

Examination of Fingerprints in Relation to Gender Classification

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Abstract— Fingerprint is most important evidence which commonly encountered in mainly all types of crime scene. Gender classification from fingerprint has a pivotal role in the forensic anthropology in order to identify the gender of the criminal and minimize the list of suspects search. Despite the advent of advance technology as DNA fingerprint, methods such as lip print and fingerprint analysis and mandibular canine index calculation are routinely used in gender differentiation, as they are simple and cost effective. Fingerprints evidence is undoubtedly the most reliably and acceptable evidence till the date in the court of law because fingerprint pattern are unique in each individual and chance of two person having identical fingerprint is very rare

Method: Due to immense potential of fingerprints as an effective method of identification has been made in present work to analysis the different gender belonging to different age group. This study was carried out on 100 subjects (50 male and 50 females) of age 0 to 60.

Result: Result shows that loop fingerprint pattern was prominent in male and female and the arches were found in least frequency in all the other patterns.

Keywords: Fingerprints, loops, Whorls, Arches, Gender

I. BACKGROUND

Fingerprint is an impression of ridge outline which appears on the anterior surface of the proximal, middle and distal phalanges and on same on the thumb. They are reproduction of the friction skin ridges present on the palmer of hand and sole of feet. These ridges designed to provide former grip and resistance to slip of the things hold by hand. Each skin ridge is peccated with the single row of pores that are opening for ducts leading the sweat glands. It's through these pores that perspiration is discharge and deposited on the surface of skin. Once the finger touch any surface perspiration along with oils and other organic matter transferred onto that surface [1]. The general composition of the perspiration consists of water, minerals, lactate and urea. On average, the mineral composition is: sodium (0.9 gram/litre), potassium (0.2 gram/litre), calcium (0.015 gram/litre), and magnesium (0.0013 gram /litre). Trace metals that the body excretes in sweat include: zinc, copper, iron, chromium, nickel and lead [2].

Skin is composed of many layers of cells, the uppermost is known as epidermis and the inner one known as dermis. The boundary between these 2 layers is called the dermal papillae. Once the dermal papillae develop in the human fetus, the ridge patterns remain unchanged throughout life, except for enlarging during growth. Primary ridges develop during 12-16 week of the embryonic development and their formation gets completed by the 14th week [3].

The principle reason for becoming the fingerprint as the main physical evidence in every integral part of policing and forensic science is that the fingerprints constitute a uniqueness and unchanging means of personal identification.

Due to which fingerprint analysts also formulated the three basic principles of fingerprint. The first principle is state that a fingerprint is an individual characteristics, no two individual can have exactly same set of fingerprints until and unless produced by same finger of the same person.

Even the twins do not have same set of the fingerprints. This is the principle of uniqueness. The second principle is state that a fingerprint remains unchanged during an individual lifetime. It is impossible to forgery fingerprint but nowadays the criminals are creating artificial skin like gloves with papillary ridges and are using it for human trafficking. A permanent scarp will formed and this in itself became an identification mark. This principle is also known as the principle of stability. The third and most important principle state that fingerprints have general ridge patterns that permit them to be classified systematically. All the fingerprints basically divided into three parts: loops, arches and whorls. Loops have 60-65% of population. Whorls have 30-35% of population and about 5% have arches [4, 5].

Legal importance of fingerprinting includes identifying the criminals, in cheques, in bank notes or passports as a means of identification, in case of mass disasters, to prevent impersonation, in case of accidental exchange of new born infants and to identify unknown corpses.

Criminal identification system originally emerged in late 19th century. They were triggered by landmark development of Henry System of Fingerprint classification. In which fingerprint are sorted by physiological and anthropometric characteristics in which measurement are obtain from suspect and filed. By 1920's, FBI had created its first identification department for criminal identification where fingerprint were manually searched, compared and identified. As the time progress the manual identification had turned out to be very izidious and painstaking lengthy processor therefore the researchers and for fingerprint experts together devised a new automated method for fingerprint searching, comparison and identification; known as AFIS.

There are numerous highlights in the history of fingerprint. Since 700AD, the study of unique fingerprint impression has been utilized in the motivation behind ID [6]. In 200BC, china first used impression as the official archives in the Qin and Han dynasty. In 1788, by Mayer; German anatomist and doctor wrote book "Anatomical Copper Plates" with appropriate explanation contains drawing of fingerprint on skin ridges. Mayer was the first who declares the uniqueness of frictional ridges. In 1823, Jan Evangelista Purkinje, anatomy professor, published his thesis discussing on nine fingerprint patterns. The framework was first done in 1858, by Sir Herschel but due to the systematic study with all the proper classification in detailed; main credit is given to Sir Francis Galton. His framework was formally received in Britain in 1894, and was additionally adjusted by Sir Edward Henry [7, 8].

