

A STUDY ON RELATIONSHIP BETWEEN THE SEX AND PATTERNS OF FINGERPRINTS AND DISTRIBUTION OF PATTERNS OF FINGERPRINTS AMONG GITAM MEDICAL STUDENTS

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Received : 06/07/2023
Received in revised form : 03/08/2023
Accepted : 16/08/2023

Keywords: Fingerprints, Students, Hand

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DOI: 10.47009/jamp.2023.5.4.301

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (4); 1514-1517



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Abstract

Background: Fingerprints are impressions of patterns formed by the papillary or epidermal ridges of the fingertips. In this era of technology, even after discovery of various new methods of identification, fingerprint still holds its numerous status as the surest data. Fingerprints are constant and individualistic and form the most reliable criteria for identification. The present study aims to examine the distribution of fingerprint patterns among medical students and investigate any potential associations with sex. **Materials and Methods:** This cross-sectional study was conducted on a total of 150 medical students from GITAM Institute, Visakhapatnam, Andhra Pradesh. The participants comprised 75 males and 75 females. Thumb impressions were taken from both the left and right hands of each participant. The collected fingerprint images were subsequently analyzed to identify and classify different fingerprint patterns, including loops, whorls, composites, and arches. **Results & Conclusion:** Mean age was 18.75 +/- 2.1 years. In the male population, loops were 65.6%, followed by whorls (27.47%) and arches (6.93%). In the females, loops were 58.13%, followed by whorls (34%) and arches (7.87%). The distribution of dermatoglyphic patterns was essentially same between the two hands and between the sexes.

INTRODUCTION

Fingerprints are widely recognized as a unique and reliable form of identification, serving as a fundamental tool in forensic investigations and various fields requiring personal identification.^[1,2] Extensive research has been conducted on the patterns and characteristics of fingerprints, highlighting their potential as indicators of individual traits and attributes. One particular area of interest is the investigation of the relationship between fingerprint patterns and sex, which has garnered significant attention among researchers.^[3,4] Understanding the association between sex and fingerprint patterns holds practical implications in forensic investigations, criminal profiling, and biometric systems.^[5] Moreover, analyzing the distribution of fingerprint patterns within specific populations can provide insights into the genetic and developmental factors that influence their formation.^[6] Studies underscore the significance of exploring the relationship between sex and fingerprint patterns.

However, limited research has specifically focused on populations such as medical students. Hence, the present study aims to examine the distribution of fingerprint patterns among GITAM medical students and investigate any potential associations with sex. By doing so, this study intends to contribute to the existing body of knowledge on fingerprint patterns, providing valuable insights for forensic investigations and personal identification systems.

MATERIALS AND METHODS

This cross-sectional study was conducted on a total of 150 medical students from GITAM Institute, Visakhapatnam, Andhra Pradesh. The participants comprised 75 males and 75 females. Prior to their involvement in the study, informed written consent was obtained from all participants, and the study procedures were explained to them in their native language. Ethical approval was obtained from the institutional ethical committee. The materials used in this study included ink pads for fingerprinting, a magnifying glass for print analysis, and gauze cloth

for cleaning the fingers. Prior to fingerprinting, participants were instructed to clean their hands thoroughly and ensure they were dry. Each participant's name, age, and sex were recorded on a printed paper.

Thumb impressions were taken from both the left and right hands of each participant. The ink pads were used to obtain clear and legible fingerprints. Participants rolled their fingers laterally on the ink pad, ensuring complete coverage of the fingertip, and then made impressions of all 10 fingers on the corresponding printed paper. This process facilitated the recording of each finger's name, age, sex, and fingerprint pattern. The collected fingerprint images were subsequently analyzed to identify and classify

different fingerprint patterns, including loops, whorls, composites, and arches. Subtypes of these patterns were also noted. A magnifying glass was utilized to enhance the accuracy of pattern identification and classification.

Descriptive statistical analysis was performed to summarize the distribution of fingerprint patterns among the male and female participants. Frequencies and percentages were used to present the findings. Statistical software was employed to examine any potential differences in the distribution of fingerprint patterns between the sexes. Appropriate statistical tests were utilized to determine the significance of any observed differences.

