ASSESSMENT OF FINGERPRINT PATTERN AND DENSITY IN RELATION TO BLOOD GROUPS AND SUBGROUPS

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ABSTRACT

Objectives: This study aimed to figure out the relation between pattern and density of fingerprint and ABO blood group and subgroups**. Material and Methods:** We have conducted a study on 221 healthy Egyptian individuals of both sexes in the age range from 18 to above 60 years old with different ABO blood groups. Fingerprints were obtained by the ink method on Standard cards; a magnifying hand lens was used to study the patterns. Epidermal ridges from fingerprint samples were counted within a 5x5mm square is drawn on transparent film. Anti-A, Anti-B, and Anti-D reagent were used to determine the blood group. **Results:** Frequencies of different fingerprint patterns showed that the most frequent were loops while the least frequent in both hands were composite. Loops were more frequent in the left than the right hand. Whorls were most frequent in the right than left hand. Loops were more frequent in O, followed by AB and AB. where whorls were more frequent in A, followed by O, AB and B. Loops were most frequent with O+ and whorls with A+. The highest density was in individuals with blood group B, and the least one was with blood group AB. **Conclusion:** There was an association between distribution of fingerprint patterns, density and the blood group and subgroups in our opinion, and blood group of a person is possible based on his/her fingerprint patterns and density

Keywords: Fingerprints, Blood groups, Pattern, Density, Identification

INTRODUCTION

Identification helps to know dead and living persons **(Aggrawal, 2016).** The fingerprint is one of the oldest and mature biometric methods and is one of the cheapest and best proofs of identification, as they are constant and individualistic and their types are unique and based on genetic characteristics of individuals **(Bansal et al., 2011) (Shrestha et al ,2019)** and **(Fayrouz et al., 2012).** Fingerprints and bloodstains are commonly found in crime scenes **(Missa et al 2020).** The fingerprint is an impression of ridges of the fingers. Fingerprints are skin markings delineated by epidermal ridge patterns present on the skin of the hands' fingers, and palms. There is an association between fingerprint distribution and different diseases like diabetes mellitus, making it a useful tool for its prediction **(Mohamed et al.2021).** Ridge is a raised portion of the epidermis on digits, palmar and plantar skin. Fingerprints may be deposited in normal secretions present in the ridge of the skin, or they may be made by ink or other contaminants transferred from the skin ridges to a relatively smooth surface **(Vij, 2011).** Fingerprint ridge density is defined as the count of ridges of the fingerprints corresponding to a defined fingerprint area, it is detected by two parameters; ridge width and distance between ridges **(Krishan et al., 2013).** During comparing the suspect fingerprints with the latent fingerprints found at the crime scene, the examiner of fingerprints studies the ridge counts and ridge characteristics, so their study is very critical **(Kahn, 2005).** There is an association between fingerprints

pattern distribution and blood groups and subgroups **(Bharadwaja et al, 2004)** also, other studies support the association between distribution between fingerprints pattern, sexes, personality, and blood groups **(vankara et al 2021).** In the current study, we aimed to find a relation between the pattern and density of fingerprints

MATERIALS & METHODS

This study was conducted on 221 subjects from a healthy Egyptian population of both sexes in the age range from 18 to above 60 years old after obtaining informed written consent at Kasr al Ainy hospital from 2018 to 2019. Demographic data (name, age, and occupation of the subject) were taken and recorded**.** Exclusion criteria: Subjects with scars that are of permanent type. Any deformities of the hand affecting fingerprints pattern and density caused by injury or birth defect. Diseases: chronic skin diseases causing histopathological changes of epidermis and dermis like fingertip eczema, tinea of the palm, keratolysis exfoliative, and lichen planus. Deep skin erosion or burn. Correlations were done to show linear relations between quantitative variables. P-values equal to or less than 0.5 were considered statistically significant **(Dawson and Trapp 2001).**

Fingerprints were obtained by the ink method using the following materials:

- An inking pad with blue Printer ink (fig.1).

Figure (1): Blue ink pad

- Standard cards measuring 8x8 inches (20 x 20 cm) of average durability and its surface were slightly glazed (fig.2).

