Eurasian Journal of Analytical Chemistry
ISSN: 1306-3057 OPEN ACCESS 2019 14 (2): 55-59

Gender Identification of Emirati Population Using Finger Prints

Nrashant Singh, Dinesh Chand, Mohamed Kader Hussain, Mayda Bakri

Received: 05 March 2019 ▪ Revised: 12 April 2019 ▪ Accepted: 16 April 2019

Abstract: With today's ever growing population, there naturally arises a concern over keeping up with individualization and organization methods fully utilized by developing technology. Fingerprints are one of the most mature biometric technologies and are considered legitimate proof of evidence in various courts of law throughout the world. The aim of the present study is to determine the gender on the basis of fingerprints of Emirati population of Abu Dhabi, Al Ain and Dubai. For the study, we collected 200 Emirati individual's fingerprint samples, which included 100 males and 100 females. Results of the study showed significant difference in the ridges density of Emirati peoples, the average ridge density is more in female in comparison to males. The results of our study documented that there is significant difference in ridge density and we can use it as a tool for gender differentiation.

Keywords: Finger Prints, Ridge Density, Emirati Population.

INTRODUCTION

As authentication based systems are growing in demand, personal identification has become an absolute necessity. Personal identification has wide applications in security systems, video surveillance, reducing the amount of search space on huge database. A person can be identified by a number of features such as his face, height, body, shape, gait, voice etc. Sex is among the most important orientation that discriminates between individuals. The recognition of a suspect's sex can both restrict the search between enrolled suspects to minimize decision time and increase recognition performance [1-4]. Fingerprinting remains as one of the best ways to aid in identifying and tracking criminals with close precision. Nitin and coworkers documented that the use of fingerprints for gender identification will be more helpful in short listing the suspects[5].

Gender recognition is an interesting problem that can be used to boost the performance of several important applications such as face recognition and video surveillance. Gender classification can be utilized as an indexing technique to reduce the search space for automatic and manual recognition techniques. Numerous studies have been carried out with regards to gender identification but there are very few centered on gender determination from fingerprints [6-8]. Furthermore, other areas such as human computer interaction also have many interesting applications ranging from automatically identifying gender of individuals to performing an image search over the Internet.In recent times, more and more civilian and commercial applications are either using or actively considering using fingerprint-based identification because of the availability of inexpensive and compact solid state scanners as well as its superior and proven matching performance over other biometric technologies[9].

Skin on human fingertips contains ridges and valleys, which together form distinctive patterns. These patterns are fully developed during pregnancy and are permanent throughout an individual's lifetime. Prints of those patterns are called fingerprints. Injuries like cuts, burns and bruises can temporarily damage quality of fingerprints but when fully healed, patterns will be restored to their original formation[10]. Fingerprints have many important characteristics that make them invaluable evidence in crime scene investigations. A fingerprint is unique to a particular individual, and no two fingerprints possess exactly the same set of characteristics. This also includes identical twins, who may exhibit similar DNA, but will not have similar individual characteristics. Fingerprints do not change over the course of a

Nrashant Singh, Forensic Sciences, Amity University, Dubai, Diac, Dubai, United Arab Emirates.
Dinesh Chand, Forensic Sciences, Amity University, Dubai, United Arab Emirates.
Mohamed Kader Hussain, Forensic Sciences, Amity University, Dubai, United Arab Emirates.
Mayda Bakri, Forensic Sciences, Amity University, Dubai, United Arab Emirates.

person's lifetime (even after superficial injury to the fingers). While patterns may be similar, individual characteristics differ from person to person [11-13].These individual characteristics are important to establish as they are wholly unique to the bearer and serve to help differentiate prints of similar patterns. The identification of sex based on fingerprints reduces burden of an investigation officer [14,15].

The present study is focused on determining gender based on ridge count within a well-defined area on a print. This study aims to attempt to combat the issue of partial prints by requiring a small window of visible prints in order to determine gender.

MATERIALS AND METHODS

The study was carried out by taking the rolled fingerprints of 200 subjects (100 men and 100 women) of Emirati origin, all within the age range of 17-25 years. The subjects were chosen based on their ability to meet sensitive criteria and willingness to consent. The materials used in this study were black printer ink, transparent glass plates, and a5mmx5mm cardboard window, pencil, and horseshoe lens.

- Subjects were chosen based on their ability to fit the required criteria. They were informed of the study and asked to consent to participation.
- A note was taken of the subject's name (voluntary), age, and nationality.
- Following standard procedure, a rolled fingerprint was taken and imprinted on a collection card.

