

# A Comparative Study on Toe Prints Among Males and Females

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## ABSTRACT

Fingerprints are the most widely accepted evidence in court of law owing to their uniqueness. Similar to fingerprints, the toe dermal ridge pattern is unique in nature. The objective of this study is to analyse the most common toe print patterns in males and females, it also aims to find out the specific pattern that predominates in each individual toe. The study also analyses the frequency distribution of the patterns, dividing them both gender-wise and toe-wise. 200 samples are being collected for this study, of which 100 are males and 100 are females from Chennai. Toe print impressions are being collected using an inkless fingerprint pad. The data analysis reveals that the loops were seen to be the most common pattern in both males and females, there are total of 41.45% percentage of loop pattern followed by arch pattern 35% and last whorl pattern contain 23.55%. In male 39.9% contain loop patterns followed by arch pattern contain 36.3% and then whorl pattern contains 23.8%. In female the dominant pattern is loop pattern contain 43% followed by arch pattern 33.7% and then whorl pattern contains 23.3%. Toe prints have various applications in multiple fields like identification of disabled persons, identification of victims of mass causality, and evidence in crime scene investigation. Addition of toe prints to the biometric system may increase the accuracy of identification systems, increasing their application in security, healthcare, and law enforcement.

**Keywords:** Toe prints, Ridges, Dominant print, Loop, Whorl. Arch

## INTRODUCTION

The dermatoglyphics is the study of patterns of skin ridge on finger, toe, palm, soles, has been of great interest in variety of scientific discipline [1]. Fingerprint analysis is widely used in forensic science for individual identification but the potential use of toe prints in biometric verification is not widely explored. Likewise, fingerprints, Toe prints are also unique in nature and which are formed during the embryonic development. The Toe prints remind unchanged throughout the life of an individual [2]. The primary pattern of Toe prints is characterized into three type that are Loop, Whorl and Arch, which are also observed in fingerprints. Arch: The ridges enter from one side of the finger, rise in the centre forming an arc, and then exit the other side of the finger. Loop: The ridges enter from one side of a finger, and forming a curve, and then exit on that same side. Whorl: Ridges form circularly around a central point on the finger [3]. Two fingers or toe prints even from the same individual or identical twins are not exactly alike. These features increase the effective

identification of the suspect by giving a clue crime at a in the crime scene [2]. The differentiation of gender-based toe prints could improve the profiling accuracy and also helped in crime scene investigation, mass disaster victim identification, and contributions to health-related research. It can have practical applications in security systems and medicine as well, with the advantage of further enriching the scholarly knowledge of gender-based biological variations. This study helps in crime scene investigation by identifying the individuals involved in the scene of crime. And the toe print can also use a biometric tool and for security purpose, this will increase the digital safety of an individual and the biometric tools can help for the personal identification. Developing a new database by using Toe prints will help in criminal investigation. The research questions involved in this paper is what are the main difference between male and female ridge patterns, and what are the most common pattern seen each gender and also to determine the most dominant pattern in each particular Toes. By identifying the common pattern in each gender help to narrow down the suspect list

**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

involved in a crime scene, and the investigator can easily identify the suspects and this will also help for the personal identification in various situations. This research focused to compare the Toe prints patterns of males and females to identify the most dominant patterns among each gender. And also, to identify the most dominant pattern among each particular Toe and identify the frequency of patterns in both gender wise and toe wise. By studying gender differences, to understand the variation in toe structure and how these variations correlate with gender. The Toe prints were collected from 100 males and 100 females those who are resides in Chennai using an ink less fingerprint pad. Examine the prints of each samples using a magnifying glass to identify the prints. And statical analyse also done by using SPSS software to identify the frequency of each pattern. The main significance of the study is, Toe prints in males and females could provide an understanding of potential distinctions that could improve biometric identification. Toe prints can also be used in medical identification, especially for patients who are unconscious or unable to communicate. And also in crime scene, toe prints may be a supplementary tool for personal identification. By studying gender differences, to understand the variation in toe structure and how these variations correlate with gender.

