

The association between fingerprint patterns and blood groups in the Omani population

Fingerprint
patterns and
blood groups

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Received 16 October 2022
Revised 18 November 2022
22 November 2022
Accepted 30 November 2022

Abstract

Purpose – Fingerprints and blood samples are important for the identification of individuals and criminals. The present study aims to identify the predominant fingerprint patterns and the association between the fingerprint patterns and ABO–Rh blood groups in Omani population.

Design/methodology/approach – A cross-sectional study was conducted on 200 Omani individuals aged 18 years (104 males and 96 females). The imprints of all right and left-hand fingers were taken, and the types of the fingerprints were determined using a standard protocol. The blood group of all the subjects was recorded. Chi-square test was performed to identify the association between the fingerprint patterns and the ABO and Rh blood groups.

Findings – The loop fingerprint pattern was the most common in Omani subjects (49.4%), followed by whorl (44.9%) and arch (5.7%) pattern. A significant association ($p < 0.001$) was found between gender and fingerprint pattern. The loop was the highest occurring pattern in the females (54.6%), while the whorl was more in males (50.0%). The whorl pattern was the most common in the AB+ and O– groups. The loop was a predominant pattern in the A+, A–, B+, B– and O+ groups. The Chi-square test also revealed a significant correlation between different fingerprint patterns and blood groups of the subjects ($p < 0.001$).

Originality/value – The present study is an outcome of undergraduate student's research project thesis for the Doctor of Medicine (MD) program. The results of the present study may help in creating a data bank for biometrics, which can be useful for diagnosing associated diseases and also help in identification of individuals.

Keywords Fingerprints, Blood groups, Forensic medicine, Identification, Omani

Paper type Research paper

1. Introduction

Verification of an individual's identity has always been challenging. Identification is mostly related to forensic medicine but also involves civil affairs, legal documents and financial transactions. Fingerprints are the impressions of the pattern formed by the papillary or epidermal ridges of the fingertips (Bardale, 2011). The science that deals with the configuration and arrangement of fingertips is known as dermatoglyphics or dactylography (Bardale, 2011). The formation of epidermal ridges takes place between the 10th and 16th weeks of intrauterine life and remains until death (Sandhu, Verma, Padda, & Raj, 2017). In addition to the inability of



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Arab Gulf Journal of Scientific
Research
Vol. 41 No. 3, 2023
pp. 283-292
Emerald Publishing Limited
e-ISSN: 2536-0051
p-ISSN: 1985-9899
DOI 10.1108/AGJSR-10-2022-0223

passing these patterns from parents to their offspring, the possibility of having two individuals with the same fingerprint has been speculated to be one in 64 billion (Vij, 2011). There are three primary types of fingerprint patterns, i.e. loops, whorls and arches. The loop pattern is the one where the ridgelines appear from one side of the fingerprint (either the radial side or ulnar side), arch around the center and return to the side where they originally appeared. The whorl pattern is the one in which one or more of the ridgelines form a circular pattern around the center of the print. Finally, the arch pattern is the simplest pattern, where the ridge flows from one side of the print to the other (Sandhu *et al.*, 2017).

ABO and Rhesus blood (Rh) groups have been described as the most important red blood cell antigen groups with regard to its clinical significance (Vij, 2009). The ABO blood group's antigens (A, B and H) are determined by molecules of carbohydrate that are ordinarily considered as red blood cell antigens. They are also expressed on several other human tissues which include vascular endothelium and epithelium, sensory neurons and platelets (Gong *et al.*, 2014). The ABO blood groups are also important for organ and blood transfusion.

With the recent process of urbanization, the crime rate has increased considerably (Malik and Malik, 2016). Unfortunately, the tools available for detection have their limitations in identification an individual with a criminal background. Fingerprints and blood samples are valuable biometrics always collected from the crime scenes. Many studies aimed to explore the link and suggested a connection between the distribution of fingerprint patterns and ABO blood groups. Previous studies reported a correlation between these two identification tools (Manikandan *et al.*, 2019; Patil, Sonawane, & Sharma, 2019; Sisodia *et al.*, 2020). In the Middle East region, a study reported an association between the distribution of fingerprint patterns and ABO blood groups in the Libyan population (Fayrouz, Farida, & Irshad, 2012). In terms of the predominant fingerprint pattern, loop was found to be the most common pattern with a range of 40%–69% in several studies (Sandhu *et al.*, 2017; Manikandan *et al.*, 2019; Patil *et al.*, 2019; Sisodia *et al.*, 2020; Smail, Wahab, & Abdullah, 2019). The majority of studies did not find any gender difference in the distribution of fingerprint patterns (Sandhu *et al.*, 2017; Patil *et al.*, 2019; Chaudhary, Deuja, Alam, Karmacharya, & Mondal, 2017; Kc, Maharjan, Adhikari, & Shrestha, 2018; Thakur, Yadav, & Tiwari, 2019). In addition, previous studies have demonstrated an ethnic variation in the proportion of fingerprint pattern types among various populations (Li *et al.*, 2006; Zhang *et al.*, 2010; Nanakorn, Kutanant, & Chusilp, 2013).

