

## ORIGINAL ARTICLE

# A Study on the Pattern of Fingerprint Ridges for Determination of Gender in an Ethnic Tamil Population in Thiruporur Taluk of Tamilnadu

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## Abstract:

Human identification is critical, although it might be difficult given that each person has a particular trait. Fingerprint is the best identification of both living and deceased individual. There are patterns like ridge density, macro characteristic and micro characteristic in fingerprint. Ridge density and thickness plays major role in differentiation male and female gender. This is comparative study conducted on 223 volunteers of 125 female and 98 males under the age group varying from 18-65 years in Tamil speaking population in Thiruporur Taluk. After informed consent and preliminary data, fingerprints were obtained from the volunteers by means of simple inking method as suggested by Cummins and Midlo for fingerprint pattern we used blue stamp ink with clean and dry hands of all ten fingers, fingerprint were imprinted on fingerprint format paper. The present study resulted that mean value of ridge density of female vary from 11.2 – 12.7 ridges/mm<sup>2</sup> with average of 11.95 ridges/mm<sup>2</sup> (~ 12 ridges/mm<sup>2</sup>) and mean value of ridge density of male are 12.1 -13.7 ridges/mm<sup>2</sup> with average of 12.9 ridges/mm<sup>2</sup> (~13 ridges/mm<sup>2</sup>) which shows that male have higher ridge density than female. In our study 'P' value compared between male and female showed non-significance in all fingers except little finger which was significant. Fingerprint ridge density is a very important parameter useful in gender distinction. In this study the fingerprint ridge density was found to be higher in males than in females. This will be useful among individuals of ethnic Tamil descent to predict the degree of sexual dimorphism based on ridge density pattern,

**Keywords:** Fingerprint; Identification; Ridge density; Ethnic; Tamil; Sexual dimorphism.

## Introduction:

Fingerprint plays an important role for the identification of an individual in both living and deceased. Nowadays, Fingerprint identification is one of the most extensively used biometric technologies.<sup>1</sup> Fingerprint is a terminology which predominantly means an impression of the epidermal ridges of the fleshy distal portion of a finger formed by applying ink and pressing the finger on paper and is used as means of establishing identity. In 1926, Cummins and Midlo first coined a term called dermatoglyphics which mean the study of fingerprint.<sup>2</sup> The word dermatoglyphics took from greek words where derma means skin and glyph means curve. Later, all over the world the study of fingerprint was known as dactyloscopy.<sup>3</sup> Before the development begins in 7<sup>th</sup> week of gestation there is a formation of volar pads. These pattern of elevation over the volar area of thenar, and hypothenar regions of the finger surfaces are not permanent but are temporary.<sup>4</sup> In intrauterine development the fingerprint development in foetus occurs between 10<sup>th</sup> to 14<sup>th</sup> week of gestation. Dermal ridges start to appear during the 12<sup>th</sup> week of intrauterine life and completed by the 24<sup>th</sup> week of intrauterine life.<sup>5-7</sup> These patterns are genetically determined and formed once, remain permanent for a lifetime.<sup>8</sup> Scientifically and

mathematically proved that even identical and non – identical twin born with same zygote does not have same fingerprint. Statics shows that one in 64 million of population in worldwide shows same fingerprint.<sup>9</sup>

Gender is determined using ridge metrics which includes thickness to valley thickness ratio, ridge count, ridge density, ridge breadth, macro characteristic and micro characteristic. An important component of epidermal ridge is ridge density or number of ridges occurs in defined space in fingers. Ridge density has two important parameters: (1) Ridge breadth and (2) Ridge-to-ridge (furrow) distance. The fingerprint ridge density is the number of ridges present in a unit area of a fingerprint (FPRD). The density of epidermal ridges can be calculated using two parameters: Ridge width and distance between ridges.<sup>10,11</sup> The thickness of the epidermal ridges varies from person to person and from gender to gender. The number of ridges present in a unit area of a fingerprint is known as fingerprint ridge density. It is also known as the number of ridges in a specific location. The density of the epidermal ridge can be determined by looking at the following two parameters:

1. The width of the ridge.
2. The distance between ridges is measured in meters.

Individual epidermal ridge thickness varies with gender difference.<sup>12</sup> This present study was done with the aim to evaluate the ridge density of fingerprint patterns for determination of sex among ethnic Tamils using fingerprint format sheet.

## Materials and Methods:

This cross-sectional study was conducted at Thiruporur Taluk of

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Tamil Nadu on an ethnic Tamil population from the period of July 2021 to July 2022. The study subjects were males & females of ethnic Tamil origin. The study was done among 223 (98 males and 125 females) of participants between the age group of 18 – 65 years living in Thiruporur Taluk. After the institutional ethical committee clearance (IEC No: 2019/446), the study was undertaken in the department of Forensic Medicine & Toxicology at Shri Sathya Sai Medical College & research Institute. Informed consent was obtained from the volunteers.