## MATERIAL AND METHODOLOGY

This study aimed to examine the Toe prints patterns of both males and females to identify the most dominant patterns. The samples were collected from 100 males and 100 females those who all between the age group of 18-40 [4]. So, in the beginning of sample collection return consent would be obtained from all the participants. For this research paper, the sample was collected physically from the participants. So, the main materials used for the sample collection and analysis of the sample were an inkless fingerprint pad, a magnifying glass, gloves, tissue paper, and sanitizer. The sample was collected from the participants using an inkless fingerprint pad by

pressing the Toes on the pad and then the toe was pressed against the paper to obtain the pattern. Before collecting the sample, one needs to wear gloves for hygiene purposes, and then using the sanitizer and tissue paper, clean the toes of the participants so it will help to get clear prints. The magnifying glass was used to identify the prints. When collecting the samples, injured, deformed, incomplete, wrinkled and worn patterns, prints should be excluded for accurate data [5]. The Toe prints were collected from 100 males and 100 females those who all are resides in Chennai. Before collecting the sample ensured that the feet of the participants should be cleaned to remove the dirt and oils, for this sanitizer and tissues were provided to the participants [1]. After cleaning the, the Toes are pressed into inkless fingerprint pad gently and press into the paper where the prints were collected and paper marked as right feet and left feet [5]\*. Ensure that the prints should not be smudged and patterns are clear. The collected samples should be marked properly for better identification. After the collection process analyse the collected sample by using a magnifying glass for pattern identification. The patterns were seen in the samples were Loop, Arch and Whorl. In the identification process any patterns were seen as entry and exist of the ridge is in same side and a loop-like structure is seen in the middle was marked as Loop pattern, Circle-like structure is in the middle of the pattern was marked as Whorl pattern and at last entry of the ridge is in one side and exist is in other side was marked as Arch pattern. The collected data was entered to the data table for easy examination. Using the SPSS software collected data was examined.

## RESULT & DISCUSSION

### RESULT

The male and female Toe prints are analysed using a magnifying glass and the data obtained from that was uploaded in SPSS software and given the frequency and percentage of each pattern Toe wise.

**Table 1: Frequency of different toe print patterns of right thumb**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 63        | 63%     |
|        | Whorl    | 11        | 11%     |
|        | Arch     | 26        | 26%     |
|        | Loop     | 69        | 69%     |

|        |       |    |     |
|--------|-------|----|-----|
| Female | Whorl | 11 | 11% |
|        | Arch  | 20 | 20% |

Table 1 represents the frequency and percentage of the right thumb of each gender. This table shows that among males, the loop pattern dominates the right thumb, which was observed in 63 individuals. Followed by the arch pattern, which was observed in 26 individuals, and the least-seemed pattern is the

whorl pattern, and it is observed in 11 individuals among 100. In females, the loop pattern is the most dominant, observed in 69 individuals, followed by the arch pattern, observed in 20 individuals, and the least-seen pattern is the whorl pattern, which is observed in 11 individuals among 100.

**Table 2: Frequency distribution of different toe print patterns of right index**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 55        | 55%     |
|        | Whorl    | 22        | 22%     |
|        | Arch     | 23        | 23%     |
| Female | Loop     | 62        | 62%     |
|        | Whorl    | 26        | 26%     |
|        | Arch     | 12        | 12%     |

Table 2 represents the frequency and percentage of right Index of both males and females. The table show among males, the loop pattern dominates the right index, which was observed in 55 individuals. Followed by Arch pattern, which was observed in 23 individuals and least seemed pattern was Whorl,

which was observed in 22 individuals among 100. In females, the loop pattern is the most dominant, observed in 62 individuals, followed by the whorl pattern, observed in 26 individuals, and the least-seen pattern is the arch pattern, which is observed in 12 individuals among 100.