Upon collection of the sample, a ridge count was performed using a window with an outer diagonal border 5mm from the interior window. An arbitrary but common reference point was chosen and the viewing apparatus was used to perform a ridge count. Certain ridge characteristics such as dots were not counted, while others such as forks and enclosures were given a ridge count of two. Hence this value represented number of ridge/25mm square and would reflect the ridge density value. Ridge thickness and furrows were important factors detrimental of ridge density. Ridge counts were performed on all samples and calculations mentioned in the following section were made.

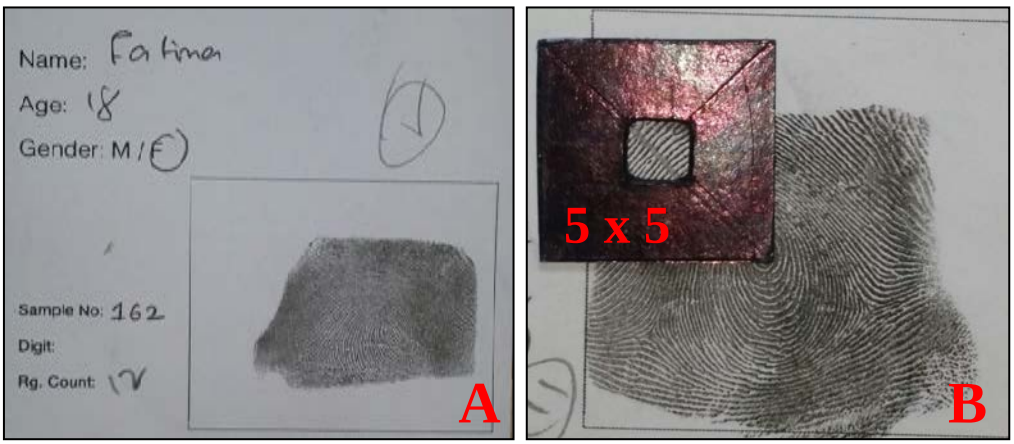

Figure 1: Collected sample (A) and the technique to count dermal ridges (B)

RESULTS

The outcome of present study showed that the males tend to have lesser number of ridges compared to females with a maximum of 15 ridges, where nearly 32% of males have 11. After 11 ridges the number of males decreases rapidly and no male was found to have more than 15 ridges. The number of females with 14 ridges (43%) was very high as compared to males and shown in Table 1.The descriptive statistics of epidermal ridges for male and female were compiled in Table 2.

Table 1: Gender wise distribution of epidermal ridges

No. of Ridges	Male		Female	
	No. of Cases	%	No. of Cases	%
10	16	16	4	4
11	32	32	12	12
12	27	27	16	16
13	9	9	8	8
14	9	9	43	43
15	7	7	9	9
17	-	-	8	8
Total	100		100	

Table 2: Descriptive Statistics of ridge density in both Males and Females

Parameter	Male	Female
Mean	11.84	13.41*
SD	1.43	1.71
SE	0.14	0.17
Minimum	10	10
Maximum	15	17

The ridge density ranges from 10-15 ridges/25mm2 in male and 10-17 ridges/25mm2 in females. The analysis of variance (ANOVA) results show that females have significantly greater density than males (P<0.001).

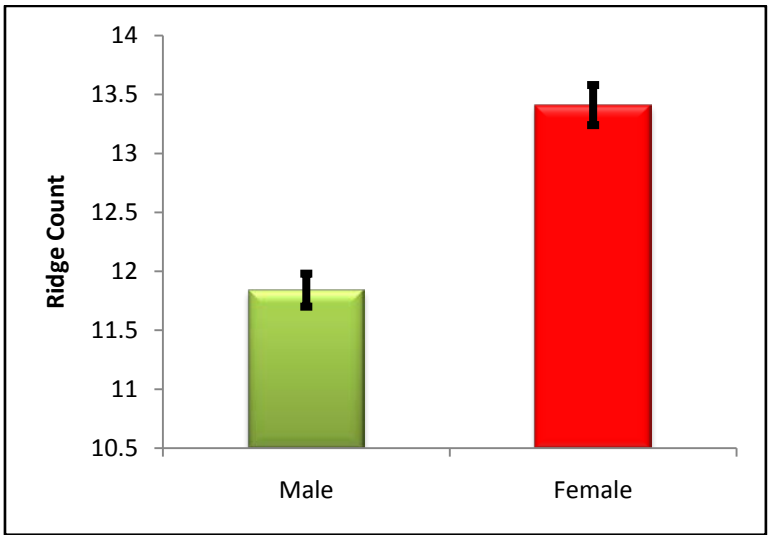

Figure 2: Ridge density of Male and Female

Figure 2 shows that the mean value of ridge count for male was 11.84 and that of female were 13.41.The values are expressed as mean ± SE.

