



# International Journal of Forensic Expert Alliance

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Professor Dr (Dr) Mohammed Nasimul Islam  
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## Managing Editor

Dr. Md. Kafil Uddin  
MBBS, MCPS (FM), FACP (USA), PhD

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The Official Journal of Forensic Expert Alliance of Bangladesh (FEAB)



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The Forensic Expert Alliance of Bangladesh (FEAB) is a professional, non-profitable, non-political, and charitable organization committed to advancing forensic medicine and toxicology in Bangladesh. Registered under The Societies Registration Act, 1860 (Act XXI of 1860), FEAB brings together forensic experts to foster collaboration, uphold professional integrity, and drive innovation in the field.

As the custodian of the **International Journal of Forensic Expert Alliance (IJFEA)**, FEAB is dedicated to promoting academic excellence, cutting-edge research, and the dissemination of knowledge on forensic medicine and toxicology, both nationally and globally. IJFEA serves as a platform for scholars and forensic science practitioners to share advancements, explore contemporary challenges, and contribute to the evolution in this vital field.

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# International Journal of Forensic Expert Alliance (IJFEA)

(The Official Journal of Forensic Expert Alliance of Bangladesh)

## Editor-in-Chief

**Professor Mohammed Nasimul Islam**  
MBBS, MCPS, DLM, LLB, FRCP, PhD  
Professor and Senior Forensic Consultant  
University Technology MARA (UiTM), Malaysia.  
E-mail: [nasimul@uitm.edu.my](mailto:nasimul@uitm.edu.my)

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M.B.B.S (King George's Medical College, Lucknow, India), M.D (Pathology, LLRM Medical College/Ch. Charan Singh University, India). Professor & Incharge, Department of Pathology (Female Campus), Faculty of Medicine, Northern Border University, Arar, Kingdom of Saudi Arabia. E-mail: [dranshoo3@gmail.com](mailto:dranshoo3@gmail.com)

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MSc (Raj); PhD (Raj), Professor, Genetic Engineering & Biotechnology; University of Rajshahi; Rajshahi-6205; Bangladesh. E-mail: [deba@ru.ac.bd](mailto:deba@ru.ac.bd), [anil\\_deb2001@yahoo.com](mailto:anil_deb2001@yahoo.com)

### Dr. Md. Ariful Haque

MSc (UK), PhD (UK), Postdoctoral (USA), Associate Professor, Institute of Biological Sciences, University of Rajshahi; Rajshahi-6205; Bangladesh. E-mail: [haque@ru.ac.bd](mailto:haque@ru.ac.bd)

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MBBS, MCPS (FM), FACP (USA), PhD, Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Rajshahi Medical College, Rajshahi-6000, Bangladesh. E-mail: [mdkafiluddin1982rnc@gmail.com](mailto:mdkafiluddin1982rnc@gmail.com)

### Md. Kariul Islam

BSS (hons.), MSS (Economics), MPH (Epidemiology), ALAF (Australia), INED (Paris, France), PMP (Malaysia), Founder & Chief Researcher, International Online Journal Hub-(IOJH). Founder & President, Top Scholars Society of Bangladesh. Ex-Fellow of icddr (2001-2015). E-mail: [kariul@hotmail.com](mailto:kariul@hotmail.com)

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MBBS, MCPS (FM), DFM, Professor (Visiting), Dept. Of Forensic Medicine & Toxicology, East West Medical College, Dhaka, Bangladesh.  
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MBBS, MCPS (FM), DFM, Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Dhaka Central International Medical College 1/2 Ring Road, Shaymoli, Dhaka, Bangladesh. Secretary General, The Medico-legal Society of Bangladesh. E-mail: kamrul60@gmail.com

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E-mail: shahjahan.201@gmail.com

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MBBS, MCPS (FM), DFM, FCPS (FM), Professor, Dept. Of Forensic Medicine & Toxicology And, Vice-Principal, Anwer Khan Modern Medical College, Dhaka, Bangladesh. E-mail: drhabibuzzamanchowdhury@gmail.com

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MBBS, MD, PhD, Professor & HOD, Dept. Of Forensic Medicine & Toxicology, US-Bangla Medical College, Kornogop, Tarabo, Rupgonj, Narayangonj, Dhaka, Bangladesh. E-mail: goninurul@yahoo.com

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MBBS, MCPS, LLB, DLM, PhD, Professor & HOD (Ret.), Dept. of Forensic Medicine & Toxicology, Pabna Medical College, Pabna, Bangladesh.  
Monbusho Scholar, Osaka University, Japan. Appraised UN Specialist (Legal Medicine) E-mail: kamalosman538@gmail.com

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MBBS, DFM, MCPS (FM), Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Bashundhara Ad-din Medical College, South Keraniganj, Dhaka, Bangladesh. E-mail: drsumonadib@gmail.com

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MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Satkhira Medical College, Satkhira, Bangladesh.  
E-mail: drgazi224@gmail.com

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MBBS, BCS (Health), MCPS (FM), DFM, Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Sir Salimullah Medical College, Mitford Rd, Dhaka, Bangladesh. E-mail: drrosy81@gmail.com

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MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Khulna City Medical College  
Khulna, Bangladesh. E-mail: drmirraihan@gmail.com