**Table 3: Frequency of different toe print patterns of right middle**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 35        | 35%     |
|        | Whorl    | 51        | 51%     |
|        | Arch     | 14        | 14%     |
| Female | Loop     | 38        | 38%     |
|        | Whorl    | 52        | 52%     |
|        | Arch     | 10        | 10%     |

Table 3 represents the frequency and percentage of the right middle of each gender. This table shows that among males, the whorl pattern dominates the right middle, which was observed in 51 individuals. Followed by the loop pattern, which was observed in 35 individuals, and the least-seemed pattern is the

arch pattern, and it is observed in 14 individuals among 100. In females, the whorl pattern is also the most dominant, observed in 52 individuals, followed by the loop pattern, observed in 38 individuals, and the least-seen pattern is the arch pattern, which is observed in 10 individuals among 100.

**Table 4: Frequency of different toe print patterns of right ring**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 34        | 34%     |
|        | Whorl    | 23        | 23%     |
|        | Arch     | 43        | 43%     |
| Female | Loop     | 43        | 43%     |
|        | Whorl    | 14        | 14%     |
|        | Arch     | 43        | 43%     |

Table 4 represents the frequency and percentage of the right ring of each gender. This table shows that among males, the arch pattern dominates the right ring, which was observed in 43 individuals. Followed by the loop pattern, which was observed in 34 individuals, and the least-seemed pattern is the whorl pattern, and it is

observed in 23 individuals among 100. In females, loop pattern and arch pattern are seemed as most dominant, which were observed in 43 individuals. Followed by Whorl pattern, which was observed in 14 individuals among 100. In this table the dominant patterns are distributed equally.

**Table 5: Frequency of different toe print patterns of right little**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 15        | 15%     |
|        | Whorl    | 9         | 9%      |
|        | Arch     | 76        | 76%     |
| Female | Loop     | 14        | 14%     |
|        | Whorl    | 7         | 7%      |
|        | Arch     | 79        | 79%     |

Table 5 represents the frequency and percentage of the right little of each gender. This table shows that among males, the arch pattern dominates the right little, which was observed in 76 individuals. Followed by the loop pattern, which was observed in 15 individuals, and the least-seemed pattern is the whorl

pattern, and it is observed in 9 individuals only among 100. In females, the arch pattern is the most dominant, observed in 74 individuals, followed by the loop pattern, observed in 14 individuals, and the least-seen pattern is the whorl pattern, which is observed in 7 individuals only among 100.

**Table 6: Frequency of different toe print patterns of left thumb**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 63        | 63%     |
|        | Whorl    | 15        | 15%     |
|        | Arch     | 22        | 22%     |
| Female | Loop     | 72        | 72%     |
|        | Whorl    | 11        | 11%     |
|        | Arch     | 17        | 17%     |

Table 6 represents the frequency and percentage of the left thumb of each gender. This table shows that among males, the loop pattern dominates the left thumb, which was observed in 63 individuals. Followed by the arch pattern, which was observed in 22 individuals, and the least-seemed pattern is the

whorl pattern, and it is observed in 15 individuals among 100. In females, the loop pattern is the most dominant, observed in 72 individuals, followed by the arch pattern, observed in 17 individuals, and the least-seen pattern is the whorl pattern, which is observed in 11 individuals among 100.

**Table 7: Frequency of different toe print patterns of left index**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 61        | 61%     |
|        | Whorl    | 24        | 24%     |
|        | Arch     | 15        | 15%     |
| Female | Loop     | 47        | 47%     |
|        | Whorl    | 35        | 35%     |
|        | Arch     | 18        | 18%     |

Table 7 represents the frequency and percentage of the left index of each gender. This table shows that among males, the loop pattern dominates the left index which was observed in 61 individuals. Followed by the whorl pattern, which was observed in 24 individuals, and the least-seemed pattern is the arch pattern, and it

is observed in 15 individuals among 100. In females, the loop pattern is the most dominant, observed in 47 individuals, followed by the whorl pattern, observed in 35 individuals, and the least-seen pattern is the arch pattern, which is observed in 11 individuals among 100.