Previous research work was confined to certain regional populations, and to the best of our knowledge, no research study has been conducted in the Omani population to date. Hence, the present study was conducted to observe the predominant fingerprint pattern and identify the association between fingerprint patterns and ABO and Rh blood groups. The results of the study may aid in identification of individuals and help in creating local biometrics bank in future.

2. Materials and methods

A cross-sectional study was conducted in Oman during January 2020–June 2021 to examine the association between fingerprint patterns and ABO blood groups. The present study was approved by the Medical Research Ethics Committee, Sultan Qaboos University (EC/038/19). In the present study, 200 Omani individuals of both genders participated voluntarily with prior informed consent without specifying an age group.

Inclusion criteria: we included all Omani individuals of both genders who had a valid driving license obtained from the Royal Oman Police (ROP).

Exclusion criteria: All nonOmani individuals with hand anomalies, permanent scars on the hands and finger and hand injuries along with those who refused to consent were excluded from the study.

2.1 Data collection method

A blue ink stamp pad was used to collect the fingerprints of the participants. Each participant was given a code to conceal his/her identity and maintain confidentiality. Before recording the fingerprints, the hands were washed and dried. Then, by using a plain method (Bardale, 2011), the imprints of their right- and left-hand fingers were taken on an A4 sized white sheet from the inked fingers without rolling (Figure 1). The details of the subject's code, gender, age, region, blood group and a statement of consent were included within the fingerprint sheet. The blood groups of the subjects were recorded from their ROP driving license, which was based upon valid healthcare reports in order to avoid any misleading data that might affect the validity of the results. All necessary precautions were taken to minimize any inconvenience to the participants while taking the imprints. After collecting the sheets with the imprints of fingers of both hands, the fingerprints were analyzed and classified using a magnifying lens. The fingerprint pattern types were classified as per earlier description (Sandhu *et al.*, 2017). Fingerprint patterns of each finger along with other participants' information were recorded.

2.2 Statistical analysis

The data were analyzed by using Statistical Package for Social Sciences (SPSS) software for statistical analysis. The distribution of the variables was presented by different descriptive statistics. A Chi-square test was performed to test the association between the selected variables and the value of $p < 0.05$ was considered to be significant.

3. Results

In the present study, a total of 2,000 fingerprints were obtained from both right and left hands of 200 participants. Among them, 104 were males (52.0%), while 96 were females (48.0%). Regarding the fingerprint pattern distribution, the loop pattern (49.4%) appeared to be the predominant one among the study population, followed by whorl (44.9%) and arch (5.7%)

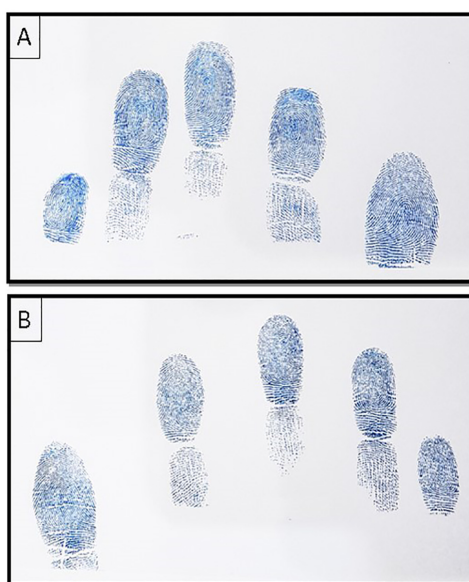


Figure 1.
(a). Imprints of right-
hand fingers
(b). Imprints of left-
hand fingers

(Figure 2). The Chi-square test analysis showed a significant association ($p < 0.001$) between gender and fingerprint pattern of the subjects (Figure 3) (Table 1). The whorl pattern was found to be the most predominant type (50.0%) in the male subjects. On the other hand, loop (54.6%) was the most common pattern in the female subjects. Arch was found to be the least common pattern in both the genders. The frequency of blood groups (ABO and Rh) among the participants was in the following order, from highest to lowest: O+ (54.0%), A+ (19.0%), B+ (18.0%), AB+ (4.5%), O- (2.5%) and A- and B- (1.0% each). However, none of the subjects had AB- group. Results of the present study showed that the whorl pattern was the most common among the AB+ and O- groups, while in A+, A, B+, B- and O+ groups, the loop pattern was found to be the most common. A Chi-square test analysis revealed a significant correlation between different fingerprint patterns and blood groups among the subjects with a $p < 0.001$ value (Figure 4) (Table 2).