II. MATERIAL AND METHODS:

The aim of this study is to analyse all ten fingerprints of an individual to achieve the difference and understand the big picture of fingerprints taken from 100 Faridabad citizens (50 males, 50 females) aged among 1 to 60 years were used in year of 2018-19.

The materials used in the study were black ink, lens, pencil and performa. The entire sample was taken in fingerprint card (shown in figure 1).

The inkless fingerprint pad was used for taking prints.



Fig. 1:

The verbal content of all the subjects was obtained after properly explanation about the objectives of the intended study to them. In this study we take the rolled fingerprint, all ten individual; rolled from nail to nail. Then the plain impressions are used to verify the sequence and accuracy of rolled fingerprints.

The recommended height for recording legible fingerprints is approximately 39 inches from the floor. This allows the forearm of an average adult to be parallel with the floor but when the individual are not adult, in this case shoulders should be straight. This is recommended position to record fingerprints on the fingerprint card.

- Soap and water are preferred; but sometimes rubbing alcohol is also used for cleaning the hand.
- If hands are moist then wipe it with rubbing alcohol properly.
- If hands are dry or flaky use a small amount of hand lotion and wipe off if any residues were present.

The first priority is to clean the individual's hand properly.

Roll the finger on the ink pad in the way that entire fingerprint pattern area is evenly covered with the ink. Ink should cover from all the side i.e. from one edge to the nail to the other and from the crease of the first joint to the tip of the finger. Use of correct amount of ink is very important.

During taking the rolled impression on the paper, the one side of the finger bulb is placed and then rolled to the other side until it faces the opposite direction. During the rolling, care should be exercised so it rolled evenly. The appropriate amount of pressure should be required to record a fingerprint. In order to take advantage of natural moment of the forearm, the hand should be rotated in the individual rotation position.

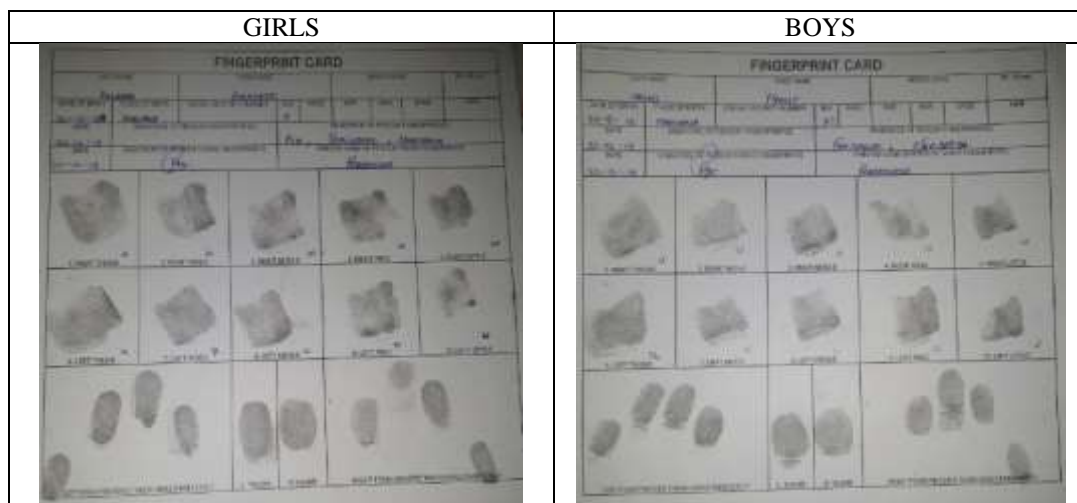
Roll each finger in the given appropriated space. During the time of lifting of finger up, extra care should be needed to avoid smudging at end.

Plain impressions are typically taken last. In this individual's four finger, keeping together and press on the paper after applying on the ink in their allotted space. Repeat the same process for the both thumbs.

After all that process, completed the all required textual information with their signature.

Last but not the least, prints that was taken were analysed under a magnified lens and were studied with indentified as: Loops, whorls, and arches based on the appearance of ridges lines.

