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Relationship between fingerprint patterns and blood types among science undergraduates in a Nigerian university

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Abstract
This study investigates the relationship between blood types and fingerprint patterns among biology undergraduates. A total of 1,150 students from the College of Science and Information Technology, Tai Solarin University of Education, Ijagun, Ogun State, Nigeria was selected using simple random sampling. Data collection involved ink-based fingerprinting and self-reported ABO and Rh blood group classification. Results showed that blood type O was the most common (489), followed by A (321), B (233), and AB (46). Rh-positive individuals accounted for 960, while Rh-negative individuals were 129. Among fingerprint patterns, loops were the most prevalent (7,918), followed by whorls (2,264), and arches (1,318). Loops were more common among females (5,623) than males (2,295), while whorls and arches also showed higher female representation. No participants had the AB-negative blood type. Furthermore, the data revealed a higher prevalence of O+ (449), followed by A+ (278) and B+ (187). The rarest patterns included A- (43), B- (46), and O- (40). A chi-square test showed a significant association between blood group and fingerprint pattern distribution ($\chi^2 = 0.000$). However, no direct relationship was found between gender and fingerprint pattern beyond general distribution trends. These findings suggest a potential genetic influence in the co-distribution of fingerprint patterns and blood groups, with loops being most frequent across all blood types, particularly among those with blood types O and A. This study provides baseline data for future research and contributes to forensic and biometric science, particularly in contexts where combined fingerprint and blood group data may aid personal identification.

Keywords: Fingerprint, Blood Group, Rhesus, ABO
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Introduction

In humans, fingerprints and the ABO-Rhesus (Rh) blood group systems have long been useful in forensic identification and human population genetics (Abegaz, 2021; Khare and Singla, 2022). Fingerprints, formed by epidermal ridge development in utero, are fixed early in gestation (Glover *et al.*, 2023), and remain stable throughout life, making them invaluable for personal identification and, increasingly, for anthropological and biomedical inquiry (Li *et al.*, 2022). ABO and Rh blood groups, defined by specific carbohydrate antigens and their related transferase enzymes, are likewise immutable genetic markers that show well-documented geographic and ethnic variation; in many West African populations. Type O and Rh-positive phenotypes predominate, a fact with both clinical (transfusion, obstetrics) and population-genetic relevance. Recent Nigerian studies and regional surveys report an excess of group O and high Rh positivity, although exact proportions vary by sample and region (Imoru *et al.*, 2025; Okunbor *et al.*, 2024).

Since both fingerprints and blood-group phenotypes are genetically influenced and

develop along defined embryological trajectories, some researchers have asked whether the two traits are correlated within populations (Fesenko *et al.*, 2022; Li *et al.*, 2022). If a reproducible association exists, it would be of interest across three domains namely: forensic practice; anthropology/genetics; and medical screening or epidemiology. Empirical literature shows inconsistency regarding possible associations between the phenotypes (Koura *et al.*, 2022; Kumar *et al.*, 2023). Developmentally, a plausible biological link exists between blood-group antigen expression and epidermal features.

Multiple studies from Asia and the Middle East report statistically significant heterogeneity in fingerprint pattern frequencies across ABO classes (Koura *et al.*, 2022; Kumar *et al.*, 2023; Smail *et al.*, 2019). For example, some moderate samples show loops dominate overall but vary in proportion across A, B, AB and O, and whorls sometimes cluster in specific ABO subgroups (Patil & Ingle, 2021). Studies have reproduced these patterns in samples of students and blood-donors, typically using chi-square or logistic regression frameworks and reporting modest but statistically significant associations that vary by sex and by finger position (digit-specific effects) (Koura *et al.*, 2022; Kumar *et al.*, 2023).

Counterbalancing those positive findings are some studies that report either no association or highly population-specific effects groups (Smail *et al.*, 2019). The heterogeneity of results is partly methodological. Studies differ in sample size, in how fingerprints are recorded (inked-rolled prints versus digital scanners), in whether analyses are per-finger or aggregated across all ten digits, and in whether investigators control for sex, ethnicity and age. More importantly, population stratification and sampling bias (for example, overrepresentation of group O among voluntary blood donors) can produce spurious associations unless carefully handled. Contemporary studies therefore caution against over-generalisation: where associations are reported, effect sizes are usually small and often fail to replicate in independent samples from neighbouring regions or different age-groups (Button *et al.*, 2013; Wacholder *et al.*, 2000).

