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Original Research Article

Association Between Fingerprint Patterns and ABO (±Rh) Blood Groups

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Abstract:

Background: Fingerprints and blood groups are both genetically determined traits that remain constant throughout life. Establishing a correlation between the two can aid in forensic identification and anthropological studies.

Objective: To determine the correlation between ABO (±Rh) blood classes and fingerprint patterns among individuals attending a tertiary care hospital.

Materials and Methods: This retrospective study was conducted in the Department of Forensic Medicine at a tertiary hospital from August 2024 to July 2025. Records of 130 individuals with documented ABO and Rh blood groups and available fingerprint impressions were included. Fingerprint patterns were categorized as Whorls, Loops, and Arches using standard classification methods. The dominant pattern per individual was identified. Statistical analysis was performed using the Cramér's V and the chi-square test are used to evaluate the degree of association between blood groups and fingerprint patterns. A p-value <0.05 was considered statistically significant.

Results: Among the 130 participants, 52 (40.0%) were of blood group O, 39 (30.0%) A, 26 (20.0%) B, and 13 (10.0%) AB. Rh positivity was seen in 117 (90.0%) individuals. The dominant fingerprint patterns observed were Loops (62.3%), Whorls (30.8%), and Arches (6.9%). Statistical analysis showed no significant correlation between ABO blood groups and fingerprint patterns (χ^2=2.66, p=0.85, Cramér's V=0.10) or Rh factor (χ^2=1.25, p=0.54, V=0.10). Inter-observer reliability between two independent examiners was excellent (κ=0.86).

Conclusion: There was no discernible relationship between fingerprint patterns and Rh or ABO blood types. Nonetheless, the most prevalent pattern among all blood types was loops. The findings suggest that while both traits are genetically determined, they may be inherited independently. Larger multicentric studies are recommended to further validate these observations.

Introduction

Personal identification has always been a crucial aspect of forensic medicine, criminal investigation, and legal proceedings. Determining an individual's identity is essential in cases involving accidents, disasters, unidentified bodies, and criminal activities. Among various scientific methods available, fingerprint analysis and blood group determination are two of the most reliable and practical techniques because both are genetically determined, distinct, and unaltered during the course of a lifetime. Fingerprints—technically known as dermatoglyphics—represent the raised ridge patterns on the skin of the fingertips, palms, and soles. These ridges develop during early intrauterine life, generally between the 10th and 16th week of gestation, and remain permanent from birth to death. Sir Francis Galton's classification system, which categorizes fingerprints into loops, whorls, and arches, continues to serve as the foundation for modern fingerprint science. The permanence and individuality of these ridge patterns make them invaluable in personal identification. Beyond their forensic utility, dermatoglyphic traits have also been studied in genetics, anthropology, and medicine because their formation reflects both hereditary and developmental influences during fetal growth.

Parallel to fingerprints, blood groups are also genetically controlled markers that play an important role in medicine and forensic identification. Karl Landsteiner developed the ABO blood type system in 1900. It uses particular antigens found on the surface of red blood cells to categorize people as A, B, AB, or O. Individuals are further separated into Rh-positive and Rh-negative groups by the Rhesus (Rh) system, namely the D

antigen. Since both fingerprints and blood groups are inherited traits that show stable expression throughout life, it has long been speculated that a relationship might exist between the two. Establishing such an association could be valuable in situations where one form of evidence is absent or destroyed. For instance, if certain blood groups tend to show characteristic fingerprint patterns, the available dermatoglyphic evidence might provide an indirect clue to an individual's blood type, which can assist in narrowing the field of identification in forensic investigations. Moreover, such correlations can contribute to genetic and anthropological research by highlighting population-specific inheritance patterns.

Several studies worldwide have explored the possible link between ABO blood group and fingerprint pattern, nevertheless their results have been inconclusive. Some researchers have observed a predominance of loop patterns among individuals with blood group O, while others reported a higher frequency of whorls in groups A or B. Many others, however, have found no significant statistical relationship between the two parameters. Differences in population characteristics, genetic diversity, sample size, and methods of classification may explain these inconsistent findings. Very few studies have been conducted at the regional level, and there remains a lack of local baseline data correlating fingerprint types and blood groups. Considering that both traits can vary with ethnicity, heredity, and environmental factors influencing prenatal development, region-specific research is necessary to strengthen or refute existing claims. In light of this, the current investigation was carried out in a tertiary care hospital to investigate the relationship between ABO (±Rh) blood types and fingerprint patterns. The purpose of the study is to evaluate the potential use of these two genetically inherited traits in forensic identification and to ascertain whether there is a statistically significant relationship between them. The findings may enhance the understanding of hereditary markers used in forensic science and support the development of more comprehensive identification systems for practical use.

