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Fingerprint Analysis in Relation to Blood Group and Gender in the Saudi Arabian Population

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ABSTRACT

Objective: fingerprints are permanent and an individual physical characteristic, and are considered an authentic proof of identification. The aim of the present study was to investigate whether fingerprints have any significant relationship with gender and blood group.

Materials and Methods: the fingertip patterns of 400 Saudi subjects were recorded using ink and paper, and identified by magnification lens, and the blood group was determined by the agglutination method. After recording the blood group and fingerprints of the subjects of both genders, their correlation was analyzed by Chisquared test.

Results most subjects (49.25%) belonged to blood group O, followed by A, B and AB, of which 92% were Rhesus (Rh) positive; the relationship between gender and blood group was statistically significant. Regarding the fingertip patterns among the genders and ABO and Rh factor blood groups, loopsweremore frequent, followed by whorls and arches. Regardless of the Rh factor, the fingerprint pattern in blood groups A and AB was statistically significant, but it was not significant in the B and O groups. The incidence of loops was higher on the middle and little fingers, as well as on the thumb, in blood groups A, B and O, and this relationship was statistically significant.

Conclusions: the present study reveals that the fingerprint pattern is not associated.

Keywords: Blood group; Dermatoglyphics; fingerprint; Gender; Identification

Introduction

Dermatoglyphics is the scientific study of human epidermal ridges and their pattern on the volar aspect of the palmar and plantar regions.[1] Fingerprints play an important role in increasing friction and the tactile sensation. The epidermal ridges start to appear on the digits, palms, soles and toes between the 11th and the 16th weeks postfertilization, and their development and differentiation ends by the 24th week.[2] The fingerprint patterns are absolutely individual and con-stant, even in monozygotic twins, from birth to death.[3] The permanence of the fingerprint frictional ridges is attributed to three structural features of the volar skin: the attachment of the skin epidermal cells to each other, and the attachment of the basement membrane to the stratum basale layer of the epidermis and to the dermis.[4] Henry Faulds[5] proposed the uniqueness and individuality of the fingerprint pattern. Galton[6] classified the primary human fingerprint configuration into three classes: arches, loops, and whorls. Nowadays, fingerprint patterns are used as an inexpensive and infallible gold standard for personal identification in a wide range of fields: in forensic science, for criminal identification; in bank-ing, to authenticate cashless transactions;[7] and in Medicine, to predict the diagnosis of genetic disorders, for example.[8]

Karl Landsteiner identified the first human ABO blood group system. Clinically, the grouping of blood types is made using the ABO and Rhesus (Rh) classification systems. Four major blood group types (A, B, AB and O) are categorized based on the presence of the corresponding antigen in the plasma, and the Rh system is divided into Rh þve (Rhesus positive) and Rh -ve (Rhesus negative) based on the presence or absence of antigen D.[7] The blood group is clinically essential in transfusion medicine, genomic research and organ transplantation, as well as to predict diseases like duodenal ulcer in the O blood group.[9] An association has been noted between the distribution of blood groups and fingerprint patterns.[10] The average distribution of finger-print patterns has been studied in different racial and ethnic groups;[11–22] unfortunately, there is little published literature on the distribution of fingerprint patterns among the Saudi Arabian population. The purpose of the present investigation was to quantify the distribution of fingerprint patterns on all digits. The secondary aim was to determine the association of fingerprints with blood groups and gender.

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Materials and Methods

The present study was approved by the Institutional Review Board (IRB) under number SP17/182. All of the participants provided written informed consent prior to the study. A total of 400 Saudi subjects (males: 185; females: 215) aged between 17 and 45 years were enrolled from the staff and medical students at the King Saud Bin Abdulaziz University for Health Sciences from 2017 to 2018. All of the included subjects were healthy, with no genetic disorders, but two male subjects were excluded because they had scars and injuries in one of their fingers. The finger prints were recorded by applying ink to the fingers of the subjects, who then pressed them against paper, as suggested by Cummins and Midlo.[1] A fingerprint template was created using a white sheet of paper, which consisted of left and right columns, and each columnwas again divided into 5 to record the finger prints of every finger and the thumb. The template also included boxes to record the subject's name, gender, age, ABO blood group, and Rh blood type.

