

Determination of Gender Differences from Fingerprints Ridge Density in Two Northern Indian Population of Chandigarh Region

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Abstract

Ridge width influences the number of ridges present in a specified area of a fingerprint epidermal ridge density and several researches have been carried out on this aspect of fingerprints. The present study has been carried out to examine ridge density differences in two Northern Indian populations (Khatri and Bania). In the present study it has been found that 92% of Khatri females have a mean ridge density above 13, whereas 76% of Khatri males have (a mean ridge density) below 13, while in Bania, 100% of females have mean ridge density above 14 and 80% of males below 14. The study suggests that there are significant differences in epidermal ridge density between males and females within each of the two populations and also significant differences between the two populations. This study will provide additional information for the fingerprint examiner in analyzing finger impressions and narrowing down an investigation involving a large number of samples.

Keywords: Sex; Ridge density; Fingerprint; Northern Indian population

Introduction

Numerous researches have been carried out on the human population in the field of dermatoglyphics, which is one of the most precise activities within forensic science. There are many features which have been studied in fingerprints (ridge count, ridge orientation etc) in relation to various factors of human population. Sex is one such factor. Ridge width influences the number of ridges present in a specified area of fingerprints i.e. the epidermal ridge density.

Recently, a few researches have been carried out on this aspect of fingerprint [1-5]. All of these papers have reported higher epidermal ridge density in females as compared to males. The present study has been carried out to study such differences in two northern Indian populations of Chandigarh region. No work on the differences in ridge density has been reported among the Khatri and Banias of Chandigarh region. There are two hypothesis which have been tested empirically in the present study. The first is that there is a difference in the ridge density between males and females of two populations and the second is that females possess greater ridge density as compared to males in the present study an attempt has been made to find out the differences in ridge density between the genders as well as between the two populations.

Khatri is the warrior's caste of northern India and who took to trade and have a important role in India transregional trade under the Mughal Empire. Due to strong build they have a extensive military tradition and have excelled in the armed forces. Their staple food is wheat, pulses, milk, butter and curd.

The Indian Bania castes are generally moneylenders or merchants, found chiefly in northern and western India. In religious affiliation, they are generally vaishnavas (worshippers) of the Hindu god Vishnu and tend to be strict vegetarians, teetotalers and orthodox in observing ceremonial purity.

Materials and Methods

The samples for the present study consist of fingerprints from 50 khatri and 50 Banias (25 males and 25 females in both populations) aged between 18-40 years. The subjects include students of Punjab

university campus, Chandigarh. The verbal consent of all the subjects was obtained and the objective of the study was explained to them. Before taking fingerprints, the subjects were asked to clean their hands. A plain glass plate of 15 cm × 15 cm was smeared with printer's black ink with the help of a roller that was used for collection of prints. The subjects were asked to roll their finger from the radial side (thumb) to the ulnar side (little finger) on the smeared plate and then transferred their finger prints in the same manner onto the specified space on the bond paper. In this manner, fingerprints of all the ten fingers were obtained for each individual.

The methodology is followed as per Acree, (Figure 1). Epidermal ridges in each fingerprint sample were counted within a 5 mm × 5 mm square drawn on transparent film. This value represents the epidermal ridge density. For finger prints from the right hand, this square was



Figure 1: Illustration of the technique to count dermal ridges.

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placed directly onto the upper left of the central core region. Likewise, for finger prints from the left hand, the square was placed onto the upper right of the central core area. This sampling method is useful in the case of arches, where the ridge count is zero as per the traditional method of ridge counting. Furthermore, the ridge counts were not analysed in central core regions due to the variability of pat tern shapes and recurving ridges, which are sometimes counted more than once in these regions. After calculating the epidermal ridge density of all ten fingers, the mean is calculated for it. This value represents the single data point for that individual. The means of 25 data points were calculated for both the populations. From this, variance values were calculated and these were compared by using the in dependent t-test for unequal variances. The confidence level was set at 95% (level of significance is 0.05). These calculations were performed using Microsoft office Excel. Inferences were drawn on the basis of analyzing the *t*-values obtained from the test. 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 (of support) for accepting the hypothesis.

Results and Discussion

Table 1 shows the descriptive statistics of dermal ridge densities for male and female Khatri subjects. The ridge density of Khatri males ranged from 10.6 to 14.1 ridges/25 mm and for females from 12.8 wsto 15.5 ridges/25mm. From the frequency distribution of epidermal ridge density (Table 2), it has been found that 92% of Khtri females have mean ridge density above 13 and 76% of Khatri males have mean ridge density below 13. As is evident from Table 3, the unequal variance t-test results show that there is a significant difference between the ridge density of males and females of the Khatri population with females having significantly higher ridge density than males. The calculated *t*-value (8.59) is greater than the critical value of 2.02, indicating the results to be significant.