Materials and Methods

Study Design and Setting: A retrospective cross-sectional study was conducted in the Department of Forensic Medicine, covering the period August 2024 to July 2025.

Study Population: A total of 130 records were reviewed from the departmental database. Only those individuals with both complete blood group information and clearly recorded fingerprints were included.

Inclusion Criteria

- Age ≥18 years
- Availability of complete ABO and Rh typing
- Readable fingerprints from all ten digits (minimum 8 acceptable)

Exclusion Criteria

- Smudged or incomplete prints
- Skin diseases or deformities affecting ridge patterns
- Duplicate or repeated records

Fingerprint Analysis: Fingerprints were obtained using standard ink and pad methods from hospital biometric records. Each print was classified as Loop, Whorl, or Arch based on the Henry classification. When multiple patterns were observed in a subject, the dominant pattern (present in ≥5 fingers) was recorded.

Two independent observers analyzed the prints, blinded to blood group information. A 20% random subset was re-evaluated for inter-observer reliability using Cohen's kappa.

Statistical Analysis: Data were tabulated in Microsoft Excel and analyzed using SPSS (version 26.0). Frequencies and percentages were calculated for categorical variables. The chi-square test assessed associations between ABO blood group and fingerprint pattern, and Cramér's V estimated effect size. Significance was set at $p<0.05$.

Results

A total of 130 subjects were included in the study after applying inclusion and exclusion criteria. The study population comprised both females and males across various age groups, all having complete records of blood group and fingerprint data.

1. **Distribution of ABO and Rh Blood Groups:**

Among the study participants, the most common blood group was O, observed in 52 individuals (40.0%), followed by A in 39 (30.0%), B in 26 (20.0%), and AB in 13 (10.0%). The Rh-positive factor was predominant, seen in 117 (90.0%) individuals, while only 13 (10.0%) were Rh-negative.

Table 1: Distribution of Participants According to ABO and Rh Blood Groups

Blood Group	Rh Positive	Rh Negative	Total (%)
A	34	5	39 (30.0)
B	23	3	26 (20.0)
AB	11	2	13 (10.0)
O	49	3	52 (40.0)
Total	**117 (90.0)**	**13 (10.0)**	**130 (100)**

2. **Distribution of Fingerprint Patterns**

The overall frequency of fingerprint patterns revealed that Loop was the most prevalent pattern, found in 81 individuals (62.3%), followed by Whorl in 40 (30.8%), and Arch in 9 (6.9%). Loops were more commonly observed among both males and females, indicating no major gender difference in dominant pattern distribution.

Table 2: Distribution of Fingerprint Patterns Among Study Subjects

Fingerprint Pattern	Frequency (n)	Percentage (%)
Loop	81	62.3
Whorl	40	30.8
Arch	9	6.9
Total	**130**	**100.0**

3. **Association Between ABO Blood Groups and Fingerprint Patterns**

The relationship between ABO blood groups and dominant fingerprint patterns is summarized in Table 3.Loop patterns were common in all blood types, with the highest frequency among individuals of blood group O (35/52; 67.3%).Whorls were most frequent in blood group A (14/39; 35.9%) and B (8/26; 30.7%), while arches were relatively uncommon in all groups.Using the chi-square test, statistical analysis revealed no meaningful correlation between ABO blood group and fingerprint pattern (χ^2=2.66, p=0.85).The calculated Cramér's V (0.10) indicated a very weak association, suggesting that both traits are likely inherited independently.

Table 3: Association Between ABO Blood Groups and Fingerprint Patterns

Blood Group	Loop	Whorl	Arch	Total
A	23	14	2	39
B	16	8	2	26
AB	7	4	2	13
O	35	14	3	52
Total	**81**	**40**	**9**	**130**

Chi-square value (χ^2) = 2.66 p-value = 0.85
Cramér's V = 0.10

4. **Association Between Rh Factor and Fingerprint Patterns**

The comparison between Rh factor and fingerprint pattern is displayed in Table 4. Among Rh-positive individuals, loops were seen in 73 (62.4%), whorls in 36 (30.8%), and arches in 8 (6.8%). In Rh-negative individuals, 8 (61.5%) had loop patterns, 4 (30.8%) had whorls, and 1 (7.7%) had arches. No statistically significant association was observed between ABO blood group and fingerprint pattern (χ^2=1.25, p=0.54), again indicating a weak correlation (Cramér's V=0.10).