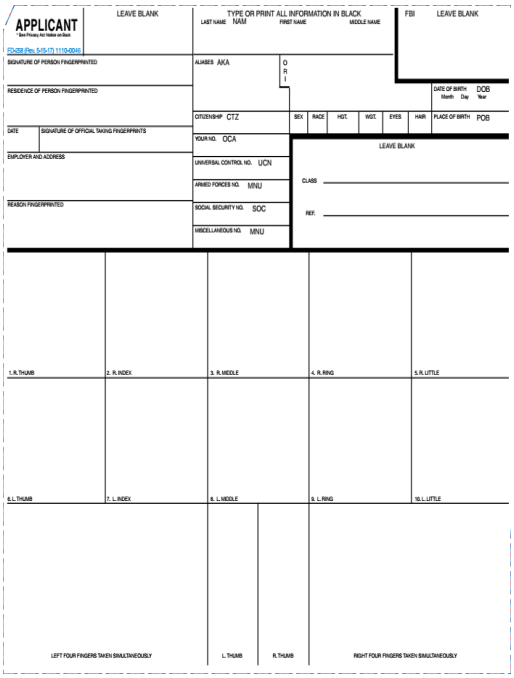

Figure (2): Standard card for finger print collection.

- A magnifying hand lens and a simple stand to fix the lens (fig.3).

Figure (3): fixed magnifying lens

The blood group is tested using the following material:

- Anti-A, Anti-B, and Anti-D reagent (fig.4).

Figure (4): blood group reagent

- Sterile lancets, microscope slides, and glass rods. Gauze pads, alcohol, gloves, and safe container.

Steps of the procedure:

1. Informed written consent for voluntary participation in the research work was taken from the subjects after taking permission of the ethical committee.
2. The skin of the hand was cleaned with alcohol and dried before printing.
3. Fingerprint is obtained by the plain method. Ten fingerprints were taken from everyone.
4. Fingers were given numbers from 1 to 10, beginning from the right thumb to the right little finger (1 to 5). The left hand begins by the thumb (no 6), to little finger to (no 10).
5. Ridge counting epidermal ridges samples of both males and females were counted within a 5x5mm and square was drawn on transparent film, this value represented the number of ridges /25 mm2 and will be the ridge density value. In right hand, this square was placed in the upper left of the central core region. While in left hand the square was placed in the upper right of the central core area. In this square, ridges were counted from one corner to the diagonally opposite corner (fig.5).

Figure (5): Location of count area (5 mmx5 mm square)

6. The ridge count for every finger was taken then; the mean of every hand was calculated then the mean ridge count for was calculated for every person. Ridge pattern of each subject was described as one of the basically identified ridge patterns (Arches, Whorls, Ulnar and Radial loops). Data were arranged by the number of fingers mentioned above. Blood samples were collected on separate glass slides marked as A, B, and D were used to mix suspended RBCs with anti-A, anti-B, and anti-D anti-sera. Glass rods were used to mix blood drop with anti-sera for three glass slides to prevent false results. The mixture was observed for agglutination, macroscopically. If agglutination was present in on slide marked A, then it belonged to A group, agglutination in slide B, so it belonged to B group, if agglutination in both A and B drops, AB group was detected and if there was no agglutination in both A and B drops, then O group was detected. Agglutination on glass slide marked D was identified as Rh Positive and no agglutination as Rh negative (fig.6).

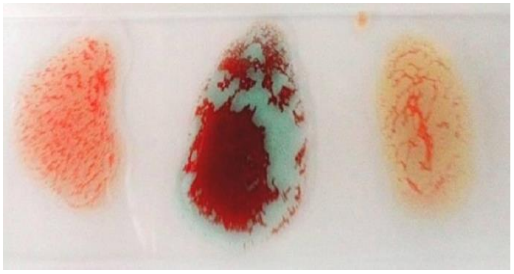

Figure (6): Agglutination of blood with anti A, anti B and anti D

Statistical methods:

Data was coded and entered using the statistical package SPSS version 21 then it was summarized using percent and number for qualitative variables, mean and standard deviation, median and inter quartile range IQR for quantitative variables which are not normally distributed. Comparison between groups was made using **Chi-square** test for qualitative variables while non-parametrical **Kruskal Wallis and Mann-Whitny** tests were used for quantitative variables which are not normally distributed. Correlations were done to test for a linear relation between quantitative variables. P-values equal to or less than 0.05 were considered statistically significant **(Dawson and Trapp 2001).**

RESULTS

In the current study, the following descriptive data of subjects:

- The included subjects. Regarding gender, the males were 123 (55.7%), and the females were 98 (44.3%).
- Blood groups, where the majority of the subjects were group O+ (35.3%) which is followed by A+ (30.3%), then B+ (14.9%), AB+ (11.3%), O- (4.5%), A- (2.7%) and the least is B- (0.9%). as shown in table (1)

Table (1): Personal data and blood groups of studied subjects as percentage.