**Table 8: Frequency of different toe print patterns of left middle**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 22        | 22%     |
|        | Whorl    | 57        | 57%     |
|        | Arch     | 21        | 21%     |
| Female | Loop     | 32        | 32%     |
|        | Whorl    | 55        | 55%     |
|        | Arch     | 13        | 13%     |

Table 8 represents the frequency and percentage of the left middle of each gender. This table shows that among males, the whorl pattern dominates the left middle which was observed in 57 individuals. Followed by the loop pattern, which was observed in 22 individuals, and the least-seemed pattern is the arch pattern, and it is observed in 21 individuals

among 100. There was a minor difference between loop pattern and Arch pattern. In females, the whorl pattern is the most dominant, observed in 55 individuals, followed by the loop pattern, observed in 32 individuals, and the least-seen pattern is the arch pattern, which is observed in 13 individuals among 100.

**Table 9: Frequency of different toe print patterns of left ring**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 34        | 34%     |
|        | Whorl    | 16        | 16%     |
|        | Arch     | 50        | 50%     |
| Female | Loop     | 33        | 33%     |
|        | Whorl    | 18        | 18%     |
|        | Arch     | 49        | 49%     |

Table 9 represents the frequency and percentage of the left ring of each gender. This table shows that among males, the arch pattern dominates the left ring which was observed in 50 individuals. Followed by the loop pattern, which was observed in 34 individuals, and the least-seemed pattern is the whorl pattern, and it is

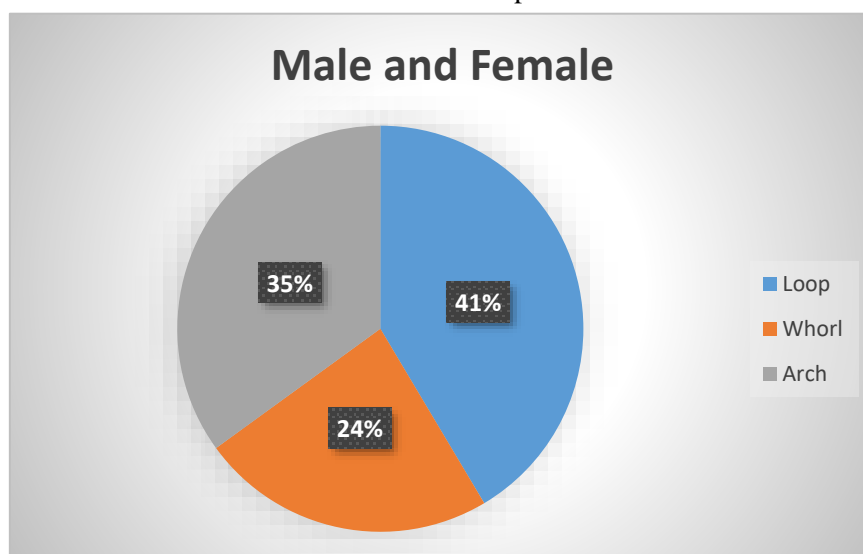
observed in 16 individuals among 100. In females, the arch pattern is the most dominant, observed in 49 individuals, followed by the loop pattern, observed in 33 individuals, and the least-seen pattern is the whorl pattern, which is observed in 18 individuals among 100.

**Table 10: Frequency of different toe print patterns of left little**

| Gender | Patterns | Frequency | Percent |
|--------|----------|-----------|---------|
| Male   | Loop     | 17        | 17%     |
|        | Whorl    | 10        | 10%     |
|        | Arch     | 73        | 73%     |
| Female | Loop     | 20        | 20%     |
|        | Whorl    | 4         | 4%      |
|        | Arch     | 76        | 76%     |

