**Scholars Journal of Applied Medical Sciences**
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

**Health and Life Sciences**

# Gender Determination from Toe Print among Tagalog Population in Philippines for Crime Scene Application

Nataraja Moorthy, T[1*], Ivan Nikkimor, L. D[2], Sairah, A. K[3]

[1]Professor of Forensic Sciences, Faculty of Health and Life Sciences (FHLS), Management and Science University (MSU), Shah Alam, Selangor, Malaysia
[2]Master Student, FHLS, Management and Science University, Selangor, Malaysia
[3]Dean, Faculty of Health and Life Sciences, Management and Science University, Selangor, Malaysia

**DOI:** https://doi.org/10.36347/sjams.2024.v12i12.027 | **Received:** 14.11.2024 | **Accepted:** 18.12.2024 | **Published:** 24.12.2024

***Corresponding author:** Nataraja Moorthy, T
Professor of Forensic Sciences, Faculty of Health and Life Sciences (FHLS), Management and Science University (MSU), Shah Alam, Selangor, Malaysia

**Abstract** **Original Research Article**

***Background:*** Footprint forms valuable physical evidence left unintentionally by the offenders during crime operations as recovered at the crime scenes. Foot impressions are used to determine stature, body weight and gender during crime scene investigation. However, there are incidences wherein partial footprints, or toe prints, are found at the crime scenes, hence some investigators have neglected such prints. ***Aim:*** The present study aimed to examine the ridge density of toe prints of Tagalog people living in the Philippines for gender determination. ***Methodology****:* The study recruited 242 consented Tagalogs, including 109 males and 133 females, and their toe prints were collected, following the standard procedure. The ridge density of right and left side toe prints was calculated by "Acree's method". The data were analysed statistically by SPSS software version 26 and performed an independent T-test. The correlation between the toe regions was studied using the Pearson correlation coefficient (r). ***Result:*** The result demonstrated that the mean ridge density of females is comparatively higher than the mean ridge density of males in all toes. On the right side, maximum sex differences were reflected for the ridge density in the third toe print area, followed by the second toe, fourth toe, and fifth toe with minimum sex differences in the great toe. The left side reflected maximum sex differences for the ridge density in the fourth toe, followed by the great toe, second toe, and third toe with a minimum in the third toe. The results were presented in the form of tables and figures. ***Conclusion:*** The study provided valuable information for gender determination from toe prints for crime scene application. This finding cannot be generalized and used only for the Tagalog population in the Philippines.

**Keywords:** Forensic Anthropology, Gender, Toe print, Tagalogs, Philippines.



## INTRODUCTION

Identification of an individual is a mainstay in any forensic investigation [1]. Forensic crime scene investigators have shown that footprints are found almost at all crime scenes, and the investigator has to locate and identify the offenders [2-4]. Dermatoglyphics is the study of hand and foot impressions, used by anthropologists and forensic scientists for the inclusion and exclusion of suspects through analysis [5]. Forensic investigators employ fingerprints and footprints for person identification because friction ridge patterns are unique to an individual throughout their life [6]. The friction ridge density refers to the number of ridges in a defined region on a print or mark, influenced by ridge width and ridge spacing [7]. Foot and toe prints show individual characteristics and provide multiple pieces of information and hence may be used to identify victims and perpetrators regardless of complete or partial footprint [8, 9]. Additionally, footprints are helpful to determine stature [2], body weight [10] and gender [11] for crime scene application. There are incidences wherein partial footprints or toe prints are found at crime scenes, and again the investigators have simply neglected such prints, considered unfit for comparison [12]. However, unlike criminals who used to wear gloves to avoid their fingerprints, it is cumbersome to avoid leaving footprints at crime scenes when standing, walking, or running during their crime operations [13]. Some perpetrators forego wearing footwear during operations to reduce the noise while walking and improve their grip while scaling walls [14]. The footprint is tangible evidence that provides more data than a fingerprint, such as the number of people involved in a

crime, the perpetrator's activities, age, sex, stature, body weight, speed, and direction of his movement [15, 16].

The corresponding author (Prof. T. Nataraja Moorthy), formerly a Government Forensic Crime Scene Investigator in Tamil Nadu, India solved many crime scenes like homicide, burglary fire, bomb, suspicious death etc. and solved the crime through footprints found at the crime scenes [4, 17]. Hence, this study aimed to examine the toeprint ridge density for gender determination among the Tagalog population in the Philippines.