	Total Number=221	**Percent (100 %)**
Gender:	N	%
Male	123	55.7
Female	98	44.3
Blood group:	N	%
A+	67	30.3
A-	6	2.7
B+	33	14.9
B-	2	.9
AB+	25	11.3
O+	78	35.3
O-	10	4.5

Frequencies of different fingerprint patterns in left, right, and both hands, the most frequent were loops (61.8%) while the least frequent in both hands were composite (01%). Loops were more frequent in left than right hand (64.3%). Whorls were most frequent in the right hand than the left hand (32.6%). Arches were nearly equal in the right hand (7.9%) and the left hand (7.4%), as shown in table (2).

Table 2: Fingerprint pattern of right, left and both hands of studied groups.

Pattern	**Loop**		**Whorl**		**Arch**		**Composite**	
N -%	N	%	N	%	N	%	N	%
Right hand	656	59.4	360	32.6	87	7.8	2	0.2
Left hand	710	64.3	312	28.2	82	7.4	1	0.1
Both hands	1366	61.8	672	30.5	169	7.6	3	0.1

Moreover, about the relation between the pattern of fingerprints and different ABO **chi-square** test showed a statistically significant difference between the pattern of fingerprints among blood groups in the right, left, and both hands with p-value <0.001***. As shown in table 3, in both hands, loops were more frequent in O (42.5%), followed by A (34.6%), B (16.2%) ,and AB (6.7%). Where whorls were more frequent in A (33.2%), followed by O (30.7), AB (22%), and B (14.1) for both hands, except for left hands, whorls were nearly equal in A and O (32.4%-32.1%). Arches were more frequent in O (55.6%) followed by B (20.1%), A (18.3%), and AB (5.9%). The commonest pattern in right, left and both hands for AB blood group were whorls (22%), for A, B, O were loops.

Table 3: Fingerprint pattern of right, left and both hands among different blood groups using chi-square test.

	Loop		Whorl		Arch		composite		P value
Rt. Hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A	226	34.5	122	33.9	15	17.2	2	100	
B	107	16.3	51	14.2	17	19.5	0	0.0	
AB	40	6.1	81	22.0	4	4.6	0	0.0	
O	283	43.1	106	29.4	51	58.6	0	0.0	
Lt. hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A	247	34.8	101	32.4	16	19.5	1	100.0	
B	114	16.1	44	14.1	17	20.7	0	0.0	
AB	52	7.3	67	21.5	6	7.3	0	0.0	
O	297	41.8	100	32.1	43	52.4	0	0.0	
Both hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A	473	34.6	223	33.2	31	18.3	3	100	
B	221	16.2	95	14.1	34	20.1	0	0.0	
AB	92	6.7	148	22	10	5.9	0	0.0	
O	580	42.5	206	30.7	94	55.6	0	0.0	

(p<0.001*) highly significant (P< or = 0.05**) significant (p>0.05*) insignificant**

The relation between the pattern of fingerprints and different ABO, chi-square test showed that there was a statistically significant difference between the pattern of fingerprints among blood group in the right, the left and both hands with p value<0.001***. The loops were most frequent with O+ (36.5%), whorls were most frequent with A+ (31.3%) and arches were most frequent with O+ (48.5%). In AB+, whorls were predominant (22%) for right and both hands. The same for left hand but whorls are frequent in both A+ and O+ (30.8%) as shown in table (4).

Table (4): Fingerprint pattern among different blood subgroups using chi-square test.