### **Dr. Mamtaz Ara**

MBBS, DFM, MCPS (FM), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Dhaka Medical College, Dhaka, Bangladesh.  
E-mail: mamoon\_askari@yahoo.com

### **Dr. Sharmin Shabnam**

MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Pabna Medical College, Pabna, Bangladesh.  
E-mail: sharminpammi@yahoo.com

### **Dr. Md. Mizanur Rahman**

Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Shaheed Ziaur Rahman Medical College, Bogura, Bangladesh.  
E-mail: drmizan0711@gmail.com

### **Dr. Md. Razibul Islam**

Assistant Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Rangpur Medical College, Rangpur, Bangladesh.  
E-mail: rashinraowal1998@gmail.com

### **Dr. Mustafa Sumon Al Rashid**

Professor (C.C) & HOD, Dept. Of Forensic Medicine & Toxicology, Ad-din Sakina Women's Medical College, Jashore, Bangladesh.  
E-mail: dr.schumon@gmail.com

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MBBS, DFM (BSMMU), Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Khwaja Yunus Ali Medical College, Enayetpur, Sirajganj, Bangladesh. E-mail: lailayesmin2019@gmail.com

## Reviewers Panel

**Dr. Md. Shamsul Islam**, MBBS, DFM, MCPS, Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh. E-mail: drshams18@gmail.com

**Dr. K.M Moynuddin**  
MBBS, MPH (Psy.), MCPS (FM), DFM, Assistant Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Dinajpur Medical College, Dinajpur, Bangladesh. E-mail: kmmoinuddinbappi@gmail.com

**Dr. Sandwip Talukdar**  
MBBS, DFM, MCPS, Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, North Bengal Medical College, J.C Road, Dhanbandha, Sirajganj, Bangladesh. E-mail: sandwip.talukdar@yahoo.com

**Dr. Md. Jasim Uddin**  
MBBS, DFM (BSMMU), Associate Professor, Dept. Of Forensic Medicine & Toxicology, Ashiyar Medical College, Barua, Khilkhet, Dhaka-1229, Bangladesh. E-mail: jasim.mia005@gmail.com

**Dr. Joya Debnath**  
MBBS, DFM (BSMMU), Associate Professor, Dept. Of Forensic Medicine & Toxicology, Kumudini Women's Medical College, Mirzapur, Tangail, Bangladesh. E-mail: drjoyadebnath@gmail.com

**Dr. Muhammad Abdullahil Kafi**  
Assistant Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Shaheed M Monsur Ali Medical College, Sirajganj, Bangladesh. E-mail: drmahkafi@gmail.com

**Dr. Shaima Hafiz Shimi**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Ad-din Sakina Women's Medical College, Jashore, Bangladesh. E-mail: shaimahafiz1988@gmail.com

**Dr. Happy Rani Barua**  
MBBS, DFM, MCPS (FM), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Chattogram Maa O Shishu Hospital Medical College, Chattogram, Bangladesh. E-mail: dr.happybarua@gmail.com

**Dr. Nusrat Afroze**  
MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Rangpur Community Medical College, Rangpur, Bangladesh. E-mail: nusrat.afroze@gmail.com

**Dr. Syeda Nadia Hassan**  
MBBS, BCS (Health), DFM, MCPS (FM), Assistant Professor, Dept. Of Forensic Medicine & Toxicology Mugda Medical College, Dhaka, Bangladesh. E-mail: dmadiyahassan@gmail.com

**Dr. Harun-Or-Rashid**  
MBBS, DFM, MCPS (FM), Assistant Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Sheikh Hasina Medical College, Jamalpur, Bangladesh. E-mail: drharunorashid94@gmail.com

**Dr. Mohammad Shohab Nahyan**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Mymensingh Medical College, Mymensingh, Bangladesh. E-mail: nahyanfm@gmail.com

**Dr. Md. Rafayatul Haider**  
MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Sher-e-Bangla Medical College, Barishal, Bangladesh. E-mail: rafayatulhaider@gmail.com

**Dr. Nasrin Akter Mili**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Army Medical College, Rangpur, Bangladesh. E-mail: nasrinaktermili0@gmail.com

**Dr. Malay Kumar Das**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Army Medical College, Bogura, Bangladesh. E-mail: malaykumarjp@gmail.com

**Dr. Md. Mahfuzul Haque Sarkar**  
MBBS, DFM (BSMMU), Associate Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Army Medical College Jashore, Jashore Cantonment, Bangladesh. E-mail: dr.mahfuz00@gmail.com

**Dr. Md. Mashiour Rahman Rikabder**  
MBBS, DFM, MCPS (FM), Associate Professor, Dept. Of Forensic Medicine & Toxicology, Jahurul Islam Medical College, Bhagalpur, Bajitpur, Kishoreganj, Bangladesh. E-mail: dr.rizvirahman@gmail.com

**Dr. Rowshon Ara Begum**  
MBBS, DFM, MCPS (FM), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Khwaja Yunus Ali Medical College, Enayetpur, Sirajganj, Bangladesh. E-mail: roshnirowshon@gmail.com

**Dr. Zeenat Jahan**  
MBBS, DFM (BSMMU), FCGP, Associate Professor, Dept. Of Forensic Medicine & Toxicology, Barind Medical College, Rajshahi, Bangladesh. E-mail: drzeenatjahan7@gmail.com