## MATERIALS & METHODS

The study recruited 242 consented healthy Philippine Tagalog volunteers, 109 males and 133 females. Excluded subjects with any orthopaedic deformity or injury from the study. Before starting the sample collection, the subjects cleaned their feet, and toe prints were collected on A4 size white papers using the 'inking technique,' using footprint ink following the standard procedure [9]. Figure 1 shows the toeprint and the designated areas for analysis.

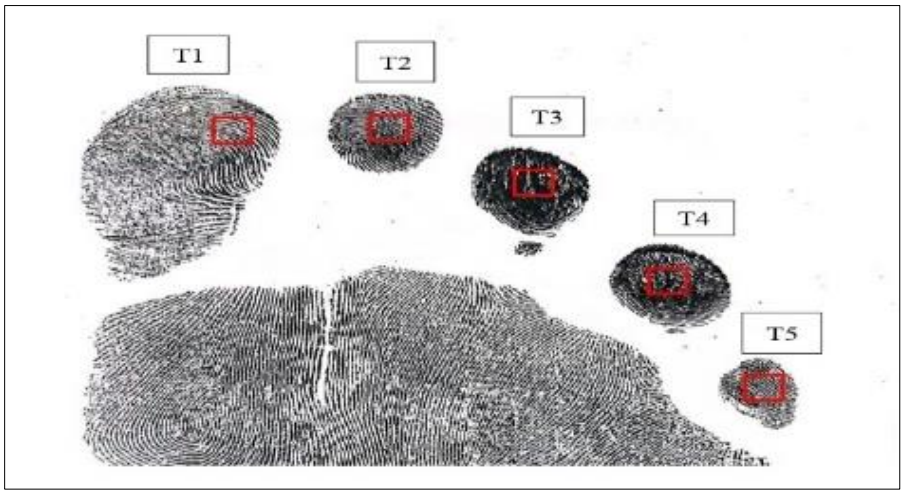


**Figure 1: The designated areas in toe prints for analysis**

The designated areas in a right toe print are named RT1 (great toe), RT2 (second toe), RT3 (third toe), RT4 (fourth toe) and T5 (little toe), and the left print as LT1, LT2, LT3, LT4 and LT5. The ridge densities were analysed as described by "Acree" [6]. A transparent film with a 5mm x 5mm square area was drawn on a clean film, placed on each area, counted the number of ridges within the area, and recorded for analysis.

## STATISTICAL ANALYSIS

The data were analysed statistically by SPSS software version 29 and an independent t-test to investigate the variations in each designated area. The correlation between the toe regions was studied using the Pearson correlation coefficient (r), and the findings were presented in tables and figures.

## RESULTS

Table 1 presents the ridge density of toe prints in males and females of the study population, including great toe (T1), second toe (T2), third toe (T3), fourth toe (T4) and fifth or little toe (T5) on both sides. The result demonstrated that the mean ridge density of females is comparatively higher than the mean ridge density of males in all toes.

**Table 1: Descriptive statistic of toe print ridge density (T1 to T5) on both sides among the Tagalog population**

| | Great toe (T1) | | Second toe (T2) | | Third toe (T3) | | Fourth toe (T4) | | Fifth toe (T5) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| **Right Side** | | | | | | | | | | |
| Mean | 11.80 | 15.65 | 10.84 | 14.98 | 10.82 | 15.03 | 10.54 | 14.74 | 9.88 | 13.47 |
| S.D. | 1.59 | 2.326 | 1.41 | 2.14 | 1.32 | 2.157 | 1.36 | 2.42 | 1.20 | 2.34 |
| Range | 9.14 | 11.22 | 9-14 | 10-24 | 9.14 | 10-22 | 9.14 | 10.23 | 9.14 | 10.19 |
| **Left Side** | | | | | | | | | | |
| Mean | 11.62 | 15.86 | 10.58 | 14.49 | 10.59 | 14.50 | 10.23 | 14.67 | 9.44 | 13.30 |
| S.D. | 1.37 | 2.27 | 1.36 | 2.20 | 1.30 | 2.36 | 1.15 | 2.15 | 0.75 | 2.81 |
| Range | 9.14 | 10.22 | 9-14 | 10-21 | 9.14 | 10.22 | 9-14 | 10.21 | 9.13 | 10.20 |

Table 2 shows the independent T-test used to determine the sex difference in toe prints ridge density. The result shows statistically significant sex differences in all toe prints. On the right side, maximum sex differences were reflected for the ridge density in the third toe print area, followed by the second toe, fourth toe, and fifth toe with minimum sex differences in the great toe. The left side reflected maximum sex differences for the ridge density in the fourth toe, followed by the great toe, second toe, and third toe with a minimum in the third toe.

