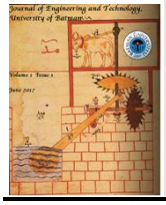

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Analysis of Blood Groups from Fingerprint Patterns of Turkish Citizens

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ABSTRACT

This study examines 10 fingerprints of each of 82 Turkish citizens the ages between 18 and 70 and presents the results of blood group distribution of people from only fingerprints. The fingerprint patterns are first divided into 3 categories such as loop, whorl and arches. The blood group distribution was then analyzed according to these categories.

It was found that the loop-type patterns were found more intensively than other patterns, AB blood group had little relation among loop-type patterns and loop rate for A blood group is higher. The results were compared to other types of patterns. The results were also demonstrated that the relation among fingerprint feature vectors and blood groups might exist and blood group can be achieved from fingerprints. It is expected that the proposed analysis might help to develop systems and various new applications such as determination of blood group of a criminal from a fingerprint found on crime scene and determination of blood group of a person when he/she borns fastly and without any cost.

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1. INTRODUCTION

Biometrics is the science based on the statistical analysis of the measurable physical, behavioural and chemical characteristics of an individual such as foot print, lip prints, palm prints, hand geometry, fingerprint, retina, iris, the chemical composition of body odour, facial features, wrist and hand veins, signature, voice prints, gait and keystroke-style on keyboard. Biometric systems work with the principles of recognizing physical, behavioural and chemical features which separate the individual from the other individuals and they are only owned by the individual. Biometric systems today are used in ATM security, personnel entrance-exit, driver and voter registration, customs and immigration procedures and many other areas [1].

The studies, which are performed intending to identify individual, have increased with the wide spread of biometric systems. Fingerprints are widely used in identification tools and they are used as the main evidence of individual's identity in the courts of law. Fingerprint recognition is widely used in biometric technologies [2]. The aim of a fingerprint recognition system is the assignment of the given fingerprint pattern to one of the IDs in the database [3].

The problem of classification patterns of fingerprints has been a topic studied by many biometric operators [4]. Each fingerprint pattern are characterized as arch, radial loop, ulnar loop and whorl (whorl loop, loop accidental included) and each pattern is statistically different in men and women [5].

Blood group classification technique was first discovered by Karl Landsteiner in 1901 [6]. This technique is not only important in blood transfusion used but also it is used in organ transplants and genetic studies [1].

According to Landsteiner's study, the most important ones among 19 groups are determined as 'ABO' and 'Rhesus' [6]. In the literature, there are a limited number of studies examining the relationship between fingerprints and blood groups. Fingerprint patterns are collected in three general categories, including loop, whorl and arch [1,6-17].

In two different studies performed with 305 Libyan individuals [1] and 300 Indians [7] using their fingerprints, statistical analysis were made by forming a database from fingerprint patterns. In these studies, A, B, 0 and AB blood groups were examined separately for each finger.
A study, in which statistical inferences were made according to fingerprint patterns by handling with Rh factors [6], showed that the distribution of fingerprint patterns was; loop (58.9%), whorl (29.6%), arch (11.5%) and the distribution of blood groups were found as; A (21%), B (37%), AB (7%) and 0 (35%) in a database which was obtained from 100 males and 100 females and total 200 individuals.

In another study performed with 89 people between the ages of 17 and 21 in India, women were more likely to have A, B and 0 blood groups, while men had B and 0 blood groups, and it was concluded that it was possible to determine the blood group and gender from fingerprints. The distribution of the data used in the study according to blood groups are; A Rh(+) (21%), A Rh(-) (0%), B Rh(+) (33%), B Rh(-) (1%), 0 Rh(+) (33%), 0 Rh(-) (2%), AB Rh(+) (9%) and AB Rh(-) (1%). The distribution of the fingerprint patterns of database used were found as; loop (57%), whorl (26%), arches (8%) and composite fingerprints (9%) [8].

In the study performed with 150 women and 150 men in Mangalore, India [9], the distribution percentage of fingerprint patterns according to the genders were, in men; Loop (46.8%), Whorl (54.9%) and Arch (55.4%), in women; Loop (53.2%), Whorl (45.1%) and Arch (44.6%). The distribution of the data according to the blood group were found as; A (22.6%), B (29.3%), AB (5.7%) and 0 (42.4%), respectively. In the study, information of ten fingers, which were not separated based on fingers, was expressed with percentage according to the patterns.