**Dr. Bablu Kishor Biswas**  
Assistant Professor & HOD, Dept. Of Forensic Medicine & Toxicology, Jashore Medical College, Jashore, Bangladesh. E-mail: bablukishor52@gmail.com

**Dr. Syeda Farha Sultana**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Shahabuddin Medical College, Gulshan-2, Dhaka-1212, Bangladesh. E-mail: farhasultana950@gmail.com

**Dr. Ishrat Jahan**  
MBBS, DFM (BSMMU), Assistant Professor, Dept. Of Forensic Medicine & Toxicology, Barind Medical College, Rajshahi, Bangladesh. E-mail: ishtarrahman294@gmail.com

**Dr. Akhter Uz Zaman Sajib**  
MBBS, DFM (BSMMU), Senior Lecturer, Dept. Of Forensic Medicine & Toxicology, Green Life Medical College, Green Rd, Dhaka-1205, Bangladesh. E-mail: akhter.uz.zaman.sajib@gmail.com



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### Editor-in-Chief

**Professor Dr (Dr) Mohammed Nasimul Islam**

MBBS, MCPS, DLM, LLB, FRCP, PhD

### Managing Editor

**Dr. Md. Kafil Uddin**

MBBS, MCPS (FM), FACP (USA), PhD

Original Article

# Decoding the Science of Fingerprints: The Influence of Sex and Blood Group on Dermatoglyphic Traits among Medical Students



Shammi Akter<sup>1</sup>, A.B.M. Kamrul Hasan<sup>2</sup>, Happy Rani Barua<sup>3</sup>

<sup>1</sup>: Assistant Professor, Department of Forensic Medicine and Toxicology, North Bengal Medical College, Dhanbandhi, Sirajganj, Bangladesh. <sup>2</sup>: Assistant Professor, Department of Transfusion medicine, Dinajpur Medical College, Dinajpur, Bangladesh. <sup>3</sup>: Assistant Professor, Department of Forensic Medicine and Toxicology, Chattogram Maa O Shishu Hospital Medical College, Agrabad, Chattogram, Bangladesh

## Abstract

**Background:** Fingerprint or dermatoglyphics is the study of the patterns of dermal ridges and bridges on the volar surfaces of the fingers, palms, and soles. Fingerprint ridge patterns begin to form between the 12th and 16th weeks of intrauterine life, and are fully developed by the 24th week. Fingerprints exhibit a vast range of possible variations, with the probability of two individuals having identical fingerprints estimated at one in sixty-four billion. Even identical twins have distinct fingerprints

**Materials and methods:** This descriptive cross-sectional study aimed to explore the relationship between sociodemographic factors (age, gender, blood group and handedness) in medical students through fingerprint analysis. Conducted at North Bengal Medical College, the study included 390 undergraduate students from the 1st to 5th year, selected using census sampling. Inclusion criteria included students willing to participate and provide accurate sociodemographic information. Exclusion criteria included graduate students, those with skin conditions affecting fingerprint analysis, and those who did not consent. Data were collected using a structured questionnaire and fingerprint analysis. Descriptive statistics and the Chi-square test were used for analysis. Ethical approval was obtained from the Institutional Review Board (IRB) before the study.

**Result:** The sociodemographic profile of 390 medical students revealed a mean age of 21.95 years, with 58% females and 42% males. Most students were right-handed (95.9%), and blood group B+ was the most common (36.7%). Fingerprint analysis showed that whorls were the predominant pattern across all fingers, with variations in distribution by sex and blood group. Significant sex differences were found in fingerprint patterns, with males exhibiting more whorls and females showing higher frequencies of arches and radial loops. Blood group associations were observed for both hands, with B+ and O+ blood groups showing stronger links to whorl patterns. Chi-square tests revealed significant associations between fingerprint patterns and blood groups for both hands ( $p < 0.05$ ), suggesting a genetic correlation between these traits.

**Conclusion:** In conclusion, this study highlights significant associations between sociodemographic factors, including sex and blood group, and fingerprint patterns in medical students. The findings suggest that fingerprint patterns, particularly whorls, are influenced by genetic factors related to blood groups and sex differences. These results contribute to the understanding of the genetic underpinnings of fingerprint formation and may provide valuable insights for future research in the field of biometrics and genetic traits.

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## Address for Correspondence:

Dr. Happy Rani Barua, Assistant Professor, Department of Forensic Medicine & Toxicology, Chattagram Maa O Shishu Hospital Medical College, Agrabad, Chattogram, Bangladesh. Mobile: 01831887196, E- mail: drhappybarua@gmail.com

