

Distribution of Fingerprint Patterns among Bengali Postgraduate Medical Residents in Bangladesh

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**ABSTRACT**

Background: Fingerprints serve as unique, permanent, and reliable biometric identifiers that remain unchanged throughout life. Dermatoglyphic studies have gained increasing interest for their potential applications in forensic and anthropological sciences. However, such data are limited among Bangladeshi populations, especially in medical professionals. **Objective:** To determine the distribution of fingerprint patterns among Bangladeshi postgraduate medical residents and to assess the association with sex. **Methods & Materials:** This cross-sectional study was conducted at the Department of Forensic Medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), from February 2024 to January 2025. A total of 115 postgraduate medical residents (1150) were included through convenient sampling. Fingerprints were collected using the rolling ink method and classified into arches, loops, and whorls. Data were analyzed using SPSS version 26. The Chi-square (χ^2) test was applied to assess the association between fingerprint patterns and sex, with a significance level set at $p < 0.05$. **Results:** Loops were the most prevalent fingerprint pattern (62.5%), followed by whorls (29.1%) and arches (8.4%). Female participants exhibited a higher proportion of loop patterns than males, though the difference was not statistically significant ($\chi^2 = 1.409$, $p = 0.494$). Finger-wise analysis showed loops were most frequent on middle and little fingers, while whorls predominated on ring digit. **Conclusion:** Loop patterns predominated among Bangladeshi postgraduate medical residents, with no significant sex-based differences. These findings provide baseline dermatoglyphic data for Bangladeshi adults and highlight the need for broader population-based research to explore potential genetic and biological influences.

Keywords: Fingerprint patterns, Dermatoglyphics, Sex association, Bangladeshi medical residents, Loops, Whorls, Arches

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INTRODUCTION

Fingerprints are unique, permanent, and highly reliable biometric identifiers that remain unchanged throughout an individual's life. The ridge patterns begin to develop in the fetal stage and persist despite aging or superficial skin injuries [1]. Because of their individuality and stability, fingerprints play a critical role in forensic identification, linking individuals to crime scenes or confirming personal identity [2].

Recent studies have expanded the scope of dermatoglyphic research beyond forensics, exploring potential associations between fingerprint patterns and genetic or physiological traits, including ABO and Rh blood groups [3,4]. Establishing such correlations could enhance forensic and anthropological

profiling by providing an additional predictive marker when biological samples such as blood or DNA are unavailable.

The permanence of fingerprint patterns is attributed to the structural integrity of volar skin, composed of the epidermis and dermis layers. Strong intercellular adhesion, the regenerative basal cell layer, and firm epidermal-dermal attachment through the basement membrane ensure that ridge configurations remain constant throughout life [5,6]. Notably, even monozygotic twins possess distinct fingerprint patterns, underscoring the influence of intrauterine environmental factors and developmental variability [7].

Despite several international studies exploring the relationship between fingerprint patterns and sex, findings remain inconsistent. While some recent researches, such as that by Iqbal et al. (2024), reported no significant association, others, including Akter et al. (2024), observed distinct gender-based variations in fingerprint distribution [8,9]. These contradictory results highlight the need for further investigation within different populations. Given the growing interest in dermatoglyphics and its forensic implications, this study aims to determine the distribution of fingerprint patterns among Bangladeshi postgraduate medical residents and to examine their association with sex. Findings from this study may contribute to establishing population-specific dermatoglyphic data and enhance the understanding of fingerprint variation in forensic and anthropological contexts.

METHODS & MATERIALS

The study population comprised Bengali Bangladeshi postgraduate medical residents from various departments of Bangabandhu Sheikh Mujib Medical University (BSMMU) who met the eligibility criteria and provided written informed consent. The study was conducted at Department of Forensic Medicine of BSMMU from February 2024 to January 2025. A total of 115 participants were enrolled in the study using a convenient sampling technique. Participants were included in the study based on voluntary participation. Individuals were excluded if they had skin conditions or deformities that could obscure fingerprint patterns (such as eczema, psoriasis, or leprosy), fingers with permanent scars, burns, abrasions, or recent injuries, or if their fingerprints were of poor quality or unidentifiable. Participants' hands were cleaned and dried before printing. Each finger was gently rolled on an ink pad and pressed onto an A4 fingerprint sheet to obtain complete ridge impressions. Participants practiced on plain paper before the final print. Every print was inspected for clarity and completeness; unclear impressions were recollected. Data were checked for completeness, coded, and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics (frequency and percentage) were calculated for categorical variables. Associations between fingerprint patterns and sex were assessed using the Chi-square (χ^2) test. A p -value < 0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University. Written informed consent was obtained from all participants. Confidentiality and anonymity were strictly maintained throughout the study.