Table 3: Probability Densities and Likelihood Ratios derived from Observed Ridge Count

Ridge Count	Probability Density		Likelihood Ratio	
	Male (C)	Female (C")	C/C"	C"/C
10	0.16	0.04	4	0.25
11	0.32	0.12	2.67	0.37
12	0.27	0.16	1.69	0.59
13	0.09	0.08	1.12	0.89
14	0.09	0.43	0.21	4.78
15	0.07	0.09	0.78	1.28
17	0	0.08	0	0

Table 3 illustrate the probability density for male (C) and female (C") and using these values, the likelihood ratio (LR) for male to female (C/C") and female to male (C"/C) were calculated. It is found that the LR is very high for the prints of 10 ridges because few female are found in this group. The LR value tends to decrease till 15 ridges and when we see the other LR value (C"/C) it is found that it increases drastically from 10 ridges onwards.

DISCUSSION

The identification process by fingerprints is of no doubt a reliable and unique method of individualizing a person, and with this study the hopes have risen, making fingerprints a new tool for gender identification. This can further aid fingerprint experts with saving time and minimizing the search for matches - even in the case of partial prints.

The present study broadens the view on how a simple ridge counting can provide complex information about an individual's gender. The study demonstrates an important difference in the ridge density between male and females of Emirati origin in the Abu Dhabi, Al Ain and Dubai regions.

Results of present study showed that females have a significantly higher ridge count than male. Application of Baye's theorem suggests that a fingerprint possessing ridge density <12 ridges/25 mm^2 is most likely to be of male origin. Likewise, a fingerprint having ridge count >14 ridges/25 mm^2 is most likely to be of female origin. Looking into the history of fingerprinting, it is evident that similar studies regarding gender determination via ridge count have been conducted but failed in methodology. A previously conducted study by Reddy [12] revealed that the mean ridge count in males is 13.41 and 12.04 in females. However, Acree[13] documented opposite figures.A similar study by Plato et al [18] was conducted on African American and Caucasian American males and females. These previous studies advocated that males had higher mean ridge density than females. These results may be due to the fact that Plato et al. made no mention of what ridge counting method was used in the study.

Cummins and Midlo[19] have established that the mean ridge count in females (23.4) is more than that of males (20.7). These values are higher than the present study results. The reason for this could be due to the smallersample size and/or geographical variations. Okajima[20] also found that the fork index was higher female than in male fingerprints. This again reciprocates the present study, thus showing the possibility that the ridge count in females is higher than in males.Ohler and Cummins [21]also reported that males have a ridge breadth of 0.48 mm, whereas females have 0.43 mm. Neither study included the furrow breadth. Moore [9] reported a higher value of ridge-to-ridge distance in males, and lesser ridge density as compared to females. However, Moore's study only involved 10 males and 10 females, a very small sample size. A work of Kumar et al [22] stated that females have greater ridge density than males in Uttarakhand, India. Several previous studies and present study demonstrated that there is a significant difference in ridge density of male and female. Therefore, ridge density difference hypothesis is tested in current study and proved that we can use it as a tool for gender differentiation.

Thus, the present study supports the conclusions made by Moore [9] and we can conclude that there are significant differences in the ridge density of male and female. The results help illustrate a reasoning behind the reported higher ridge counts in females, as in a smaller space it was found that they presented a higher ridge density than males. These results can be used as a valuable means to narrow down the search in investigations specially when there are a large number of fingerprints encountered that need to be analyzed.

These results are helpful as a tool for fingerprint experts as they can be used as a presumptive indicator of gender based on the degree of ridge density. Furthermore, it is also possible to determine the gender of a print found on the crime scene and therefore narrow down the list of possible suspects. The data may be cross-referenced with other findings from various ethnicities to also help form a possible ethnicity of the origin. Ultimately, this adds to what is already a wide variety of information that may be extracted from prints found at a crime scene, further emphasizing the importance of them. Conducting this research among other specific ethnicities will help create a more stable reference chart so that not only may gender may become easily distinguishable, but also the possible ethnicity of the suspect. This can prove very useful to scene of crime officers when genetic information is difficult to extract.