## Introduction

Fingerprint or dermatoglyphics is the study of the patterns of dermal ridges and bridges on the volar surfaces of the fingers, palms, and soles. The development of fingerprints is influenced by both genetic factors and environmental or accidental factors that create tension during the development process. Fingerprint ridge patterns begin to form between the 12th and 16th weeks of intrauterine life, and are fully developed by the 24th week. Fingerprints exhibit a vast range of possible variations, with the probability of two individuals having identical fingerprints estimated at one in sixty-four billion. Even identical twins have distinct fingerprints. Any disruptions in intrauterine growth that affect the extremities can lead to abnormal fingerprint patterns. These disturbances may arise from either hereditary or environmental factors<sup>1-5</sup>. Fingerprinting is commonly used as an efficient and cost-effective method of identification. The impressions left by fingerprints are referred to as fingerprint patterns. The skin on the fingers is made up of raised areas (ridges) and recessed areas (grooves). Fingerprints are influenced by a variety of factors, including genetic, environmental, and regional factors<sup>6-8</sup>. Individuals can be identified through various features such as their face, height, body shape, gait, voice, and sex. Among these, sex is one of the most significant characteristics for distinguishing individuals. Researchers have explored the use of fingerprints for gender identification, which can be particularly useful for narrowing down suspects. In recent years, an increasing number of civilian and commercial applications are either utilizing or actively considering fingerprint-based identification. This is due to the availability of affordable

and compact solid-state scanners, as well as the technology's proven superior performance in matching compared to other biometric methods<sup>9</sup>. People may show similar variations in their interests, values, desires, and motivations because of systematic differences in how they perceive things and the conclusions they draw. They may also vary in what they excel at and what they enjoy doing the most. The indicator follows this idea and seeks to identify individuals' core preferences for perception and judgment through self-reported reactions, aiming to understand how these preferences interact with one another in their daily lives<sup>10</sup>. Even in monozygotic twins, dermatoglyphics (fingerprints) remain consistent and unique from birth to death. A person's fingerprint serves as a distinct form of identification, being a permanent and individualized trait that is highly detailed and difficult to alter. Similarly, a person's blood type is a biological characteristic that stays the same throughout their life<sup>11-13</sup>. In psychology, one of the most significant efforts has been the measurement of intelligence, which plays a crucial role not only in an individual's life but also in society. Compared to individuals with high IQs, those with low IQs may face difficulties in acquiring, thinking about, and processing new information and knowledge. These individuals may require additional care, education, and medical services, with the need for ongoing support throughout their lives. This is especially true for those with low IQs linked to genetic abnormalities, as they often struggle to achieve personal independence. It is believed that approximately 50% of these challenges have a prenatal origin<sup>14</sup>.

## Aims and Objectives

To examine the relationship between sociodemographic factors (age, gender, socioeconomic status, and blood group) and fingerprints in medical students.

## Materials and Methods

- **Study Design:**

This is a descriptive cross-sectional study designed to explore the relationship between sociodemographic factors (age, gender, blood group and handedness) in medical students, through fingerprint analysis. The study was conducted at **North Bengal Medical College**, located at J.C. Road, Dhanbandhi, Sirajganj. Census sampling was used to include all undergraduate medical students from 1st to 5th years of the college. The study population consisted of **390 undergraduate medical students** from the 1st to 5th year of North Bengal Medical College.

- **Inclusion Criteria:**

1. *Medical students enrolled in the 1st to 5th years at North Bengal Medical College.*
2. *Students who voluntarily consent to participate in the study.*
3. *Students who were willing to provide accurate sociodemographic information and undergo fingerprint analysis.*

- **Exclusion Criteria:**

1. *Medical students not enrolled in the undergraduate program (e.g., graduate or postgraduate students).*

2. *Students who refused to participate or provided incomplete data.*
3. *Students with any known skin conditions or physical conditions that may interfere with fingerprint analysis.*
4. *Students who did not provide informed consent.*

- **Data Collection Method:**

Data was collected using a **structured questionnaire**, which included questions related to sociodemographic factors (such as age, gender, handedness, and blood group). The fingerprint analysis was performed using a standard method of collecting and analyzing fingerprints. Before data collection began, participants were briefed about the study's objectives and were provided with an informed consent form to sign. The principal investigator then administered the structured questionnaire to all eligible students. Fingerprint patterns were recorded using standardized equipment, and participants were asked to provide their blood group information. The study involved 390 participants, each providing their name, age, and gender. The participants were instructed to clean their hands using tap water and soap, then dry them to remove any dirt. Following this, they were asked to roll their fingertip pads on a forensic fingerprint ink pad, ensuring even ink application on the finger's tip by rolling the thumb towards the body while keeping the other fingers out. The fingerprints were then rolled onto paper from the outside to the inside, capturing the full fingerprint impression (using the ink method by Cummins and Midlo). If any prints were deemed undesirable, the procedure was repeated. The resulting fingerprint patterns were categorized into loops, whorls, arches, or composite forms, using a magnification lens for better clarity. Following data collection, the information underwent a process of scrutiny for accuracy, after which it was compiled and organized.

The data were then presented for statistical analysis. A professional data manager conducted the statistical analysis using statistical software. Statistical analysis was performed using the  $\chi^2$  test and p-value. Data analysis was conducted using SPSS software (version 23). Descriptive statistics, including mean, standard deviations, and frequencies, were used to summarize sociodemographic characteristics and psychological traits. The Chi-square test was applied to examine associations.

## Results

The sociodemographic profile of the 390 students in this research reveals several key characteristics. The participants have a mean age of 21.95 years, indicating that the sample primarily consists of young adults. In terms of sex distribution, there is a higher proportion of female students (58%) compared to male students (42%). When considering handedness, the majority of participants (95.9%) are right-handed, with a small percentage (4.1%) being left-handed, and no participants identified as ambidextrous. Blood group distribution shows diversity, with the most common blood group being B+ (36.7%), followed by O+ (24.4%), A+ (20.5%), and AB+ (12.8%). A smaller proportion of students have the blood groups A- (2.3%), B- (0.8%), AB- (0.8%), and O- (1.8%) shown in Table 1.

