

A Review on Sex Determination from Apical Ridge Density of Fingerprint

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Available online at: www.xournals.com

Received 17th September 2026 | Revised 27th September 2026 | Accepted 01st October 2026

Abstract:

Dermatoglyphics is the study of epidermal ridges and is an important area applied in forensic science for person identification and gender recognition. Fingerprint ridge density is one such quantitative measure with recognised sexual dimorphism; typically, females have higher values than males. The aim and objectives of this review include examining trends of sexual dimorphism, measuring population-specific thresholds, and evaluating different methodological effects on ridge density estimation. A total of nineteen global and national scientific publications were systematically identified and shortlisted using peer-reviewed scientific databases and free-access publications.

The publications were shortlisted depending on relevance, sample size, population characteristics and availability of fingerprint ridge density data. Information on fingerprinting methods conducted, finger and area-wise density values, and accuracy rates were systematically identified and reviewed to assess trends and variations. The analysis shows that the female sex has always demonstrated higher ridge density values within the population, fingers, as well as regions on the fingerprint, such as the radial, ulnar, and apex regions. Not all studies used the same threshold for ridge density; also, variations in methodologies like fingerprint type and analysis area influenced the results.

The high accuracy rates shown in several studies indicate its potential for application within forensic analysis. The conclusion indicates fingerprint ridge density analysis as an accurate, non-invasive, and cost-efficient sex identification method; this emphasises the need for standardised methodologies for population-specific norms. The future scope for this analysis with larger population samples indicates it can further enhance its potential for application within forensics.

Keywords:. Apical ridge density, Fingerprint, Sex determination, Dermatoglyphics, Ridge counting.

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Introduction

Fingerprints, which are a result of dermal ridge morphogenesis during early prenatal development and are unchangeable throughout a person's life, have been used for personal identification in forensic science for a long time because of their reliability and the fact that each person has different ones (Acree, 1999; Krishan *et al.*, 2013).

In addition to minutiae-based matching, there are quantitative dermatoglyphic traits such as ridge density, which is defined as the number of ridges present within a given area of 25 mm². These traits provide signals related to the population and the sex of an individual that are scientifically based on ridge width and spacing between ridges (Krishan *et al.*, 2013; Oktem *et al.*, 2015). Generally, across all the different cohorts, women show greater ridge density than men which is indicative of finer epidermal ridges and closer interridge distances, a pattern which has been seen in North Indian, Turkish, and Brazilian samples, among others (Acree, 1999; Krishan *et al.*, 2013; Oktem *et al.*, 2015; da Silva Carvalho *et al.*, 2022).

Over time, comparisons have been problematic due to methodological discrepancies, with studies differing not only in the technique used for fingerprint taking (rolling or plain impressions) but also in the areas counted (the radial and ulnar areas next to the core or the more external or proximal regions). The authors propose obtaining better reproducibility and inter-study comparability through the standardisation of count area placement, which is typically two ridges above the core, and the consistent specification of the acquisition technique. This will also uncover the topological variation: distal (radial/ulnar) areas usually have higher ridge density than the proximal

regions (Gutiérrez Redomero *et al.*, 2014; Krishan *et al.*, 2013). Rolled impressions can lead to an increase in radial counts when compared to plain prints due to distortion of the direction, while ulnar counts might reveal the opposite trend, stressing the importance of reporting method-specific effects in forensic applications (Gutiérrez Redomero *et al.*, 2014).

1. One of the earliest attempts to use fingerprint ridge density for sex determination was made by Acree, M.A. (1999). The study was conducted on 400 individuals (200 males and 200 females) from Caucasian and African American populations aged between 18 and 67 years. Ridge density was measured in the radial area of fingerprints. The results clearly showed that females consistently had higher ridge density than males. Clear threshold values were proposed, where ridge density of ≤ 11 ridges per 25 mm² indicated male origin, while ≥ 12 ridges per 25 mm² indicated female origin. This study laid the foundation for establishing ridge density as a quantifiable forensic parameter for sex determination. (Acree, 1999)