In Nigeria ABO and Rh distributions vary regionally across the country but repeatedly show a strong dominance of group O and high Rh-positivity in many sampled cohorts, including blood donors, pregnant women, and hospital populations (Imoru *et al.*, 2025; Okunbor *et al.*, 2024). These distributions have clinical consequences, be it blood-bank planning or alloimmunisation risk. Taken together, the theoretical plausibility (epidermal expression of ABH antigens and the developmental timing of dermatoglyphics), the mixed but suggestive global empirical evidence, and the specific demographic patterns of Nigerian blood groups justify a focused study among biology undergraduates.

The relationship between fingerprint patterns and ABO/Rh blood groups sits at an intersection of developmental biology, population genetics and forensic science. Recent mechanistic work on epidermal expression of ABH antigens provides biological plausibility, and recent cross-sectional studies deliver mixed but informative empirical results: associations sometimes emerge but are small and inconsistent across populations. More investigation in Nigerian population is needed to fill an important gap in the literature, clarifying whether dermatoglyphic traits carry meaningful, population-level information about blood-group phenotypes and, if so, whether that information has forensic or biological value in the Nigerian context.

Materials and Methods

Research Design

A descriptive survey design was employed to relate various patterns of fingerprint with ABO/Rh blood types among science undergraduates. This design was chosen for its suitability in obtaining detailed, cross-sectional data on naturally occurring variables without experimental manipulation (Siedlecki, 2020).

Study Participants

The population of the study consisted of all science students of Tai Solarin University of

Education (TASUED), Ijagun, Ogun, Southwest Nigeria across all academic levels in the 2024-2025 academic year. Using a stratified technique of random sampling, where academic departments served as strata, 1,150 students from the College of Science and Information Technology, TASUED, were selected. Randomisation was implemented to minimise selection bias and enhance the representativeness of the sample (Almusaed *et al*., 2025).

Inclusion and Exclusion Criteria

Eligible participants were required to be in good health, without pre-existing medical conditions, and to have fingerprints free from scars, congenital anomalies, or irregularities that could impede accurate pattern analysis. Individuals with permanent scars, deformities, or reduced finger mobility due to injury or burns; students having chronic dermatological issues affecting their fingers; and those unwilling or unable to comply with study protocols were excluded (Sah *et al.,* 2023).

Instruments for Data Collection

Two primary instruments were employed. First, fingerprint patterns were obtained via the standard ink-and-paper method. Participants' fingertips were coated with ink and rolled onto plain white paper to produce clear impressions (Sah *et al.,* 2023). These prints were classified into loops, whorls, and arches by trained examiners using the Henry Classification System. Second, ABO blood-group and Rh (D) blood-group data were elicited via a structured, self-administered questionnaire in which participants reported their blood type based on prior laboratory testing (Xie *et al.,* 2010). Participants were encouraged to confirm this information from personal or medical records. Face and content validity were established through expert review of the questionnaire by experts in Genetics and human biology. Instrument reliability was determined via a pilot test involving 20 students outside the main study population. The Cronbach's alpha coefficient (reliability index) was calculated and a value of 0.782 was obtained, indicating acceptable internal consistency (Taber, 2018).

Data Analysis

Data collected were analysed using Statistical Package for the Social Sciences (SPSS) software, version 23. Descriptive statistics summarised demographic variables and pattern distributions. Chi-square statistics was used to test relationship of fingerprints with ABO/Rh blood groups. Statistically significant value of $p < 0.05$ was used.

Results

Participants with various blood types.

Table 1 shows the distribution of participants of both genders categorised according to blood type, with their respective frequencies recorded in each group. The study sampled 822 females and 328 males. The result also shows that blood type 0+ was the most prevalent, with 449 individuals, followed by A+ with 278 individuals, and B+ with 189 individuals. AB+ and B- both had 46 individuals each, while A- had the least, with 43 individuals. It was also noted that there was no individual with AB- in the study sample.