After collecting the preliminary data related to the subjects like name, age, sex, mother tongue and address, fingerprints of all the ten fingers of the hand was collected. The fingerprints were obtained from the participants by means of simple inking method as suggested by Cummins and Midlo. The selected subjects were asked to wash and dry their hands. A clean fingerprint plate was smeared with Kores thumb impression ink (black), with the help of a roller. The subjects were then asked to ink their fingers, rolling nail to nail on the inked surface, and imprint them on the finger-print slip in the designated area of all ten fingers. Hence fingerprints from 223 subjects (2230 prints) were analyzed during the study. Two straight lines bisecting each other were drawn. This bisecting point will be placed at the core or center of

the print. 5 mm above this, another transverse line will be drawn. Two squares of 25 mm<sup>2</sup> each were drawn on both sides (left and right). Ridge counting was analyzed and tabulated in all ten fingers of both males and females. The average tabulated values for both sides will represent the ridge density in a 25 mm<sup>2</sup> area.

For statistical analysis the data collected was tabulated and analyzed. The variations of average mean of ridge density and the ridge thickness were calculated for all the ten fingers in males and females. The differences in fingerprint ridge densities between the sexes were analyzed individually for each finger in both hands together. Student's t-test was applied for comparative analysis 'P' value of less than 0.05 was considered as significant.

**Results:**

The data analysis of this study on 223 volunteers (98 males and 125 females) shows that mean value of ridge density of female vary from 11.2–12.7 ridges/mm<sup>2</sup> with average of 11.95 ridges/mm<sup>2</sup> (~12 ridges/mm<sup>2</sup>) and mean value of ridge density of male are 12.1-13.7 ridges/mm<sup>2</sup> with average of 12.9 ridges/mm<sup>2</sup> (~13 ridges/mm<sup>2</sup>) which shows that male have higher ridge density than female (as shown in table -1).

Mann Whitney U-test done for all ten fingers which states that there exists no significant difference between the median of male and female samples in the all fingers of both the hands (as shown in table–2).

Student's t-test will be applied for comparative analysis where 'P' value of less than 0.05 was considered as significant. In our study 'P' value was not significant when compared with all fingers of both male and female except in little finger which showed a significant in right hand of p - 0.031 and left hand of p - 0.039 and

**Table 1. Mean value of ridge density of male and female.**

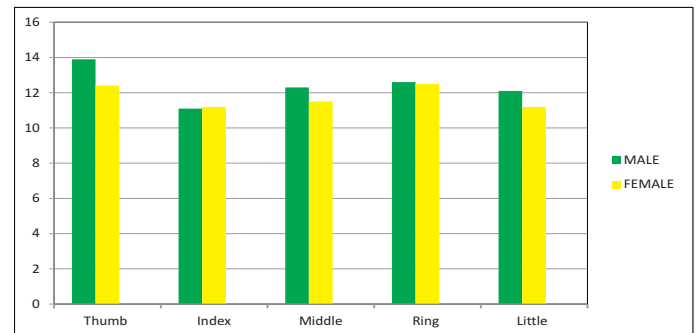
Finger	Male		Female		t statistic	p-value
	Mean	SD	Mean	SD		
<b>Right hand</b>						
Thumb finger	13.8	4.2	12.7	4.2	1.834	0.068
Index finger	11.1	3.0	11.2	3.0	0.279	0.780
Middle finger	12.2	3.7	11.8	3.4	0.788	0.431
Ring finger	12.6	3.7	12.4	3.1	0.456	0.649
Little finger	12.1	3.3	11.2	3.0	2.172	0.031*
<b>Left hand</b>						
Thumb finger	13.9	3.5	12.4	4.4	2.778	0.006
Index finger	12.6	3.7	11.2	3.0	1.379	0.168
Middle finger	12.3	3.8	11.5	4.4	1.394	0.165
Ring finger	12.6	3.4	12.5	3.3	0.306	0.760
Little finger	12.1	3.4	11.2	2.8	2.071	0.039*

**Table 2. Mann whitney U-test for right and left of all ten fingers.**

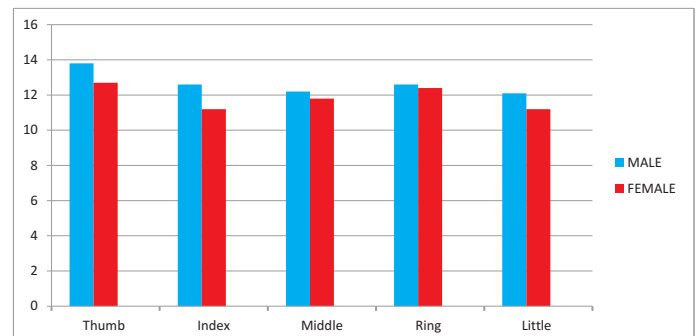
Finger	z-value	p-value
<b>Right hand</b>		
Thumb finger	2.697	0.007
Index finger	0.279	0.780
Middle finger	1.228	0.220
Ring finger	1.796	0.072
Little finger	3.488	0.0005
<b>Left hand</b>		
Thumb finger	2.729	0.006
Index finger	1.379	0.168
Middle finger	1.579	0.114
Ring finger	0.832	0.405
Little finger	3.614	0.0003

**Table 3. Comparison of 'P' value between right and left little finger.**

Finger	P value
Right little finger	0.031*
Left little finger	0.039*



**Figure 1. Graphical comparison of right - hand ridge density of male and female.**



**Figure 2. Graphical comparison of left hand ridge density of male and female.**

left-hand show slightly higher value than female as comparison (as shown in table–3).