**Table 2: Sex differences in toe prints ridge density using independent t-test.**

| | **Right side** | | **Left side** | |
|---|---|---|---|---|
| | ***t*-value** | ***p*-value** | ***t*-value** | ***p*-value** |
| Great toe | 14.727 | 0.000 | 17.130 | 0.000 |
| Second toe | 17.315 | 0.000 | 16.181 | 0.000 |
| Third toe | 17.838 | 0.000 | 15.456 | 0.000 |
| Fourth toe | 16.162 | 0.000 | 19.430 | 0.000 |
| Fifth toe | 15.045 | 0.000 | 13.926 | 0.000 |
| | **Right side** | | **Left side** | |
| | ***t*-value** | ***p*-value** | ***t*-value** | ***p*-value** |
| Great toe | 14.727 | 0.000 | 17.130 | 0.000 |
| Second toe | 17.315 | 0.000 | 16.181 | 0.000 |
| Third toe | 17.838 | 0.000 | 15.456 | 0.000 |
| Fourth toe | 16.162 | 0.000 | 19.430 | 0.000 |
| Fifth toe | 15.045 | 0.000 | 13.926 | 0.000 |

Figures 2 to 7 present the illustrative example of the frequency distribution of toe print ridge densities of great, third and fifth toes on the right and left sides. Again, the ridge density of females is higher than that of males in all toe prints. The mean ridge density difference in the great toe is found to be 3.50 (F15.65-M11.80), second toe 4,14 (F14.98-M10.84), third toe 4.21 (F15.03-M10.82), fourth toe 4.20 (F14.74-10.54) and little toe be 3.59 (F13.47-M9.88). Thus, in the Philippine Tagalog population, the sexual dimorphism was statistically significant in all toe prints.