Table 1: Distribution of the subjects with various ABO/ Rh blood-types

Blood Type & Rh Factor	Blood Type	Rh Factor	Male	Female	Total	Chi-square
A+	A	+	82	196	278	0.000
A-	A	-	17	26	43	
B+	B	+	70	117	187	
B-	B	-	30	16	46	
AB+	AB	+	15	31	46	
AB-	AB	-	0	0	0	
O+	O	+	84	365	449	
O-	O	-	7	33	40	
Total			328	822	1150	

Distribution of Blood Types

Table 1 also reveals a varied distribution of blood types. Blood type O appeared most frequently (in a total of 489 individuals). Blood type A had a total of 321 individuals, while blood type B was present in 233 individuals, and blood type AB in 46 individuals. Among the males, 91 reported blood type O, 99 reported blood type A, 100 reported blood type B while 15 reported blood type AB. In females, 398 reported blood type O, 222 reported blood type A,133 reported blood type B while 31 reported blood type AB.

Distribution of Rhesus Factor

Result in Table 1 also shows the distribution of the Rhesus factor among the study participants, revealing a clear difference in frequencies of Rh positive/negative individuals. Among the 1150 participants, the Rh-positive group comprises 960 individuals, with the following distribution: A+ (278), B+ (187), AB+ (46), and O+ (449). Of the 960, 709 are females and 251 are males having Rh positive. While the Rh-negative group consists of 129 individuals, with A- (43), O- (46), AB- (0), and B- (40), among which 75 are females and 54 are males. This indicates a higher prevalence of the Rh-positive phenotype among the study participants.

Distribution of Blood Types and Rh Factor

Revealed in Table 1 is the distribution of blood types and Rhesus factors. A+ had a total of 278 individuals, out of which 82 are males and 196 females. A- had 43 persons (17 males and 26 females). B+ had 187 persons (70 males and 117 females). B- had a total of 46 persons (30 males and 16 females). AB+ had 46persons, 15 males and 31 females. O+ had 449 persons, of 84 males and 365 females. O- had 40 persons, 7 males and 33 females.

The result indicates that O+ was the commonest, but O- was the least frequent among the participants. A notable majority of participants, 960 individuals, are Rh-positive, while a smaller proportion, 129 individuals, are Rh-negative.

Distribution of Fingerprint Patterns among Participants by Gender

Table 2 presents the distribution of various patterns on fingerprint that were found among the study subjects. The loop pattern was the most frequently found among both males (2,295) and females (5,623), totaling 7,918 and showing a slight female predominance. The whorl pattern was found in 2,264 individuals, with 635 males and 1,629 females, while the arch fingerprint pattern was the least common, with a total of 1,318, comprising 350 males and 968 females.

On the whole, the distribution of fingerprint patterns between both genders was highly similar. Though loops predominated in both genders, females had slightly higher frequencies of loops and whorls.

Table 2 Distribution of Various Fingerprint Patterns among Participants by Gender

Fingerprint Patterns	Male (%)	Female (%)	Total
Arch	350 (9.31)	968 (8.57)	1,318
Whorl	635 (5.13)	1,629 (5.09)	2,264
Loop	2,295 (1.42)	5,623 (1.47)	7,918
Total	3,260	8,300	11,500

Fingerprint Patterns by Gender

Figure 1 displays the distribution (%) of the various fingerprint patterns found among the study participants according to their genders. In the bar chart, there is higher prevalence of loop among females (5,623) compared to males (2,295), with a total of 7,918 individuals exhibiting loop patterns. This is followed by whorls, with females having, 1629 and males having 635, totaling 2,264 individuals. Arches are the least common pattern, with females having 968 and males having 350, totaling 1,318 individuals.

Figure 2 shows the samples of fingerprint patterns obtained from study participants, including arch, loop and whorl. The arch was identified by its wavy pattern, with ridges flowing smoothly from one side to the other. The loop was identified by its curved shape, with ridges that bent and curved back. The whorl was identified by its circular pattern, with ridges forming a spiral or circular shape.