The finger prints were recorded by rolling the pulp of each finger on blue stamp ink pads, and then, imprints of the fingerprints of all 10 digits were obtained on the corresponding blocks of the template. Care was taken to prevent smudging; the prints were taken four times, and their pattern (arch; whorl; loop) was studied using a magnifying glass (Fig. 1). The blood groups were identified by the slide agglutination method, by mixing one drop of blood with antiserum (anti-A, anti-B, and anti-D). The distribution of fingertip patterns and their association with gender and ABO and Rh blood groups was analyzed by the Chisquared test, with values of $p < 0.05$ considered significant.

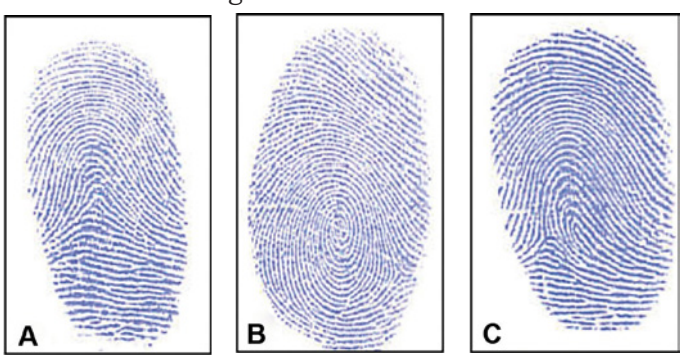

Figure 1. The three primary fingerprint patterns: (A)arch;(B)whorl;(C) loop.

Results

The sample of the present study consisted of 185 male and 215 female subjects, with a male to female ratio of 1:1.2, and their average age was 21 years.

ABO and Rh blood groups

The Rh þve group was composed of 368 (92%) subjects, and 184 (46%) of them belonged to blood group O. The numbers of subjects with blood groups A, B and AB were 85 (21.5%), 81 (20.25%) and 18 (4.5%) respectively.

In the Rh -ve group, out of 32 (8%) subjects, 13 (3.25%) belonged blood group O, followed by blood groups A and B, with 9 (4.5%) subjects each, and the AB blood group, with 1 (0.25%) subject (Table 1).

Table 1. Distribution of the subjects according to blood group and Rhesus factor (n = 400)

Blood group	Rhesus factor	
	Positive	Negative
A	85 (21.25%)	9 (2.25%)
B	81 (20.25%)	9 (2.25%)
AB	18 (4.5%)	1 (0.25%)
O	184 (46%)	13 (3.25%)
Total (n)	368 (92%)	32 (8%)

Gender and blood group

Most subjects (197; 49.25%) belonged to blood group O, followed by blood groups A, B and AB, which were composed of 94 (23.5%), 90 (22.5%) and 19 (4.5%) subjects respectively. After blood group O, the second predominant blood group among males was A (23.24%), and, in females, it was B (24.19%), and a statistically significant ($p < 0.001$) difference was observed (Table 2).

Type of finger print patterns

Loops were the prevailing pattern (50.5%), followed by whorls (35.1%) and arches (14.4%) on both hands. The frequency of whorls among females (37.49%) was slightly higher than among males (36.43%), but the frequency of arches (8.84%) was the same, while among males, the frequency of loops (56.22%) was higher than among females (53.67%). However the relationship between gender and fingerprint pattern was not statistically significant ($p > 0.05$) (Table 3).

Fingerprint patterns regarding

ABO and Rh blood groups In blood group A, the incidence of loops was higher (Rh þve: 58.23%; Rh -ve: 51.11%), than that of whorls (Rh þve: 37.53%; Rh -ve: 46.67%) and arches (Rh þve: 4.24; Rh -ve: 2.22%). In Blood group AB, the incidence of loops was higher (Rh þve: 61.67%; Rh -ve: 70%), followed by arches (Rh þve: 5%; Rh -ve -30%) and whorls (Rh þve: 33.3%; Rh –ve: 0%). Among the AB Rh -ve blood group, only loops and arches were observed on the fingerprints of the subjects. These differences between the A and AB blood groups were statistically significant ($p < 0.05$).