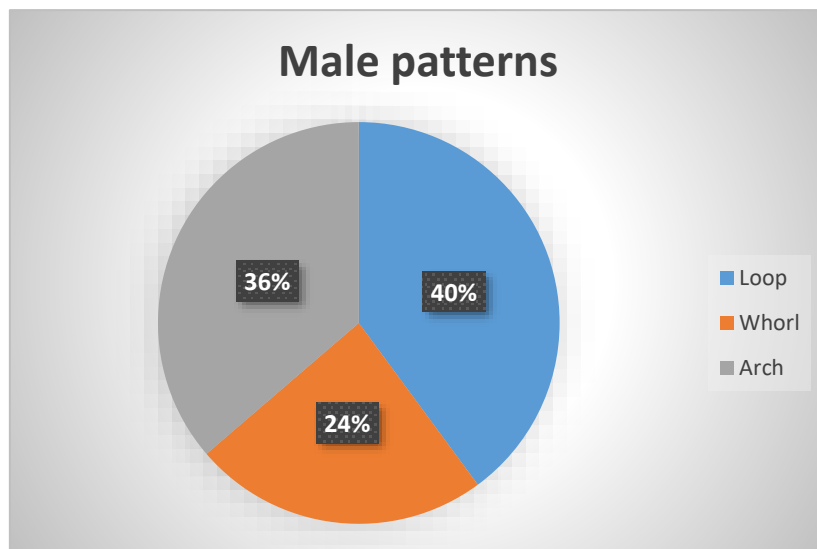
Table 10 represents the frequency and percentage of the left little of each gender. This table shows that among males, the arch pattern dominates the left little which was observed in 73 individuals. Followed by the loop pattern, which was observed in 17 individuals, and the least-seemed pattern is the whorl pattern, and it is observed in 10 individuals among 100. In females, the arch pattern is the most dominant, observed in 76 individuals, followed by the loop pattern, observed in 20 individuals, and the least-seen pattern is the whorl pattern, which is observed in 4 individuals only among 100. In this research the most dominant pattern in both genders are loop patterns. There are total of 829 loop patterns are present followed by 700 arch patterns and 471 whorl patterns are present. Males have total of 399 loop pattern followed by 363 arch pattern and 238 whorl patterns and female have 430 loop patterns followed by 337 whorl pattern and 233 arch patterns are present.

- The dominant pattern in male right thumb is loop pattern – 63%
- The dominant pattern in male right index is loop pattern – 55%
- The dominant pattern in male right middle is whorl pattern – 51%
- The dominant pattern in male right ring is arch pattern – 43%
- The dominant pattern in male right little is arch pattern – 79%
- The dominant pattern in male left thumb is loop pattern – 63%
- The dominant pattern in male left index is loop pattern – 61%
- The dominant pattern in male left middle is whorl pattern – 57%
- The dominant pattern in male left ring is arch pattern – 50%
- The dominant pattern in male left little is arch pattern – 73%
- The dominant pattern in female right thumb is loop pattern – 69%
- The dominant pattern in female right index is loop pattern – 62%
- The dominant pattern in female right middle is whorl pattern – 52%
- The dominant patterns in female right ring are loop and arch patterns – 43%
- The dominant pattern in female right little is arch pattern – 79%
- The dominant pattern in female left thumb is loop pattern – 72%
- The dominant pattern in female left index is loop pattern – 47%
- The dominant pattern in female left middle is whorl pattern – 55%
- The dominant pattern in female left ring is arch pattern – 49%
- The dominant pattern in female left little is arch pattern – 76%