III. SAMPLE PAPER:



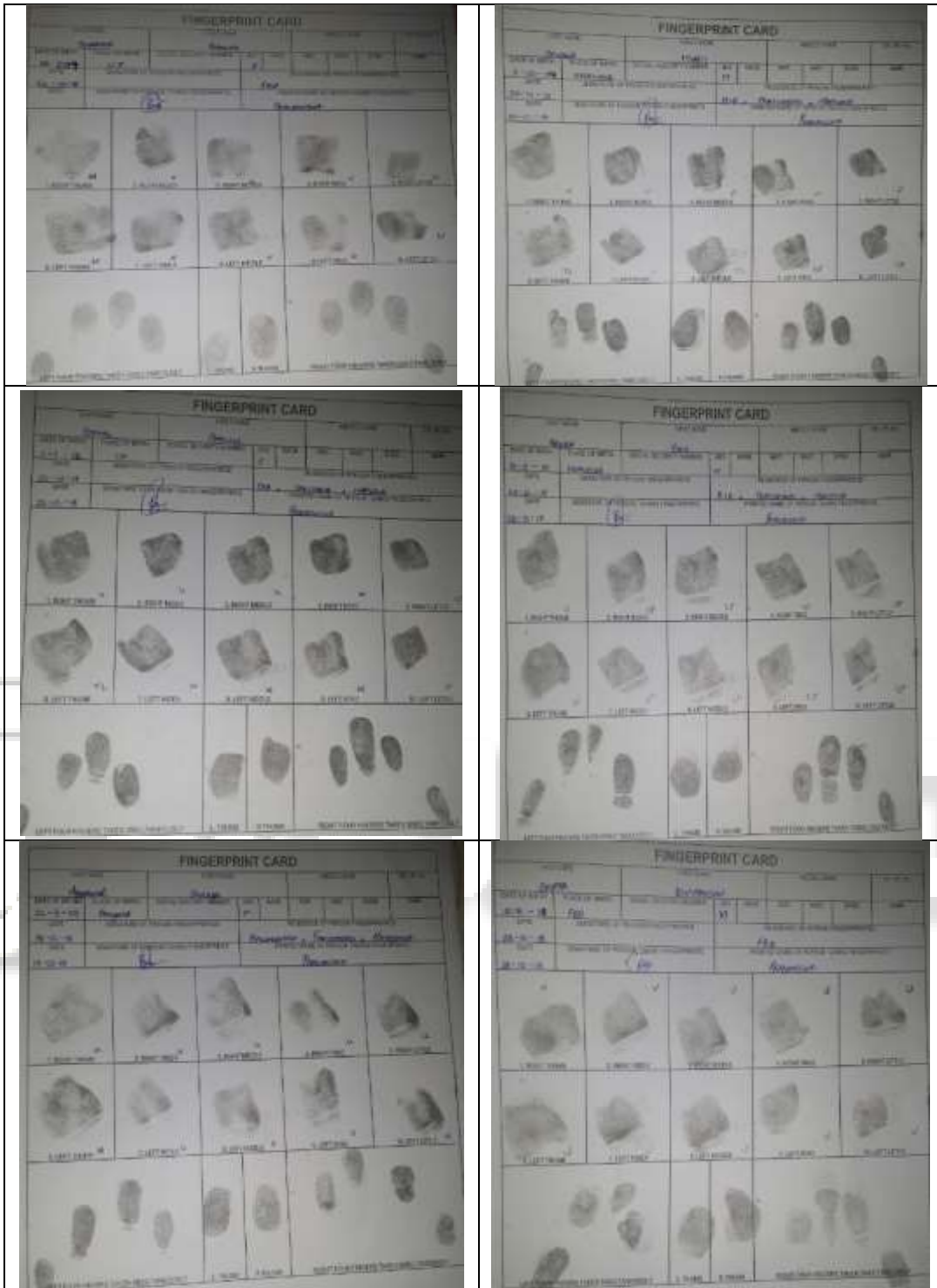




Table 1: Sample of Boys and Girls of Age 0-10

GIRLS	BOYS
<p>This is a fingerprint card for a girl. The header section contains handwritten information: 'NAME: Ananya', 'AGE: 10', 'SEX: F', 'DATE: 10/11/2020', and 'TIME: 10:30'. The card shows impressions for the right and left hands, with individual fingers and a full-hand view at the bottom.</p>	<p>This is a fingerprint card for a boy. The header section contains handwritten