Among the subjects in blood group O, the incidence of loops was higher (Rh þve: 52.88%; Rh -ve: 52.5%), followed by whorls (Rh þve: 38.26%; Rh -ve: 37.69%) and arches (Rh þve: 8.86%; Rh –ve: 13.08%). Similarly, in blood group B, loops had a higher incidence (Rh þve: 55.43%; Rh -ve: 54.44%), followed by whorls (Rh þve: 33.58%; Rh -ve: 37.78%) and arches (Rh þve: 10.99%; Rh -ve: 7.78%). However, the differences between the O and B groups were not statistically significant ($p > 0.05$) (Table 4).

Table 2. Distribution of subjects according to gender and blood group

Blood group	Males (*n* = 185)	Females (*n* = 215)	Total (*n* = 400)	Chi-squared	*p*-value
A	43 (23.24%)	51 (23.71%)	94 (23.5%)	47.44	< 0.001*
AB	6 (3.24%)	13 (6.05%)	19 (4.75%)		
B	38 (20.55%)	52 (24.19%)	90 (22.5%)		
O	98 (52.97%)	99 (24.19%)	197 (49.25%)		
Total	185 (100%)	215 (100%)	400 (100%)		

Note: *Statistically significant difference.

Table 3. Overall distribution of fingerprint patterns on both hands among males and females (*n* = 4,000)

Fingerprint patterns	Male	Female	Total	Chi-squared	*p*-value
Arches	136 (7.35%)	190 (8.84%)	326 (8.15%)	4.164	> 0.05
Loops	1,040 (56.22%)	1,154 (53.67%)	2,194 (54.85%)		
Whorls	674 (36.43%)	806 (37.49%)	1,480 (37%)		
Total	1,850 (100%)	2,150 (100%)	4,000 (100%)		

Table 4. Distribution of fingerprint patterns among subjects according to blood group and Rhesus factor (*n* = 4,000)

Blood group Arches		Types of fingerprint patterns				Chi-squared	*p*-value
		Loops	Whorls	Total			
A	Rh +ve	36 (4.24%)	495 (58.23%)	319 (37.53%)	850 (21.25%)	7.003	< 0.05*
	Rh -ve	2 (2.22%)	46 (51.11%)	42 (46.67%)	90 (2.25%)		
B	Rh +ve	89 (10.99%)	449 (55.43%)	272 (33.58%)	810 (20.25%)	1.216	> 0.05
	Rh -ve	7 (7.78%)	49 (54.44%)	34 (37.78%)	90 (2.25%)		
AB	Rh +ve	9 (5%)	111 (61.67%)	60 (33.33%)	180 (4.5%)	10.099	< 0.05*
	Rh -ve	3 (30%)	7 (70%)	0	10 (0.25%)		
O	Rh +ve	163 (8.86%)	973 (52.88%)	704 (38.26%)	1,840 (46%)	2.682	> 0.05
	Rh -ve	17 (13.08%)	64 (49.23%)	49 (37.69%)	130 (3.25%)		

Abbreviations: Rh þve, Rhesus positive; Rh -ve, Rhesus negative. Note: *Statistically significant difference..

Fingerprint patterns on each finger

In the subjects with blood groups A, B & O, the incidence of loops was higher on the thumbs (A: 65.43%; B: 63.89%; and O: 62.2%), followed by the middle (A: 70.2%; B: 67.78%; and O: 62.69%), and little fingers (A: 64.9%; B: 63.89%; and O: 56.60%), while the incidence of whorls was higher on the index (A: 51.06%; B: 42.22%; and O: 47.46%), and ring fingers (A: 50.53%,; B: 45.55%; and O: 45.69%). In the AB blood group, the incidence of loops was higher (54.85%), followed whorls (37%) and arches on every finger (8.15%). As for the incidence of arches, it was lower on the little fingers (A: 1.06%; B: 1.11%; AB: 5.26%; and O: 4.31%) and the thumbs (A: 1.06%; B: 3.89%; AB: 5.26%; and O: 3.54%). The fingerprint pattern distribu-tion was statistically significant (p >0.001) in blood groups A, B and O, but not significant in the AB blood group (p > 0.05) (Table 5).