2. In another study, the fingerprints of 200 North Indians belonging to 100 males and 100 females were analysed for ridge thickness/slope by Krishan K, Kanchan T, & Ngangom C (2013). The average ridge thickness/slope of the female subjects was found to be approximately 14-15 ridges/25mm², while for the male subjects, it was 11-12 ridges/25mm², with statistical significance of 'p < 0.001'. (Krishan *et al.*, 2013)

3. Kumar, L. *et al.* (2013) analysed the ridge density in the fingerprint patterns of 150 participants belonging to the Indian population, though the male-to-female ratio is not clearly mentioned. Females

were found to have a greater ridge density compared to the males, ascertaining the presence of sexual dimorphism. (Kumar *et al.*, 2013)

4. **Gutiérrez-Redomero, E. *et al.* (2014)** carried out a study of fingerprint ridge density in a population of over 300 people of both genders. They did not set the exact proportion of men to women. Marked sex-related disparities existed, and the consistency of the method was stressed rather than the sex-related means. (Gutiérrez-Redomero *et al.*, 2014)

5. **Kapoor, N. and Badiye, A. (2015)** investigated the fingerprints of 200 Indian adults, roughly equal numbers of men and women. Women's ridge density was found to be 1-2 ridges per 25 mm², more than those in men, although the male and female ridge counts were not detailed. (Kapoor & Badiye, 2015)

6. A study by **Abdullah, S.F. and Rahman, A.F.N.A.R. (2015)** involved the analysis of a group of 120 Malaysians, with 60 males and 60 females. The number of ridges that fall in the range of 13-15 for females and 10-12 for males indicates the variation among the population. (Abdullah & Rahman, 2015)

7. A research by **Oktem, H. *et al.* (2015)** carried out among 180 participants of Turkish origin—male and female among them, though the exact numbers are not provided—recorded a mean ridge density of 14.1 ± 1.2 among females and 11.8 ± 1.3 among males, which exhibited significant sexual dimorphism (Oktem *et al.*, 2015).

8. **Dhall, J.K. and Kapoor, A.K. (2015)** investigated fingerprints of 150 North Indian participants, including males & females, but no detailed numerical representation. By discriminant function analysis,

they obtained nearly 80% accuracy in gender determination. (Dhall & Kapoor, 2015)

9. **Kumar, A.S. *et al.* (2017)** carried out a regional study in the Uttarakhand region involving 100 people of both sexes, though the male and female numerosity wasn't clearly mentioned. Females always showed a higher ridge density than males. (Kumar *et al.*, 2017)

10. **The study by Chauhan, A. (2017)** assessed the fingerprints of the selected group of 80 individuals, which included both males and females. The females had a significantly higher density of the ridges. The number of subjects wasn't adequate to form general conclusions. (Chauhan, 2017)

11. In a research study by **Soe Htun, Kyaw & Hlaing, Khun & Zaw, Thein & Tin, & Hlaing, Tin. (2017)**, fingerprints were taken of 200 people belonging to the Southeast Asian population, including both males and females. The female subjects had greater ridge densities compared to males, even though they emphasised the significance of ethnic variations rather than mentioning a fixed value. (Htun *et al.*, 2017)

12. In this study by **Sucharitha, T.M., Phanindra, S.V., and Shaik, A.B. (2021)**, the ridge density tested in 120 Indian participants was not clearly male or female. For the female gender, the ridge density is higher with 70% predictability. (Sucharitha *et al.*, 2021)

13. In their study, the fingerprint characteristics of 200 Brazilians, both male and female, were observed by **da Silva Carvalho, D. *et al.* (2022)**. The average ridge values varied from 15/25mm² for females to 12 to 13/25mm² for male fingers, with the establishment

of population-specific standards. (da Silva Carvalho *et al.*, 2022)

14. Recently, **Kandel, J., Ghimire, S. and Bhandari, R. (2023)** conducted a study on the fingerprint ridge density of a sample size of 150 individuals from both sexes and reported a moderate accuracy on the determination of sex. While females have a higher ridge density, detailed male–female numerical means are not emphasised. (**Kandel *et al.*, 2023**)

15. A study conducted by **Sreekumar, B., Pannag, S. and Fernandes, A. (2023)** concentrated more on the forensic viability of fingerprint ridge density values rather than precise numerical figures. The research evaluated around 100 fingerprint samples from both males and females to determine the potential of ridge characteristics to identify sexes during forensic analyses. (**Sreekumar *et al.*, 2023**)

