooves alternatively. The ridges flow in various directions, giving rise to innumerable patterns which are unique for every individual. Bansal et al., (2014) cited that Identical twin sharing the same DNA profile, have distinctive fingerprints as development of ridges was found to be affected by genetic and environmental factors. These patterns begin to develop between the fifth and sixth week of intrauterine life, and are fully developed by the 21st week. (Wijerathne, 2013) These fingerprint patterns cannot be changed with time even up to the death of an individual as these are encoded at the interface between dermis. (Sangam et al., 2011) That why, in the court of law, fingerprints are most dependable and acceptable dermatoglyphic traits for personal identification.

Sir Francis Galton classified fingerprint patterns in different groups as loops, whorls and arches which was further modified by Sir Edward Richard Henry in 1900 by adding a new group -composites. Loops are the patterns that start from one side, move towards the centre, curve backwards and terminate on the same side. Whorls are circular or spiral arrangement of ridges in the centre, in Arches, the ridge lines start from one side and end at the opposite end and composites are combination of all the patterns (Kanchan & Chattopadhyay, 2006). Although worldwide average distribution of different fingerprint patterns is known but their distribution is said to vary in different digits and genders. Bilateral asymmetry of the dermal ridge patterns, is one of the least understood aspects as well as published literature on the distribution of fingerprint patterns on individual digits is very few. Hence the current study is an attempt to observe the percentage frequency distribution of patterns of fingerprint bilaterally as well as digit wise, to assess the predominant pattern type, besides, evaluating the statistically significant gender variations. This study may enhance the authenticity of finger print patterns in identifications of suspects.

Material and Methods

The study sample was consisting of fingerprints of 600 medical students of Punjab, the subjects were aged between 17–25 years and male female ratio was 1:1. The study was carried out after obtaining ethical approval from the Institutional Review Committee. All subjects were properly explained about the objectives of the intended study and then consent was taken. The materials used for recording the finger prints were: Stamp pad, Sheets of papers, Magnified glass.

Technique

The fingerprints were recorded by the ink and roller method, as was suggested by Cummins and Midlo (1961).

Recording of Fingerprints

Subjects were asked to wash their hands with soap and water to remove any oil or dirt. A clean, white bond paper sheet was kept at the edge of the table, marked with their name, sex and age. Then they were asked to press their finger tips on stamp pad and then on respective blocks of Performa to transfer the fingerprint impressions. Care was taken to avoid sliding of thumbs to prevent smudging of print.

Sr.No	THUMB	INDEX FINGER	MIDDLE FINGER	MIDDLE FINGER	LITTLE FINGER
RIGHT HAND					
LEFT HAND					

Criteria of exclusion

- Subject with permanent scars on their palm, fingers or thumbs.
- Subject with any hand deformities due to injury, birth defect, burns or disease.
- Subject having worn finger-prints, extra, webbed or bandaged fingers.
- The fingerprint patterns were studied with the help of a magnifying lens and were identified into basic patterns. The frequency distribution of fingerprint patterns in both hands of subjects and its relationship with gender were evaluated and analysed by using chi square test.

Results

In this cross-sectional study, the quantitative analysis of digital dermatoglyphics revealed that the most common finger print pattern of both hands was Loops followed by Whorls, Arches and Composites.

Table 1
Gender wise distribution of finger print patterns of left hand

[illegible]

Gender												
LOOPS Counts % Within the Gender	182 60.7 %	158 52.6 %	122 40.6 %	91 30.4 %	188 62.6 %	158 52.7 %	103 34.3 %	102 34.0 %	224 74.7 %	221 73.6 %	819 52.9% 730 47.1%	1549 51.6%
ARCHES Counts % Within the Gender	09 03.0 %	12 04.0 %	59 19.7 %	55 18.3 %	39 13.0 %	54 18.0 %	05 1.7%	19 6.4%	04 1.3%	08 2.7%	116 43.9% 148 56.1%	264 8.8%
COMPOSITE Counts % Within the Gender	04 1.3%	02 0.7%	05 1.7%	03 1.0%	02 0.7 %	06 2.0 %	0 0%	07 2.3%	00	00	11 37.9% 18 62.1%	29 1.0%
TOTAL	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	1500 1500	3000 100%

The most common finger print pattern of left hand was Loops (51.6%) followed by Whorls (38.6%), Arches (8.8%) and Composites (1.0%). The whorls were most commonly found in Ring finger, then Index, thumb, Middle finger and little finger. In Thumbs, Index and middle fingers, Whorls were more frequent in females than males. The loops were most prevalent in little finger followed by middle, thumb, index and ring finger. In all fingers, Loops were more prevalent in males than their female counterparts. The Arches were mostly found in index and few were present in middle, ring, thumb and ring finger. In all digits, Arches were more frequent in females than males. The composites were most frequent in index finger, followed by middle, ring finger and thumb. No composites were seen in little fingers in both genders as well as in ring fingers of males. Thumb and Index finger showed male dominance while middle and ring fingers showed female dominance. According to this study, the most common finger print pattern found in both genders, more precisely -in thumb was Loop, in middle finger-Loop, in ring finger- Whorl and in little finger-loop. The frequency distribution of finger print pattern in index finger showed gender variation -loop in males and Whorl in females.