The fingerprint patterns observed on both hands of the 390 participants reveal distinct trends across different fingers. For the thumb, whorls were the most common pattern on both the right (62.1%) and left (53.3%) hands, with radial loops more prevalent on the left hand (16.2%) compared to the right (7.9%). The index finger also exhibited a predominance of whorls, with 48.7% on the right and 47.9% on the left, while radial loops were more frequent on the left

(16.9%) than the right (10%). The middle finger displayed a higher percentage of whorls on the left (45.9%) than the right (43.3%), with a notable increase in radial loops on the left hand (22.6%) compared to the right (9.5%). For the ring finger, whorls were again the most common pattern, with 65.9% on the right hand and 61.3% on the left, while radial loops were more pronounced on the left hand (12.8%) compared to the right (6.2%). Lastly, the little finger showed a higher proportion of whorls on the right hand (49.2%) than the left (42.8%), while radial loops were more frequent on the left (25.6%) compared to the right (8.2%) shown in Table 2.

**Table 2: Pattern of fingerprints on both hands**

| FINGER           | Right      | Left       |
|------------------|------------|------------|
| 1. Thumb         |            |            |
| • Whorls         | 242 (62.1) | 208 (53.3) |
| • Arches         | 75 (19.2)  | 72(18.5)   |
| • Ulnar loops    | 23 (5.9)   | 25(6.4)    |
| • Radial loops   | 31 (7.9)   | 63(16.2)   |
| • Composite      | 19 (4.9)   | 22(5.6)    |
| 2. Index finger  |            |            |
| • Whorls         | 190 (48.7) | 187 (47.9) |
| • Arches         | 74 (19)    | 85 (21.8)  |
| • Ulnar loops    | 65 (16.7)  | 33 (8.5)   |
| • Radial loops   | 39 (10)    | 66 (16.9)  |
| • Composite      | 22 (5.6)   | 19 (4.9)   |
| 3. Middle finger |            |            |
| • Whorls         | 169 (43.3) | 179 (45.9) |
| • Arches         | 82 (21)    | 75 (19.2)  |
| • Ulnar loops    | 97 (24.9)  | 38 (9.7)   |
| • Radial loop    | 37 (9.5)   | 88 (22.6)  |
| • Composite      | 5 (1.3)    | 10 (2.6)   |
| 4. Ring finger   |            |            |
| • Whorls         | 252 (65.9) | 239 (61.3) |
| • Arches         | 54 (13.8)  | 62 (15.9)  |
| • Ulnar loops    | 41 (10.5)  | 26 (6.9)   |
| • Radial loops   | 24 (6.2)   | 50 (12.8)  |
| • Composite      | 14 (3.6)   | 13 (3.3)   |
| 5. Little finger |            |            |
| • Whorls         | 192 (49.2) | 167 (42.8) |
| • Arches         | 72 (18.5)  | 62 (15.9)  |
| • Ulnar loops    | 71 (18.2)  | 31 (7.9)   |
| • Radial loops   | 32 (8.2)   | 100 (25.6) |
| • Composite      | 23 (5.9)   | 30 (7.7)   |

For the right thumb, males and females predominantly exhibited whorl patterns (121). This difference was highly significant with a chi-square value of 31.701 (p=0.000).

Similarly, the left thumb showed a significant difference (chi-square = 16.398, p = 0.003), with males having a greater frequency of whorls (105) and females exhibiting more arches (49) and radial loops (38).

**Table-3: Association between sex and pattern of fingerprints**

| Fingers      | Sex          | Whorls | Arches | Ulnar loops | Radial loops | Composite | Chi square | p- value |
|--------------|--------------|--------|--------|-------------|--------------|-----------|------------|----------|
| Right thumb  | Male (164)   | 121    | 24     | 13          | 6            | 0         | 31.701     | 0.000*   |
|              | Female (226) | 121    | 51     | 10          | 25           | 19        |            |          |
| Left thumb   | Male (164)   | 105    | 23     | 7           | 25           | 4         | 16.398     | 0.003*   |
|              | Female (226) | 103    | 49     | 18          | 38           | 18        |            |          |
| Right index  | Male (164)   | 91     | 26     | 31          | 12           | 4         | 12.145     | 0.016    |
|              | Female (226) | 99     | 48     | 34          | 27           | 18        |            |          |
| Left index   | Male (164)   | 92     | 38     | 19          | 15           | 0         | 31.330     | 0.000*   |
|              | Female (226) | 95     | 47     | 14          | 51           | 19        |            |          |
| Right middle | Male (164)   | 83     | 25     | 37          | 19           | 0         | 13.507     | 0.009    |
|              | Female (226) | 86     | 57     | 60          | 18           | 5         |            |          |
| Left middle  | Male (164)   | 94     | 25     | 18          | 27           | 0         | 22.746     | 0.000*   |
|              | Female (226) | 85     | 50     | 20          | 61           | 10        |            |          |
| Right ring   | Male (164)   | 126    | 18     | 5           | 15           | 0         | 36.092     | 0.000*   |
|              | Female (226) | 131    | 36     | 36          | 9            | 14        |            |          |
| Left ring    | Male (164)   | 124    | 19     | 7           | 10           | 4         | 25.889     | 0.000*   |
|              | Female (226) | 115    | 43     | 19          | 40           | 9         |            |          |
| Right little | Male (164)   | 102    | 20     | 21          | 17           | 4         | 27.565     | 0.000*   |
|              | Female (226) | 90     | 52     | 50          | 15           | 19        |            |          |
| Left little  | Male (164)   | 91     | 3      | 5           | 55           | 10        | 62.203     | 0.000*   |
|              | Female (226) | 76     | 59     | 26          | 45           | 20        |            |          |