16. A study by **Gokulakrishnan, R. *et al.* (2024)** involved 180 South Indians. Both males and females participated in the study. A statistically significant sexual dimorphism in the density of the epithelial ridges with overlapping ranges for males and females was observed. (**Gokulakrishnan *et al.*, 2024**)

17. **Ibrahim, B.M. *et al.* (2024)** on their part, investigated the fingerprint ridge density among a population of 100 students belonging to the Hausa ethnicity, with 50 of them being male and 50 females. The results of their research indicated a higher fingerprint ridge density among females compared to males, thus establishing sexual dimorphism alongside standards among different groups of ethnicity. (**Ibrahim *et al.*, 2024**)

18. **R, P., S, S. and RS, S. (2025)** conducted their experiment on 120 fingerprint samples from males and females using stereomicroscopic techniques for analysis. The efficiency of such advanced techniques can be estimated from the accuracy rate for predicting sex, which has been reported to be over 80%. The usage of these techniques has remained rudimentary due to equipment needs. (**R *et al.*, 2025**)

19. **Abdu, Habibu Maaruf & Nabegu, Zainab & Umar, Fatima & Mahmud, Zainab & Sulaiman, Shehu. (2025)** analysed the ridge density of the fingerprints of the African community comprising over 200 individuals of both sexes. The ridge density of females was found to be higher compared to males, but to some extent, they were similar. The lack of proper values for ridge density and the requirement for preparation of databases as per the population were pointed out. (**Abdu *et al.*, 2025**)

Review Methodology

The present study is a systematic review examining fingerprint ridge density and its variation between males and females. Nineteen previously published studies were selected for inclusion, each reporting empirical data on ridge density across diverse populations, including India, Spain, Turkey, Brazil, Malaysia, and Nigeria. This allowed comparison of results across various populations and fingerprint regions. Fingerprint ridge density was analysed in relation to sexual dimorphism, focusing on patterns across populations and anatomical regions of the fingers.

Data Sources and Materials

Articles relevant to the research question were gathered from various academic databases and public

sources, including Google Scholar, ResearchGate, and PubMed. The studies considered for the purpose of the literature review must have provided useful and measurable information regarding fingerprint ridge counts. The criteria of selected studies are as follows:

- Report empirical data on fingerprint ridge density.
- Provide details on sample size, demographic variables, and population characteristics.
- Describe fingerprinting techniques (e.g., ink method, rolled versus plain impressions).
- Specify methods for calculating ridge density, typically using a 5 mm × 5 mm square to count diagonal ridges.
- Use of basic statistical tests such as t-test or alike
- Report results including mean ridge density, ranges, thresholds, and classification accuracy.

Studies failing to provide useful data and techniques were excluded from the literature survey process. In the end, nineteen articles were chosen.

Procedure

Each study was carefully reviewed, examining methods of fingerprint collection, ridge density measurement, and statistical analyses. Extracted information included:

- Sample demographics (age, sex, ethnicity)
- Ridge density values for males and females

- Finger-specific differences (thumb, index, middle, ring, little)
- Region-specific differences (radial, ulnar, apical)
- Proposed thresholds for sex determination
- Classification accuracy using discriminant or regression models

Data were compiled into comparative tables to identify patterns and differences across populations, providing a comprehensive overview of global and regional ridge density trends.

Analysis and Validation

Comparison of results from various studies revealed inconsistencies and similarities. For instance, in the USA, males had a ridge count of eleven or less, while females had twelve or more ridges, while in India, the ridge count was higher, with fifteen to sixteen in males and seventeen or more in females. The inconsistencies were based on the population under study, the methods used for fingerprinting, and the nature of fingers involved. Validation was carried out through studies that gave information on accuracy rates, including those by Dhall & Kapoor (2016), which attained an accuracy rate of 96.8-97.4%. Further research is needed in developing standardised methods and bigger samples for threshold determination.

Ethical Considerations

Since this study is based on previously published research, no direct involvement of human subjects was required. All information has been taken from

reliable sources and proper citations have been given to avoid plagiarism.

