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Decoding gender variations: Ridge counting approach in Karunya Nagar (India) Population

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Abstract

Depending on the situation or the actions at work, the word "identification" might indicate several different meanings. In forensic sciences, identification is used to "determine the individuality of a person". The terms "papillary ridges" or "friction ridges" are frequently used when referring to the ridges that the papillae form. The term "ridge count" refers to the number of ridges separating the core from the delta. An arbitrary line divides the core from the delta. The line is counted along with every ridge that touches or crosses it. A dataset of 90 persons (45 male and 45 female) from Karunya Nagar, Coimbatore was analysed. Any two loop patterns (From both hands or either one hand) were collected from all the individuals of ages between 17 to 35. Stereomicroscope was used for ridge counting and the data was analysed by SPSS software. Determining the person's gender based on their Ridge Count is the goal of this study. As per the data analysed, the female subjects have more ridges than male subjects belonging to a particular region of Karunya Nagar. The mean value for females is 13 and for males is 12.

Keywords: Gender estimation, Ridge count, Fingerprints, Stereomicroscope, Loop pattern, Minutiae.

Introduction

Gender estimation based on fingerprint patterns has been extensively explored in the literature. However, only a handful of researchers have delved into the gender estimation through ridge counting in fingerprints. Notably, Gnanasivam. P, et al., employed fingerprint ridge count and fingertip size as parameters for automatic gender classification[1]. In a study conducted by Nithin K et al., rolled fingerprints from 550 individuals belonging to the South Indian population, aged between 18 and 65 years, were analysed[2]. The results revealed that women exhibit a significantly higher ridge count compared to men. These friction skin ridges encompass ridge characteristics or minutiae, which leave distinct impressions of their shape upon contact with an object. Consequently, an individual can be identified based on their unique ridge features[2].

These friction ridges are arranged in a distinct pattern that can be traced back to a single source of origin[3]. Fingerprints have long been employed for forensic identification, primarily due to their ridge characteristics or minutiae. This study on gender identification holds immense potential in aiding the sorting of suspects and victims at crime scenes. By leveraging the knowledge gained from gender estimation through fingerprint analysis, law enforcement agencies can enhance their investigative capabilities in a more efficient and accurate manner.

Material and Methods

Material: Black Ink and a Pad, Roller, Magnifying Glass, Stereomicroscope, Collection Performa with consent clause, Fingerprint Card etc.

Exclusion criteria: Individuals with any form of disease or injury affecting their fingertips, such as leprosy, lacerations, or scars, which could potentially interfere with the formation of fingerprint patterns, were excluded from the study. The study focused on individuals within the age range of 17 to 35, while those above the age of 35 were not included in the analysis.

Inclusion criteria: A total of 90 subjects were included in this study, with an equal distribution of 45 males and 45 females. The focus of this study was on two specific loop patterns found among the ten digits of fingerprints.

Methods: The present study was conducted on a sample of 90 individuals, consisting of 45 males and 45 females, residing in Karunya Nagar, Coimbatore, Tamil Nadu. The age group analysed ranged from 17 to 35 years. Prior to sample collection, the subjects were provided with detailed information about the study and their consent was obtained. Additionally, they were instructed to thoroughly wash their hands to ensure the removal of any dirt or grease. To collect the fingerprints, a glass plate was meticulously cleaned and then uniformly coated with a thin layer of black ink using a roller. The subjects were then asked to press their fingers onto the inked plate, which was subsequently transferred onto a prepared fingerprint Performa. This process allowed for the collection of two loop patterns from each subject, resulting in a total of 90 samples. These loop patterns were designated as Sample A and Sample B, with LOOP 1 Pattern representing Sample A and LOOP 2 Pattern representing Sample B. This consistent labelling, system was applied to all the collected samples. Subsequently, the fingerprint samples underwent ridge counting using a stereo microscope. A magnification of 3X was employed for accurate ridge counting.