4. Discussion

To the best of our knowledge, this was the first study that investigated the association between fingerprint patterns and blood groups (ABO and Rh) in Omani subjects. Also, it is the first to identify the predominant fingerprint pattern among this population. The implications of finding a positive correlation between these two identification tools will expand the scope of biometric technology, which can offer identification solutions for personal and medical purposes, particularly in the field of forensic medicine. The identification for any individual is usually done by using fingerprints (dactylography), behavioral/physiological characteristics such as voice, signature, etc. which are termed as “Biometrics” (Fayrouz *et al.*, 2012). The biological characteristics such as fingerprints and blood groups cannot be replicated nor lost easily like keys, passwords, etc. (Fayrouz *et al.*, 2012). Hence, fingerprints and blood groups are important biometrics used for identity cards and visa application forms.

The results of the present study suggested that the predominant fingerprint pattern among the study population was loop (49.4%), followed by whorl (44.9%) and then arch (5.7%) pattern. Similar results were observed in majority of the earlier studies (Patil *et al.*, 2019; Fayrouz *et al.*, 2012; Smail *et al.*, 2019; Chaudhary *et al.*, 2017). However, a study by Thakur *et al.*, conducted on Indian population, reported whorl to be the most common pattern (Thakur *et al.*, 2019). This difference could be attributed to the geographical distribution of the study samples (Thakur *et al.*, 2019). It might be due to genetic variations among different

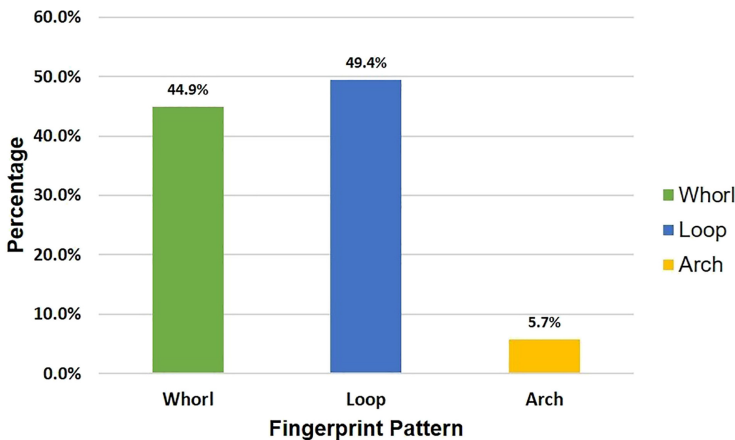


Figure 2.
General distribution of
fingerprint patterns in
both hands (n = 2,000)

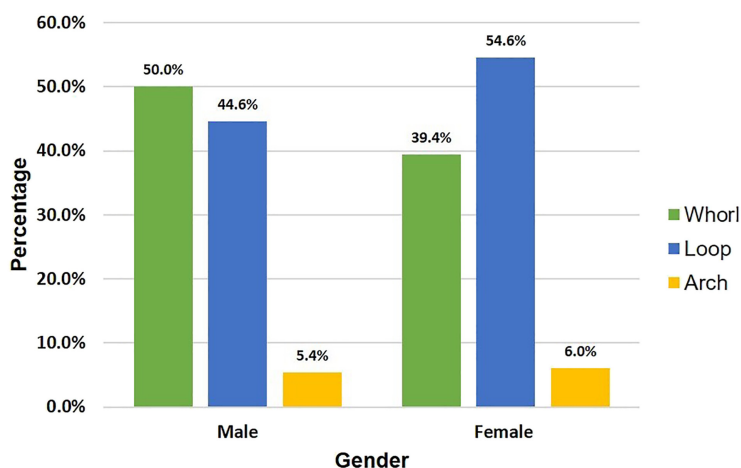


Figure 3. Association between the fingerprint patterns and gender ($n = 2,000$)

			Fingerprint pattern			Total
			Arch	Loop	Whorl	
Gender	Female	Count	58	524	378	960
		% within gender	6.0%	54.6%	39.4%	100.0%
	Male	Count	56	464	520	1,040
		% within gender	5.4%	44.6%	50.0%	100.0%
Total		Count	114	988	898	2,000
		% within gender	5.7%	49.4%	44.9%	100.0%