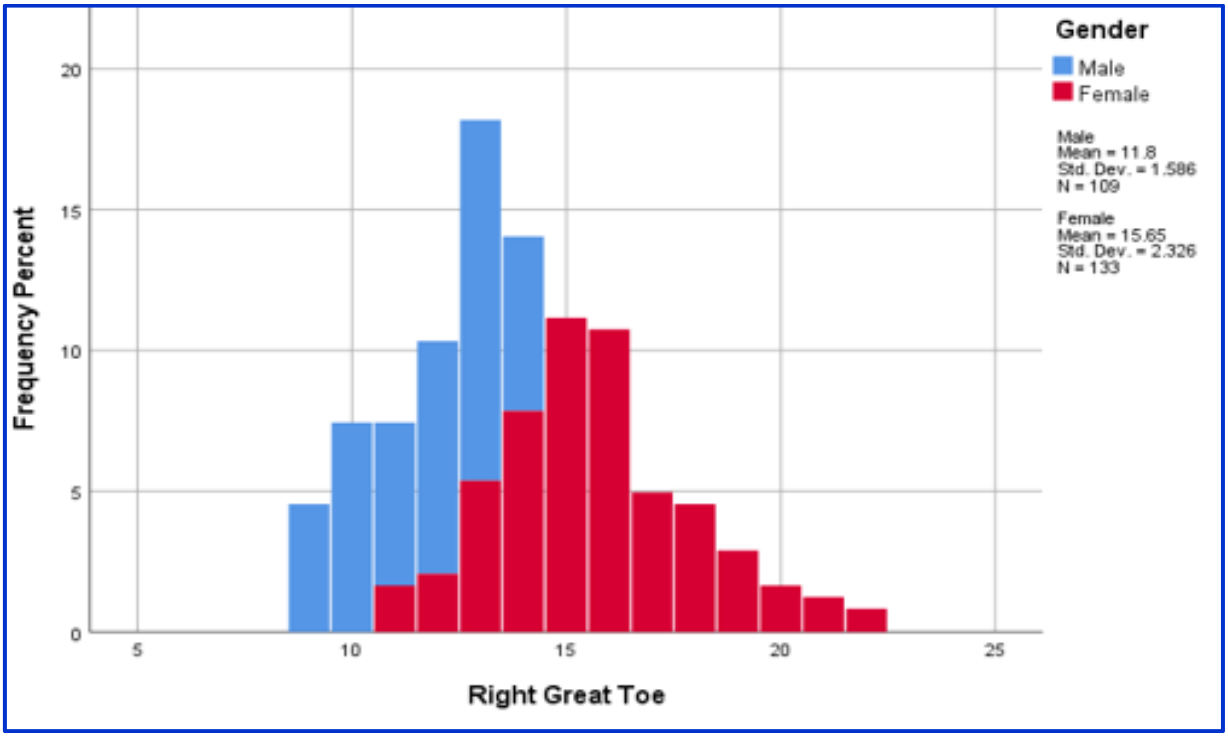


**Figure 2: Frequency of ridge density percent on right great toe among males and females**

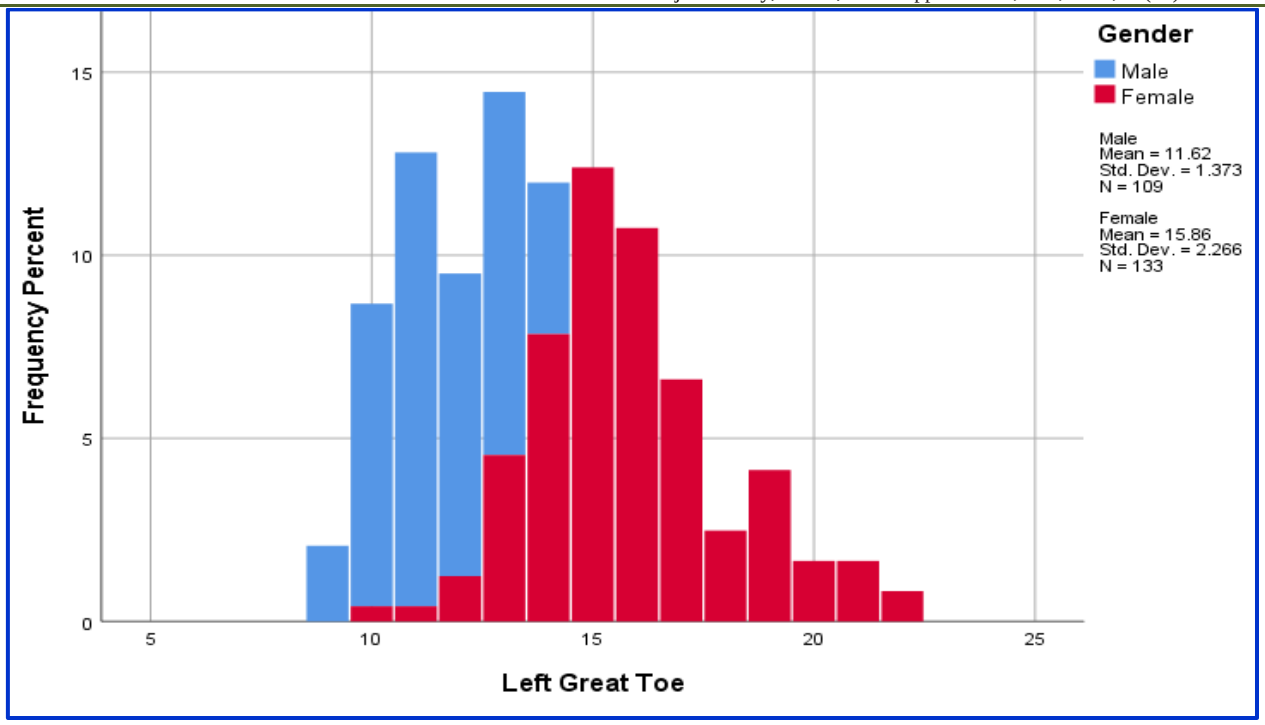


**Figure 3: Frequency of ridge density percent on left great toe among males and females.**

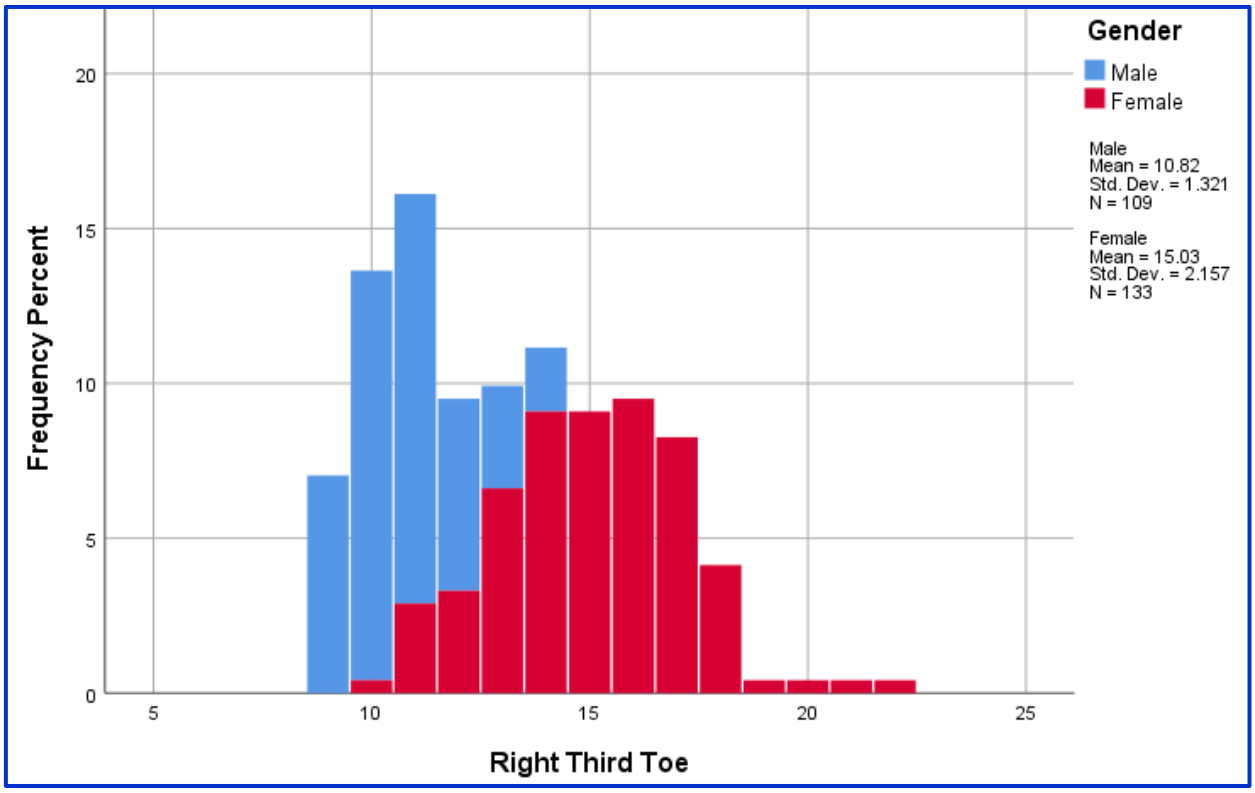