On the index fingers, significant sex differences were also

observed. For the right index finger, the distribution of patterns differed significantly (chi-square = 12.145, p = 0.016), with females showing a higher frequency of whorls (99), arches (48), radial loops (27) and composite (18). The left index finger demonstrated a stronger pattern with a chi-square of 31.330 (p=0.000), where females exhibited higher frequencies of arches (47), radial loops (51) and composite patterns (19) compared to males.

Further, the right middle and left middle fingers revealed notable differences in pattern distribution. Males showed a tendency towards left middle finger whorls (94), whereas females exhibited higher counts of radial (61) and ulnar loops (20). The chi-square results were significant (left middle: chi-square = 22.746, p 0.000).

The ring and little fingers also presented significant results. Females showed a higher frequency (131) of whorls on the right ring (chi-square = 36.092, p 0.000) and males showed higher frequency (124) on the left ring fingers (chi-square = 25.889, p 0.000). Additionally, for the left little finger, females had a significantly higher frequency of arches (59) and ulnar loops (26) with (chi-square = 62.203, p 0.000) revealed in Table 3.

The association between fingerprint patterns and blood groups across the five fingers of the right hand, with significant differences observed for all fingers. Chi-square values ranged from 88.405 to 131.277, with p-values 0.000, indicating a strong statistical association between fingerprint patterns and blood groups. For the right thumb, individuals with blood group B+ve exhibited the highest frequency of whorls, while A+ve and O+ve groups also showed notable differences in pattern distributions. Similar trends were observed for the right index, middle, ring, and little fingers, where specific blood groups were more strongly associated with particular fingerprint patterns,

especially whorls. These findings suggest a significant correlation between blood group and fingerprint pattern distribution, highlighting the potential role of genetic factors in shaping both characteristics revealed in Table 4.

**Table-4: Association between fingerprint patterns of right hand with blood group**

| Finger                | fingerprint  | A+ve | A-ve | B+ve | B-ve | AB+ve | AB-ve | O+ve | O-ve | Chi square     | P-value       |
|-----------------------|--------------|------|------|------|------|-------|-------|------|------|----------------|---------------|
| Right thumb<br>n=390  | Whorls       | 47   | 4    | 89   | 0    | 32    | 3     | 67   | 0    | <b>110.367</b> | <b>0.000*</b> |
|                       | Arches       | 15   | 5    | 13   | 0    | 4     | 0     | 14   | 7    |                |               |
|                       | Ulnar loops  | 3    | 0    | 7    | 3    | 6     | 0     | 4    | 0    |                |               |
|                       | Radial loops | 6    | 0    | 10   | 0    | 5     | 0     | 10   | 0    |                |               |
|                       | composite    | 9    | 0    | 7    | 0    | 3     | 0     | 0    | 0    |                |               |
| Right index<br>n=390  | Whorls       | 23   | 0    | 87   | 0    | 33    | 0     | 43   | 4    | <b>131.277</b> | <b>0.000*</b> |
|                       | Arches       | 35   | 5    | 23   | 3    | 1     | 0     | 7    | 0    |                |               |
|                       | Ulnar loops  | 15   | 4    | 18   | 0    | 3     | 3     | 24   | 0    |                |               |
|                       | Radial loops | 3    | 0    | 11   | 0    | 8     | 0     | 14   | 3    |                |               |
|                       | composite    | 6    | 0    | 4    | 0    | 5     | 0     | 7    | 0    |                |               |
| Right middle<br>n=390 | Whorls       | 25   | 3    | 72   | 0    | 16    | 3     | 43   | 7    | <b>98.861</b>  | <b>0.000*</b> |
|                       | Arches       | 38   | 2    | 19   | 3    | 4     | 0     | 6    | 0    |                |               |
|                       | Ulnar loops  | 11   | 4    | 44   | 0    | 12    | 0     | 26   | 0    |                |               |
|                       | Radial loops | 6    | 0    | 6    | 0    | 8     | 0     | 17   | 0    |                |               |
|                       | composite    | 0    | 0    | 2    | 0    | 0     | 0     | 3    | 0    |                |               |
| Right ring<br>n=390   | Whorls       | 34   | 7    | 116  | 3    | 18    | 3     | 69   | 7    | <b>88.405</b>  | <b>0.000*</b> |
|                       | Arches       | 19   | 2    | 9    | 0    | 10    | 0     | 14   | 0    |                |               |
|                       | Ulnar loops  | 15   | 0    | 15   | 0    | 6     | 0     | 5    | 0    |                |               |
|                       | Radial loops | 6    | 0    | 3    | 0    | 11    | 0     | 4    | 0    |                |               |
|                       | composite    | 6    | 0    | 0    | 0    | 5     | 0     | 3    | 0    |                |               |
| Right little<br>n=390 | Whorls       | 37   | 3    | 71   | 3    | 14    | 0     | 57   | 7    | <b>97.344</b>  | <b>0.000*</b> |
|                       | Arches       | 2    | 2    | 35   | 0    | 6     | 3     | 10   | 0    |                |               |
|                       | Ulnar loops  | 4    | 4    | 27   | 0    | 19    | 0     | 11   | 0    |                |               |
|                       | Radial loops | 0    | 0    | 4    | 0    | 11    | 0     | 13   | 0    |                |               |
|                       | composite    | 0    | 0    | 6    | 0    | 0     | 0     | 4    | 0    |                |               |