information: 'NAME: Ananya', 'AGE: 10', 'SEX: M', 'DATE: 10/11/2020', and 'TIME: 10:30'. The card shows impressions for the right and left hands, with individual fingers and a full-hand view at the bottom.</p>
<p>This is a fingerprint card for a girl. The header section contains handwritten information: 'NAME: Ananya', 'AGE: 10', 'SEX: F', 'DATE: 10/11/2020', and 'TIME: 10:30'. The card shows impressions for the right and left hands, with individual fingers and a full-hand view at the bottom.</p>	<p>This is a fingerprint card for a boy. The header section contains handwritten information: 'NAME: Ananya', 'AGE: 10', 'SEX: M', 'DATE: 10/11/2020', and 'TIME: 10:30'. The card shows impressions for the right and left hands, with individual fingers and a full-hand view at the bottom.</p>



Table 2: Samples of Boys and Girls of Age 11-20

GIRLS	BOYS
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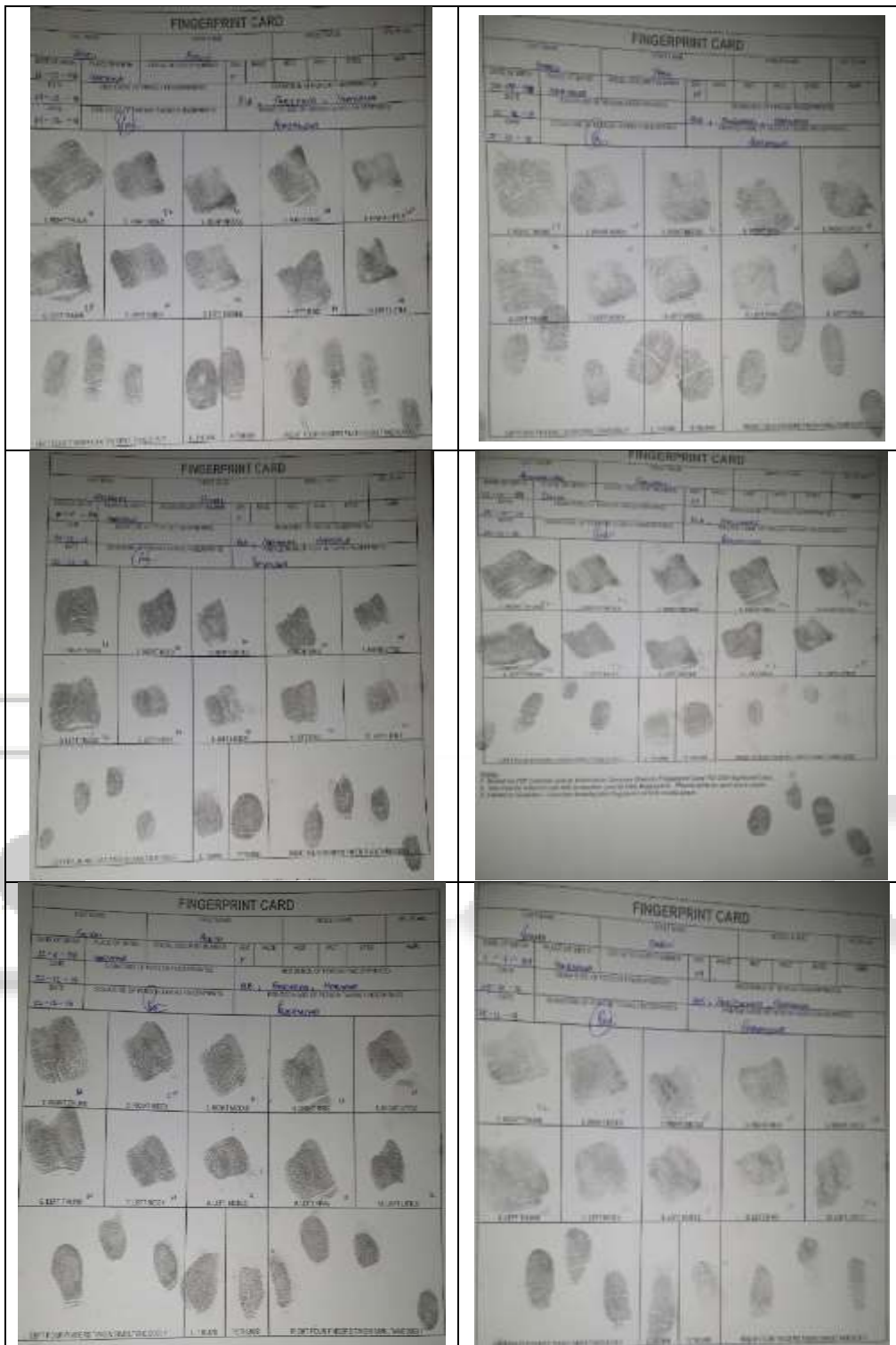
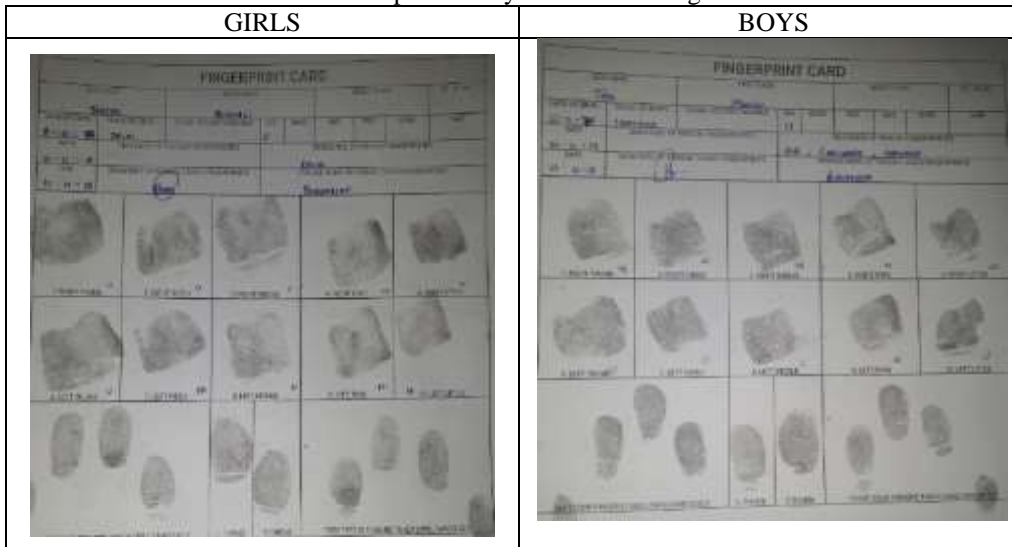




