*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 8 Ver. 4 (August. 2018), PP 18-21*
*www.iosrjournals.org*

# Finger Print Ridge Density a Tool for Gender Determination

Dr Amit Patil[1], Dr Amrit Malik[2], Dr TrezaShirole[3]

[1]*Dr Amit Maruti Patil [Corresponding Author] Additional Professor and Head, Department of Forensic Medicine and Toxicology, Second Floor, Academic Block, All India Institute of Medical Sciences, Phulwarisharif, Patna, Bihar*

[2]*Miss Amrit Mallik, Intern Past Undergraduate [MBBS] Student, Dr D Y Patil Medical College, Hospital and Research Centre, Nerul, Navi Mumbai, Maharashtra, India*

[3]*Miss TrezaShirole, Intern Past Undergraduate [MBBS] student, Dr D Y Patil Medical College, Hospital and Research Centre, Nerul, Navi Mumbai, Maharashtra, India*

*Corresponding Author: Dr Amit Patil*

***Abstract:***

***Background:*** *Fingerprints being unique to a human being, is a valuable tool in identification. Identification of sex from fingerprint ridge density has been attempted by earlier researchers.* ***Objectives:*** *The objective of the study was to determine ridge density of males and females and to identify whether sexual differences exist between them.*

***Methodology:*** *The study was conducted on 170 subjects [70 males and 100 females] in the age group of 18-65 years. Mean ridge density was calculated from the finger prints of the participants and were statistically analysed.*

***Results:*** *The results showed that in male subjects, the ridge density ranged from 8.0 to 12.90 ridges/25 mm$^2$ with a mean of 10.62 ridges/25 mm$^2$ [S.D - 1.02], and in females from 10.20 to 15.00 ridges/25 mm$^2$ with a mean of 12.69 ridges/25 mm$^2$ [S.D - 1.01]. Mean ridge density was higher in females than males. Fingerprint possessing > 13 ridges/25 mm$^2$ has a higher probability of being from female (p = 0.99). The probability of fingerprint of < 11 ridges/25 mm$^2$ of being from a male origin is very large.*

***Conclusion:*** *The study confirms that females have higher ridge density than males. Mean fingerprint ridge density of 12 ridges/25 mm$^2$ or less is more likely to be of male origin and a mean ridge density of more than 13 ridges/25 mm$^2$ is more likely of female origin.*

***Keywords:*** *Fingerprint, Ridge Density, Gender, Identification*

---

Date of Submission: 01-08-2018 Date Of Acceptance: 14-08-2018

---

## I. Introduction

Fingerprints are unique to a human being. Establishing identity of an individual using fingerprints is one of the most reliable criterion for identification as they are individualistic. No two fingerprints are found to have an identical print, and it is an overwhelming mathematical probability that no two ever will be found to match. [1] The genotypical fingerprint pattern remains unchanged from birth till death.

A great number of research has been done on the human population in the field of dermatoglyphic in relation to various factors like patterns, ridge counts, ridge orientation etc.

Recently attempts have been made to determine gender from finger prints by studying fingerprint ridge density. [2-6] These studies have reported higher epidermal ridge density in females as compared to males. Fingerprint is an impression of the friction ridges which are raised portion of the epidermis on the finger or plantar and palmar skin surface. Fingerprint ridge density is defined as the fingerprint ridge count corresponding to a defined area. Ridge width determines the number of ridges present in a specified area of fingerprints i.e. the epidermal ridge density. There are two hypotheses which have been tested empirically in the present study. The first is that there is difference in the ridge density [RD] between males and females of the population and the second is that females possess greater ridge density as compared to the males.