Table 4: Association Between Rh Factor and Fingerprint Patterns

Rh Factor	Loop	Whorl	Arch	Total
Positive	73	36	8	117
Negative	8	4	1	13
Total	**81**	**40**	**9**	**130**

Chi-square value (χ^2) = 1.25 p-value = 0.54
Cramér's V = 0.10

5. **Inter-Observer Reliability**

Two independent observers analyzed all fingerprint samples. Inter-observer agreement was excellent, with Cohen's kappa (κ) = 0.86, demonstrating high reliability and reproducibility of fingerprint classification within the study.

6. **Visual Representation of Fingerprint Pattern Distribution**

The overall pattern distribution across ABO groups is illustrated in Figure 1, showing that loops dominated across all blood groups, followed by arches and whorls. The proportions were comparable in each blood group, supporting the statistical finding of no significant association.

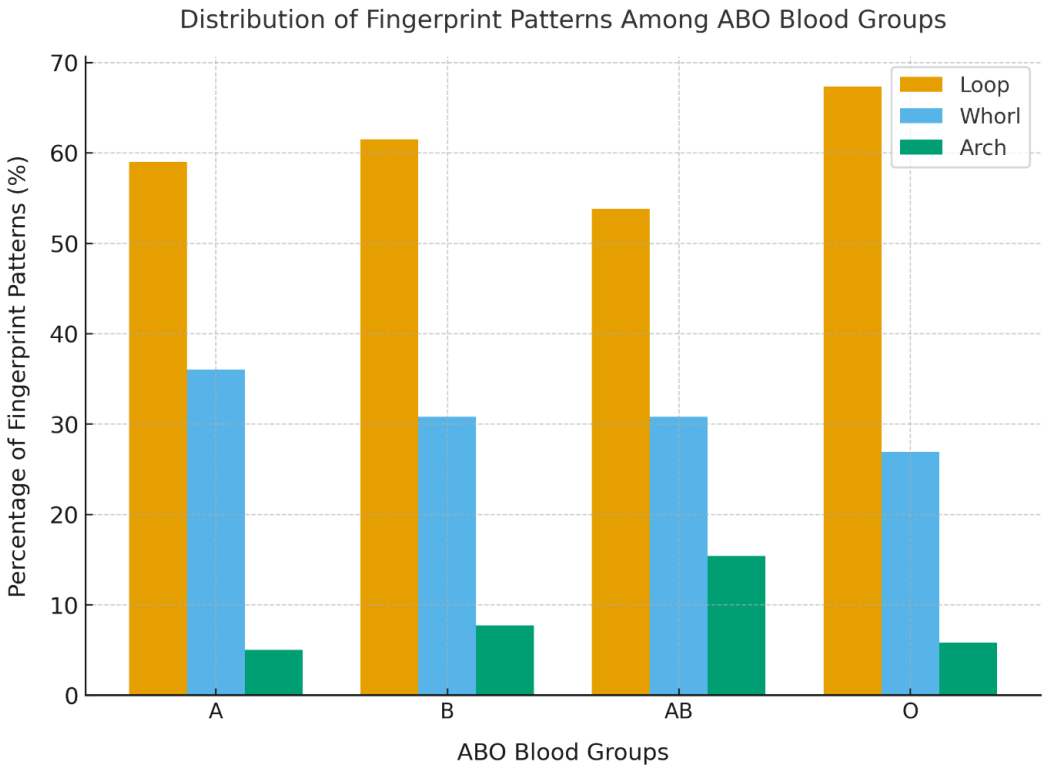

Figure 1: Percentage Distribution of Fingerprint Patterns Among ABO Blood Groups

Discussion

The present investigation examined the relationship between ABO blood group and fingerprint pattern among individuals examined in a tertiary care hospital. Both these biological traits have long been used independently in identification procedures, yet the possibility of an association between them has intrigued researchers for decades. In the current study, fingerprints were analyzed using the standard Galton classification, and blood group data were obtained from hospital records. The findings indicated that loops were the most frequently observed fingerprint pattern, followed by arches and whorls. The distribution of blood groups showed that group O was most prevalent, while Rh positivity was observed in the vast majority of subjects. Statistical evaluation revealed no significant relationship between fingerprint patterns and either the ABO or Rh blood group systems.

The overall pattern distribution found in this study closely resembles what has been reported in several earlier investigations conducted in India and abroad. Most researchers agree that loops constitute the dominant fingerprint pattern across all populations, while arches remain the least common. The blood group distribution pattern observed here also mirrors national trends, with group O being most frequent and AB least frequent. This congruence suggests that the study population is representative of the general demographic characteristics of the region. The lack of significant correlation between fingerprint type and blood group indicates that these two genetically determined traits are likely inherited through separate mechanisms and are not influenced by one another.