	Loop		Whorl		Arch		composite		P value
Rt. Hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A+	204	31.1	114	31.7	15	17.2	2	100	
A-	22	3.4	8	2.2	0	0.0	0	0.0	
B+	101	15.4	47	13.1	17	19.5	0	0.0	
B-	6	.9	4	1.1	0	0.0	0	0.0	
AB+	40	6.1	81	22.5	4	4.6	0	0.0	
O+	242	36.9	104	28.9	44	50.6	0	0.0	
O-	41	6.3	2	0.6	7	8	0	0.0	
Lt. hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A+	222	31.3	96	30.8	16	19.5	1	100	
A-	25	3.5	5	1.6	0	0.0	0	0.0	
B+	105	14.8	43	13.8	17	20.7	0	0.0	
B-	9	1.3	1	.03	0	0.0	0	0.0	
AB+	52	7.3	67	21.5	6	7.3	0	0.0	
O+	256	36.1	96	30.8	38	46.3	0	0.0	
O-	41	5.8	4	1.3	5	6.1	0	0.0	
Both hands	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*** **
A+	426	31.2	210	31.3	31	18.3	3	100	
A-	47	3.4	13	1.9	0	0.0	0	0.0	
B+	206	15.1	90	13.4	34	20.1	0	0.0	
B-	15	1.1	5	0.7	0	0.0	0	0.0	
AB+	92	6.7	148	22	10	5.9	0	0.0	
O+	498	36.5	200	29.8	82	48.5	0	0.0	
O-	82	6	6	0.9	12	7.1	0	0.0	

(p<0.001*) highly significant (P< or = 0.05**) significant (p>0.05*) insignificant**

Table (5) showed the relation between fingerprint patterns among RH+ and RH- blood groups. **Chi-square** test revealed a statistically significant difference between fingerprint patterns among RH blood group with P value 0.003** for the right hand,0.001**for the left hand and <0.001*** for both hands, RH+ contain 84.7% of loops, 94.8% of whorls,91.3% of arches and100%of composites. As for RH-, loops were 15.3%, whorls were5.2%, arches were 8.7%, and composites were absent.

Table (5): Finger print pattern and RH using chi-square test

	Loop		**Whorl**		**Arch**		**Composite**		**P value**
Rt.hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**.003****
Rh+	587	89.5	346	96.1	80	92	2	100	
RH-	69	10.5	14	3.9	7	8	0	0.0	
Lt.hand	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**.001****
RH+	635	89.4	302	96.8	77	93.9	1	100	
RH-	75	10.6	10	3.2	5	6.1	0	0.0	
Both hands	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**<0.001*****
Rh+	1222	84.7	648	94.8	157	91.3	3	100	
RH-	144	15.3	24	5.2	12	8.7	0	0.0	

(p<0.001*) highly significant (P< or = 0.05**) significant (p>0.05*) insignificant**

Regarding finger ridge density: Mean finger ridge density (ridge count per 25 mm2) of all fingers as well as right, left and both hands ± standard deviation in addition to interquartile range is shown in **table 6**. The thumb finger had the least ridge density (10.28-10.65) while the ring finger had the highest in both hands (12.07-12.06).

Table (6): Mean finger ridge density of right, left and both hand using Mean ±SD, median and inter quartile range (IQR) using Kruskal Wallis Test.

	N	**Mean+/-SD***	**Median (IQR)****
Rt. Hand	221	11.16±1.35	11.20 (10.20:12.20)
Rt. Thumb	221	10.28±1.49	10 (9:11)
Rt. Index	221	10.75±1.44	11 (10:12)
Rt. Middle	221	11.46±1.77	12 (10:13)
Rt. Ring	221	12.07±1.96	12 (11:14)
Rt. Little	221	11.23±1.66	11 (10:12)
Lt. hand	221	11.26±1.40	11.40 (10.30:12.40)
Lt. thumb	221	10.65±1.58	11 (10:12)
Lt. index	221	10.81± 1.64	11 (10:12)
Lt. middle	221	11.49±1.73	12 (10:13)
Lt. ring	221	12.06±1.90	12 (11:13)
Lt. little	221	11.29±1.69	11 (10:12)
Both hands	221	11.21±1.30	11.30 (10.30:12.20)

***SD: standard deviation**IQR: Inter quartile range**

For different age groups, mean finger ridge density (ridge count per 25 mm2) of all fingers as well as right, left, and both hands ± standard deviation in addition to the median and interquartile

range was shown in table (7). In all age groups, the thumb finger had the least ridge density, while the ring finger had the highest in both hands except in the left hand for age group >60 years the index finger had the least density.

Table (7): Finger ridge density and different age group using Mean ±SD, median and Inter quartile range (IQR)using Kruskal Wallis Test.