Discussion

In accordance with other studies,[11–22] the order of distribution of fingerprint patterns in the present study was as follows: a high incidence of loops, a moderate incidence of whorls, and a low incidence of arches. In the comparison between genders, whorls and arches were more predominant in females, and loops were more predominant males. In agreement with that, Ekanem *et al*,[16] in a study with residents of Maiduguri, Nigeria, reported a higher incidence of loops (31%) in males. In contrast, Shivhare *et al*,[11] in Chhattisgarh (central India), and Sudikshya *et al*,[12] in Nepal, observed a higher incidence of loops in females (55.8% and 52.4% respectively), but in males they found a higher incidence of whorls (34.23% and 43%respectively) and arches (16.23% and 5.87% respectively). Sangam *et al*,[13] Deopa *et al*,[14] and Desai *et al*[15] found a higher incidence of loops (60.5%, 64.53% and 52.63% respectively) in females, and, regarding the ABO groups, most individuals belonged to the O group, and the AB group had the lowest incidence. A similar observation was noted by Sudikshya *et al*,[12] Sangam *et al*,[13] and Bharadwaja *et al*.[17] In contrast, Deopa *et al*,[14] in their study in Uttarakhand, India, found that most subjects belonged to blood group B. Fayrouz *et al*[18] reported a significant relationship between gender and blood group, which is in agreement with the present study. The incidence of Rh þve (92%) subjects

Table 5. Distribution of fingerprint patterns on different fingers of both hands of the subjects (*n* = 800 [400 x 2])

Fingers	Blood group A (*n* = 940)			Blood group B (*n* = 900)			Blood group AB (*n* = 190)			Blood group O (*n* = 1970)		
	Arches	Loops	Whorls	Arches	Loops	Whorls	Arches	Loops	Whorls	Arches	Loops	Whorls
Thumb	2	123	63	7	115	58	2	22	14	14	245	135
	1.06%	65.43%	33.51%	3.89%	63.89%	32.22%	5.26%	57.90%	36.84%	3.54%	62.20%	34.26%
Index	10	82	96	32	72	76	3	23	12	51	156	187
	5.32%	43.62%	51.06%	17.78%	40%	42.22%	7.90%	60.52%	31.58%	12.94%	39.60%	47.46%
Middle	13	132	43	31	122	27	2	28	8	50	247	97
	6.90%	70.2%	22.9%	17.22%	67.78%	15%	5.26%	73.70%	21.04%	12.69%	62.69%	24.62%
Ring	11	82	95	24	74	82	3	23	12	48	166	180
	5.85%	43.62%	50.53%	13.33%	41.11%	45.55%	7.90%	60.52%	31.58%	12.18%	42.13%	45.69%
Little	2	122	64	2	115	63	2	22	14	17	223	154
	1.06%	64.9%	34.04%	1.11%	63.89%	35%	5.26%	57.9%	36.84%	4.31%	56.60%	39.09%
Statistics	Chi-squared = 65.034 $p < 0.001$**			Chi-squared = 94.154 $p < 0.001$ **			Chi-squared = 3.5678 $p > 0.05$			Chi-squared = 111.027 $p < 0.001$**		

Notes: Values expressed as numbers and percentages. **Statistically significant difference.

was higher in every blood group (Rh -ve: 8%), which is similar to other studies[15–21] performed with different ethnic and racial groups.

In the present study, the frequency of loops and arches was higher in the A Rh þve blood group, and the frequency of whorls was higher in the A Rh - ve group. These differences were statistically significant, which is in agreement with the observations made by Fayrouz *et al*[18] and Sudikshya *et al*.[12] In contrast, Desai Bhavana *et al*,[15] Sangam *et al*,[13] Prateek and Pillai,19 and Umraniya *et al*[20] reported a higher incidence of loops and arches in the A Rh þve group, and of whorls in the A Rh -ve blood group. Shivhare *et al*[11] observed a higher frequency of loops and whorls in the A Rh -ve blood group.

In the present study, in the B blood group, the frequency of loops and arches was higher among the Rh þve subjects, and the incidence of whorls was higher among the Rh + ve subjects. This observation correlates with those of the studies by Umra-niya *et al*,[20] Sudikshya *et al*,[12] and Desai *et al*.[15] In agreement with other studies,[12,18] this differencewas not significant in the present study. But Deopa *et al*[14] observed a greater percentage of both loops and arches in the B Rh -ve and whorls in the B Rh þve blood group. Fayrouz *et al*[18] observed a higher frequency of both loops and whorls in the B Rh -ve blood group, and of arches in the B Rh þve blood group. And Shivhare *et al*[11] only observed a high percentage of loops in the B Rh -ve group, andwhorls and arches were higher in the B Rh þve blood group.