**Figure 4: Frequency of ridge density percent on right third toe among males and females**

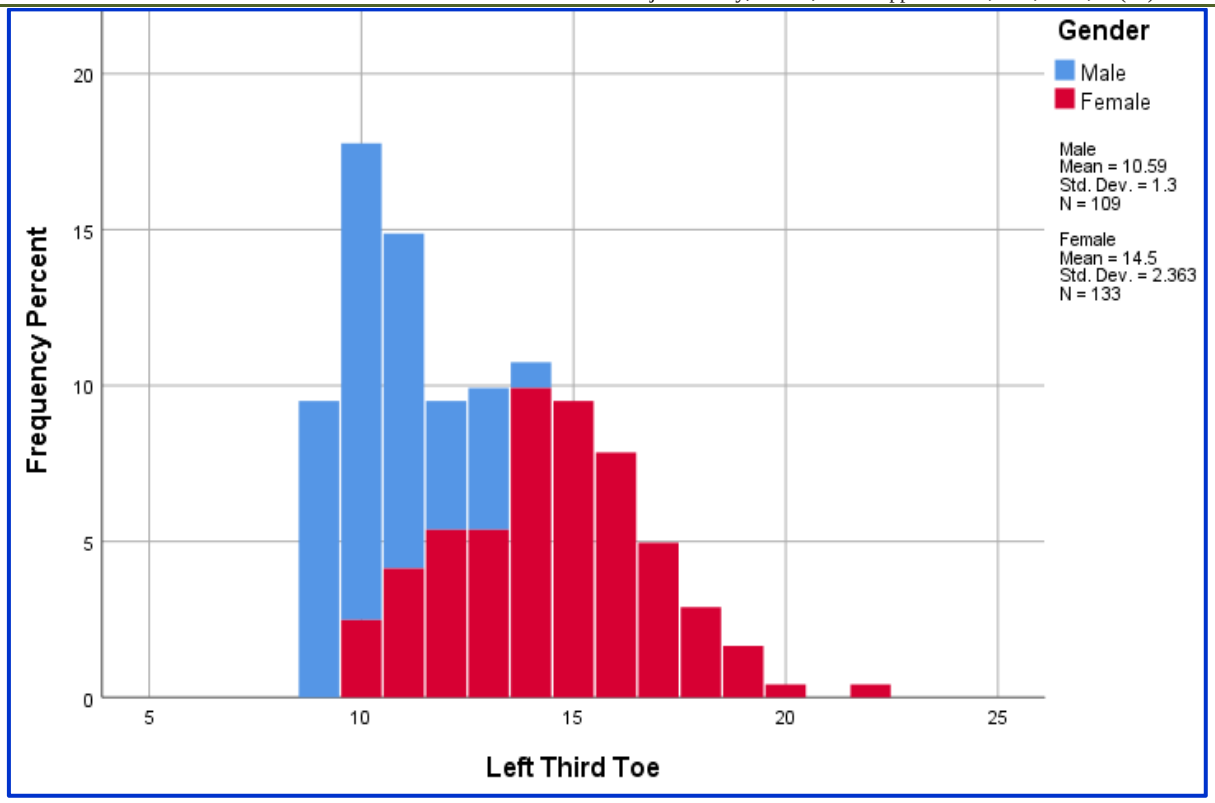


**Figure 5: Frequency of ridge density percent on left third toe among males and females**

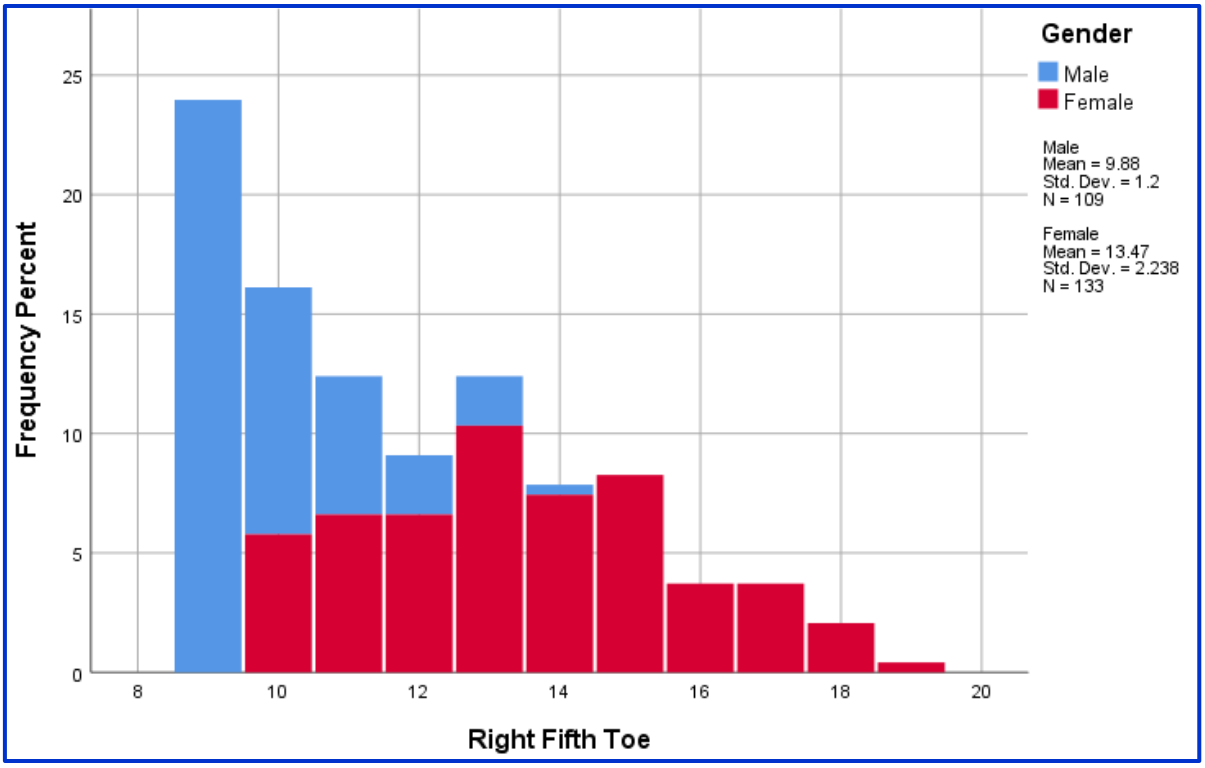