	Age groups						P value
	18-40		>40-60		>60		
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Rt. Hand	11.27±1.39	11.4 (10.2-12.4)	10.83±1.12	10.8 (9.9-11.6)	10.37±.98	10.4 (9.2-11.6)	.036**
Rt. Thumb	10.39±1.53	10 (9-12)	9.85±1.26	10 (9-10.50)	10.00±1.29	9 (9-11)	.086*
Rt. Index	10.80±1.49	11 (10-12)	10.63±1.26	11 (10-11)	10.00±1	10 (9-11)	.268*
Rt. middle	11.52±1.83	12 (10-13)	11.27±1.55	11 (10-13)	11.14±1.68	11 (9-13)	.665*
Rt. Ring	12.27±1.98	12 (11-14)	11.49±1.69	11 (10-13)	10.57±1.81	11 (8-12)	.008*
Rt. Little	11.35±1.71	11 (10-13)	10.90±1.39	11 (10-12)	10.14±1.07	10 (9-11)	.040*
Lt. hand	11.40±1.38	11.4 (10.6-12.5)	10.83±1.35	10.8 (9.7-11.9)	10.23±1.49	10 (8.8-11.8)	.014**
Lt.thumb	10.76±1.58	11 (10-12)	10.27±1.50	10 (9-11)	10±1.63	11 (8-11)	.068*
Lt. index	10.89±1.65	11 (10-12)	10.61±1.59	10 (10-12)	9.86±1.46	9 (9-11)	.207*
Lt. middle	11.61±1.72	12 (10-13)	11.17±1.66	11 (10-12)	10.4±2.15	9 (9-13)	.069*
Lt. ring	12.23±1.83	12 (11-13)	11.59±1.91	12 (10-13)	10.71±2.69	11 (9-13)	.037**
Lt. little	11.51±1.71	12 (10-13)	10.54±1.42	11 (9.50-11)	10.14±.9	10 (9-11)	.001**
Both hands	11.33±1.31	11.5 (10.5-12.3)	10.83±1.16	10.9 (9.7-11.7)	10.30±1.22	10.1 (9-11.7)	.015**

(p<0.001*) highly significant (P < or = 0.05**) significant (p>0.05*) insignificant**

Kruskal Wallis Test revealed that there was a statistically significant difference in mean ridge density between different age groups for the right hand with p value=.036**, left (ring, p=0.037 **& little, p=0.001**), left hand with p= 0.014**and both hands with p=0.015**. The highest density was in the age group 18-40 and the least one in the age group >60.

Mean ridge count of the right hand, left hand, and both hands ± standard deviation in addition to median and IQR in the different ABO blood groups. **Kruskal Wallis** test revealed a statistically significant difference in mean ridge density of right, left, and both hands, between different blood groups with P<0.001***, table (8). In the right, left, and both hands, the highest density was in individuals with blood group B (11.5-12-11.75), and the least one was with blood group AB (10.4-10.17-10.28)

Table 8: Finger ridge density and ABO blood groups using Mean ± SD, median and Inter quartile range (IQR) using Kruskal Wallis test.

	A N=73	B N=35	AB N=25	O N=88	P value
Rt. Hand					**<0.001*** **
Mean±SD	10.93±1.39	11.50±.99	10.4±1.48	10.9±2.12	
Median (IQR)	11.2 (10-12)	11.4 (10.512)	12.2 (10.913)	10.9 (9.4)	
Lt. hand					**<0.001*** **
Mean	11.07±1.45	12±.95	10.17±1.2	11.2±1.13	
Median (IQR)	11.2 (10-12.2)	11.5 (11.313)	12.4 (1112.8)	11.2 (10.4)	
Both hands					**<0.001*** **
Mean±SD	11±1.34	11.75±.95	10.28±1.23	11.05±1.63	
Median (IQR)	11.2 (9.911.8)	11.5 (1112.7)	12 (10.912.7)	11.05 (9.9)	

(p<0.001*) highly significant (P < or = 0.05**) significant (p>0.05*) insignificant**

In this study, mean ridge count of the right hand, left hand, and both hands ± standard deviation in addition to median and IQR in the different ABO blood subgroups. **Kruskal Wallis** test revealed a statistically significant difference in mean ridge density of right, left, and both hands in different blood subgroups with p<0.001*** (left hand and both hands), P=0.002** (right hand). In the right hand, the highest density belongs to individuals with blood group B+ (11.9), while the least one belongs to individuals with blood group AB+ (10.4). In left hand, the highest density belongs to individuals with blood groups A- (12) while the least belongs to individuals with blood group AB + (10.2). In both hands, the highest density belongs to individuals with blood group B+ (11.9) while the least belong to individuals with blood group AB+ (10.3), table (9)

Table (9): Finger ridge density and different blood subgroups using Mean ± SD, median and inter quartile range (IQR) using Kruskal Wallis test.