Table 1. Association between the fingerprint patterns and gender ($n = 2,000$)

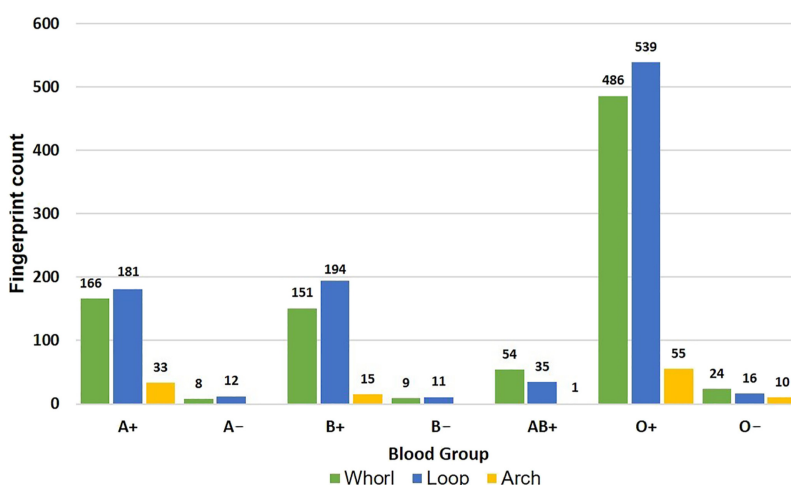


Figure 4. Association between the distribution of fingerprint patterns among subjects of A, B, O and Rh blood groups ($n = 2,000$)

racess. An earlier study suggested that the use of dermal ridges formation or total ridge count as markers in population studies and phylogenetic analysis to be greatly influenced by

Fingerprint Pattern	Arch	Count	A−	A+	Blood group				O−	O+	Total
					AB+	B−	B+	O−			
	Loop	% within blood group	0	33	1	0	15	10	55	114	
		Count	12	28.9%	0.9%	0.0%	13.2%	8.8%	48.2%	100.0%	
			181		35	11	194	16	539	988	
	Whorl	% within blood group	1.2%	18.3%	3.5%	1.1%	19.6%	1.6%	54.6%	100.0%	
		Count	8	166	54	9	151	24	486	898	
			20	18.5%	6.0%	1.0%	16.8%	2.7%	54.1%	100.0%	
Total	Count		380	90	20	360	50	1,080	2,000		
	% within blood group	1.0%	19.0%	4.5%	1.0%	18.0%	2.5%	54.0%	100.0%		

certain parameters such as the geographical location, the ethnic background and the language (Sharma, Gautam, & Tiwari, 2007). In contrast to most of the earlier studies (Sandhu *et al.*, 2017; Patil *et al.*, 2019; Chaudhary *et al.*, 2017; Kc *et al.*, 2018), in the present study gender influence on the distribution of fingerprint pattern was observed, and it was in accordance with an earlier study (Anyanwu, 2020). This influence manifested by having the whorl pattern (50.0%) being the most dominant among male participants, whereas among the female participants it was the loop pattern (54.6%). Furthermore, one of the studies that did not find a significant difference among gender suggested that fingerprint patterns are not linked to sex chromosomes despite the possibility of inheriting them genetically (Heng, Ismail, Rahman, & Anan, 2018).

In Oman, O+ group was the most common blood group which was similar to our study (Al-Riyami *et al.*, 2019). Similarly, studies by Eboh (2013), Manikandan *et al.* (2019) and Patil *et al.* (2019), also reported a predominance of the O+ group. This study also revealed that Rh-positive blood groups (95.5%) had a higher incidence than Rh-negative (4.5%), which is consistent with previous results. in Omani subjects (89.3% Rh positive) (Al-Riyami *et al.*, 2019). After analyzing the distribution of the fingerprint patterns within the ABO–Rh blood groups, we found that individuals with A+ (47.6%, 181 fingerprints), A– (60.0%, 12 fingerprints), B+ (53.9%, 194 fingerprints), B– (55.0%, 11 fingerprints) and O+ (49.9%, 539 fingerprints) groups had a higher frequency for loop. On the other hand, whorl was higher only in AB+ (60.0%, 45 fingerprints) and O– (48.0 %, 24 fingerprints) groups. Similarly, a study from Nigeria found a similar fingerprint patterns' distribution in all blood groups except AB+ (Eboh, 2013). Studies from India (Manikandan *et al.*, 2019; Sisodia *et al.*, 2020), Pakistan (Abbasi, Mengal, & Khan, 2012), Nepal (Kc *et al.*, 2018) and Libya (Fayrouz *et al.*, 2012) showed a higher incidence of the loop pattern in O+ subjects, which is similar to our results. Another study from Kurdistan region of Western Asia reported the loop as the most common pattern in all blood groups (Smail *et al.*, 2019).