**Figure 6: Frequency of ridge density percent on right fifth toe among males and females**

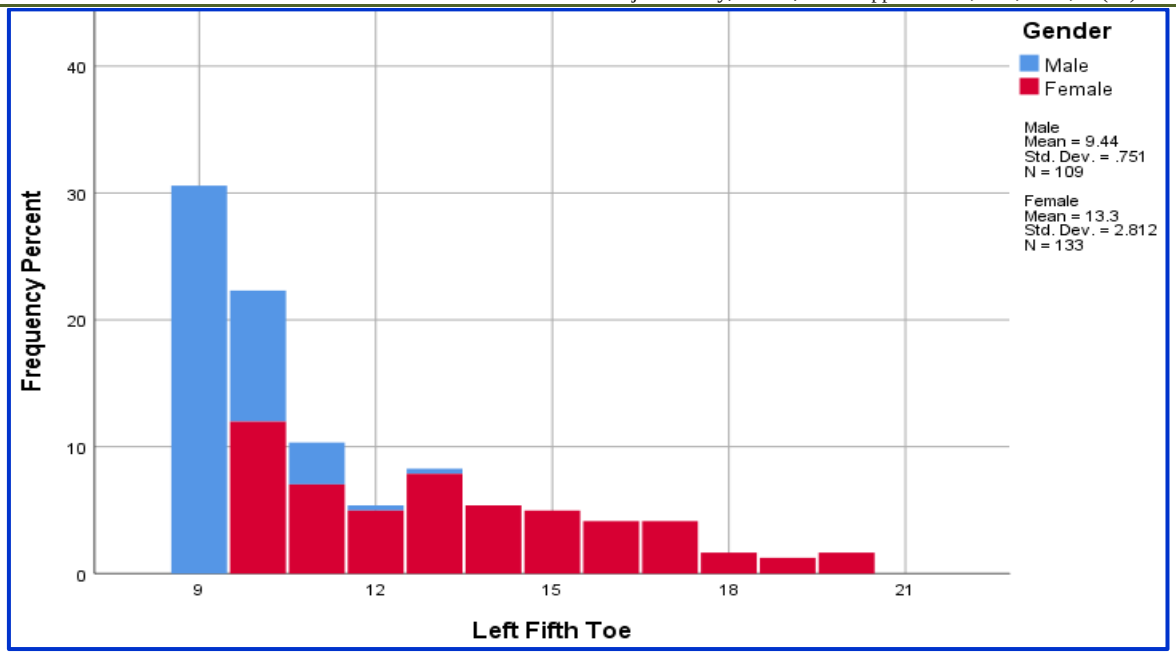


**Figure 7: Frequency of ridge density percent on left fifth toe among males and females**

## DISCUSSION

The Philippines country has culturally and ethnically diverse people living happily, and Tagalog is one of the largest ethnic groups, with 28% of the total population. Most of them follow Christianity which is the national religion [18]. One of the valuable physical evidence that a suspect leaves unintentionally at a crime scene is the footprint or sometimes, toe prints.