In conclusion, this study involved a meticulous collection of fingerprint samples from 90 individuals in Karunya Nagar, Coimbatore, Tamil Nadu. The subjects provided their consent and followed specific instructions to ensure the cleanliness of their hands. The collected samples were then labelled and subjected to ridge counting using a stereo microscope at a magnification of 3X.

Procedure for ridge counting: An imaginary line is drawn between the core and the delta, and each ridge that intersects or makes contact with this line is tallied. The delta and core are excluded from consideration and counting. At the bifurcation junction, where the line intersects a ridge, two ridges are counted. When the line traverses an island, both sides are taken into account. Fragments and dots are only counted if they exhibit a similar thickness and prominence as the other ridges in the pattern.

Ridges including in ridge counting and their numerical values: An inland ridge or dot is assigned a ridge count of 1. A short ridge is also assigned a ridge count of 1. A long ridge is likewise assigned a ridge count of 1. An abrupt ending ridge is assigned a ridge count of 1. If a ridge bifurcates into two across the imaginary line, it is assigned a ridge count of 2. If the point of origin of a bifurcating ridge is on the line of count, it is assigned a ridge count of 2. If the legs of the enclosure or eyelet ridge are on the line of count, it is assigned a ridge count of 2. If the intersection of two enclosures is on the line of count, it is assigned a ridge count of 4. These guidelines serve as a standardized approach to accurately determine the ridge count in different ridge patterns. Figure-1 illustrates the guidelines for ridge counting in a loop pattern. All 90 samples were analysed using Ridge Counting, and the data was recorded separately for males and females to facilitate statistical analysis.

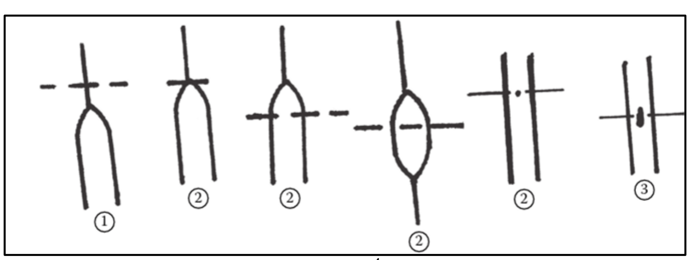

Figure-1: Rules for ridge counting[4].

Statistical Analysis: The Statistical Package for the Social Sciences (SPSS) was utilized to conduct statistical analysis on the collected data. Key statistical measures such as the mean, standard deviation, and 't' test were employed to compare the ridge counting averages between males and females. Additionally, the standard error was calculated to ensure accuracy. To facilitate the analysis, the samples were assigned unique numbers and divided into two groups: sample A and sample B. The ridge counting process was meticulously carried out, and the resulting data was recorded in a table. Subsequently, the data was imported into the SPSS software, enabling us to extract the mean values from the descriptive table.

To enhance our understanding of the data, we employed the frequencies chart to generate visually appealing graphs for Female A (Figure-2), Female B (Figure-3), Male A (Figure-4), and Male B (Figure-5). These graphs provide a clear representation of the ridge counting patterns within each gender group. By utilizing the SPSS software and employing various statistical techniques, we were able to conduct a comprehensive analysis of the data, ultimately yielding valuable insights into the ridge counting differences between males and females.

Results and Discussion

The ridge count values obtained from the subject's fingerprints were analysed using the Statistical Program for the Social Sciences (SPSS) software. The samples were divided into two groups, labeled as sample A and sample B. Table-1 consisted of female loop patterns, while Table-6 consisted of male loop patterns. The data were then imported into the SPSS software, and the mean values were calculated and presented in the descriptive Table.

For sample A, the mean ridge count value for females was determined to be 12.27, with a standard deviation of 4.438. In sample B, the mean ridge count value for females was found to be 13.82, with a standard deviation of 5.010. On the other hand, for sample A, the mean ridge count value for males was calculated as 11.76, with a standard deviation of 4.825. In sample B, the mean ridge count value for males was derived as 12.44, with a standard deviation of 5.500.