The present study also revealed that in all the blood groups, the arch pattern had the lowest percentages, except with the A– and B– groups, in which no arch pattern was reported. This might be explained by the low number of participants within the A– and B– groups. Previous studies also found that the arch pattern had the lowest incidence among the primary fingerprint patterns in all blood groups (Fayrouz *et al.*, 2012; Smail *et al.*, 2019; Kc *et al.*, 2018; Eboh, 2013). However, Manikandan *et al.* reported that arch was the most frequent pattern in the A–, B+ and O– groups (Manikandan *et al.*, 2019). Fayrouz *et al.* (2012) observed that loop was highest in Rh-positive subjects of A and O blood groups, whereas the Rh-negative subjects of the same groups had the whorl as the highest. In our study similar results were found only in the O group. In contrast to their study (Fayrouz *et al.*, 2012), the loop pattern was the most prevalent in both A+ and A–. In another related study, the general distribution of fingerprint patterns between Rh-positive and Rh-negative subjects was the same, in which loop was the highest and arch was the lowest (Eboh, 2013). However, they found the association between primary patterns and Rhesus blood groups to be significant with a $p = 0.013$ (Eboh, 2013).

A significant correlation was found between primary fingerprint patterns and ABO–Rh blood groups. These findings are similar to earlier studies (Sandhu *et al.*, 2017; Manikandan *et al.*, 2019; Patil *et al.*, 2019; Fayrouz *et al.*, 2012; Nanakorn *et al.*, 2013; Ahmad and Karmakar, 2014). In contrast, a few studies did not support such associations (Chaudhary *et al.*, 2017; Kc *et al.*, 2018). Interestingly, a previous study that assessed the genetic variations among different Indian populations through dermatoglyphic markers, suggested a genetic basis for the association between fingerprints and blood groups (Sharma *et al.*, 2007). However, further studies on bigger population in different geographical areas are suggested for knowing the possible association genes and the biometric markers.

The current literature confirms that fingerprints are still one of the most preferred ways of identification and it will be in the next years despite the advancement that is happening with the detection technology and the field of biometrics. Positive association between the fingerprint patterns and blood groups is important in the field of forensic medicine for accurate identification and narrowing the scope of search in case of limited data (Sandhu *et al.*, 2017). Also, using such biometrics, it is much cheaper and more approachable compared to using DNA analysis, which is difficult to perform in each and every case (Srilekha, Anuradha, Vijay Srinivas, & Sabitha Devi, 2014). Moreover, a study from Malaysia observed that fingerprints could be useful to discriminate between major ethnicities and showed more similarities between siblings than nonsiblings except in the arch pattern (Heng *et al.*, 2018). Therefore, fingerprint patterns and blood groups could enhance the effectiveness of handling criminal cases. Fingerprints have also been used for confirming paternity along with other diagnostic purposes (Gyenis, 2000). With recent advances in fingerprint sensing, knowing such an association will definitely expand the biometric technology, which can be beneficial for personal identification and medical purposes. Moreover, such data could also be helpful in the prediction of various diseases and malignancies (Smail *et al.*, 2019). The blood type O was reported to be associated with increased incidence of cholera, plague, tuberculosis infections and mumps, while on the other hand, blood type A was linked to higher incidence of smallpox and *Pseudomonas aeruginosa* infection (Abegaz, 2021). Research studies reported higher incidence of cancers in the stomach, ovaries, salivary glands, cervix, uterus and colon/rectum to be associated with blood type As compared to blood group O individuals (Abegaz, 2021). There are reports of association of ABO blood types and thromboembolic diseases (Abegaz, 2021). Hence, study of blood groups may be beneficial for diagnosing diseases.

The present study had few limitations. Admittedly, the sample size was small. As the study sample was restricted to few regions of Oman, hence the findings cannot be generalized outside of the study environment. Including study subjects from various parts of Oman with a larger sample study would portray a better picture.

5. Conclusion

Results of the present study report the baseline data of fingerprint pattern among Omani subjects. The loop fingerprint pattern was the most common pattern. There is a significant association between fingerprint patterns and blood groups. Further studies on a larger sample size of subjects are needed to explore the genetic role in such associations.

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