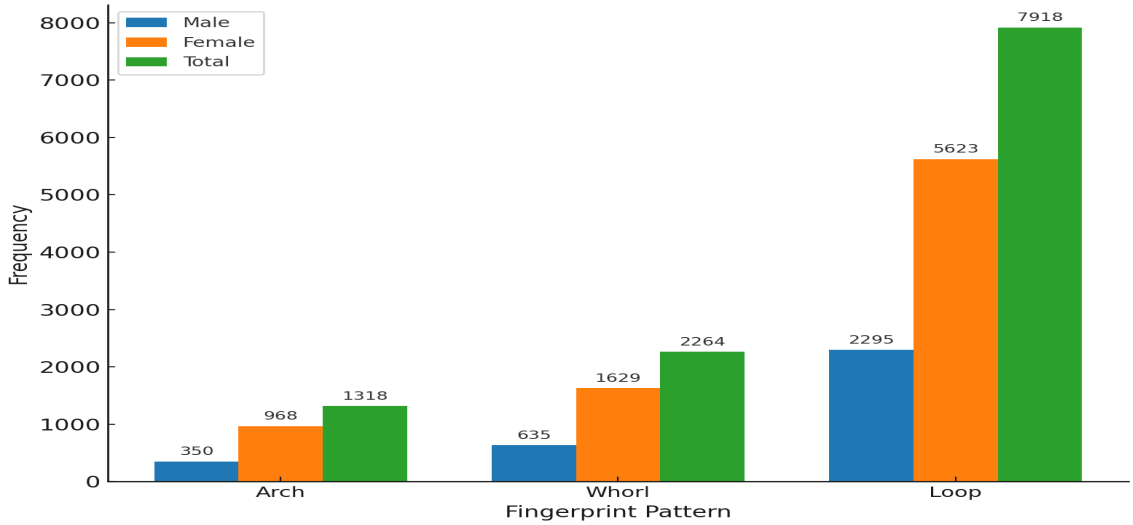

Figure 1: Fingerprint Patterns by Gender

Figure 2: Fingerprint Patterns Observed among Study Participants (A, Loop; B, Whorl; C, Arch)

Discussion

The present study revealed that, based on the proportion of students who participated, blood group O emerged as the most prevalent among respondents, followed by blood group A, then group B, and group AB being the least represented. This pattern reflects the broader significance of the ABO blood group system, which is one of the most clinically and genetically important classification systems in human biology. These blood groups have been extensively studied not only for their role in transfusion compatibility but also for their associations with disease susceptibility, demographic trends, and genetic inheritance. This study is strongly supported by Ajayi *et al.* (2022), who reported a similar distribution among students of Bamidele Olumilua University of Education, Science, and Technology, Ikere, Ekiti State. Their study noted blood group O as the most common, followed sequentially by blood groups A, B, and AB. mirroring the pattern established in the present study. Likewise, Azi *et al.* (2023), in a study conducted at Ebonyi State University, affirmed the high prevalence of blood group O among undergraduates, further reinforcing this trend among student populations within Nigeria.

Support for this distribution pattern also extends beyond Nigeria. Syaravicena *et al.* (2023), who investigated blood types among biology students at Samudra University, found blood group O to be the most frequently occurring type within their population. This cross-border consistency suggests that group O may possess a widespread genetic prevalence, particularly among youth populations. Alshwesh *et al.* (2024) likewise reported a similar dominance of group O in their study population, suggesting the group's high prevalence may not be restricted to African

populations alone but may also be reflective of broader global distribution patterns. However, the study of Thakur *et al.* 2019) disagrees with this present finding. It was reported that majority of their study participants have blood group B followed by blood group O. Also, Ameigaal and Ageel (2019), in their study of the Libyan population, observed that although blood group O remained the most common, blood group B was more prevalent than group A, contrasting with the order reported in the current study.