Table 2
Gender wise distribution of finger print patterns of right hand

FINGER PRINT PATTERN	Thumb		INDEX		MIDDLE		RING		LITTLE		TOTAL	
	M	F	M	F	M	F	M	F	M	F	M	F
WHORLS Counts % Within the Gender	131 43.7 %	137 45.7 %	119 39.7 %	129 43.0 %	72 24.0 %	62 20.7 %	187 62.3 %	173 57.7 %	78 26.0 %	58 19.3 %	587 51.3% 559 48.7%	1146 38.2 %
LOOPS Counts % Within the Gender	158 52.7 %	148 49.3 %	121 40.3 %	107 35.6 %	201 67.0 %	202 67.3 %	103 34.4 %	107 35.7 %	218 72.7 %	23 3 77.7%	801 50.1% 797 48.9%	1598 53.3 %
ARCHES Counts % Within the Gender	04 1.3%	14 4.7%	49 16.3 %	53 17.7 %	23 7.7%	29 9.7%	06 2.0%	16 5.3%	04 1.3%	05 1.7 %	86 42.3% 117 57.6%	203 6.7%
COMPOSITE S Counts % Within the Gender	07 2.3%	01 0.3%	11 3.7%	11 3.7%	04 1.3%	07 2.3%	04 1.3%	04 1.3%	0 00%	04 1.3 %	26 49.1% 27 50.9%	53 1.8%
TOTAL	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	300 100 %	30 10 0%	1500 1500	3000 100 %

The most common finger print pattern of right hand was Loops (53.3%) followed by Whorls (38.2%), Arches (6.7%) and Composites (1.8%). The whorls were most commonly found in Ring finger, then thumb, Index, Little and Middle finger. In Thumbs and Index fingers, Whorls were more frequent in females than males. The loops were most prevalent in little finger followed by middle, thumb, index and ring finger. In Thumbs and Index fingers, Loops were more prevalent in males than females. The Arches were mostly found in index and few were present in middle, ring, thumb and ring finger. In all digits, Arches were more frequent in females than males. The composites were most frequent in index finger, followed by middle, ring, thumb and little finger. No gender variation was seen in Index and ring finger but these were more prevalent in females than their male counter parts, in middle and little finger. only thumb showed male dominance while composites were absent in little finger. According to this study, the most common finger print pattern found in both genders, more precisely -in thumb was Loop, in middle finger-Loop, in ring finger- Whorl and in little finger-loop. The frequency

distribution in index finger showed gender variation -loop in males and Whorl in females.

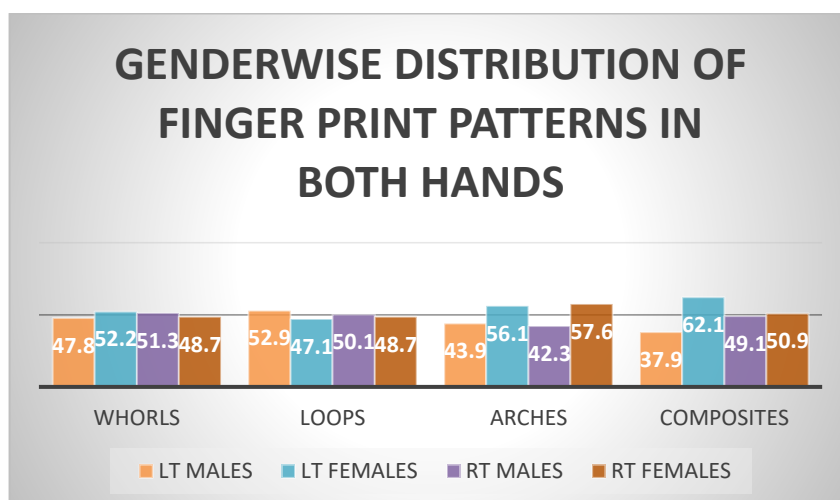


Figure 1. Genderwise distribution of finger print patterns in both hands

Discussion

The Research on fingerprint has been used since ages for the identification or verification of people as these are unique and lifelong persistent unless damage to the dermis occurs. It has unlimited application in our complicated society especially in solving the problem of human crimes, forensic science and for official documentation. If this study found that fingerprint patterns are influenced by gender, it would be useful in documentation, matching and database build-up (Iso et al., 2019). According to current study, the bilateral distribution of the finger print pattern in descending order was - loops (L-51.6%, R-53.3%) were the most prevalent pattern, followed by whorls (L-38.6%, R-38.2%), arches (L-8.8%, R- 6.7%) and composites (L-1.0%, R-1.8%) respectively [Table1,2].