In accordance with findings in this study ridge density of male and females of both hands are shown in graphical diagrams (as shown in fig. 1 & 2).

### Discussion:

Among fingerprint pattern ridge density plays an important role in differentiating sex in various ethnic groups. The appreciation of finding ridge density goes to Cummins and midlo. This study shows sex determination among Tamil ethnic groups using ridge density pattern of fingerprint. Our present study show average mean ridge density of male ~ 13 ridges/mm<sup>2</sup> and female ~ 12 ridges/mm<sup>2</sup> respectively which says that male ridge density is higher than females where similar findings of previous studies such as Khadri SY, who found that male have ridge density of 12.4 ridges/mm<sup>2</sup> slightly greater than female having 12 ridges/mm<sup>2</sup> respectively.<sup>13</sup>

Compared with previous studies which differ from present study like Gagandeep Singh showed that female have ridge density of greater than 14 ridges/mm<sup>2</sup> when compared with male who have ridge density lesser than 14 ridges/mm<sup>2</sup> which resulted that female have higher ridge density than male.<sup>14</sup> Some other author like Regine Ynez H. De Mesa also showed dissimilar with present study showing female (25 ridges/mm<sup>2</sup>) have higher ridge density than male (17 ridges/mm<sup>2</sup>).<sup>15</sup> Even Natarajan Moorthy T study findings were not in concurrence with this study and showed that females (12 -14 ridges/mm<sup>2</sup>) have higher ridge density than male (11 ridges/mm<sup>2</sup>).<sup>16</sup> Amira A et al. study also have different finding when compared with present study which resulted female (~15 ridges/mm<sup>2</sup>) have higher ridge density than male (~12 ridges/mm<sup>2</sup>).<sup>17</sup> Study of TM Sucharitha showed dissimilar findings when compared with present study were female (~15 ridges/mm<sup>2</sup>) have higher ridge density than male (~13 ridges/mm<sup>2</sup>).<sup>18</sup> Thakkar analyzed that female (~14 ridges/mm<sup>2</sup>) have higher ridge density than male (~12 ridges/mm<sup>2</sup>) which was not similar with our present study.<sup>19</sup> Nayak analyzed that female (~15 ridges/mm<sup>2</sup>) have higher ridge density than male (~11 ridges/mm<sup>2</sup>) which dissimilar to present study.<sup>20</sup> Nithin analyzed that female (~14 ridges/mm<sup>2</sup>) have higher ridge density than male (~13 ridges/mm<sup>2</sup>) which was not alike to our present study.<sup>21</sup>

Gutierrez-Redomero analyzed that female (~17 ridges/mm<sup>2</sup>) have higher ridge density than male (~16 ridges/mm<sup>2</sup>) which was different to present study.<sup>22</sup> Kumar analyzed in index and middle finger of female having mean ridge density of index (13.22 ridges/mm<sup>2</sup>), middle (13.94 ridges/mm<sup>2</sup>) and male having mean ridge density of index (12.32 ridges/mm<sup>2</sup>), middle (12.7 ridges/mm<sup>2</sup>) showed that female have higher ridge density of index and middle finger compared with male which was dissimilar to our present study.<sup>23</sup>

The study of Chavan VA and Rajesh Kumar showed no significant difference of ridge density of males and females in Marathwada population and these findings neither agreed nor disagreed with the findings of the present study.<sup>24</sup> Another study done Nagurka ML showed that ridge density feature alone was

not an effective factor for gender determination.<sup>25</sup>

The finding of increased ridge density in male subjects of the present study compared to females have differed with the findings of several other studies and this could be attributed to the possible reason that this study have been conducted in the ethnic Tamil population living in the Thiruporur taluk of Tamil Nadu and since this is ethnically a different population compared to the other studies which have been done in other ethnically different and diverse population. As India is a land of several ethnic diversities hence there is always a strong possibility of observing variable findings and this also explain the finding of increased male ridge density in this study compared to females.

### Conclusion:

Fingerprint is considered as the best identification marker in both living and deceased individual. There were many studies on different population across the world to determine sex based on ridge density pattern in all ten fingers. The findings of this study showed that male have higher ridge density than female and this may be useful in differentiating between genders based on fingerprint ridge density analysis.

The findings of this study may be applied in establishing the degree of sexual dimorphism among the Tamil males and females based on fingerprint ridge density pattern found at the scene of crime.

### Limitation of the study:

This study was done in a taluk of Tamil Nadu and for future research and extrapolation of the findings and results of this study it is essential to conduct similar studies in different other taluks and districts of Tamil Nadu to compare the findings and develop a broad database which will be useful to predict the identification of sexual dimorphism from the examination of fingerprint ridge density in the population of Tamil Nadu.

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