## II. Materials and Methods

The present prospective study was conducted on 170 subjects at Dr D Y Patil Medical College and Hospital, Nerul, Navi Mumbai. The samples for the present study consist of fingerprints of 70 males and 100 females aged between 18 to 65 years of age. The subjects included students [medical, nursing, dental], medical faculty teachers, clerical staff and workers of this institute. Ethics Committee approval was taken before initiation of the study project. The verbal consent of all the participants was obtained after explaining them about the aims and objectives of the study. Before taking fingerprints, the subjects were asked to clean their

hands with a hand sanitizer to remove any dirt and grease to obtain clean and legible fingerprints. The tips of the finger, that is the entire area above the crease of the first phalangeal joint, was painted with black ink with the help of a roller. Then a rolled fingerprint from radial to ulnar border was obtained on to the specified space of a bond paper with normal pressure. In this manner, fingerprints of all the ten fingers were obtained for everyone.

The methodology is followed as per Acree. [2] Epidermal ridges in each fingerprint sample were counted within a 5 mm X 5 mm square drawn on a transparent film in the chosen area of 25 square mm using magnifying glass. This value represents the epidermal edge density. For fingerprints from the right hand, this square was placed directly onto the upper left of the central core region.

Similarly, for left hand finger prints, the square was placed onto the upper right of the central core. This method is useful in the case of arches, where the ridge count is zero as per the traditional method of ridge counting. The central core region of the print was not analysed due to the variability of pattern shapes and recurving ridges. Counting was done from one corner of the square to the diagonally opposite corner, while counting, the dots were excluded and the handle of the fork and lake were counted as two ridges. After calculating the epidermal ridge density of all ten fingers, the mean was calculated for it. This value represents the single data point for that individual. The means of ridge density of all male and female population were calculated. Chi-square test was applied to know association between the mean ridge density and gender wise distribution of the population. The analysis was done by SPSS 20.0 [Statistical Package for Social Sciences, Inc., Chicago, IL, USA]. If $P < 0.05$, i.e. statistically significant at 5% level, then both the variables are associated with each other. Next the posterior probability inferences of gender based on ridge density values are calculated on likelihood ratio [LR] based on Baye's theorem. The odds were computed by the following formula

$$LR = \frac{\text{Probability of a given fingerprint originating from a male contributor (C)}}{\text{Probability of a given fingerprint originating from a female contributor (C')}}$$

## III. Results

Descriptive statistics of dermal ridge densities for male and female subjects is shown in Table 1. The value of mean ridge density ranged from 8 ridges/mm$^2$ to 15 ridges/mm$^2$. In male subjects, the ridge density ranged from 8.0 to 12.90 ridges/25 mm$^2$ with a mean of 10.62 ridges/25 mm$^2$ [S.D - 1.02], and in females from 10.20 to 15.00 ridges/25 mm$^2$ with a mean of 12.69 ridges/25 mm$^2$ [S.D - 1.01].

The frequency distribution of mean ridge densities of male and female population is shown in Table 2. It is observed that 90% of males have mean RD less than 12 while 82% of females have mean RD more than 12. None of the males have mean RD more than 13 and none of the females have mean RD less than 10. Table 2 shows that the mean ridge density versus gender distribution is statistically highly significant at 0.001 level, i.e. $P < 0.001$. The mean ridge density of females is significantly different from males and is statistically associated.

Probability densities derived from the frequency distribution were used to calculate the likelihood ratio and posterior probabilities of gender determination for given ridge count for subjects using Bayes theorem [Table 3]. Fingerprint possessing > 13 ridges/25 mm$^2$ has a higher probability of being from female (*p = 0.99).* There is high probability (*p = 0.99*) of a finger print of $\geq$ 14 ridges/25 mm$^2$ of being from a female origin. The probability of fingerprint of < 11 ridges/25 mm$^2$ of being from a male origin is very large.Odds ratio was calculated for subjects. It is observed that a dermal ridge count of more than 13 ridges/25 mm$^2$ is more likely of female origin.

## IV. Discussion

The present study is done to identify the gender of a person in the defined population using fingerprint ridge density. The ridge density is determined by ridge thickness and furrows present on the skin. Cummins and Ohlers work on ridge thickness in fingerprints suggest that males have less coarse finger ridges than females with less ridges in each area than females and hence have less ridge density. [7-8] This study demonstrates that there is a significant difference in the epidermal ridge density between the two sexes. Fingerprint possessing > 13 ridges/25 mm$^2$ has a higher probability of being from female (p = 0.99). There is high probability (p = 0.99) of a finger print of $\geq$ 14 ridges/25 mm$^2$ of being from a female origin. The probability of fingerprint of < 11 ridges/25 mm$^2$ of being from a male origin is very large. Females were found to have significantly higher ridge density than males [$p < 0.001$].