The association between fingerprint patterns and blood groups for the left hand, revealing significant associations for most fingers, with p-values consistently below 0.05. For the left thumb, the highest frequency of whorls was seen in individuals with blood group B+ve, with a chi-square value of 117.803 ( $p < 0.0001$ ). Similar patterns were observed for the left index and middle fingers, where whorls were more common among individuals with blood group B+ve and

O+ve. However, the left little finger's association was not statistically significant (chi-square = 38.436,  $p = 0.090$ ). Overall, the results suggest that fingerprint patterns, particularly whorls, show significant associations with specific blood groups across most fingers of the left hand, pointing to a potential genetic correlation between these traits shown in Table 5.

**Table-5: Association between fingerprint patterns of left hand with blood group**

| Finger               | fingerprint  | A+ve | A-ve | B+ve | B-ve | AB+ve | AB-ve | O+ve | O-ve | Chi square | P-value |
|----------------------|--------------|------|------|------|------|-------|-------|------|------|------------|---------|
| Left thumb<br>n=390  | Whorls       | 38   | 4    | 90   | 0    | 29    | 0     | 47   | 0    | 117.803    | 0.000*  |
|                      | Arches       | 7    | 5    | 23   | 0    | 10    | 0     | 20   | 7    |            |         |
|                      | Ulnar loops  | 10   | 0    | 3    | 0    | 8     | 0     | 4    | 0    |            |         |
|                      | Radial loops | 14   | 0    | 23   | 3    | 0     | 3     | 20   | 0    |            |         |
|                      | composite    | 11   | 0    | 4    | 0    | 3     | 0     | 4    | 0    |            |         |
| Left index<br>n=390  | Whorls       | 30   | 0    | 93   | 0    | 19    | 0     | 41   | 4    | 171.057    | 0.000*  |
|                      | Arches       | 22   | 5    | 27   | 0    | 7     | 0     | 24   | 0    |            |         |
|                      | Ulnar loops  | 3    | 4    | 4    | 0    | 11    | 0     | 8    | 3    |            |         |
|                      | Radial loops | 14   | 0    | 19   | 3    | 13    | 0     | 17   | 0    |            |         |
|                      | composite    | 11   | 0    | 0    | 0    | 0     | 3     | 5    | 0    |            |         |
| Left middle<br>n=390 | Whorls       | 12   | 3    | 84   | 0    | 22    | 3     | 48   | 7    | 116.717    | 0.000*  |
|                      | Arches       | 36   | 2    | 16   | 0    | 5     | 0     | 16   | 0    |            |         |
|                      | Ulnar loops  | 6    | 4    | 10   | 0    | 11    | 0     | 7    | 0    |            |         |
|                      | Radial loops | 20   | 0    | 33   | 3    | 12    | 0     | 20   | 0    |            |         |
|                      | composite    | 6    | 0    | 0    | 0    | 0     | 0     | 4    | 0    |            |         |
| Left ring<br>n=390   | Whorls       | 38   | 7    | 95   | 0    | 27    | 3     | 62   | 7    | 92.196     | 0.000*  |
|                      | Arches       | 21   | 2    | 16   | 3    | 5     | 0     | 15   | 0    |            |         |
|                      | Ulnar loops  | 0    | 0    | 3    | 0    | 3     | 0     | 14   | 0    |            |         |
|                      | Radial loops | 0    | 0    | 25   | 0    | 15    | 0     | 4    | 0    |            |         |
|                      | composite    | 0    | 0    | 4    | 0    | 0     | 0     | 0    | 0    |            |         |
| Left little<br>n=390 | Whorls       | 24   | 3    | 67   | 0    | 26    | 3     | 41   | 3    | 38.436     | 0.090   |
|                      | Arches       | 16   | 2    | 29   | 0    | 6     | 0     | 9    | 0    |            |         |
|                      | Ulnar loops  | 7    | 0    | 10   | 0    | 3     | 0     | 11   | 0    |            |         |
|                      | Radial loops | 24   | 4    | 28   | 3    | 10    | 0     | 27   | 4    |            |         |
|                      | composite    | 9    | 0    | 9    | 0    | 5     | 0     | 7    | 0    |            |         |

## Discussion

The sociodemographic profile of the 390 students in this study provides valuable insights into the characteristics of the sample population. The mean age of 21.95 years reflects a predominantly young adult group, which is typical for many research studies involving university or college students. The higher proportion of female students (58%) compared to males (42%) aligns with trends seen in many academic settings where females tend to outnumber males. In research by Vishwakarma AK, the sample included a total of 194 medical students, consisting of 107 (55.15%) males and 87 (44.85%) females<sup>15</sup>.