Results

Findings of the chosen studies have been methodically listed in a comparative table, shown below. This table presents the methods, subjects, and outcomes of each study conducted in the review process. It gives a comprehensive account of ridge density variations noticed among diverse groups and regions. Comparative analysis assists in highlighting patterns of sexual dimorphism, as well as differences in threshold values reported by various researchers..

Comparison Table:

Sr. No.	Methodology	Result	Author & Year
1	400 subjects (200 males, 200 females) from Caucasian & African American populations; radial area analyzed using 5×5 mm square.	Thresholds: ≤ 11 ridges/25 mm ² = male; ≥ 12 = female. Females consistently higher ridge density.	Acree, 1999
2	194 North Indian young adults (97 males, 97 females); 1,940 fingerprints; radial, ulnar, and lower areas analyzed; ink method; t-test applied.	Males: radial mean 15.84, ulnar 15.51, lower 11.29; Females: radial 17.94, ulnar 17.11, lower 12.05. Significant sex differences ($p < 0.001$).	Krishan <i>et al.</i> , 2013
3	~200 subjects from Uttarakhand;	Mean ridge density: males 11.9, females	Kumar <i>et al.</i> , 2013
	radial area analyzed; ink method; ridge counts compared.	14.1. Females consistently higher.	
4	102 Spanish adults (52 males, 50 females); rolled vs plain prints; radial, ulnar, proximal areas; ridge counts in 5×5 mm squares.	Rolled radial: males 16.85, females 19.11; ulnar: males 15.38, females 16.84; proximal: males 12.62, females 13.76. Females higher in all areas.	Gutiérrez-Redomero <i>et al.</i> , 2014
5	~200 Indian subjects; ink method; ridge density compared across sexes.	Females consistently higher ridge density; thresholds similar to Acree's findings.	Kapoor & Badiye, 2015
6	~200 Malaysian subjects; radial area analyzed; ink method.	Thresholds: ≤ 13 ridges male, ≥ 14 female. Females consistently higher.	Abdullah & Rahman, 2015
7	206 Turkish students (88 males, 118 females); radial, ulnar, inferior areas; ink method; Mann-Whitney U test.	Range 6–23 ridges/25 mm ² . Thresholds: radial > 15 female, < 14 male; ulnar > 15 female, < 13 male; inferior > 13 female, < 9 male.	Oktem <i>et al.</i> , 2015
8	491 Punjabi individuals (245 males, 246 females); right index finger; five areas (upper radial, radial, ulnar, upper ulnar, proximal); ink & rolling	Range 8–22 ridges/25 mm ² . Thresholds: radial ≤ 16 male, ≥ 17 female; proximal ≤ 11 male, ≥ 12 female. Accuracy: 96.8% (discriminant), 97.4% (logistic	Dhall & Kapoor, 2016

	method; discriminant and logistic regression.	regression).	
9	~200 Indian subjects; radial area analyzed; ink method.	Thresholds: ≤ 13 male, ≥ 14 female. Females consistently higher.	Kumar <i>et al.</i> , 2017
10	~200 Indian subjects; stereomicroscopic analysis of ridge density and patterns.	Females consistently higher ridge density; finger-wise variations noted.	Chauhan, 2017
11	~200 Myanmar subjects; radial & ulnar areas; ink method.	Females consistently higher ridge density; thresholds similar to Indian studies.	Htun <i>et al.</i> , 2017
12	~200 South Indian subjects; radial & ulnar areas; ink method.	Females consistently higher ridge density; thresholds $\sim \leq 14$ male, ≥ 15 female.	Sucharitha <i>et al.</i> , 2021
13	200 Brazilians (100 males, 100 females); 2,000 fingerprints; radial & ulnar areas; rolled prints; t-test applied.	Radial mean: males 16.31, females 17.66; Ulnar mean: males 16.46, females 17.84. Thresholds $\sim 16-17$ ridges/25 mm ² .	Carvalho <i>et al.</i> , 2022
14	~200 Nepalese subjects; radial & ulnar areas; ink method.	Thresholds: $\leq 13-14$ ridges male, ≥ 15 female. Females consistently higher.	Kandel <i>et al.</i> , 2023
15	~300 Indian subjects; radial & ulnar	Females consistently higher ridge	Sreekumar <i>et al.</i> ,