Research Funding: None

CONCLUSION

The present study was conducted with an aim to distinguish between male and female fingerprints, successfully showing significant results. However, these results can only be accepted and implemented universally when the study is conducted on various ethnicities and regions. This will ensure a concurrency on the validity on gender determination from fingerprints, thus allowing its use by universal law enforcement authorities and its admissibility in courtrooms. The small area required determining gender is also beneficial, as more often than not prints are not found in their complete form, and partial prints may fail to provide the necessary information for a database search.

REFERENCES

[1] VijK (2001) Textbook of forensic medicine, principles and practice, 1st edition New Delhi: Churchill Livingstone Pvt; p 62.

[2] Jain AK, Prabhakar S and PankantiS (2002) On the similarity of identical twin fingerprints. Pattern Recognition 35(11): 2653-2663.

[3] PahujaK and Agarwal SK (2012) Analysis of quantitative and qualitative dermatoglyphic traits in Schizopherinic patients. J Anat Soc of India 61(2): 269-272.

[4] Kapoor N and BadiyeA (2015) Sex differences in thumbprint ridge density in a central Indian population Egyptian. Journal of Forensic Sciences. 5(1): 23-29.

[5] Nitin MD, Balaraj BM, Manjunathan B and Mestri SC (2009) Study of fingerprint classification and their gender distribution among South Indian population. Journal of Forensic and Legal Medicine16(8): 460-463.

[6] Eshak GA, Zaher JF, El Hasan and El Azeem AA(2013) Sex identification from fingertip features in Egyptian population. Journal of For ensicand Legal Medicine 20: 46-50.

[7] Redomero EG, Rivaldería N, Rodríguez CA and Andrés AS (2014) Fingermarks and other body impression. Science& Justice54(3): 199-207.

[8] Kanchan T, Krishan K, Aparna KR and ShyamsundarS (2013) Is there a sex difference in palm print ridge density?Medicine Science and Law 53(1): 33-39.

[9] Moore RT. Automatic fingerprint identification system -Advances in fingerprint technology, Lee H.C., Gaensslen R.E (eds.), CRC Press, Boca Raton 1994.

[10] Han Y, Ryu C, Moon J, Kim H and Choi H (2004) ICISC. 467-477.

[11] Grieve MC and Dunlop J (1992) Apractical aspect of the bayseian interpretation of fibre evidence. Journal of Forensic Science Society 32: 169-175.

[12] Reddy CC (1975) Finger dermatoglyphics of the Bagathas of Araku valley. American Journal ofPhsical Anthropology 42: 225-228.

[13] Acree MA (1999) Is there a gender difference in fingerprint ridge density? Forensic Science International 102: 35-44.

[14] Nayak VC, Rastogi P, Kanchan T, Lobo SW, Yoganarsimha K and Nayak S (2010) Sex differences from fingerprint ridge density in the Indian population. Journal of Forensic and Legal Medicine17:84–86.

[15] Nayak VC, Rastogi P, Kanchan T, Yoganarsimha K, Kumar GP and Menezes RG (2010) Sex differences from fingerprint ridge density in Chinese and Malaysian population. Forensic Science International197:67–9.

[16] Ahmed AA and Osman S (2016) Topological variability and sex differences in fingerprint ridge density in a sample of the Sudanese population. Journal of Forensic and Legal Medicine 42: 25-32.

[17] AdamuLH, OjoSA, Danborno B, Adebisi SS and TauraMG (2018)Sex prediction using ridge density and thickness among the Hausa ethnic group of Kano state, Nigeria. Australian Journal of Forensic Science 50(5): 455- 461.

[18] Plato CC, CereglinoJJ and Steinberg FS (1975)The Dermatoglyphics of American Caucasian. American Journal of Physical Anthropology 42: 192-210.

[19] Cummins H and MildoC (1961) Fingerprints, Palms and Soles. An introduction to Dermatoglyphics, Dover Publication, New York, p 272.

[20] OkajimaM (1970) Frequency of fork in epidermal ridge minutiae in fingerprint American Journal of Physical Anthropology 32: 41-48.

[21] Ohler EA and Cummins H (1942)Sexual differences in breadths of epidermal ridges on the finger tips and palms.American Journal of Physical Anthropology 29: 341-362.

[22] Kumar L, Agarwal S, Garg R, Pratap A and Mishra VK (2013) Gender Determination Using Fingerprints In the Region of Uttarakhand. Journal of Indian Academy of Forensic Medicine35: 308-311.