Upon comparing the mean values of ridge counting between males and females, a significant difference was observed. The mean ridge count value for females was consistently higher than that of males. This finding suggests a notable disparity in ridge counts between the two genders.

In conclusion, our analysis using SPSS software revealed a significant difference in the mean ridge counts between males and females. This finding contributes to our understanding of fingerprint patterns and highlights potential gender-related variations in ridge counting.

Table-1: Female data value.

Sample A (Ridge count)	Sample B (Ridge count)
12	6
4	14
13	10
14	12
6	22
17	21
13	18
15	16
15	16
15	15
4	10
10	9
10	15
12	16
8	6
11	4
4	9
10	9
10	15
12	16
8	6
11	16
20	13
16	20
10	15
15	14
19	17
18	20
10	15
13	18
11	9
12	14
9	10
14	13
4	10
10	9
7	7
16	18
17	20
21	20
17	20
16	19
13	23
9	10
19	14

Table-2: Standard Deviation in Female A Samples.

No. of terms		Minimum	Maximum	Mean	Std.D
Sample A	45	4	21	12.27	4.438
Valid N (list wise)	45				

Table-3: Frequencies of Female A samples.

No. of terms	Valid	45
	Missing	0

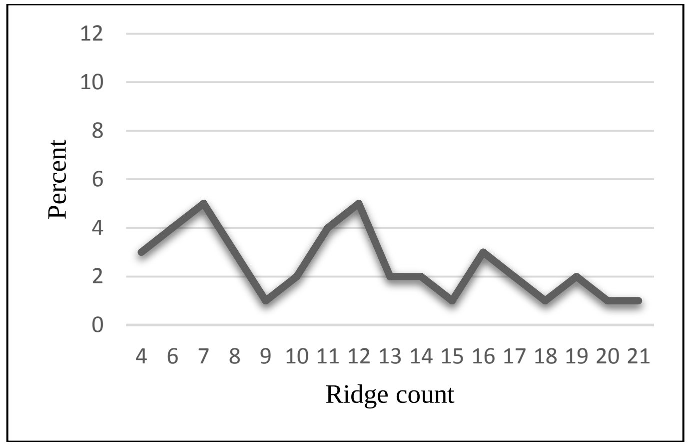

Figure-2: Statistical representation of female A samples.

Table-4: Standard Deviation of Female B samples.

No. of terms		Minimum	Maximum	Mean	Std.D
Sample A	45	4	23	13.82	5.010
Valid N (list wise)	45				

Table-5: Frequencies of female B samples.

No. of terms	Valid	45
	Missing	0

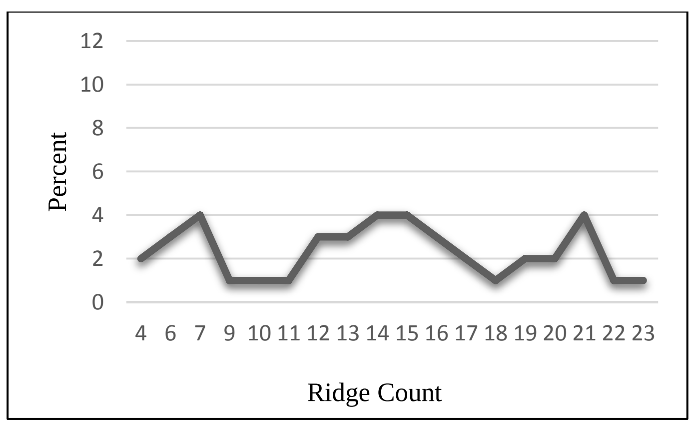

Figure-3: Statistical representation of female B samples.

Table-6: Male data value.