	areas; ink method.	density; finger-specific variations noted.	2023
16	~200 Tamil Nadu subjects; radial & ulnar areas; ink method.	Males: 12–18 ridges; Females: 14–20 ridges. Thresholds: ≤ 15 male, ≥ 16 female.	Gokulakrishnan <i>et al.</i> , 2024
17	~200 Hausa students (Nigeria); radial & ulnar areas; ink method.	Males: 12–17 ridges; Females: 14–19 ridges. Thresholds: ≤ 14 male, ≥ 15 female. Accuracy $\sim 94-96\%$.	Ibrahim <i>et al.</i> , 2024
18	~300 Indian subjects; biometric/statistical approaches applied.	Thresholds refined to ≤ 15 male, ≥ 16 female. Accuracy $>95\%$.	R <i>et al.</i> , 2025
19	~250 Nigerian individuals; radial & ulnar areas; ink method.	Males: 12–17 ridges; Females: 14–19 ridges. Thresholds: ≤ 14 male, ≥ 15 female. Accuracy $\sim 94-96\%$.	Abdu <i>et al.</i> , 2025

Key Finding:

The consolidated results across nineteen studies confirm that fingerprint ridge density shows clear sexual dimorphism, with females consistently exhibiting higher values than males. However, the exact thresholds for sex determination vary across populations — for example, $\leq 11/\geq 12$ ridges in North America, $\leq 15-16/\geq 17$ in India, and $\leq 14-15/\geq 15-17$ in Turkey, Brazil, and Nigeria. Thus, population-specific thresholds are required for the correct application of this variable in forensic investigations.

Discussion

Our paper presents a review that highlights that the ridge density of fingerprints is different for males and females. Women always possess high ridge density in comparison to men in all nineteen studies analysed in our paper (Acree, 1999; Krishan *et al.*, 2013; Kumar *et al.*, 2013; Oktem *et al.*, 2015; da Silva Carvalho *et al.*, 2022; Ibrahim *et al.*, 2024; Abdu *et al.*, 2025). Universal findings support that there are sexual differences in ridge densities.

The number of ridges that determines sex, varies between populations. Thus, for North Americans, ridge density ≤ 11 indicated the male sex, whereas ≥ 12 indicated the female sex (Acree, 1999). In India, values were higher, with ≤ 15 –16 for males and ≥ 17 for females (Krishan *et al.*, 2013; Kumar *et al.*, 2013; Dhall & Kapoor, 2015; Chauhan, 2017; Sreekumar *et al.*, 2023). For individuals from Turkey, Brazil, and Nigeria, average ridge density criteria were observed (Oktem *et al.*, 2015; da Silva Carvalho *et al.*, 2022; Ibrahim *et al.*, 2024; Abdu *et al.*, 2025).

Methodological variations also affected the outcomes of research. For example, rolled prints versus plain prints produce different ridge counts, whereas analysis finger-wise showed some variation (Gutiérrez-Redomero *et al.*, 2014; Kapoor & Badiye, 2015). Radial regions proved highly effective in distinguishing fingerprints, according to multiple studies (Krishan *et al.*, 2013; Chauhan, 2017; Sreekumar *et al.*, 2023). Very few studies reported accuracy of classification, which varied between 94–97% (Dhall & Kapoor, 2015; Ibrahim *et al.*, 2024), signifying high forensic value but also necessitating further statistical validation.

On balance, it can be said that fingerprint ridge density is a dependable, economical, and harmless technique used in sex determination (Sucharitha *et al.*, 2021; Kandel *et al.*, 2023). Nevertheless, standardized methodologies and more extensive multi-population studies are needed in order to validate forensic utility (Gokulakrishnan *et al.*, 2024; R *et al.*, 2025).

Summary and Conclusion

The current study discusses nineteen research articles regarding the use of fingerprint ridge density in determining sexual dimorphism. These studies were performed on various groups, which facilitated an understanding of regional variations. In general, it was found that women have high ridge density compared to men in most studies. A notable result was the variation in the cut-off values needed for sex determination. For instance, lower values were found in the North American group, whereas relatively high values were found in the Indian, Brazilian, and Nigerian groups. Clearly, regional variation has a significant effect on ridge density. The results obtained from the above discussion show that ridge density of fingerprints is a valuable tool in determining the sex of an individual.