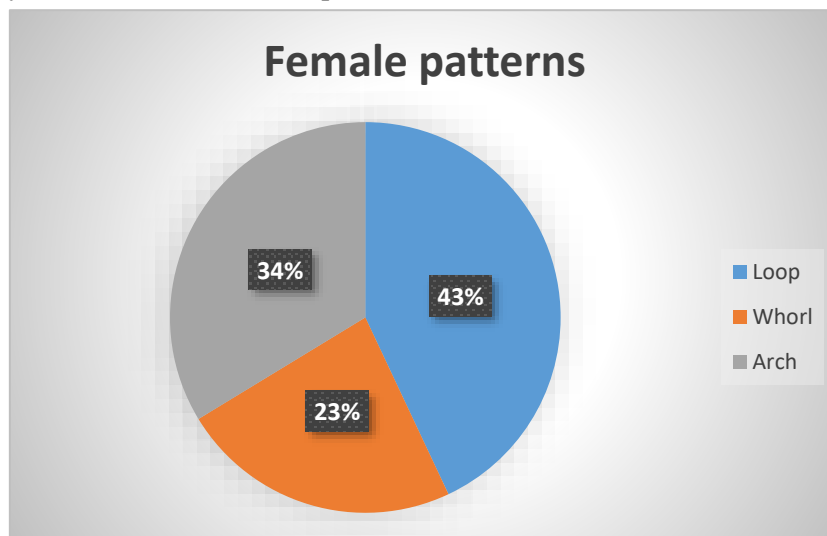
Graph 1: The graph represented that, in both males and females 41% loop patterns are seen followed by

arch pattern, 35% and at last whorl pattern 24%. So, in both gender loop pattern is more dominant.



**Graph 2:** The graph represented the frequency of each pattern in males. Loop pattern is seen more dominant 40% and followed by arch 36% and then whorl pattern

24%. So, most dominant pattern in male is loop pattern.



**Graph 3:** The graph represented the frequency of each pattern in females. Loop pattern is seen more dominant 43% and followed by arch 34% and then whorl pattern 23%. So, most dominant pattern in female is loop pattern.

## DISCUSSION

The findings of the study indicated that the loop pattern is the most dominant pattern in both genders. There are total of 829 loop patterns are present the total samples followed by 700 arch pattern and at last 471 whorl patterns are present. The loop patterns are mostly observed in thumb and index finger of both right and left in males and females. The whorl patterns are commonly seen only in middle finger of left and right in males and females. The arch patterns are seen

in the ring and index fingers but most commonly seen little finger. Arch pattern in little finger is above 75% of both genders. The early research paper related to comparison of Toe print patterns from different region that are “Analysis of Finger and Toe Prints and their Corresponding Correlations in the Anioma People of Nigeria” This study also indicated that the most predominant pattern on both males and females is loop pattern followed by arch and then whorl pattern [2]. Another study “Experimental Analysis of Toe Print Class Distribution in Caucasian and Lepers” indicated that the loop pattern was more dominant followed by whorl, then arch and tented arch [6]. Another study on blind and non- blind students would indicate that the, in blind subjects, distal loop more frequent in right foot and the whorl pattern was less

common. Non-blind subjects show higher distal loop and fibular loop more dominant on the right foot and arches and whorl were more frequent on the left foot [7]. Another study that was “A comparative sex wise study of fingerprints in relation to toe prints” given the result that the in fingerprint and toe print loop patterns are more dominant but in the case of fingerprint second one was whorl pattern and followed by arch pattern and in toe prints second dominant will be arch pattern and then whorl pattern [8]. A study related to arch pattern that was “The Arch Pattern Dermatoglyphics on the Toes of Hausa Ethni Group of Nigeria” indicated that the, arch pattern are more frequent on females (63%) right toe and less frequent in males (9.9%) [9].

## CONCLUSION

The comparative study on toe prints among males and females confirmed that the loop patterns are most dominant in males and females followed by arch pattern and then loop patterns. The loop patterns are commonly seen in thumb and index fingers, while whorl pattern is seen in middle finger only and the arch patterns are commonly seen in ring and little fingers. In little fingers of both right and left arch pattern are seen above 75%. This finding given a reference for the use of toe prints in various field including forensic field, biometric authentication, and also in medical identification. This will help in biometric authentication especially those who with different abilities. This work is a part of an expanding body of forensic biometric studies and provides avenues for incorporating toe print information into national identification schemes, supporting the accuracy and universal applicability of personal verification technologies

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**HOW TO CITE:** Aryananda K. \*, A Comparative Study on Toe Prints Among Males and Females, *Int. J. Sci. R. Tech.*, 2025, 2 (5), 161-168. <https://doi.org/10.5281/zenodo.15345880>