Table 4 shows descriptive statistics of dermal ridge densities for male and female Bania subjects. The ridge density value ranges from

Gender	Ridge count/25mm				
	N	Minimum	Maximum	Mean	S.D
Females	25	12.8	15.5	14.14	0.72
Males	25	10.6	14.1	12.05	0.97

Table 1: Descriptive Statistics: Ridge Density in Males and Females in the Khatri Population.

Mean ridge density	Males	Females
10-11	2(8%)	—
11-12	15(60%)	—
12-13	2(8%)	2(8%)
13-14	5(20%)	8(32%)
14-15	1(4%)	13(52%)
15-16	—	2(8%)
Total	25(100%)	25(100%)

Table 2: Frequency Distribution of Mean Densities in the Khatri Population.

Statistical parameter	Value
<i>t</i> stat	8.59
<i>P</i> (<i>T</i> > <i>t</i>) one-tail	2.95
<i>t</i> critical one-tail	1.68
<i>P</i> (<i>T</i> ≤ <i>t</i>) two-tail	5.9
<i>t</i> critical two-tail	2.2

Table 3: Results of Independent T-Test for Unequal Variances for the Khatri Population.

Gender	Ridge count/25mm				
	N	Minimum	Maximum	Mean	S.D
Females	25	12.8	15.5	14.14	0.72
Males	25	10.6	14.1	12.05	0.97

Table 4: Descriptive Statistics: Ridge Density in Males and Females of the Bania Population.

Mean ridge density	Males	Females
10-11	—	—
11-12	6(24%)	—
12-13	9(36%)	—
13-14	5(20%)	—
14-15	4(16%)	10(40%)
15-16	1(4%)	8(32%)
16-17	—	4(16%)
17-18	—	2(8%)
18-19	—	—
19-20	—	—
20-21	—	1(4%)
Total	25(100%)	25(100%)

Table 5: Frequency Distribution of Mean Ridge Densities in Baniyas of Chandigarh.

Statistical parameter	Value
<i>t</i> stat	7.05
<i>P</i> (<i>T</i> > <i>t</i>) one-tail	3.9
<i>t</i> critical one-tail	1.67
<i>P</i> (<i>T</i> ≤ <i>t</i>) two-tail	7.8
<i>t</i> critical two-tail	3.2

Table 6: Results of Independent T-Test for Unequal Variances for the Bania Population of Chandigarh.

11.4 to 15.6 ridges/ 25 mm² for males and from 14.1 to 20.5 ridges/25 mm² for females. From the frequency distribution of epidermal ridge density (Table 5) it has been found that 100% of females have mean ridge density above14 and 80% of males have below 14. Similarly (to Khatri), for Baniyas, the un equal variance t-test results (Table 6) show that there is a significant difference between the ridge density of males and females, with females having a significantly higher ridge density than males. The *t*-value comes out to be 7.05, which is greater than critical value of 2.01, thus making the results significant.

This study demonstrates that there is a significant difference in the epidermal ridge density between males and females of both the northern Indian populations taken for the study, with females possessing a higher ridge density as compared to males. The magnitude of difference between the means of Khatri males and females is 2.1 ridges/25 mm and between Bania males and females is 2.6 ridges/25 mm.

This observed trend of a difference between males and females of various populations may be similar. Studies have been carried out in the past on this very aspect of finger prints. Cummins et al. [6] established that males have coarser epidermal ridges than females. Ohler and Cummins [7] reported that males have a ridge breadth of 0.48 mm, whereas females have 0.43 mm, but none of them have included the furrow breadth. This was taken into consideration by Moore who reported a higher value of ridge to ridge distance in males and thus a lesser ridge density as compared to females. Thus, the present study supports the observation made by Moore [8]. On the basis of the obtained results it can be concluded that there are differences in epidermal ridge density between women and men and they can be used to determine the sex of the donor. This study can be used as a sorting

parameter in cases where there are a large number of fingerprints available in case work analysis.

Conclusion

This study provides an aid for the finger print examiner in analyzing fingerprint samples as it shows that there is a significant difference in epidermal ridge density between males and females of the two populations. Further research on various other populations is in progress.

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