	A+ N=67	A- N=6	B+ N=33	B- N=2	AB+ N=25	O+ N=78	O- N=10	P value
Rt. Hand								.002**
Mean±SD	11±1.4	11.5±.9	11.9±1.5	10.9±2	10.4±1	11.21±1.3	11.5±.68	
Median (IQR)	11.2 (10-12)	11.4 (10.5-12)	12.2 (10.9-12.9)	10.9 (9.4-11.4)	10 (9.5-11.1)	11.3 (10.4-12.4)	11.6 (11.2-12)	
Lt. hand								<0.001***
Mean±SD	11±1.4	12±.95	11.9±1.2	11.2±1	10.2±1	11.4±1.4	11.3±.7	
Median (IQR)	11.2 (10-12.2)	11.5 (11-13.1)	12.4 (11.3-12.8)	11.2 (10.4)	10.2 (9.1-10.9)	11.4 (10.55-12.6)	11.3 (10.7-11.9)	
Both hands								<0.001***
Mean±SD	11±1.3	11.75±.9	11.9±1.2	11±1.6	10.3±1	11.32±1.3	11.4±.63	
Median (IQR)	11.2 (9.9-12)	11.45 (12-13)	12.1 (11-12.7)	11.05 (9.-11.9)	10.3 (9.4-10.75)	11.35 (10.48-12.3)	11.45 (10.88-11.95)	

p<0.001*) highly significant (p< or = 0.05**) significant (p>0.05*) insignificant.**

Furthermore, about mean ridge count of the right hand, the left hand, and both hands ± standard deviation in addition to median and IQR in the different RH blood groups. **Mann-Whitney** test revealed no statistically significant difference in mean ridge density of right, left and both hands, between different RH blood groups, as shown in table (10).

Table (10): Finger ridge density and RH using Mean ± SD, median and inter quartile range (IQR) using Mann-Whitney test.

	RH+		RH-		P value
	Mean±SD	**Median (IQR)**	**Mean±SD**	**Median (IQR)**	
Rt. Hand	11.13±1.38	11.2 (10.2-12.2)	11.41±91	11.6 (11.5-12.2)	.393 *
Lt. hand	11.23±1.44	11.2 (10.2-12.4)	11.54±.85	11.4 (10.8-12.1)	.438*
Both hands	11.18±1.33	11.2 (10.3-12.2)	11.48±.83	11.5 (10.9-12.1)	.431*

(p<0.001*) highly significant (p< or = 0.05**) significant (p>0.05*) insignificant**

There is –ve correlation between age and each right, left, and both hands ridge density among each of studied males &females with p<0.001*** for right and both hands as shown in fig (7).