In another study performed with 88 women and 216 men [12], blood group distribution was examined by using the arch and loop patterns. According to the observation, the blood group distribution, which were sorted from the highest observed to lowest observed were listed as 0, B, A and AB, respectively. The distribution of data according to the fingerprint patterns is loop (51.54%), arch (12.67%) and whorl (35.79%), respectively. Distribution percentage of individuals examined in the study according to the blood groups were found as; A Rh(+) (15.79%), A Rh(-) (0.66%), B Rh(+) (36.18%), B Rh(-) (0.33%), 0 Rh(+) (36.51%), 0 Rh(-) (1.97%), AB Rh(+) (7.89%) and AB Rh(-) (0.66%).

In the study performed with 100 women and 100 men, in total 200 individuals, having the ages of 18-25 in India [10], blood groups were classified with Rh factor according to the fingerprint patterns. It was reported that the individuals in A Rh(+) blood group have a dominant loop type in their fingerprint patterns. The distribution of the fingerprint patterns of database used in the study was determined as; loop (60.95%), arch (6.5%) and whorl (32.55%). The distribution of the data used according to the blood group was found as; A (28%), B (31.5%), AB (4.5%) and 0 (35.5%), respectively.

In [11], it was reported the statistics of the blood group of whorl, arch and loop by taking the fingerprint patterns of 506 Indian students. The distribution in blood groups was: A (18.2%), B (32.2%), AB (6.7%) and 0 (42.9%) and the distribution of fingerprint patterns was such as; loop (56.2%), whorl (39.4%) and arch (4.4%), respectively.

As a result of fingerprints and blood group examinations taken from in another study [13], 490 Nigerian individuals between 17-30 years of age were examined and found that distribution of ABO blood group was unsuitable alone, when Rh factor was added, the new form of blood group was more suitable for distribution.

In another Nigerian study performed with 400 individuals between the ages of 18-35 in [14], the blood group distribution was examined by looking to the fingerprint patterns. The distribution of the data used in the study according to the fingerprint patterns was found as; loop (56%), whorl (30.80%) and arch (13.20%). The result of fingerprint pattern distribution according to the blood groups was given in Table 1.

Table 1. Blood group distribution in categories [14]

Blood groups	Loop (%)	Whorl (%)	Arch (%)
A	10.00	04.80	02.10
B	11.60	05.73	02.43
AB	03.73	02.30	01.15
0	30.70	18.00	07.53

In [15], separate results were obtained from the samples of fingerprints and palm prints of 127 men and 73 women individuals between the ages of 17-22. The distribution of blood groups was made with arch, loop and whorl classes in fingerprint part, and with hypothenar, thenar/I1, I2, I3 and I4 patterns in palm print part. In both results, blood group and the Rh factor were evaluated separately. According to the data used in the study, the distribution of blood groups were A (22.5%), B (41.5%), AB (5.5%) and 0 (30.5%). The distribution of Rh negative (5%) and Rh positive (95%) is added. According to the results obtained, whorl pattern is more likely to be seen in B blood group type and there is a significant difference with 0 blood group. The loop and arch are commonly seen in 0 blood group and in AB blood group, respectively.

In the study [16], 143 men and 57 women Indian individuals between the ages of 17-22 were considered and Rh factor and blood groups were discussed separately. Z-test was used for statistical analysis in the study. Distribution of data used in the study performed according to blood groups were found as; A (27%), B (51%) 0 (40%) and AB (13%). The distribution analysis results according to the fingerprint patterns were; loop (53%), whorl (39%) and arch (8%), respectively.

Major contribution of this paper is to analyze and perform the distribution of fingerprints of Turkish citizens. Distribution of fingerprint patterns according to the blood groups was focused during this study. The studies in the literature were examined and it was found that there were no studies which were performed about fingerprint distribution of Turkish people according to the blood groups. So, this is the first study that analyse blood groups from fingerprints of Turkish citizens in the literature.

2. MATERIAL AND METHOD

In order to achieve the task, fingerprint feature vectors and patterns were used and their relationships among the blood groups were examined. In this statistical study, 10 fingerprints of 36 female and 46 male (totally 82 Turkish citizens) between the ages of 18-70 was used for the Rh factor distribution according to the gender and it was shown in Table 2, the blood group distribution according to the gender was shown in Table 3, the blood group distribution and Rh factor according to the gender were shown in Table 4. All data used in this study were collected from individuals with the permission of Ethics Commission of Gazi University.