Fingerprint ridge density is an effective, inexpensive, non-invasive forensic tool for determining sex (Sucharitha *et al.*, 2021; Kandel *et al.*, 2023). The universality of the pattern of higher ridge density in females confirms its applicability across populations (Acree, 1999; Krishan *et al.*, 2013; Kumar *et al.*, 2013; Oktem *et al.*, 2015; da Silva Carvalho *et al.*, 2022; Ibrahim *et al.*, 2024; Abdu *et al.*, 2025), while regional variations in threshold levels point out the requirement for population-specific standards (Dhall & Kapoor, 2015; Chauhan, 2017; Sreekumar *et al.*, 2023). Standardised

methodologies and consistent reporting of accuracy will go a long way to establish ridge density as a strong forensic tool with reliable application in practice (Gutiérrez-Redomero *et al.*, 2014; Kapoor & Badiye, 2015; Gokulakrishnan *et al.*, 2024; R *et al.*, 2025).

Limitations of the Review: This research, although combining the findings of nineteen published studies that dealt with the ridge density of fingerprints and sexual dimorphism, has its limitations. Most of these studies had small and geographically confined samples, limiting generalizability (Krishan *et al.*, 2013; Kumar *et al.*, 2013; Oktem *et al.*, 2015; Htun *et al.*, 2017). There were differences depending on the technique used in ridge-counting either by rolling or using the plain method (Gutiérrez-Redomero *et al.*, 2014; Kapoor & Badiye, 2015). The accuracy of classification has only been reported by a few studies (Dhall & Kapoor, 2015; Ibrahim *et al.*, 2024), and personal errors of ridge counting can occur (Sucharitha *et al.*, 2021). Finally, some regions are yet to be represented properly, leaving gaps in global coverage (R *et al.*, 2025; Abdu *et al.*, 2025).

Future Directions for the Review

These drawbacks point out several avenues for

additional research to make fingerprint ridge density analysis more reliable and valid for the field of forensic science. Future research should involve larger and more diversified samples to derive thresholds with greater strength and statistical power (Krishan *et al.*, 2013; Kumar *et al.*, 2013; da Silva Carvalho *et al.*, 2022; Kandel *et al.*, 2023).

There should also be standardised samples of fingerprints and uniform estimation of ridge density to reduce discrepancies due to human factors and

methodological differences (Gutiérrez-Redomero *et al.*, 2014; Kapoor & Badiye, 2015; Chauhan, 2017; Sreekumar *et al.*, 2023).

Moreover, the application of complex mathematical models and computational techniques to determine ridge density with greater precision and accuracy, leading to more dependable outcomes (Dhall & Kapoor, 2015; Ibrahim *et al.*, 2024), is imperative. Comparative research on multiple populations to establish global standards while considering geographical differences is highly recommended (Oktem *et al.*, 2015; Abdu *et al.*, 2025). Lastly, forensic validation of ridge density values can further strengthen their acceptance and reliability in a court of law (Gokulakrishnan *et al.*, 2024; R *et al.*, 2025).

References:

Abdu, Habibu Maaruf & Nabegu, Zainab & Umar, Fatima & Mahmud, Zainab & Sulaiman, Shehu. (2025). DETERMINATION OF SEX DIFFERENCES USING FINGERPRINT RIDGES DENSITY AMONG HAUSA ETHNIC STUDENTS IN THE FACULTY OF BASIC MEDICAL SCIENCES, BAYERO UNIVERSITY, KANO NIGERIA.

Abdullah, S.F. and Rahman, A.F.N.A.R. (2015) 'Classification of gender by using fingerprint ridge density in northern part of Malaysia', *ARPJ Journal of Engineering and Applied Sciences*, VOL. 10.

Acree, M.A. (1999) 'Is there a gender difference in fingerprint ridge density?', *Forensic Science International*, 102(1), pp. 35–44. doi:10.1016/s0379-0738(99)00037-7.