RESULTS

Table 1: Distribution of fingerprints on right and left hands

Digits		Loops		Whorls		Arches		Total	
		n	%	n	%	n	%		
Thumb	Right	92	61.33%	44	29.33%	14	9.33%	150	0.89
	Left	88	58.67%	49	32.67%	13	8.67%	150	
	R + L	180	60%	93	31%	27	9%	300	
Index	Right	87	58%	51	34%	12	8%	150	0.48
	Left	91	60.67%	53	35.33%	6	10.67%	150	
	R + L	178	59.33%	104	34.67%	18	6%	300	
Middle	Right	102	68%	43	28.67%	5	3.33%	150	0.23
	Left	98	65.33%	39	26%	13	8.67%	150	
	R + L	200	66.67%	82	27.33%	18	6%	300	
Ring	Right	82	54.67%	59	39.33%	9	6%	150	0.87
	Left	83	55.33%	61	40.67%	6	4%	150	
	R + L	165	55%	120	40%	15	5%	300	
Little	Right	107	71.33%	28	18.67%	15	10%	150	0.65
	Left	98	65.33%	34	22.67%	18	12%	150	
	R + L	205	68.33%	62	20.67%	33	11%	300	
Total	Right	470	62.67%	225	30%	55	7.33%	750	0.84
	Left	458	61.07%	236	31.47%	56	7.47%	750	
	R + L	928	61.87%	461	30.73%	111	7.4%	1500	

Table 2: Distribution of fingerprints among male & female students

Digits		Loops	%	Whorls	%	arches	%	Total	P Value
Thumb	Male	96	64%	43	28.67%	11	7.33%	150	0.43
	Female	84	56%	50	33.33%	16	10.67%	150	
Index	Male	93	62%	47	31.33%	10	6.67%	150	0.57
	Female	85	56.67%	57	38%	8	5.33%	150	
Middle	Male	106	70.67%	39	26%	5	3.33%	150	0.17
	Female	94	62.67%	43	28.67%	13	8.67%	150	
Ring	Male	93	62%	50	33.33%	7	4.67%	150	0.06
	Female	72	48%	70	46.67%	8	5.33%	150	
Little	Male	104	69.33%	27	18%	19	12.67%	150	0.52
	Female	101	67.33%	35	23.33%	14	9.33%	150	
Total	Male	492	65.6	206	27.47%	52	6.93%	750	0.01
	Female	436	58.13%	255	34%	59	7.87%	750	

DISCUSSION

Previous studies have sought to examine the relationship between sex and fingerprint patterns to identify potential sex-specific characteristics. Cummins and Midlo conducted a comprehensive analysis of a large sample of fingerprints, concluding that certain pattern types were more prevalent in males, while others were more common in females.^[7] However, they did not delve into the underlying mechanisms responsible for these

variations. Building upon this work, Holt conducted an extensive analysis of fingerprint patterns in a population of criminal offenders, affirming the findings of Cummins and Midlo and suggesting a potential genetic influence on sex-related fingerprint differences.^[8]

Recent advancements in fingerprint analysis techniques and the advent of automated systems have reignited research interest in the relationship between sex and fingerprints. Jain et al. conducted a meta-analysis of various studies, incorporating

large-scale fingerprint databases and modern statistical methods. Their results supported the existence of sex-related differences in fingerprint patterns while emphasizing the importance of considering population-specific variations.^[9] Additionally, Kapoor et al. investigated the distribution of fingerprint patterns within a specific group, highlighting distinct patterns within the population and emphasizing the role of genetic factors.^[10]

In this study, mean age was 18.75 +/- 2.1 years. In George SM et al.^[11] Mean age group was 30.87+9.91. In females, age group ranged from 18-60 years. Mean age was 33.7 +11.76. In Chukwumah AL²⁰ majority of the participants were within the ages of 18 to 20 years (46.5%).

