



# Feasibility of Ridge Density: A Comparative Study of Fingerprint Ridge Densities among Different Indian Population



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Submission: September 04, 2017; Published: September 13, 2017

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## Abstract

Fingerprints have long been used as a mean of identification of an individual in an investigation which has been extensively and scientifically studied by anthropologist, pathologist and physician. Almost everyone is aware by the nature of fingerprints and its forensic significance for more than 3000 B.C. The identity of suspect can be established by the various types such as continuous characteristics found in sequence with no dissimilarities or by the fingerprints ridge density. In few cases, where fingerprints are not encountered in a proper manner; in which the identification of suspect is established by the ridge counting in a specific area (no. of ridges/25 mm<sup>2</sup>). The purpose of the conducted study is to acquaint about the fingerprints ridge density (25 mm<sup>2</sup>) whether it vary for a specific age group at different places in likely to be equal environment. We concluded that due to bodily growth of a specific group, counting of ridge density may vary in the adopted parameter or it can be differentiated by the profession (due to condition of fingerprints) of an individual. A minor change was noticed among the ridge density of the population of different parts of India, which may be an instrumental error/ factor of age/health and was not a significant identical feature of gender discrimination. Number of ridge count in a specific area should be supported by the individual features for conclusive identification

**Keywords:** Identity; Investigation; Ridge density; Age group; Characteristics

## Introduction

Within today's environment of increased importance of security and organization, identification and authentication have developed into a key technology. Such advancement is required for reliable personal identification of an individual. Everyone is well aware about the ever-reached position and importance of fingerprints for establishing the identity of an individual in court of law. Epidermal ridge which formed very early in foetal life and expected for growing in size, remain unchanged throughout the life [1,2]. Due to the nature of perpetually and distinctive, fingerprints are understood the most important tool for identification of an individual.

Fingerprints are one of the most mature features of identification and are considered legitimate proof of evidences in court of law though out the world for identification purpose. Based on the varieties of available information of fingerprints, the experts can examine the identity along with the gender, age and ethnicity from many decades [3-5]. The capabilities of identification from fingerprints have proved its importance in invaluable form of evidences from scene of occurrence. This roughened skin makes it easier to grip things and, up close, it appears as patterns of tiny ridges and furrows. The fingertips, palms, and soles can sometimes create a transfer of these

patterns when they come into contact with surfaces and objects. The most important of these transfers are fingerprints, made when the tips of the fingers and thumbs make impressions.

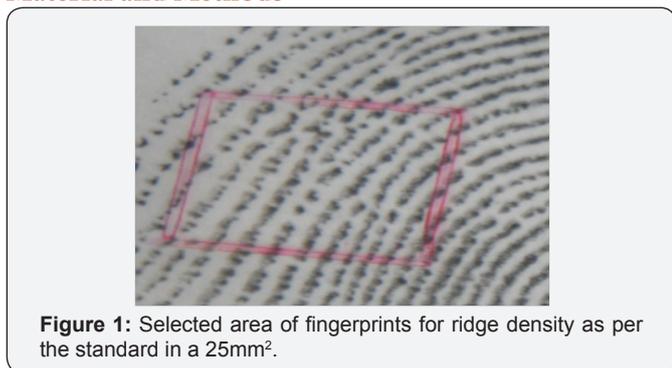
The monozygotic twin, originated from the fertilized egg are arguably most alike but their identity began existence in form of their fingerprints during their foetal life which distinctive them from each other. Ever increasing frequency of crime has made fingerprints an indispensable tool for identification and gender discrimination based on ridge densities. The experts usually study the individual features and the ridge count [6,7]. Consequently, these features of fingerprints are studied widely by the researcher and analysts. If the gender could be established certainly, the case will be solved immediately. The fingerprints ridge densities, which differ from finger to finger, even the upper tip to bottom of the same finger, can be helpful for the investigator if they investigate the number of ridge count according to the parameters along with the individual features [8]. These parameters can be useful to distinguishing gender from the latent prints encounter from crime scene in correspondence to the exemplar.

This study is based on the significance level of fingerprints ridge densities for gender discrimination for which various

assumptions have been made since so long on different populations of Indian origin. In all studies, the ridges were counted from the selected area of fingerprints and concluded at the confidence level which was set at 95% (level of significance is 0.05). But, when the investigations carried out at crime scene; mostly fingerprints are not encountered in proper formation, it is either encountered in partial form or 2-3 partial ridges are encountered. From those ridges, the identity is established based on individual features, no accurate methods is prescribed for gender discrimination based on those 2,3,4 ridges. All studies were carried out on lateral fingerprints implemented against a A4 size white sheet in proper formation. Form these prints, a 25mm<sup>2</sup> area in fingerprints is selected and based on the number of ridge count; identity of gender is concluded [9-11]. It also shows that this trend is the confidence level was set at 95% (level of significance is 0.05) universal among all races.