Table 3: Samples of Boys and Girls of Age 21-30



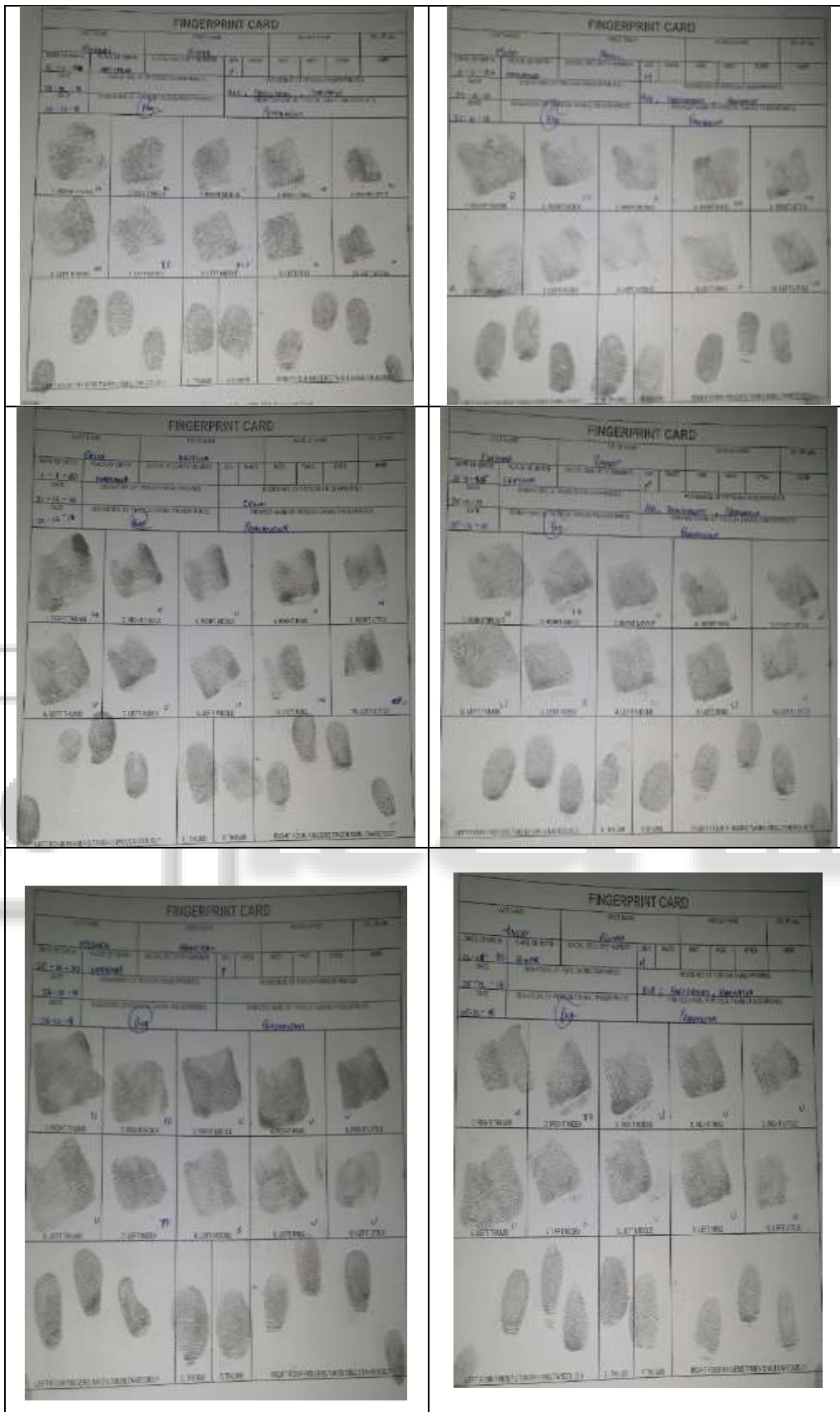


Table 4: Samples of Boys and Girls of Age 31-40



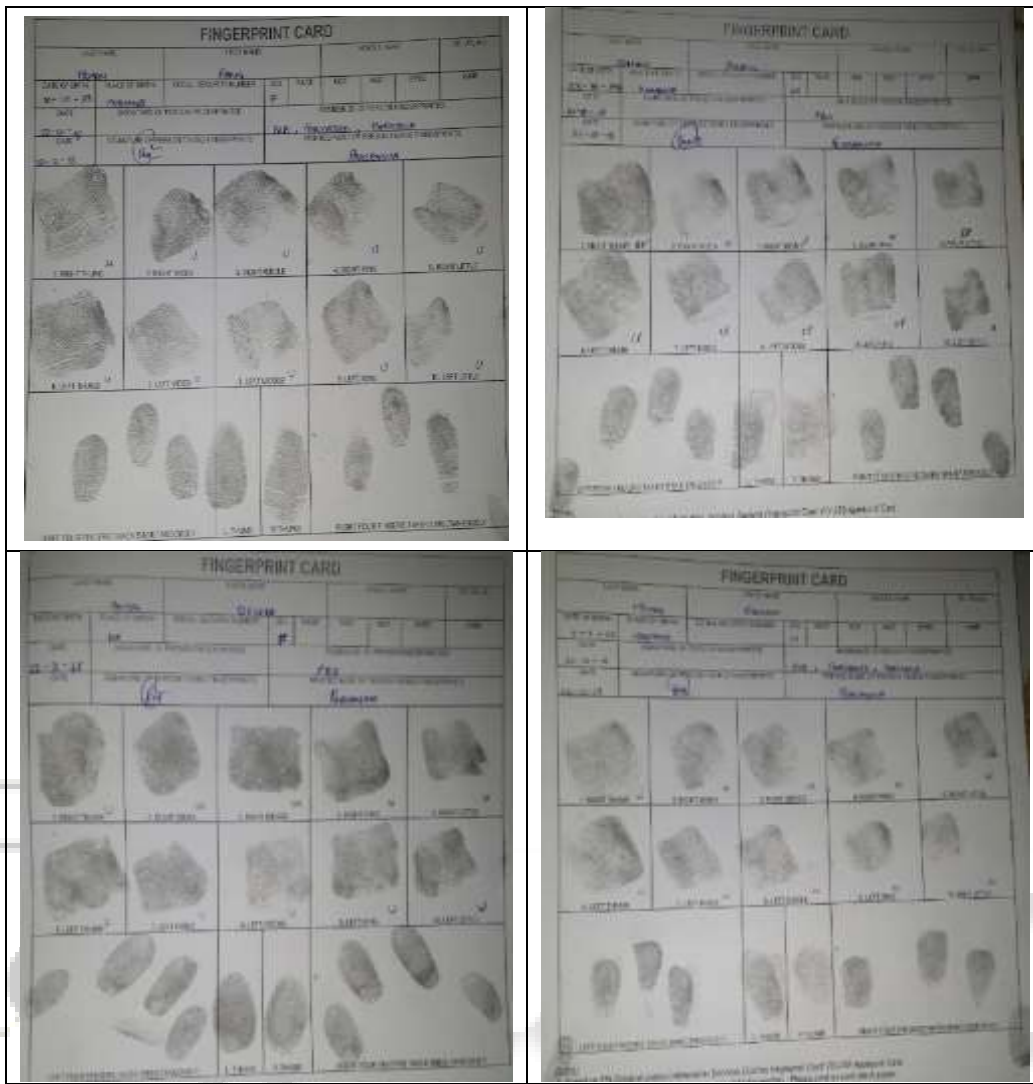


Table 5: Samples of Boys and Girls of Age 41-60

IV. RESULT & DISCUSSION

So, after keen and detailed fingerprint study with proper techniques was carried out.

Fingerprint Pattern	Total Number	Percentage
Loop	576	57.6%
Whorl	269	26.9%
Arches	34	0.34%
Composites	129	12.9%
Total	1000	100%

Table 6: Distribution of primary fingerprint patterns among the subject

Table 6 shows distribution of the primary fingerprint patterns of all the fingers of both hands of all the subjects. Loops had the highest frequency of 57.6% followed by whorls with 26.9%, composites with 12.9% and arches showed the least number with 0.34%

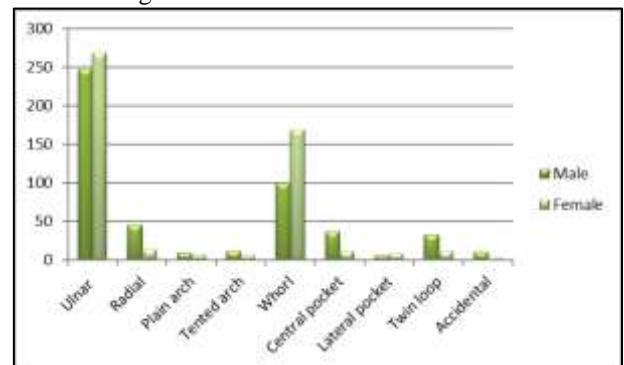


Fig. 2:

Fingerprint Pattern	Male	Female
Loop	293 (50.86%)	283 (49.14%)
Whorl	100 (37.17%)	169 (62.82%)
Arches	21 (61.76%)	13 (38.23%)
Central pocket	37 (75.5%)	12 (24.5%)
Lateral pocket	6 (42.85%)	8 (57.15%)
Twin loop	33 (73.33%)	12 (26.6%)
accidental	10 (76.92%)	3 (23.08%)

Table 7: Distribution of Fingerprint pattern according to gender

Table 7 shows distribution of fingerprint patterns according to gender. Frequency of loops were found to be higher in male (50.86%) compared to that of females (49.14%). Frequencies of the whorls were found to be higher

in females (62.82%) compare to that of male (37.17%) and arches were seen higher in male compared to females. Composites showed more inclined in males than the female.

Fingerprint Pattern	Age (0-10)		Age (11-20)		Age (21-30)		Age (31-40)		Age (41-60)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ulnar	69	61	40	48	44	54	58	53	36	53
Radial	1	1	18	10	21	0	6	0	0	3
Plain arch	0	1	2	1	0	0	6	3	1	2
Tented arch	0	1	3	0	1	0	6	1	2	4
Whorl	13	34	24	35	16	38	14	32	33	30
Central pocket	11	0	4	2	3	4	3	5	16	1
Lateral pocket	0	0	1	1	2	2	1	4	2	1
Twin loop	5	2	7	3	13	2	1	0	7	5
Accidental	1	0	1	0	0	0	5	2	3	1

Table 8: Distribution of fingerprint pattern according to the age groups (0-60)

Table 8 shows that the distribution of fingerprint patterns according to different age groups. In age group of 0-10 there are more loops as compare to the others age groups. Accidental are the rarest pattern in all groups.