Two earlier studies have reported higher mean ridge density value in males than females. [910] According to Reddy [9], males had mean ridge count of 13.41 and females 12.04. A similar study done on American Negroes and American Caucasians by Plato et al, [10] have found that the mean ridge density in males is more than females. Probable explanation to these finding may be racial differences, defect in counting method or incorrect study methodology. Moore's study [11] reports a higher value of mean ridge to ridge distance in males and lesser values in females. Study conducted by Lalit Kumar et al [12] have revealed that ridge count of $\geq$ 14/25 mm$^2$ are more likely of female origin (P= 1.0) and $\leq$ 12 ridges/25 mm$^2$ will have a probability to be that of

male (P= 0.99). Sexual dimorphism was also evident with the males ≤ 11/25mm$^2$ showing lower in finger ridge count than the females 12/25 mm$^2$. [13] Nayak et al study [6] has reported mean RD of 12 ridges/25 mm$^2$ or less in males and more than 13 ridges/25 mm$^2$ in females. Findings of our study are in accordance with earlier studies that reports higher ridge densities in females as compared to males. [14,15]

## V. Conclusion

The present study empirically tested and confirmed the two hypotheses of sexual differences in the ridge density of males and females and that females have high ridge density than males. The mean ridge densities thus can be used presumptively to determine the gender of an unknown print left at the crime scene. This study observes that mean fingerprint ridge density of 12 ridges/25 mm$^2$ or less is more likely to be of male origin and a mean ridge density of more than 13 ridges/25 mm$^2$ is more likely of female origin. The present study confirms the observations of earlier researchers on sexual dimorphism in fingerprint ridge density. The investigative authorities and forensic experts can use this tool for gender identification from a fingerprint left at the scene of the crime.

## References


[1]. Cunliffe F, Piazza PB. Criminalistics and Scientific Investigation. New Jersey: Prentice Hall, Inc.; 1980, p266.
[2]. Acree M A. Is there a gender difference in fingerprint ridge density? Forensic Science International 1999; 102: 35-44.
[3]. Galera V, Romero E, Alonso C [et al.]. Variability f fingerprint ridge density in a sample of a Spanish Caucasians and its application to sex determination. Forensic Science International 2008; 180:17-22.
[4]. Garg R K, Kaur R., Determination of gender from fingerprints based on the number of ridges in a defined area, Fingerprint World 2006; 32, 155-9.
[5]. Gungadin S., Sex. Determination from fingerprint ridge density, Internet Journal of Medical Update 2007(Jul-Dec);2(2):4-7.
[6]. Nayak V. C., Rastogi P., Kanchan T, K Yoganarasimha, G. Pradeep Kumar, Ritesh G Menzes. Sex differences from fingerprint ridge density in Chinese and Malaysian populations, Forensic Science International 2010;197:67-9.
[7]. Cummins H, Waits W.J., McQuitty J. T. The breadths of epidermal ridges on the finger tips and palms: a study of variations, Am.J. Anat. (1941); 68:127-150.
[8]. Ohler EA, Cummins H, Sexual differences in breathes of epidermal ridges on the fingertips and palms, Am. J. Phys. Anthropol. (1942); 29: 341- 62.
[9]. Reddy CC. Finger Dermatoglyphics of the Bagathas of Araku Valley, India. Am J Why. Anthrax 1975; 42:225-28.
[10]. Plato CC, Cereglino JJ, Steinberg FS. The Dermatoglyphics of American Caucasian. Am J Why Anthrop 1975; 42: 192-210.
[11]. Moore RT, Automatic fingerprint identification systems, in Advances in Fingerprint Technology, CRC Press, Boca Raton, FL;1994: p169.
[12]. Lalit Kumar, Sandeep Agarwal, Rajesh Garg, Amit Pratap, V K Mishra. Gender determination Using Fingerprints in the region of Uttarakhand. J Indian Acad Forensic Med. 2013; 35(4): 308- 11.
[13]. Asis Kumar Ray, Rathin Kumar Duari, S. N. Gole. Dermatoglyphics a Method of Sex Differentiation: A Study. Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4 (49): 8461-65.
[14]. Singh Gagandeep. Determination of Gender Differences from Fingerprints Ridge Density in Two Northern Indian Population of Chandigarh Region. J Forensic Res; 3:145.
[15]. Kaur Ramanjit, Garg R K. Determination of Gender Differences from Fingerprint Ridge Density in Two Northern Indian Populations. Problems of Forensic Sciences 2011; Vol. LXXXV: 5-10.