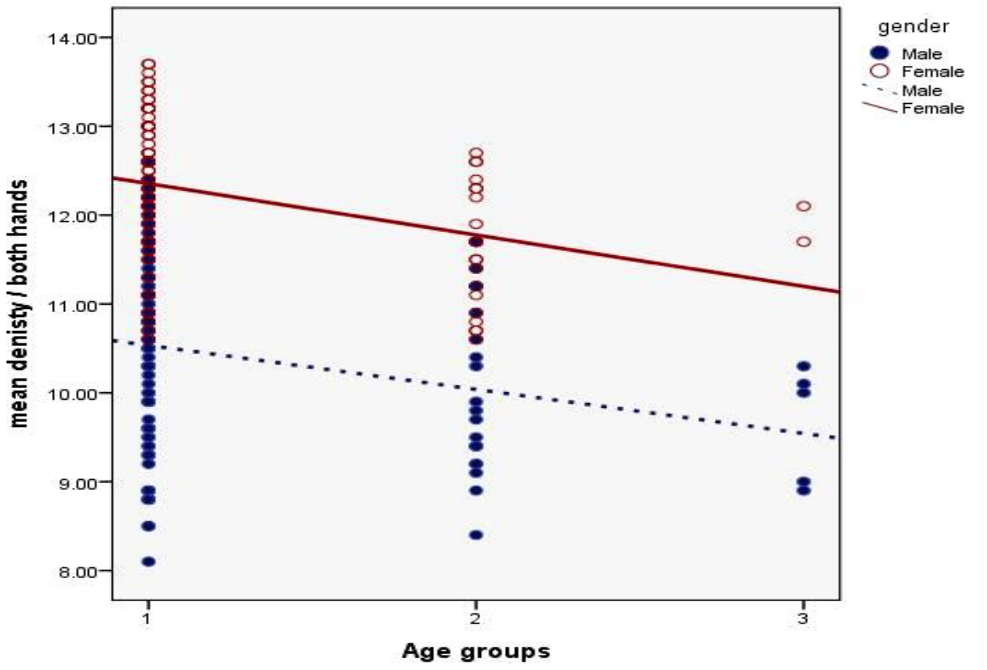

Figure (7): Negative correlation between age and mean ridge density for each sex groups.

DISCUSSION

In the present study, the four basic fingerprint patterns were loops (61.8%), whorls (30.4%), arches (7.6%), and composites (0.1 %)**.** This percentage went in the same line with studies done by **Narayana et al**.; **(2016).**

In the present study, the blood group distribution was the maximum (39.8%) belonging to blood group O while AB was the minimum (11.3%) of the subjects. The findings were in the same line with those found by **Bharadwaja et al.; (2004)**

We found that the maximum (91.9%) of the study subjects were Rh-positive while only 8.1% were Rh-negative. Regarding loops in this study, they were higher in O (42.5%) and the least in AB (6.7%) blood groups. Whorls were the highest in the blood group (33.2%) and least in B (14.1%). Arches were higher in O (55.6.%) and the least in AB (5.9%). Loops were the highest in O +ve. (36.5%) and the least in B-ve. Whorls were higher frequency in A +ve. (31.3%) and the least in B- ve. Arches were high frequency in O +ve. (48.5%) but absent in A- ve & B - ve.

While in a study done by **Hamid et al.; (2016),** Loops were highest in the B (35.29%) & least in AB (13.12%). Whorls were highest in B group (35.29%) & least in AB (16.80%). Arches were highest in B (42.30%) & least in AB (7.69%). Loops were highest in B +ve. (35.29%) and least

in AB-ve. Whorls were high frequency in B +ve (35.29%) and least in AB-ve. Arches were of high frequency in B +ve (36.66%). The study showed an association between fingerprint pattern, and blood group that result did not match with **(Shrestha et al, 2019),** who found that loops were highest in AB blood groups.

In a study done by **Ekanem et al.; (2014),** they found that the O blood group had the highest percentage of loops. The group AB had the least frequency in all the fingerprint patterns; these findings came with our study, except AB had common frequency of whorls.

In the present study, the highest number of individuals were the O; followed by A, B, and AB. 91.9% of the study group were Rh-positive, while only 8.1% were Rh-negative. Loops pattern was highest in both Rh-positive and Rh-negative except AB positive where whorls pattern was predominant followed by loops, arches, and composites. This result came in the same line with 2 studies done by **Bharadwaja et al.; (2004).** In contrast to a study conducted by **Manoranjitham et al. (2015)** showed that AB had the highest frequency of whorls. In this study, the blood group A had the highest frequency of whorls.

In this study, loops were higher in O blood group (42.5%) followed by A (34.6%), B (16.2%) blood group and lowest in AB blood group (6.7%) which matches with the study done by **Manoranjitham et al.; (2015) and (Mohsin and Hasan 2019)** who found loops were higher in blood group O and was not in the same line with **(Vankara et al ,2021)**

In the current study, whorls were higher in the A blood group (33.2%) followed by O (30.7%), AB (22%) blood group, and lowest in B blood group (14.1%) that partially agreed with **(Mohsin and Hasan 2019)** and **(Vankara et al ,2021)** and in contrast with **Manoranjitham et al.; (2015)** in that study, whorls were high in AB and lower in the O blood group.