RESULTS

Table - I: Distribution of Study Participants by Fingerprint Patterns and Sex (n = 1150 Fingers from 115 Students)

Fingerprint Pattern	Male n (%)	Female n (%)	Statistical Test
Arches	46(4.0)	51(4.4)	$\chi^2 = 1.409, P = 0.414$
Loops	296(25.7)	423(36.8)	
Whorls	138(12.0)	196(17.1)	
Total	480(41.7)	670(58.3)	

Table I shows the distribution of fingerprint patterns among males and females. Loops were the most common fingerprint pattern for both males and females. Females had a significantly higher frequency of loops compared to males. Arches were the least common fingerprint pattern in both sex.

Operational Definitions

Fingerprint pattern: The unique ridge configuration of the fingertip skin used for individual identification. Patterns were classified into Arch, Loop, Whorl, and Composite types [10].

Arch: Found in approximately 5% of fingerprints, arches consist of ridges entering from one side and exiting on the opposite without deltas [11].

Loop: Representing about 60–70% of fingerprints, loops show ridges entering from one side and curving back, forming one delta and one core; they may be ulnar or radial [12].

Whorl: Accounting for 30–35% of fingerprints, whorls display circular, spiral, or oval patterns with two deltas [13].

Composite: Mixed patterns combining features of arches, loops, and whorls, seen in roughly 1% of cases [14].



Figure - 1: Four basic patterns of fingerprint a) Loop b) Whorl c) Arch d) Composite[15]

The chi-square value (1.409) and the corresponding P-value (0.494) indicate there was no statistically significant association with fingerprint patterns between males and females.

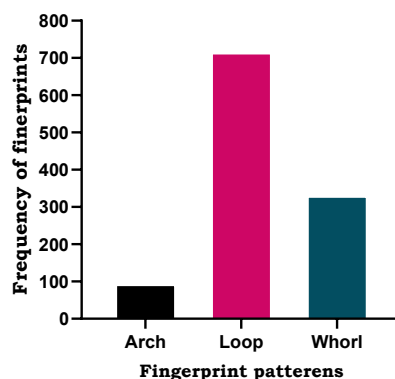


Figure - 2: Distribution of fingerprint patterns in all fingers of both hands (n=1150)

Figure 2 shows the distribution of fingerprint patterns in all the fingers of both hands. Loops were the most frequent fingerprint pattern, accounting for 719 (62.5 %) of the total. Arches made the least common of the three, only 97 (8.4%) of

the total. Whorls were the second most common pattern, comprising 334 (29.1%) of the total. The total of 1150 fingerprints reflect a balanced dataset suitable for analysis.

Table - II: Distribution of fingerprint patterns on right hand fingers of the study participants (n=115)

Fingerprint pattern	Right Hand Finger					Total
	Thumb	Index	Middle	Ring	Little	
Arch	10 (8.7%)	20 (17.4%)	15 (13.0%)	3 (2.6%)	1 (0.7%)	49 (8.5%)
Loop	69 (60%)	56 (48.7%)	80 (69.6%)	65 (56.5%)	93 (80.9%)	363 (63.1%)
Whorl	36 (31.3%)	39 (33.9%)	20 (17.4%)	47 (40.7%)	21 (18.3%)	163 (28.3%)
Total	115 (100%)	115 (100%)	115 (100%)	115 (100%)	115 (100%)	575 (100%)

Table II shows the distribution of fingerprint patterns on right hand fingers of the study participants (N=115). The Loop pattern was the most common, with a total of 363 occurrences. The Whorl pattern had an intermediate frequency, with a total count of 163, The Arch pattern

appeared least frequently, with a total count of 49 occurrences. Loop that was particularly concentrated on the little (93) and middle (80) fingers. On the whorl, the ring finger had the highest incidence (43). The index finger contained the most of the arch (20).