Table 2. The distribution of Rh factor for gender

Rh Factor	Female	Male	Total
Rh (-)	4 (4.9%)	1 (1.2%)	5 (6.1%)
Rh (+)	32 (39%)	45 (54.9%)	77 (93.9%)

Table 3. The distribution of blood groups for gender

Blood Groups	Female	Male	Total
A	22 (26.8%)	14 (17.1%)	36 (43.9%)
B	4 (4.9%)	5 (6.1%)	9 (11%)
AB	2 (2.4%)	2 (2.4%)	4 (4.8%)
0	21 (25.6%)	12 (14.6%)	33 (40.2%)

Table 4. The distribution of blood group and Rh factor for gender

Blood Groups with Rh factor		Female	Male	Total
A	Rh(-)	3 (3.7%)	1 (1.2%)	4 (4.9%)
	Rh(+)	19 (23.2%)	13 (15.9%)	32 (39%)
B	Rh(-)	0 (0%)	0 (0%)	0 (0%)
	Rh(+)	4 (4.9%)	5 (6.1%)	9 (11%)
AB	Rh(-)	0 (0%)	0 (0%)	0 (0%)
	Rh(+)	2 (2.4%)	2 (2.4%)	4 (4.8%)
0	Rh(-)	1 (1.2%)	0 (0%)	1 (1.2%)
	Rh(+)	20 (24.4%)	12 (14.6%)	32 (39%)

In this study, fingerprints were also examined separately in terms of patterns and vectors. The steps followed in this study are given below:

1. Collecting and forming the fingerprint images in a database, which will be used in analysis.

2. Transferring the fingerprint patterns of each finger found by us to a dataset.
3. Adding blood group information to the dataset for blood group distribution from fingerprint patterns.

4. Comparing the distribution with other studies in the literature.

5. Evaluation of the obtained results.

3. INVESTIGATION OF BLOOD GROUP DISTRIBUTION BASED ON FINGERPRINT PATTERNS

There have been few studies in the literature to classify blood groups [1,7]. The studies summarised in the introduction were, performed with the fingerprints taken from 305 Libyan individuals [1] and 300 Indian individuals [7]. In these studies, the ratio of fingerprint patterns, which were seen on each finger, were examined for A, B, 0 and AB blood groups. The results obtained from these studies and their comparison with the present study are given in Table 5.

When the index finger patterns of individuals having AB blood group in present study were examined, the dominant pattern type was arch with 62.5%. In [1], the dominant pattern type was loop with 43.8% and in [7], the dominant pattern type was whorl with 52%.

Table 5. Comparisons for blood group distribution in percentages based on fingerprint patterns for each finger (%) (L: Loop, W: Whorl, AR: Arch)

Blood Groups/ Studies		**A**			**B**			**AB**			**0**		
	Fingers	AR	L	W	AR	L	W	AR	L	W	AR	L	W
[1]	Thumb	09.90	47.00	43.10	11.50	53.80	34.60	09.40	62.50	28.10	14.10	47.00	38.90
	Index finger	12.90	45.50	41.60	17.90	42.30	39.70	15.60	43.80	40.60	15.80	44.30	39.90
	Middle finger	13.40	57.00	28.70	03.80	47.40	48.70	18.80	62.50	18.80	17.40	56.70	25.80
	Ring finger	13.40	40.10	46.50	12.80	55.10	32.10	21.90	31.30	46.90	12.40	46.00	41.60
	Little finger	14.40	58.90	26.70	23.10	43.60	33.30	06.30	68.80	25.00	18.80	61.10	20.10
[7]	Thumb	09.00	53.00	38.00	06.30	60.40	33.10	00.00	44.00	56.00	07.80	57.80	34.30
	Index finger	18.00	41.00	41.00	30.00	35.90	34.10	16.00	32.00	52.00	28.20	32.10	39.50
	Middle finger	16.00	64.00	20.00	17.20	64.10	18.60	04.00	60.00	36.00	17.80	55.60	26.50
	Ring finger	04.00	35.00	61.00	09.10	33.10	57.70	04.00	40.00	56.00	09.10	28.20	62.60
	Little finger	03.00	80.00	17.00	03.20	73.60	23.20	00.00	80.00	20.00	07.30	72.60	28.00
Present Study	Thumb	02.80	65.30	31.90	00.00	44.40	55.60	00.00	00.00	100.00	06.10	59.10	34.80
	Index finger	11.10	43.10	45.80	05.60	55.60	38.90	62.50	25.00	12.50	16.70	45.50	37.90
	Middle finger	09.70	80.60	09.70	05.60	83.30	11.10	25.00	50.00	25.00	16.70	60.60	22.70
	Ring finger	04.20	56.90	38.90	00.00	44.40	55.60	00.00	62.50	37.50	03.00	48.50	48.50
	Little finger	05.60	84.70	09.70	00.00	94.40	05.60	00.00	87.50	12.50	04.50	81.80	13.60