These findings correspond well with those of several previous authors who found no meaningful relationship between blood group systems and ridge configurations. Studies by Kaur, Saxena, and Bhavana, among others, have all demonstrated that while minor differences in percentage distribution may occur among blood groups, such variations are statistically insignificant. The present results also reinforce the view that fingerprints, though genetically influenced, are shaped by multiple genes and subtle developmental factors during the early stages of intrauterine growth. Because blood group antigens are controlled by entirely different gene loci, the absence of a direct genetic link is not unexpected. The consistent appearance of loop predominance across blood groups further supports the independence of the two characteristics.

Although most available research aligns with these results, a few studies from other populations have reported conflicting observations. For example, some have noted a higher occurrence of whorls among individuals with blood group B or O, and others have recorded specific trends in different ethnic groups. Such discrepancies are often attributed to regional genetic variations, small sample sizes, or methodological differences in fingerprint classification. It is also possible that environmental factors during fetal development influence ridge formation in subtle ways, leading to

small variations across populations. However, the inconsistencies among studies are not sufficient to establish any definitive pattern or causal relationship between fingerprints and blood groups.

The genetic explanation for these findings lies in the fact that the two traits are determined by distinct and unrelated sets of genes. The formation of epidermal ridges occurs early in fetal life and depends on both hereditary factors and the physical conditions within the uterus, such as pressure, nutrition, and growth rate of the fetus. In contrast, the ABO and Rh systems are controlled by specific genes located on chromosomes 9 and 1, respectively, and follow simple Mendelian inheritance. Since the loci governing fingerprint development and blood group determination are unrelated, the probability of a genetic correlation is minimal. This biological independence clarifies why statistical association between the two characteristics remains weak or absent in most studies, including the present one.

From a forensic and medico-legal perspective, the findings of this study reaffirm the independent value of both fingerprints and blood groups in establishing identity. Fingerprints remain the most reliable form of personal identification because of their uniqueness, permanence, and ease of collection. Blood grouping, while not unique to an individual, remains useful as a supporting biological marker for exclusion or probabilistic identification. If a strong relationship had been established, fingerprint evidence could have been used to infer blood group in situations where biological samples are degraded or unavailable. However, the absence of such correlation means that each parameter should continue to be used independently as complementary evidence, thereby strengthening the overall accuracy of forensic identification.

The present work has several noteworthy strengths. The use of hospital records allowed for the inclusion of authentic and well-documented data, ensuring reliability. Fingerprint classification was performed independently by two trained observers who were blinded to the blood group data, and the high inter-observer agreement confirmed consistency in interpretation. The study also adhered to well-defined inclusion and exclusion criteria, thereby reducing bias due to poor-quality prints or incomplete data. Although retrospective in nature, the design made efficient use of available records and provided meaningful insight into local patterns of fingerprint and blood group distribution. This regional evidence enriches existing literature and serves as a useful reference for future comparative studies across different populations.

Like most retrospective analyses, the study faced certain limitations. The sample size, though adequate for preliminary analysis, may not capture subtle associations that might emerge in larger populations. Being based on hospital records, data availability limited the inclusion of certain variables such as ethnicity, family history, or occupational background, which might influence genetic distribution. Only the three main categories of fingerprint patterns were considered; detailed subtypes such as ulnar and radial loops or composite whorls were not separately analyzed. Future studies involving larger, multicentric samples with broader variable inclusion may provide deeper insight into population-level variations and hereditary tendencies. Additionally, digital image analysis and advanced statistical models may further refine the interpretation of dermatoglyphic data.

In conclusion, the present study establishes that while both fingerprints and blood groups are stable, heritable characteristics, they do not exhibit a statistically significant relationship. The predominance of loop patterns across all blood groups and the consistent blood group distribution among participants confirm the independence of these two biological traits. The results emphasize that fingerprints and blood groups, though unrelated genetically, continue to serve as essential components of forensic identification. This study adds valuable regional data to the growing body of evidence supporting the independent inheritance of these traits and underlines the need for further large-scale, population-based research to explore subtle genetic and developmental influences that may shape human identification characteristics.

Conclusion

ABO (±Rh) blood types and fingerprint patterns did not significantly correlate in this retrospective analysis of patients from a tertiary care hospital. Loops were the predominant fingerprint pattern across all blood groups, and blood group O was most common among participants. These findings indicate that fingerprint ridge configurations and blood group antigens are inherited independently. Both remain valuable but distinct identifiers in forensic and clinical practice. Fingerprint analysis continues to provide the most reliable means of personal identification, while blood grouping serves as a supportive biological marker. The results underscore the need for larger, multicentric studies incorporating diverse populations and advanced digital methods to further explore subtle genetic and developmental influences on dermatoglyphic variation and to strengthen the scientific foundation of human identification.

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