Fingerprint is an impression of ridges outline which appears on the anterior surface of the finger of the proximal, middle and distal phalanges and on same of the thumb. The first ever work was done in the china which was aprox 3000 years back, to sign the legal documents. Several year before Bertillon began his work on the fingerprint system, William Herschel, an British civil servant, started fingerprints for personal identification, i.e. mainly right hand imprints to sign the legal contracts but that time his motive remain unclear. The advantages of using the fingerprint pattern as a mean of identification. After that Faulds work and suggested that skin ridges patterns could be important for the identification of criminals.

The system of classification was given by Sir Francis Galton, by published his book on "Finger Prints" and this classification is even use today, is a modified version of the system proposed by Sir Francis Galton and was modified by Sir Edward Henry and this classification is known as Henry's System of Classification or Henry Galton method. This system of classification is most efficient and use by almost all over the universe.

There are four basic fingerprint patterns which are used in this study which are:

Loops, Whorls, Arches and Composites

Arches are occurring in about 5% of the total encountered fingerprints. The ridges of the finger run continuously from one side of the finger to the other. There is no delta in the arch pattern. There are 2 types of arch pattern: plain arch and tented arch. Plain arch is the pattern in which a consistency of the flow can be observed. It started from one side and the ridge then slightly cascades upward. This almost resembles a wave out in ocean. It is the simplest pattern. Tented arch is that same one but there is little difference, i.e. it is not continuous like as plain arch and having the significant up thrusts in the ridges near the middle.

Loops can be seen in almost 60 to 70% of the fingerprints. The ridges make a backward turn in loop but not twist. Loop is distinguished by how the loop flows on the hand. Loop pattern has one delta and one core. There are 3 types of the loop pattern: Radial loop, Ulnar loop and Double

loop. Radial loop are named after a bone in a forearm known as radius bone that join the hand on the same side as the thumb. The flow of these ridges runs in the direction of the radius bone i.e. in the downward slope. These loops are not common. Ulnar loop named after a bone in the forearm called ulna. This bone is on the same side as the little finger and it is the common one pattern. Double loop consist of two distinct and separated loop formations. It is having the 2 core and the 2 deltas. There is at least one recurving ridge within the inner pattern area between the two loop formations that gets touched or cut when an imaginary line is drawn.

Whorls can be found in about 22 to 30% of the fingerprints. Any pattern that contains two or more deltas will be a whorl and can be categorised in 3 groups, i.e. plain whorl, central pocket and accidental Composites are the rarest one.

V. CONCLUSION

Present study is an attempt to associate fingerprint patterns with gender and age group. Fingerprint patterns can be of help on predicting the gender of different age groups. It may help in increasing the authenticity of fingerprints in identification of individuals and solving of crimes. The result was obtained that Loops were the most commonly found pattern and Arches the least. In loop pattern the commonest pattern was ulnar loop, which were statistically significant in the study. After the Loops, whorls are more prominent in females than the males. Accidental pattern are the rarest pattern in all age groups. Only whorls and lateral pockets are the patterns which are more in female than the male. At age 0-10, almost all excepted whorls patterns are more in male than the female. At age of 11-20, ulnar and whorl pattern are more in male than the female. At age of 21-30, radial pattern only seen in male. At age of 31-40, the ulnar are more in male and whorls are more in female. At age of 41-60, males have dominancy in the entire pattern except the ulnar. Accidental pattern are more commonly seen at the age group of 31-40. As compare to all the age group, 21-30 have more twin loop than the others. There was more central pocket seen in the age group of 41-60 than the other.

VI. ABBREVIATION

Not applicable

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A. *Figure Title:*

- [1] Figure 1: STANDARD FINGERPRINT CARD (FD-258)
- [2] Figure 2: SHOWS DISTRIBUTION OF FINGERPRINT ACCORDING TO THE GENDER IN FORM OF BAR GRAPH

B. *Table Title:*

- [1] Table 1: Sample of boys and girls of age 0-10
- [2] Table 2: Sample of boys and girls of age 11-20
- [3] Table 3: Sample of boys and girls of age 21-30
- [4] Table 4: Sample of boys and girls of age 31-40
- [5] Table 5: Sample of boys and girls of age 41-60
- [6] Table 6: Distribution of primary fingerprint patterns among the subject
- [7] Table 7: Distribution of Fingerprint pattern according to gender
- [8] Table 8: Distribution of fingerprint pattern according to the age groups (0-60)