Table 6. Comparisons for distribution of pattern types (L: Loop, W: Whorl, AR: Arch) on the blood group with Rh factor (%)

Studies/ Blood Groups	Pattern Type	[6]	[8]	[9]	[10]	[11]	[12]	[13]	Present study
A Rh (+)	L	57.94	59.00	61.30	63.20	54.80	55.00	58.40	66.00
	W	31.28	24.00	29.80	31.70	44.10	35.00	27.10	28.00
	AR	10.76	08.00	08.80	05.09	01.10	10.00	14.50	06.00
A Rh (-)	L	60.00	00.00	53.80	80.00	57.80	60.00	60.00	65.00
	W	26.67	00.00	43.80	10.00	32.10	25.00	32.50	25.00
	AR	13.34	00.00	02.50	10.00	10.00	15.00	07.50	10.00
B Rh (+)	L	59.57	63.00	62.50	62.79	54.80	53.64	54.40	64.00
	W	27.71	26.00	30.00	30.82	37.70	33.27	28.20	33.00
	AR	17.21	04.00	07.50	06.39	07.50	13.09	17.40	02.00
B Rh (-)	L	67.50	70.00	61.30	76.67	52.20	40.00	75.00	00.00
	W	17.50	20.00	37.50	20.00	45.70	40.00	25.00	00.00
	AR	15.00	10.00	01.25	03.33	02.10	20.00	00.00	00.00
AB Rh (+)	L	60.76	60.00	60.00	68.87	50.70	51.66	63.30	45.00
	W	37.60	30.00	37.60	30.00	48.70	43.75	23.30	38.00
	AR	01.53	08.00	02.35	01.11	00.60	04.59	13.30	18.00
AB Rh (-)	L	50.00	70.00	00.00	00.00	45.00	30.00	00.00	00.00
	W	60.00	10.00	00.00	00.00	55.00	60.00	00.00	00.00
	AR	10.00	10.00	00.00	00.00	00.00	10.00	00.00	00.00
0 Rh (+)	L	59.11	46.00	60.20	55.79	58.70	48.10	55.10	60.00
	W	28.52	30.00	33.40	35.65	37.40	36.94	29.00	33.00
	AR	12.35	11.00	06.50	08.60	03.90	14.96	15.90	08.00
0 Rh (-)	L	20.00	85.00	60.00	45.00	59.10	55.00	42.00	70.00
	W	70.00	05.00	30.00	55.00	40.80	30.00	48.00	30.00
	AR	10.00	00.00	10.00	00.00	00.00	15.00	10.00	00.00

In present study, the data distribution of 0 blood group for the ring finger was observed equally (48.5%) for both the loop and the whorl. It was also observed that the obtained results were similar with the study [1] (41.6% whorl and 46% loop). Although the dominant pattern type was loop with 46% in [1], and the dominant pattern type was observed as whorl with 62.6% in [7]. The loop ratio was 28.2% in [7].

In present study, there was no arch pattern type in B blood group when the data of thumb finger was examined. It was also observed that whorl was 55.6% and loop was 44.4%. Although the dominant pattern type was whorl in B blood group when the data of thumb finger was examined, it was noticed that the whorl rates were low in [1] and [7] and the dominant pattern type was loop in these studies.

The comparison of different fingerprint patterns and different blood groups with Rh factor obtained from literature [6,8-13] and the results obtained from present study are combined and given in Table 6.

When the Table 6 was analysed, it was found that fingerprint pattern distribution according to A Rh (+) blood group in present study shows close results to the results given in [6,8-13], and the dominant pattern type for A Rh (+) was observed as loop.

In Table 6, when A Rh(-) blood group was analysed, it was also observed that the loop pattern type was dominant as in the references [6,9-13].

Present study has higher loop rate than the other 7 studies [6,8-13] in the distribution of data of B Rh(+) blood groups. It was observed that the arch rate, which showed 2% distribution, was lower than it was in the other studies.