From this study, it was brought up in the notice that females have greater number of ridge densities than male but whether these ridges count were different from place to place, region to region, population to population and were capable to establish the identity of suspect's gender.

### Material and Methods



**Figure 1:** Selected area of fingerprints for ridge density as per the standard in a 25mm<sup>2</sup>.

The thickness of epidermal ridges varies between individuals; females are supposed to have finer ridges than males and therefore a greater ridge density. The present research is an attempt to distinguish sex from fingerprint ridge density in the radial, ulnar and lower areas of a fingerprint in a North Indian population, south Indian population, Central population, Punjabi Population, Population of Uttarakhand and the population of Chandigarh. All the studies were carried out by the distinguish scientists at the different time and came out with a conclusion of gender discrimination. All the studies were carried out as per

the international standard (25mm<sup>2</sup>) from the lateral fingerprint (Figure 1).

The fingerprint ridge density in radial, ulnar and lower areas and between sexes was compared statistically using t-test. From this, variance values were calculated and these were compared by using the in dependent t-test for un equal variances. These calculations were performed using Microsoft office Excel. Inferences were drawn based on analyzing the t-values obtained from the test [12,13]. These values were compared to the tabulated t-values for corresponding degrees of freedom. The magnitude of the t-value is indicative of the strength for accepting the hypothesis. The results indicate that the females tend to have a significantly higher ridge density than males in the three areas analyzed in the study.

### Results and Discussion

Since, the very beginning in the investigation process; fingerprints, palm and sole prints had played a vital role for establishing the identity of individuals. The identification is most often confirmed based on the individual characteristics while the class characteristics are used to minimize the number of unknown samples. When the fingerprints, palm or sole prints are not found in proper formation, then the ridge counting in a specific area are calculated for the identity of suspect. In India, a variety of researches have been carried out on various populations for establishing the identity even the gender discrimination too.

This study is mainly focused on the significance of ridge densities which are carried out to distinguishing the gender discrimination [14-17]. During the observation, it has been concluded that female have greater ridge densities than the male in a selected specific area such as 9 mm<sup>2</sup>, 16 mm<sup>2</sup>, 25 mm<sup>2</sup>. The study conducted over the South Indian population, in which 200 samples including equal number of male and female from the age group of 18-80 years demonstrate that male has 14 ridges/25 mm<sup>2</sup> while the female has 16 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 23.89 and the significance level was p<0.001, which is highly significant for gender discrimination. The study conducted over the Central Indian population, in which 200 samples including equal number of male and female from the age group of 18-30 years denote that male has 13 ridges/25 mm<sup>2</sup> while the female has 15 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 7.89>2.35and the significance level was p<0.50, which is highly significant for gender discrimination.

**Table 1:** A comparative study among the various Indian population's ridge density as per the findings in male and female.

S.No	Population of State	Number of samples including male & female	Age- group (years)	Mean no.of ridges/25 mm <sup>2</sup>	Conclusion
1.	South Indian Population	100-Male	18-80	Male-14	Female have greater no. of ridges
		100-Female		Female-16	
2.	Central Indian Population	100- Male	18-30	Male -13	Female has greater no. of ridges
		100-female		Female-15	
3	North Indian population	97-Male	18-25	Male-13	Female has high no. of ridges
		97-female		Female-16	

4	Uttarakhand Population	100-Male 100-Female	18-60	Male-14 Female-16	Female has high no. of ridges
5.	Punjabi population	50-Male 50-Female	18-50	Male-14 Female-16	Female has high no. of ridges
6.	Chandigarh Population	50 Male 50-Female	18-40	Male-14 Female-15	Female has high no. of ridges

The study conducted over the North Indian population, in which 194 samples including equal number of male and female from the age group of 18-25 years denote that male has 13 ridges/25 mm<sup>2</sup> while the female has 16 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 17.21 and the significance level was p>0.001, which is not so high significant for gender discrimination. The study conducted over the Uttarakhand population, in which 200 samples including equal number of male and female from the age group of 18-60 years denote that male has 14 ridges/25 mm<sup>2</sup> while the female has 16 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 10.04 and the significance level was P<0.001, which is highly significant for gender discrimination. Descriptive data are shown below in Table 1.

The study conducted over the Punjabi population, in which 100 samples including equal number of 50 male and 50 females from the age group of 18-50 years denote that male has 14 ridges/25 mm<sup>2</sup> while the female has 16 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 7.05>2.02 and the significance level was p<0.05, which is highly significant for gender discrimination. The study conducted over the Chandigarh population, in which

100 samples including equal number of 50 male and 50 females from the age group of 18-40 years denote that male has 14 ridges/25 mm<sup>2</sup> while the female has 15 ridges/ 25 mm<sup>2</sup>. The obtained t-value was 8.59>2.01 and the significance level was p<0.05, which is highly significant for gender discrimination. The significance of the ridge densities at p- v A comparative study among the female's ridge densities of the Indian population are shown in the graphical formation in Figure 2 value and t-value are given below in Table 2.