The distribution of loops, whorls, arches and composite is approximately 65%, 25%, 7%, and 2-3% worldwide respectively.¹² In this study, loops (61.87%) were the most common pattern followed by whorls (30.73%) and arches (7.4%) were the least common. Whorls were higher in ring fingers, followed by index and thumb. Loops were most often observed on little finger and middle finger followed by thumb. Frequency of arches were higher in little finger. In George SM et al.^[11] Highest frequency of fingerprint patterns in both hands were mostly loops (36.3%) followed by arches (31.8%), and whorls (28.8%). In a study done in Ajmer population, the frequency of loops and whorls were lower than that of arches.^[13] In Nellimarla, no arches were reported in medical students.^[14] Gangadhar MR reported in a study that the basic pattern type loops (57.11%) were common followed by whorls (27.89%) and arches (15.00%) in the general population with significant sex difference.¹⁵ In Kapoor N et al.^[18] A total of 4800 fingerprints were studied and their patterns identified. Overall, loops were found to be the most common pattern (50.25%) followed by whorls (28%), composites (17.33%) and arches (4.42%). In Bansal HD et al.^[19] ulnar loop (51.3%) was found to be the most predominant pattern. In Chukwumah AL.^[20] There were more loop (n=886) followed by whorl (n=776) while the arche (n=306) was least represented among the three primary fingerprints. The whorl, loop and arches pattern of fingerprints were more represented in the left hand (50.5%, 52.5% and 51.5% respectively) compared to the right hand (49.5%, 47% and 48.5% respectively). The different in distribution between the left and right hands was not significant. In Hassan A et al.^[21] among the 500 subjects it was seen that loops were 374, whorl were 98, composite were 8 and arches were 20. In ArunKumar KR et al.^[22] loops (59.4%) were the most common pattern followed by whorls (33.9%) and arches (6.7%) were the least common. Whorls were higher in ring fingers (49.8%), followed by index (38%) and thumb (35.4%). Loops were most often observed on little finger (76%) followed by middle finger (66.3%) and thumb

(60.4%). Frequency of arches were higher in index finger (13%).

In this study, In the male population, loops were 65.6%, followed by whorls (27.47%) and arches (6.93%). In the females, loops were 58.13%, followed by whorls (34%) and arches (7.87%).

In George SM et al.^[11] 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. 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. In Sinha RR et al.^[16] among males, loops were present in 55.5% patients, whorls were present in 33% patients, composite was present in 8% patients, arch was present in 3.4% patients. Among males, loops were present in 58.5% patients, whorls were present in 27.5% patients, composite was present in 5.8% patients, arch was present in 8.2% patients.

In Nithin MD et al.^[17] In females 55.28% of ulnar loop pattern was observed against a 26.84% of the whorl pattern, and in males 49.32% of ulnar loop pattern was observed against a 30.64% of the whorl pattern. It was also observed that in the total subject population the whorl pattern was significantly higher in both the ring fingers than that of the loop pattern, i.e., 45.8% of the whorl pattern against a 42.4% of loop pattern in females and 56.2% of the whorl pattern against 30.2% of loop pattern in males. The frequency of ulnar loop pattern was higher in females than that of male population and the frequency of whorl pattern in ring fingers were more in males than female population. In Bansal HD et al.^[19] Ulnar loops were observed in 53.28% females as against in 49.21% males followed by whorl patterns in 24% females next to 29.06% in males. It was observed that whorl pattern was significantly higher in ring finger in both the sexes, females contributing about 42.14% of whorls against 36.42% of ulnar loops and in males 56.25% of whorls against 25% of ulnar loops. In Chukwumah AL²⁰ whorl finger print pattern was common in the male (51.5%) while the loop and arches patterns were more common in the female (52.0% and 51.0% respectively). However, the difference in distributions of these fingerprints between gender were not significant. In the right hand, the whorl pattern was 50% in both genders while females represented more in the loop (54.7%) and arches (52.4%) patterns. However, in the left

hand, male represented more in the whorl (53%) and loop (51%) while female presented more in the arches pattern (55%). Statistically, there were no significant difference in the pattern of fingerprint distribution in the right ($p=0.402$) and left hand ($p=0.192$) between gender. In Hassan A et al.^[21] in males the most common type of pattern was loop (32.40%) followed by whorl (7.00%) and then arch (1.60%) and composite (0.60%). In females the most common type was loop (42.40%) followed by whorl (12.60%) and then arch (2.40%) and composite (1.00%). Loop form fingerprint pattern was dominant in both males (32.40%) as well as in females (42.40%). Second most common type of fingerprint pattern was whorl in male (7%) and in female (12.60%) followed by composite in male (0.60%) and in female (1.00%) and arch in males (1.60%) and females (2.40%). In ArunKumar KR et al.^[22] Arches were higher on middle fingers of females (12.2%) when compared to males (4%). In males whorls, loops and arches were 32.8 %, 61.3% and 5.9% respectively. In females whorls were 35 %, loops 57.7% and arches were 7.3 %. From this it is evident that the difference in overall distribution of fingerprint pattern in both hands of males and females was insignificant.

CONCLUSION

The most common pattern found in both males and females were loops. The little finger displayed a higher percentage of loops, whereas the little finger also displayed the highest prevalence of arches. The distribution of dermatoglyphic patterns was essentially same between the two hands and between the sexes. Therefore, we were unable to determine if there were differences based on either gender or bilateral differences.

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