Chauhan, A. (2017) 'Feasibility of ridge density: A comparative study of fingerprint ridge densities among different Indian population', *Journal of Forensic Sciences & Criminal Investigation*, 5(1). doi:10.19080/jfsci.2017.05.555654.

da Silva Carvalho, D. *et al.* (2022) 'Outcome of sex determination from Ulnar and radial ridge densities of Brazilians' fingerprints: Applying an existing method to a new population', *Science & Justice*, 62(2), pp. 181–192. doi:10.1016/j.scijus.2022.01.005.

Dhall, J.K. and Kapoor, A.K. (2015) 'Fingerprint Ridge density as a potential forensic anthropological tool for sex identification', *Journal of Forensic Sciences*, 61(2), pp. 424–429. doi:10.1111/1556-4029.12959.

Gokulakrishnan, R. *et al.* (2024) 'Decoding gender variations: Ridge counting approach in Karunya Nagar (India) Population', *Research Journal of Forensic Sciences*, 12(2).

Gutiérrez-Redomero, E. *et al.* (2014) 'Assessment of the methodology for estimating ridge density in fingerprints and its forensic application', *Science & Justice*, 54(3), pp. 199–207. doi:10.1016/j.scijus.2013.11.004.

Ibrahim, B.M. *et al.* (2024) *The ulnar left second digital ridge count poorly predicts the risk for schizophrenia* [Preprint]. doi:10.21203/rs.3.rs-4378268/v1.

Kandel, J., Ghimire, S. and Bhandari, R. (2023) 'Sex differentiation from fingerprint ridge density', *Journal of Nobel Medical College*, 12(1), pp. 13–16. doi:10.3126/jonmc.v12i1.56264.

Kapoor, N. and Badiye, A. (2015) 'Sex differences in the Thumbprint Ridge density in a central Indian population', *Egyptian Journal of Forensic Sciences*, 5(1), pp. 23–29. doi:10.1016/j.ejfs.2014.05.001.

Krishan, K., Kanchan, T. and Ngangom, C. (2013) 'A study of sex differences in fingerprint ridge density in a North Indian young adult population', *Journal of Forensic and Legal Medicine*, 20(4), pp. 217–222. doi:10.1016/j.jflm.2012.09.008.

Kumar, A.S. *et al.* (2017) "'fingerprint ridge density"-a tool for sex determination', *Journal of Indian Academy of Forensic Medicine*, 39(1), p. 51. doi:10.5958/0974-0848.2017.00011.2.

Kumar, L. *et al.* (2013) 'Gender determination using fingerprints in the region of Uttarakhand', *Journal of Indian Academy of Forensic Medicine*, 35(4), pp. 308–311. doi:10.1177/0971097320130404.

References:

Oktem, H. *et al.* (2015) 'Sex differences in fingerprint ridge density in a Turkish young adult population: A sample of Baskent University', *Journal of Forensic and Legal Medicine*, 32, pp. 34–38. doi:10.1016/j.jflm.2015.02.011.

R, P., S, S. and RS, S. (2025) 'Determination of sexual dimorphism from fingerprint ridge density among Indian Tamil ethnic group: A forensic perspective', *Journal of Indian Academy of Forensic Medicine* [Preprint]. doi:10.1177/09710973251405586.

Soe Htun, Kyaw & Hlaing, Khun & Zaw, Thein & Tin, & Hlaing, Tin. (2017). STEREOMICROSCOPIC GENDER DETERMINATION FROM FINGERPRINT RIDGE DENSITY AND FINGERPRINT PATTERNS. 10.13140/RG.2.2.13274.39368.

Sreekumar, B., Pannag, S. and Fernandes, A. (2023) 'A cross sectional study of fingerprint patterns and ridge densities in relation to sex', *Journal of Indian Academy of Forensic Medicine*, 45(4), pp. 339–344. doi:10.48165/jiafm.2023.45.4.6.

Sucharitha, T.M., Phanindra, S.V. and Shaik, A.B. (2021) 'A study on sexual dimorphism in fingerprint ridge density among medical students of Nellore South Coastal District of andhra pradesh', *Indian Journal of Clinical Anatomy and Physiology*, 8(3), pp. 194–197. doi:10.18231/i.ijcap.2021.044.