The findings of the present study revealed that among male participants, blood group B was the most dominant, followed by blood group A, with blood groups O and AB occurring less frequently. This distribution highlights a deviation from the generally observed trend of blood group O predominance and suggests a sex-linked variation in ABO blood group expression. Blood group frequencies can vary not only by population but also by gender. This is in line with the study of Kumar *et al.* (2018) who similarly observed a higher prevalence of blood group A followed by B among males compared to females in their study. This is further corroborated by Thakur *et al.* (2019), who reported that male subjects most commonly exhibited blood group B, lending credibility to the sex-specific distribution noted in the present data. Additionally, Kumar *et al.* (2023) confirmed that within male populations, blood group B remained the most prevalent, aligning closely with the trend revealed in this study.

However, not all studies agree with the observations in this present study. Devi *et al.* (2025) reported that blood group O was the dominant group among males, thus challenging the consistency of specific blood group predominance. Furthermore, Devi *et al.* (2025) offered a contrasting perspective by showing that females, not males, had the highest prevalence of blood group B, followed by blood group O, suggesting that gender differences in ABO distribution may be population specific and influenced by demographic or ethnic factors.

The findings of the present study revealed that the majority of participants belong to the Rh-positive blood group, indicating a clear dominance of Rh positivity among the student population assessed. The Rhesus blood group system, particularly the presence or absence of the D antigen, plays a critical role in transfusion medicine, maternal-foetal compatibility, and population genetics (Opara, 2023). This finding is strongly supported by Ajayi *et al.* (2022), who reported a similar Rh-positive predominance among students of Bamidele Olumilua University, Ekiti State. Likewise, the study of Azi *et al.* (2023) corroborate this present finding; reporting that Rh-positive individuals were more common in their study involving undergraduates at Ebonyi State University. Ameigaal and Ageel (2019), in their study of a Libyan population, also found Rh-positive individuals to be significantly more prevalent than their Rh-negative counterparts.

Furthermore, in line with this present study is the findings from Kumar *et al.* (2023), who observed a higher frequency of Rh-positive individuals in their sample, as well as Patil *et al.* (2017), who reported that Rh-positive was the most dominant Rhesus factor among a population of Indian students. Vadde *et al.* (2020) also confirmed this pattern in their study of 186 second-year MBBS students in India, showing that Rh-positive blood groups remain consistently more prevalent in educational and youth populations across regions. In addition, Buzdar *et al.* (2024) conducted a comparative study among 293 students in Pakistan, examining the relationship between fingerprint patterns and ABO/Rh blood groups. Their results further supported the present finding, indicating that a majority of the students belonged to the Rh-positive group, consistent with the dominance of Rh-positive reported globally.

Furthermore, the findings of the present study revealed that the loop fingerprint pattern was the most prevalent among both male and female participants, followed by the whorl pattern, while the arch pattern was the least common. This distribution reflects a widely recognised trend in dermatoglyphics, where the loop pattern is consistently reported as the most dominant across various populations (Bose *et al.*, 2023; Kumar, 2021). The present result is supported by Al Habsi *et al.* (2023), who reported that loop and whorl patterns were the most dominant fingerprint types among both male and female participants in their study. Similarly, Shrestha *et al.* (2019), in a study conducted among university students, identified the loop pattern as the most common, aligning with the distribution observed

in this research. This study also agrees with the findings of Vadde *et al.* (2020), who investigated fingerprint patterns in relation to blood groups. They found that loop and whorl patterns were the most common in both male and female students. Kumar *et al.* (2023) also supported this distribution, noting that loop and whorl patterns dominated across both genders in their sample. Additionally, Patil *et al.* (2017) reported similar findings, confirming the predominance of the loop pattern, followed by whorl and then arch, among their study population.

Conclusion

This study investigated the distribution of ABO blood groups, Rhesus (Rh) factors, and fingerprint patterns among the sampled population, with particular attention to gender-based variations. Conclusively, the findings revealed that blood group O was the most prevalent among the participants, followed by groups A, B, and AB. However, when disaggregated by gender, blood group B emerged as the dominant group among males, contrasting the general population trend. In terms of Rhesus factor distribution, the study found that the majority of respondents were Rh-positive, Furthermore, in the analysis of dermatoglyphic patterns, the loop fingerprint pattern was the most common among both male and female participants, followed by the whorl, and then the arch pattern, which appeared least frequently.

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