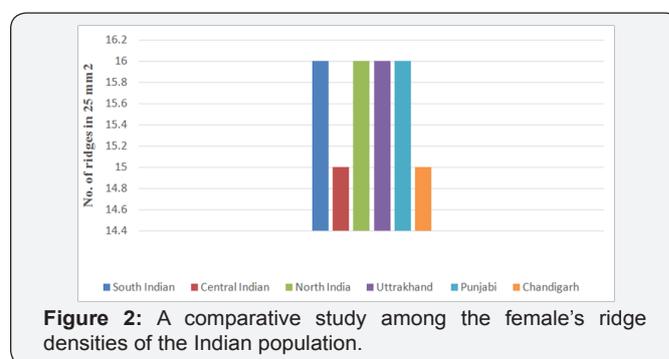


Figure 2: A comparative study among the female's ridge densities of the Indian population.

Table 2: A comparative study of p- value and t value of ridge density with their significant level.

S.No.	Population of State	p-value	t-value	Level of significance
1.	South Indian Population	p<0.001	23.89	H.S.
2.	Central Indian Population	p<0.05	7.89>2.35	S.
3	North Indian population	p>0.001	17.21	H.S.
4	Uttarakhand Population	P<0.001	10.04	H.S.
5.	Punjabi population	p<0.05	7.05>2.02	S.
6.	Chandigarh Population	p<0.05	8.59>2.01	S.

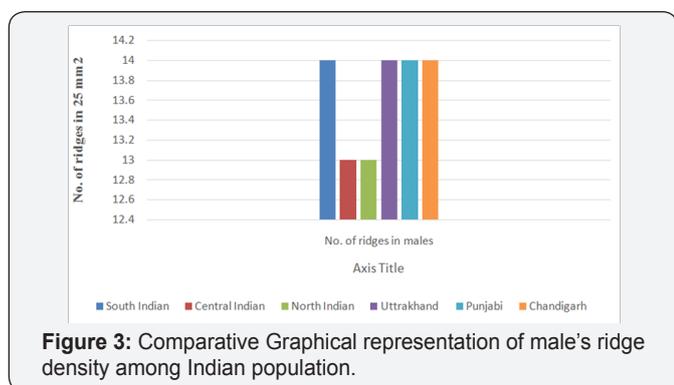


Figure 3: Comparative Graphical representation of male's ridge density among Indian population.

The graphical representation among the ridge densities of all Indian populations are given below in Figure 3 In this study, it was observed that all conducted studies show the similar results for gender discrimination. There is a minute difference was noticed between the male and female which may be because of health of

individual, disease or environmental factors. The identification of an individual from the ridge density is not possible until it will not be including the extracted individual features. Since, a lot of work has been carried out by the scientists, researchers over the ridge density, now; it is the time to find another method for conclusive gender discrimination from palmar and planter ridges of suspect.

### Conclusion

This study demonstrates that there is a significant difference in the epidermal ridge density between males and females of Indian Origin but not highly and accurately significant that their origin and region could be identified based on their ridge densities. It shows similar trends in sex difference as the other studies over the past conducted on other races and region followed by the international standard of 25mm<sup>2</sup> / 9mm<sup>2</sup> /16 mm<sup>2</sup>. This present study was conducted to broaden the horizon

of ridge count and gender discrimination by these ridge densities whether it is capable to determine the gender or not? The ridge densities differ from hand to hand, finger to finger even from tip of the finger to the bottom of finger.

The ridge count also depends upon the health, age and disease of the individual. During this study, all the carried out researches were studied carefully and comprised, it was noticed that all the region and population has a minor variation among the ridge densities. Although, it has proven that the females of Indian origin on an average have greater ridge density than the males. But the fact is that it also depends upon the health, age and condition of the person. Studies conducted in the past have more or less given insight about the difference in finger ridge density, but none of them could give an accurate method of measuring the gender from the ridge density of fingerprints.

This study suggests that the gender discrimination based on ridge density cannot be done. Either some accurate methods need to be developed, or the identification of individual should be done based on individual features along with the ridge density of a selected area. The gender discrimination can be done based on edgeoscopy or poroscopy in which the shape, size and number of pores differentiate the gender. As per the given statement by Cummins H., the gender discrimination can be done from the breadth among the ridges because the females have higher number of ridges than males in the specific area.

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DOI: [10.19080/JFSCI.2017.04.555651](https://doi.org/10.19080/JFSCI.2017.04.555651)

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