**TABLES**

**Table 1 :** Descriptive Statistics : Ridge density Combine (L+R) in Male and Female Population

| | **Ridge density/25 m** | | **m2** | |
|---|---|---|---|---|
| **Gender** | Min | Max | Mean | SD |
| **Male [n - 70]** | 8 | 12.90 | 10.62 | 1.02 |
| **Female [n - 100]** | 10.20 | 15.00 | 12.69 | 1.01 |

S.D - Standard deviation

**Table 2:** Frequency distribution of mean ridge densities of male and female population

| **Mean ridge density** | Male | Female | Total |
|---|---|---|---|
| **8 - 9** | 4 | 0 | 4 |
| **9 - 10** | 14 | 0 | 14 |
| **10 - 11** | 23 | 4 | 27 |
| **11 - 12** | 23 | 20 | 43 |
| **12 - 13** | 6 | 34 | 40 |
| **13 - 14** | 0 | 33 | 33 |
| **14 - 15** | 0 | 7 | 7 |
| **15 - 16** | 0 | 2 | 2 |

| | | | |
|---|---|---|---|
| **Total** | 70 | 100 | 170 |
| **Chi - Square Test** | | 90.710 | |
| **P - Value** | | < 0.001 | |
| **Statistically Significant** | | Yes | |

**Table 3:** Posterior probabilities and likelihood ratios derived from observed ridge count of the subjects

| **Ridge Count[a]** | **Sex** | | **Probability density** | | | | **Favoured odds** |
|---|---|---|---|---|---|---|---|
| **[RC]** | Male [C] | Female [C'] | P(RC/C) | P(RC/C') | P(RC/C)/ P(RC/C') | P(RC/C') /P(RC/C) | Male Female |
| **8 - 9** | 4 | 0 | 5.71 | 0.001 | 5714.3 | 0.00018 | 0.999>0.001 |
| **9 - 10** | 14 | 0 | 20.00 | 0.001 | 20000.0 | 0.00005 | 0.999>0.001 |
| **10 - 11** | 23 | 4 | 32.86 | 4.00 | 8.2 | 0.12174 | 85.2>14.8 |
| **11 - 12** | 23 | 20 | 32.86 | 20.00 | 1.6 | 0.60870 | 53.5>46.5 |
| **12 - 13** | 6 | 34 | 8.57 | 34.00 | 0.3 | 3.96667 | 15.0<85.0 |
| **13 - 14** | 0 | 33 | 0.001 | 33.00 | 0.0 | 33000.0 | 0.001<0.999 |
| **14 - 15** | 0 | 7 | 0.001 | 7.00 | 0.0 | 7000.0 | 0.001<0.999 |
| **15 - 16** | 0 | 2 | 0.001 | 2.00 | 0.0 | 2000.0 | 0.001<0.999 |
| **Total** | 70 | 100 | 100.00 | 100.00 | 1.0 | 1.0 | |

RC - ridge count [a] - Average number of ridges/25 $mm^2$ per sample

**FIGURES**

**Fig. 1: Photograph showing fingerprint pattern of loop and arch**

**Fig.2: Photograph showing whorl pattern**

Dr Amit Patil "Finger Print Ridge Density a Tool for Gender Determination."IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 17, no. 8, 2018, pp 18-21.