The overwhelming majority being right-handed (95.9%) is consistent with global patterns of handedness, highlighting

the natural predominance of right-handed individuals in the population. Approximately 10% of people are left-handed, but it has remained uncertain whether this is associated with changes in brain anatomy<sup>16</sup>.

The blood group distribution within the sample is diverse, with B+ being the most common blood group, followed by O+, A+, and AB+. In research by Lyande LB, the most common blood type was O+ (49.5%), followed by A+ (26.3%), B+ (17.2%), and AB+ (5%), B- (1%) and O- (1%)<sup>17</sup>.

The analysis of fingerprint patterns across different fingers reveals notable trends in the distribution of whorls and radial loops. Whorls were the most common pattern on both

the right and left thumbs, with a higher percentage observed on the right hand (62.1%) compared to the left (53.3%). In research by Kapoor N, a total of 2,900 single-digit fingerprints were collected from 290 participants, and the whorl axis slant was assessed in 743 whorl pattern fingerprints (385 from the right hand and 358 from the left hand). Among the right-hand samples, 81.82% exhibited a slant toward the right, while 80.73% of the left-hand samples showed a slant toward the left<sup>18</sup>.

Radial loops were more prevalent on the left thumb (16.2%) than on the right (7.9%), highlighting lateral variation in pattern distribution. Similar trends were observed on the index and middle fingers, where whorls were dominant on both hands, but radial loops appeared more frequently on the left hand. Specifically, the left middle finger exhibited a marked increase in radial loops (22.6%) compared to the right hand (9.5%). In research by Taiwo IA, the radial loop was more common, occurring in 51.5% of cases, compared to the ulnar loop at 48.5%<sup>19</sup>.

For the ring and little fingers, whorls again dominated, with the left hand showing a higher frequency of radial loops, especially on the little finger (25.6%) compared to the right (8.2%). These findings suggest that while whorls are the most common fingerprint pattern across all fingers, there is a consistent pattern of increased radial loops on the left hand, particularly in the middle and little fingers.

Males predominantly exhibited whorl patterns on the right thumb, right index, and right ring fingers, while females showed higher frequencies of arches and radial loops, particularly on the left thumb and index fingers. These differences were statistically significant, with chi-square values indicating strong associations ( $p < 0.05$ ). Notably, females displayed a higher prevalence of radial and ulnar loops on the middle fingers, while males tended to have

more whorls. The left little finger showed a particularly strong distinction, with females having significantly more arches and ulnar loops. These patterns suggest that while whorls are more common in males, females tend to have a greater variety of fingerprint patterns, including arches and loops. In Thai research by Nanakorn S, Males exhibited a higher frequency of radial loops on the index finger (9.1% vs. 9%;  $p < 0.001$ ), whorls on the thumb (39.0% vs. 32.9%;  $p < 0.01$ ) and little finger (34.1% vs. 5.3%;  $p < 0.001$ ), and double whorls on the little finger (6.9% vs. 3.6%;  $p < 0.01$ ). On the other hand, females had a higher frequency of ulnar loops on the little finger (69.0% vs. 57.0%;  $p < 0.001$ ) and thumb (39.3% vs. 32.8%;  $p < 0.001$ ) on their right hands<sup>20</sup>. Notably, individuals with blood group B+ve exhibited the highest frequency of whorls on the right thumb, and similar trends were observed across the right index, middle, ring, and little fingers, where certain blood groups, particularly B+ve, were more strongly associated with specific patterns, especially whorls. In research by Sudikshya KC, among "B" blood group, the percentile frequency of loops (51.05%) and arches (6.85%) was higher in the Rh-positive blood group compared to the Rh-negative blood group (loops 36.66% and arches 6.67%). However, whorls (56.67%) were more common in the Rh-negative blood group than in the Rh-positive blood group (42.10%)<sup>21</sup>.

The analysis of fingerprint patterns and blood groups for the left hand reveals significant associations for most fingers, with p-values consistently below 0.05, indicating strong statistical relevance. Specifically, individuals with blood group B+ve exhibited the highest frequency of whorls on the left thumb, with a chi-square value of 117.803 ( $p < 0.0001$ ). This pattern was similarly observed in the left index and middle fingers, where B+ve and O+ve blood groups were more strongly associated with whorls. These

results suggest a consistent correlation between specific blood groups and fingerprint patterns, particularly whorls, across most fingers of the left hand. However, the left little finger did not show a statistically significant association (chi-square = 38.436,  $p = 0.090$ ), suggesting that this relationship may not apply uniformly across all fingers.

### Limitations of the Study

This research was carried out in a non-government medical college and hospital of J.C Road, Dhanbandhi, Sirajganj, but not in government medical College Hospitals and outside Sirajganj.

### Conflict of interest:

The authors declared that there is no conflict of interest

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### Contributors:

SA- Conception, Data acquisition, study design, manuscript writing, final approval and drafting.

ABMKH- Conception, study design, and final approval.

HRB- Conception, study design, manuscript writing, Data acquisition, final approval and drafting.

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