Over the last century, numerous dermatoglyphics studies have been done in different part of the world. The results of our study are in accordance with the studies by Chattopadhyay et al.(1969) among Rarhi Brahmins of Bengal, Qazi et al. (1977) among Black Americans, Boroffice (1978)among Nigerians, Nithin et al. (2009) in South Indians of Mysore, Namouchi (2011) among Tunisians, Wijerathne et al. (2013) among Sinhalese population and Mehta & Mehta (2015) in Vidarbha region, who also reported the most common occurrence of loops followed by whorl pattern, arch pattern and composites in both hands of males and females. In the present study, different digits show preferences for specific patterns, bilateral and gender variation in the distribution of fingerprint patterns also found. (Table 1,2)

In thumbs of both hands, most prominent pattern was loop followed by whorl, Arch and composites. this is in accordance to study of Iso et al. (2019) among Nigerians residing in Calabar Municipality. Loops and composite showed male predominance while whorls and Arches showed female predominance. This is

contrast to present study, Iso et al. (2019) concluded that in pattern distribution, males have a higher incidence of whorls and females have a higher incidence of loops. The index finger showed gender variation in both hands as in males, the most prominent fingerprint pattern was loop followed by whorls, Arches and composites while in females the most prominent pattern was Whorls, followed by loops, Arches and composites. No significant bilateral variation is seen.

The Middle finger of both hands, most prominent pattern was loop followed by whorls, arches and composites. In left hand, only Loops showed male predominance while whorls, Arches and composites showed female predominance. In right hand, Loops and whorls both showed male predominance. It was observed in Ring fingers of both hands that whorl pattern was significantly higher in both the sexes followed by Loops, Arches and Composites. In left hand, Loops and whorls both showed male predominance while Arches and composites showed female dominance. In right hand only whorls showed male dominance and Loops, arches are more in females while composites showed no gender variation.

In little finger of both hands, the loops were much higher than whorls, arches and composites. Loops and whorls showed male dominance while Arches showed female predominance. Composites were found only in right little fingers of females. Karmakar et al. (2012) suggested that certain patterns tend to occur more frequently on some digit than on others, which seems to be constant for any population. The present study suggested that in both genders, Whorls were highly frequent on ring fingers, thumbs, and the index fingers respectively and they were least on the middle and little fingers where the frequency of the loops was high. Maximum whorls were found in Ring fingers while maximum Arches in index fingers. These observations are coinciding with the study of Kanchan & Chattopadhyay, (2006) and Mehta & Mehta, (2015).

Cummins and Midlo (1961) pointed out that dermatoglyphic characters of females differ from males. They observed in their dermatoglyphic study on various racial samples, frequency of ulnar loops and arches is higher but frequency of whorls and radial loops is lower in females compared to males. The current study showed significant difference in the distribution frequency of the finger print patterns in males and females. The results of left hand were in accordance to the study by Karmakar et al. (2012) among Muzzienna Bedouin. who observed that loop was the most common pattern in males followed by whorls and arch, whereas whorl pattern was found more frequently in females followed by loops and arch. In our study females presented a high frequency of whorls on all the digits except on the ring and little fingers. Arches were highly frequent in females than in males on all the digits except on the left index finger.

The observations by Tiwari et al. (1967) in their study on Tibetans, Wijerathne et al. (2013), Sangam et al.(2011) and Mehta & Mehta(2015,) are not substantiated with the current study as they suggested that the overall frequency of loop pattern is higher in females than males. The whorl pattern is observed more frequently in males compared to females. Wijerathne et al. (2013) suggested that Sexual dimorphism of these patterns might be caused by differences in heritability and developmental variation among sexes.

Conclusion

In present study, fingerprint pattern types for ten- digits of both males and females were observed and analysed. The results showed that in both hands of all the subjects, loops were the most prevalent pattern, followed by whorls, arches and composites. 1st and 4th digits showed high frequency of whorls while 3rd and 5th digits showed predominance of loops. There is definite preponderance of arches on the index finger and of whorls on ring fingers. The results of current study showed insignificant bilateral difference and significant sexual dimorphism in the distribution frequency of the finger print patterns. The loop was the most prominent pattern in males followed by whorls and arch, whereas whorl pattern was found more frequently in females followed by loops and arch. Some studies were not accordance to our study, this may be due to the influence of regional variations and genetic factors.

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