Sample A (Ridge count)	Sample B (Ridge count)
12	11
14	20
11	12
14	12
11	10
18	17
3	12
13	13
15	7
15	15
25	15
10	13
7	9
7	12
12	15
8	8
17	19
7	5
10	8
12	15
5	12
12	12
10	5
10	8
11	13
19	17
10	7
11	14
11	13
21	21
7	10
7	8
12	19
4	11
23	23
6	2
14	1
16	20
10	14
13	12
18	12
13	2
7	18
6	27
12	11

Table-7: Standard Deviation of Male A samples.

No. of terms		Minimum	Maximum	Mean	Std.D
Sample A	45	3	25	11.76	4.825
Valid N (list wise)	45				

Table-8: Frequencies of Male A samples.

No. of terms	Valid	45
	Missing	0

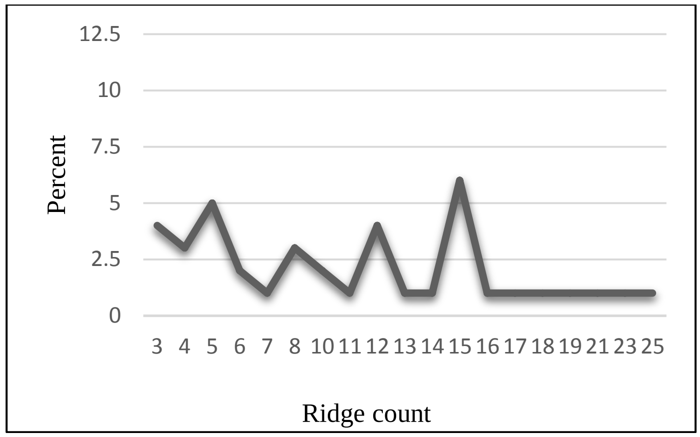

Figure-4: Statistical representations of male A samples.

Table-9: Standard Deviation of Male B samples.

No. of terms		Minimum	Maximum	Mean	Std.D
Sample A	45	1	27	12.44	5.500
Valid N (list wise)	45				

Table-10: Frequencies of Male B samples.

No. of terms	Valid	45
	Missing	0

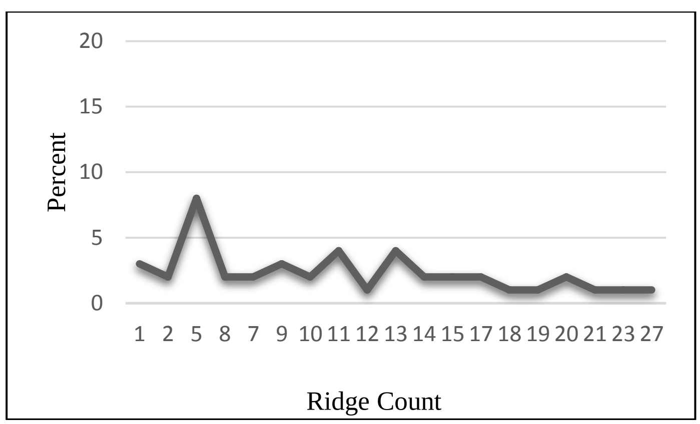

Figure-5: Statistical representation of male B samples.

Discussion: Fingerprint patterns have been extensively studied for their applications in forensic and biometric fields. Numerous studies have established connections between fingerprint patterns and various genetic traits, including gender, ethnicity, and groups[5]. This overview aims to shed light on the different types of fingerprints, namely arches, loops, and whorls. Among these, loop patterns are the most prevalent, and ridge counts can be utilized to distinguish between individuals[6].

Notably, there exists a significant disparity in the distribution of fingerprint classifications between males and females. Research findings indicate that males exhibit a higher percentage of loop patterns, while females tend to have a higher percentage of whorl patterns. These disparities may be attributed to hormonal differences between the two genders. The study conducted in Madurai and neighboring districts provides valuable data on the gender distribution of fingerprint classifications[7].