Table - III: Distribution of fingerprint patterns on left hand fingers of the study participants (n=115)

Fingerprint pattern	Left Hand Finger					Total
	Thumb	Index	Middle	Ring	Little	
Arch	10 (8.7%)	20 (17.4%)	15 (13.0%)	3 (2.6%)	0 (0.0%)	48 (8.3%)
Loop	64 (55.7%)	55 (47.8%)	75 (65.2%)	68 (59.1%)	94 (81.7%)	356 (61.9%)
Whorl	41 (35.7%)	40 (34.9%)	25 (21.7%)	44 (38.3%)	21 (18.3%)	171 (29.7%)
Total	115 (100%)	115 (100%)	115 (100%)	115 (100%)	115 (100%)	575 (100%)

Table III presents the distribution of fingerprint types: arch, loop, and whorl across the fingers of the left hand. Among the types, loop fingerprints were the most prevalent, totaling 356, particularly concentrated on the little (94) and middle (75) fingers. In contrast, arch fingerprints totaled 48, with a

striking majority found on the index finger (20), suggesting a unique distribution pattern for this type. Whorl fingerprints accounted for 171, with the ring finger showing the highest incidence (44).

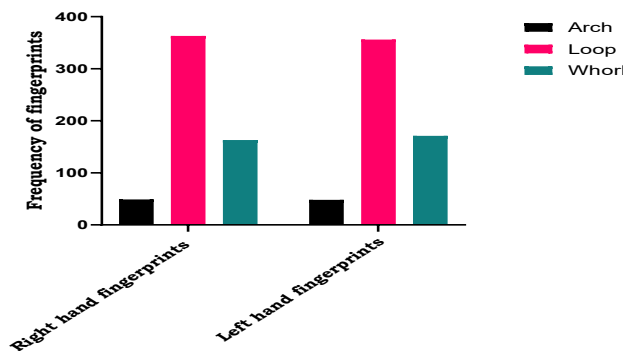


Figure - 3: Comparison of fingerprints pattern between both hands of study participants (n=115)

DISCUSSION

In this study of 115 postgraduate medical residents, females showed a higher proportion of loops than males, but the difference was not statistically significant ($\chi^2 = 1.409$, $P = 0.414$). These findings align with several earlier investigations. For example, Rastogi et al., found loops to be most common in both males and females and reported no significant gender association—similar to our result where the overall pattern distribution did not differ significantly by sex [3]. A study among medical students found loops in 65.6 % of male fingerprints and 58.13 % of female fingerprints, and concluded that distribution of dermatoglyphic patterns was essentially the same between sexes [16]. Conversely, other studies have reported significant sex-based differences. For instance, research among the Assamese population of Barpeta found loops in 50.4 % of males and 46.0 % of females, whorls in 29.6 % of males and 25.8 % of females, and arches in 20.0 % of males versus 28.2 % of females. The difference was statistically significant ($P < 0.05$) [17].

In this study of 1,031 fingertip impressions from 115 postgraduate students, loop patterns were the most frequent (61.6%), whorls were intermediate (30.2%), and arches were the least common (8.2%). Study conducted by Doku et al., 2019 found that Loop patterns were the most common fingerprint pattern [18]. A study conducted by Wilson et al (2003) found Arch patterns to constitute only 7% of the fingerprint types and it was the rare one. These findings are consistent with our study [19]. Other investigations have noted slightly higher loop frequencies among females and higher whorl frequencies among males, but these differences are often small and not consistently statistically significant across populations [20].

The finger-wise distribution observed here—higher loop frequencies on the middle and little fingers and relatively more whorls on ring digit—also echoes prior reports that primary pattern frequencies vary by digit. Several studies have reported a preponderance of loops on middle and little fingers and a relative concentration of whorls on thumbs or ring fingers, indicating that digit-specific tendencies are common across populations [21].

The contradictory nature of these findings suggests that sex-pattern associations may be influenced by population-specific genetic and environmental factors, sample size, classification criteria, and data collection methods. our study confirms the predominance of loop fingerprint patterns among Bangladeshi postgraduate medical residents, with no statistically significant difference by sex in our sample. These findings provide baseline data for this population and underline the need for more comprehensive studies to clarify possible sex-related and other biometric associations in dermatoglyphics.

CONCLUSION

The predominance of loop patterns and the low frequency of arches in our cohort are consistent with multiple published studies. Although females in our sample had a higher proportion of loops, the overall distribution of fingerprint patterns did not differ significantly between sexes. Larger and more diverse studies are needed to clarify finger-specific and population-specific dermatoglyphic patterns and any potential biological associations.

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