Table 7. Comparisons for distribution on blood groups and Rh factor (%)
(L: Loop, W: Whorl, AR: Arch)

Blood Groups	Fingerprint Pattern	[15]	[16]	Present Study
A	L	49.11	52.00	66.00
	W	41.56	39.00	27.00
	AR	09.33	09.00	07.00
B	L	50.60	60.00	64.00
	W	43.25	32.00	33.00
	AR	06.15	07.00	20.00
AB	L	47.27	48.00	45.00
	W	37.27	48.00	38.00
	AR	15.46	04.00	18.00
0	L	61.80	51.00	59.00
	W	29.02	42.00	32.00
	AR	09.18	07.00	07.00
Rh(+)	L	53.63	56.00	62.00
	W	38.37	36.00	30.00
	AR	08.00	08.00	08.00
Rh(-)	L	51.00	25.00	66.00
	W	35.00	67.00	26.00
	AR	14.00	00.00	08.00

Due to the blood groups B Rh(-) and AB Rh(-) are rarely seen, they couldn't be used in present study and their rates are placed as 0.

When the data of AB Rh(+) blood group in present study is analysed, the arch ratio is higher than the studies [6,8-13]. In present study, it was also observed that the dominant pattern type was loop in AB Rh(+) as the other studies [6,8-13].

Although it was observed that the dominant pattern type was whorl with 60% and the rare pattern type was loop with 8% in present study when the 0 Rh(+) blood group was investigated, loop was the dominant pattern type in the other seven studies [6, 8-13]. In present study, the existence of arch rate was the highest and it was 33% higher than the literature.

According to the data distribution of 0 Rh(-) blood group, neither present study nor the studies [8,10,11] have the arch pattern type. The studies [6,11,12] show different distribution results in comparison to the other studies. The dominant pattern type was whorl in [6,11,12], and loop in [8,10] and this study as well.

Table 6 summarises all the distribution results. In addition to these results, the A, B, AB and 0 blood groups without consideration of Rh factor findings in present study were compared with literature [15,16] in Table 7. This table also present comparison that analyses Rh(+) and Rh(-) separately with the studies [15] and [16]. The distribution results were obtained according to the fingerprint patterns for different blood groups as in the results of [15,16]. As a result, it was observed that the loop pattern type was dominant in each blood group. It was also observed that the individuals having Rh(-) blood group rarely have arches as in [10,11,16].

4. DISCUSSION AND CONCLUSION

Major contribution of this paper is to analyse and perform the distribution of fingerprints of Turkish citizens. Distribution of fingerprint patterns according to the blood groups was focused during this study. The studies in the literature were examined and it was found that there were no studies which were performed about fingerprint distribution of Turkish people according to the blood groups. So, this is the first study that analyse blood groups from fingerprints of Turkish citizens in the literature.

The results have shown that examining the blood group distribution according to the fingerprint patterns provided the highest results in blood groups A, B, AB and 0 as loop (66%, 64%, 45%, 59%), whorl (27%, 33%, 38%, 32%) and arch (7%, 20%, 18%, 7%), respectively. When the results are analysed according to the fingers and the patterns in fingerprints of Turkish people;

- The whorl pattern rate on thumbs of individuals, who has blood group AB, is exact 100%.
- Dominant pattern type was the loop with 83% and 94.4% rate on the middle and little finger patterns of individuals having B blood group.
- Dominant pattern type was the loop with 80.6% and 84.7% rate on the middle and little fingers of individuals who has A blood group.
- It was observed that the highest rate was in the loop pattern type in little, thumb and middle patterns for those individuals having 0 blood group.
- In addition, arch pattern type was not observed on thumbs, little and middle fingers of individuals having B and AB blood group.

The results in the literature were compared with the results obtained from this study. The results have shown similar characteristics and no major differences are among the races. Therefore, it was concluded that both time and costs could be saved by estimating the blood group from fingerprints, freely from race.

Due to the fact that there are a few people having B Rh(-), AB Rh(-) and 0 Rh(-) blood groups in Turkey, individuals having these blood groups are also few in the dataset. Therefore, our future studies will focus on getting better and more robust results by adding these people's fingerprints to the dataset.

It is expected that the proposed analysis might help to develop systems and various new applications such as determination of blood group of a criminal from a fingerprint found on crime scene and determination of blood group of a person when he/she borns. We are going to increase the dataset with different blood groups and propose a new system that predicts blood groups from only fingerprints in our next studies.

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