Moreover, the classification of gender using fingerprint ridge count and fingertip size holds immense potential as a valuable tool in forensic investigations. The study not only offers valuable insights into the accuracy of this approach but also emphasizes the necessity for further research in this domain[1].

Furthermore, ridge density emerges as a feasible and valuable parameter for comparing different Indian populations in the context of forensic investigations[8]. Several studies have explored fingerprint ridge density in the Argentinean population, revealing that males exhibit significantly higher ridge density than females in both the right and left index fingers[9]. Additionally, it has been established that a threshold value of 13 ridges per mm^2 can accurately determine gender[10].

In the present study, the ridge count was determined for both male and female subjects in a specific region of Karunya Nagar, Coimbatore, Tamil Nadu. Interestingly, our findings reveal a notable disparity in ridge count between the two genders. Specifically, female subjects exhibit a higher number of ridges compared to males. The mean ridge count for females was found to be 13, while for males it was 12. The discrepancy in mean values provides compelling evidence a significant difference in ridge counting between males and females.

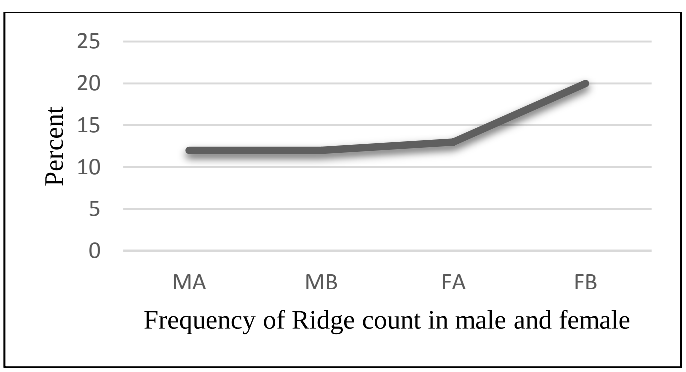

Figure-6: Final statistical chart.

Justice officials continue to rely on fingerprint technologies, even more than a century after their invention, due to their indispensable role in criminalistics. Not every crime scene provides biological evidence that can be utilized to support or challenge a case.

However, according to Locard's exchange principle, whenever two objects come into contact, there is an exchange of materials between them. This exchange can potentially establish a connection between a suspect and a crime scene or a suspect and a victim, based on transferred fragments of materials[8].

Consequently, fingerprints found at a crime scene may serve as the sole means of identifying individuals present or involved in the crime, making them one of the most crucial elements in criminal investigations.

The primary focus of this study revolves around the significance of ridge counts in identifying gender discrimination. Through careful observations, it was discovered that females exhibit higher ridge counts than males across various age groups within a specific region. This population-based study involved 90 samples, with an equal number of male and female subjects from each age group ranging from 10 to 35. The findings of this study hold immense importance in the context of gender discrimination and are statistically significant.

Conclusion

The study reveals a significant disparity in ridge count between males and females. This count varies not only from hand to hand and finger to finger but also depending on the loop pattern of the fingers. Remarkably, this research demonstrates that gender can be discerned based on ridge count. Specifically, within a specific geographical location, females exhibit higher ridge count values compared to males.

This study has profound implications for forensic investigations. By analysing the ridge count of fingerprints collected from a crime scene, it becomes possible to determine the gender of the offender. This invaluable information enables investigating officers to narrow down the list of suspects and steer their efforts in the right direction. By leveraging gender as a factor, the identification of the culprit can be expedited.

In addition to ridge characteristics, ridge count serves as a reliable method to establish the identity of an individual through their fingerprints. This supplementary tool provides crucial support in solving crimes, enhancing the overall efficacy of investigative processes.

Overall, this study sheds light on the significance of ridge count in differentiating between males and females. Its findings offer a professional and reliable approach to identifying the gender of offenders based on their fingerprints, aiding law enforcement agencies in their pursuit of justice.

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