In the AB blood group, only loops and arches were observed on both hands of the Rh -ve group; whorls were not observed. Therefore, the frequency of loops (70%) and arches (30%) is higher than that of the AB Rh þve blood group loops (61.67%) and arches (5%). This observation was statistically significant ($p > 0.05$). In the AB Rh -ve blood group, all three fingerprint patterns were observed by Desai *et al*,[15] Bharadwaja *et al*,[17] and Fayrouz *et al*.[18] However, Radhika et al[21] and Prateek and Pillai[19] did not observe any of the three fingerprint patterns in the AB Rh -ve group, while Sudikshya *et al*[12] observed only loops (100%). In the AB Rh -ve individuals, and Deopa *et al*[14] observed only loops (80%) and whorls (20%).

In the O Rh þve blood group, the loops and whorls were highly frequent, while the frequency of arches was higher in the O Rh -ve group. In contrast, Desai *et al*[15] observed a high incidence of whorls (70%) in the O Rh -ve group, while loops (59.11%) and arches (12.35%) were higher in the O Rh þve group. Sangam *et al*[13] found a higher occurrence of loops (59.1%) and whorls (40.8%), but they did not observe arches in the O Rh -ve blood group. Fayrouz *et al*[18] found a greater frequency of loops (54.3%) in the O Rh þve blood group, and of whorls (50%) and arches (20%) in the O Rh -ve blood group. In a recent study, Sudikshya *et al*[12] observed a higher percentage of loops (54%) and arches (7%) in the O Rh -ve group, and whorls (41.35%) were dominant in the O Rh þve blood group. Interestingly, in the studies by Fayrouz *et al*[18] and Sudikshya *et al*,[12] this difference was not statistically significant ($p > 0.05$), which is in line with the present study.

Regarding the fingerprint pattern on different fingers, the frequency of loops was higher on the thumb and on the middle and little fingers in the A, B and O blood groups. Similarly, Bharadwaja *et al*[17] and Jain *et al*[22] also observed a high frequency of loops on the little and middle fingers in all blood groups, while the incidence of whorls in blood groups A, B and O was higher on the index and ring fingers. Still regarding those two studies, in the AB blood group,

the incidence of loops was higher, followed whorls and arches on all of the fingers. In the present study, the incidence of arches in blood groups B and O was higher on the index and middle fingers. Interestingly, the incidence of arches was lower on the thumbs and little fingers of the subjects in blood group A. Sudikshya *et al*[12] and Bharadwaja *et al*[17] also reported a higher incidence of arches on the index finger, but in every blood group. And Jain *et al*[22] reported a high frequency of arches on the index finger in blood groups A and B, and in blood groups AB and O, the incidence of arches was higher on the little finger (35.7%) and the thumb (9.1%). Deopa *et al*[14] observed a higher frequency of arches on the index fingers of the subjects with blood groups B, AB and O. In the present study, the fingerprint pattern distribution on different fingers showed a highly significant difference in blood groups A, B and O, whereas in the AB blood group, the difference in distribution was not significant. However, Sudikshya *et al*[12] and Fayrouz *et al* observed a statistically significant difference in the distribution of fingerprint patterns in every blood group.

Conclusion

Loops are the most commonly observed fingerprint pattern, and arches are the least frequent in both males and females and in all blood groups. In the comparison between genders, the percentage of whorls and arches was higher among females, while the percentage of loops was higher among males.

The incidence of loops is more associated with the thumb and the middle and little fingers in the subjects in blood groups A, B & O, and the frequency of whorls was higher on the index and ring fingers in the A, B and O blood groups. Individuals in blood group AB had a higher frequency of loops on the middle, ring and index fingers, and of whorls on the thumb and little finger.

The authors of the present study conclude that the distribution of fingerprint patterns is not related to gender, but it is related to individual digits and blood groups. The relation ship between finger print and blood group can be useful in forensic medicine for the identification of criminals; it can also be used in the prediction of certain blood related diseases.

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