Arches were higher in the O blood group (55.6%) followed by B (20.1%), A (18.3%) blood group, and lowest in the AB blood group (5.9%) that in accordance with **(Mohsin and Hasan 2019)** and wasn't in the same line with the study of **Singh et al.; (2016) and (Shrestha et al, 2019).** Composites were found only in blood group A (100%) and not included in the previous studies. Since inheritance of patterns is polygenic and also, the genetics of ABO blood groups**.** Knowledge of this fact is essential as it may help in knowing blood group of individuals with specific distribution of the pattern of fingerprints. At the crime scene, it will become easier to predict the fingerprint pattern based on blood group or vice versa.

There was a significant difference in the mean ridge density between the different age groups, in ridge densities of the right hand, left hand, and both hands ($p<0.05$). These results were in accordance with **Gutiérrez-Redomero et al.; (2011).**

In the current study, there was a significant negative correlation between age and ridge density of the right hand, left hand, and both hands in both males and females, ($r=-0.248$ in males and -0.369 in females, $p<0.05$). Which goes in the same line with **Gutiérrez-Redomero et al.; (2011)**.

In the present study, the thumb finger in both hands had the lowest ridge density (greater ridge breadth than all the other fingers) and the ring finger had the highest, these results were previously approved by **Gutiérrez-Redomero et al.; (2013)**; **Gutiérrez-Redomero et al.; (2011)** and **Nanakorn&Kutanan , (2012).**

The mean ridge density was higher in blood group B in the current study, which is similar to the result obtained by **Bharadwaja et al.; (2004).** While in a study done by **Gowda and Rao, (2015),** they reported that the total finger ridge count (TFRC) was higher in blood group A.

CONCLUSIONS

There was an association between fingerprint patterns, density and blood group and subgroups in our opinion, and a person's blood group is possible based on fingerprint patterns and density. Loops were the most happening finger-print pattern, and composite was the least one. The highest loops were in O, then A, B, and AB. The highest whorls in A, followed by O, AB, and B except for left hands, whorls were nearly equal in A and O. The highest arch in O followed by B, A, and AB.

The commonest pattern in the right, left, and both hands for the AB blood group were whorls. For A, B, O were loops except the left hand of A blood group, loops and whorls were equally common. Loops were the most frequent in Rh+ and Rh-.

The highest density was in the age group 18-40 and the least one in the age group >60.The highest mean ridge density belongs to blood group B subjects, while the lowest belongs to blood group AB.

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الملخص العربى

كان الهدف من هذه الدراسة هو معرفة العلاقة بين نمط وكثافة بصمات الأصابع ومجموعة الدم ABO والمجموعات الفرعية. لقد أجرينا دراسة على ٢٢١ فردًا سليمًا من كلا الجنسين في الفئة العمرية من ١٨ إلى أكثر من ٦٠ عامًا مع مجموعات دم مختلفة من ABO. تم الحصول على بصمات الأصابع بطريقة الحبر على البطاقات القياسية ، وتم استخدام عدسة اليد المكبرة لدراسة الأنماط . تم حساب حواف البشرة من عينات بصمات الأصابع ضمن مربع ٥ × ٥ مم مرسوم على فيلم شفاف. تم استخدام كاشف مضاد A و Anti-B و Anti-D لتحديد فصيلة الدم. أظهرت تكرارات أنماط بصمات الأصابع المختلفة أن الحلقات الأكثر شيوعًا هي الحلقات بينما الأقل تكرارًا في كلتا اليدين كانت مركبة. كانت الحلقات أكثر تكرارًا في اليد اليسرى أكثر من اليد اليمنى. كانت الزهرات أكثر شيوعًا في اليد اليمنى من اليد اليسرى. كانت الحلقات أكثر تكرارًا في O ، تليها AB و AB. حيث كانت الفالعات أكثر تواترًا في A ، تليها O ، و AB ، و B. كانت الحلقات أكثر شيوعًا مع O + ، وكانت الزلات أكثر شيوعًا مع A +. كانت أعلى كثافة في الأفراد ذوي فصيلة الدم B وأقلها كانت من فصيلة الدم AB. كان هناك ارتباط بين توزيع أنماط بصمات الأصابع والكثافة وفصيلة الدم والمجموعات الفرعية في رأينا ، وأن فصيلة دم الشخص ممكنة بناءً على أنماط بصمات الأصابع وكثافتها.