**Table 3: Variation of mean great toe ridge density among selected populations**

| Ethnic groups | Right side | | Left side | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| Tagalog | 11.80 | 15.65 | 11.62 | 15.86 |
| Indian [7] | 10.40 | 11.30 | 10.20 | 11.20 |
| Melanau [24] | 12.94 | 14.28 | 12.96 | 14.35 |
| Bidayuh [9] | 12.80 | 14.33 | 12.80 | 14.33 |
| South African [23] | 10.06 | 10.82 | 10.56 | 10.94 |
| Malays [25] | 12.47 | 14.58 | 12.83 | 14.45 |

Table 3 shows great toe ridge density variation between the present study population and other populations living in India, Malaysia, and South Africa. The mean ridge density of the Melanau and Bidayuh populations is comparatively higher than the present Tagalog population. In contrast, the mean great toe ridge density of Indian and South African people was lower than the Tagalog population in the Philippines.

Dermatoglyphic characteristics studies on fingers and palms found many in the literature [19, 20]. However limited footprint ridge density studies were conducted on the Philippines population for use in crime scene investigation [21, 22]. Researchers have used only the 'great toe' for gender determination, ignoring the other four toes. As a field criminalist, the corresponding author noticed only toe prints at crime scenes [3, 26, 27]. Sometimes, the presence of five-toe prints, four-toe prints, three-toe prints, or even two-toe prints depends upon the circumstances of the crime operations. Thus, the present study used all toes for analysis and hence even the presence of a single toeprint at the crime scene is enough for gender determination. The toe print ridge density of the Tagalog population is different from other populations, reflecting ethnic variation.

## CONCLUSION

The present study concluded that the ridge density study on the Tagalog population in the Philippines provided valuable information for gender determination from toe prints. This finding cannot be generalized but different from other populations. The conclusions would give the crime scene investigators confidence that even the presence of any one of the toes is helpful to determine the gender for comparison with suspects and then person identification.

## REFERENCES


1. Nataraja Moorthy, T., & Siti Fatimah, S. (2015). Individual characteristics of footprints in Malaysian Malays for person identification in forensic perspective. *Egypt J Foren Sci*, 5, 13-22.
2. Nataraja Moorthy, T., Ahmad Mustaqqim, M., Boominathan, R., & Raman, N. (2014). Stature estimation from footprint measurements in Indian Tamils by regression analysis. *Egypt J Foren Sci*, 4, 7-16.
3. Nataraja Moorthy, T., Nadiah, S., Sivadurai, S. N., & Saravanan, K. (2022). Revenue Divisional Officer's inquiry on a newly-wed woman's disputed death. Toe impression indicated the cause of death. *GAP India J Foren Behav Sci*, *3*(1), 14-17.
4. Nataraja Moorthy, T. (2019). Footprint evidence solved the mystery in a suspicious death: A rare case report. *Peer Review J Forensic Genet Sci*, *3*(2), 183-185.
5. Namouchi. (2011). Anthropological significance of dermatoglyphic trait variation: An intra-Tunisian population analysis. *Int J Mod Anthrop*, 4, 12-17.
6. Acree, M. A. (1999). Is there a gender difference in fingerprint density? *Foren Sci Int*, 102, 35-44.
7. Kanchan, T., Krishan, K., Aparna, R., & Shyamsundar, S. (2012). Footprint ridge density: a new attribute for sexual dimorphism. *HOMO- J Comp Human Biol*, *63*(6), 468-480.
8. Nataraja Moorthy, T., & Hairunnisa, M. A. K. (2018). Sex determination from footprint ridge density in Bidayuh population in Malaysian Borneo. *Int J Med Tox Leg Med*, *2*1(3-4): 158-161.
9. Nataraja Moorthy, T., Hairunnisa, M. A. K., & Collin, B. (2021). Sexual dimorphism in toe prints among Bidayuhs of Malaysian Borneo for crime scene application. *J Manage Sci*, *19*(1), 62-69.
10. Nataraja Moorthy, T., & Hairunnisa, M. A. K. (2017). Determination of body weight from footprint length measurements among Melanau population in Malaysia. *Med Leg update*, *1*(2), 1-7.
11. Nataraja Moorthy, T., & Hairunnisa, M. A. K. (2020). Gender variation from footprint ridge density among Lun Bawangs of Malaysian Borneo for crime scene investigation. *Int J Med Tox & Leg Med*, *23*(3-4), 69-75.
12. Nataraja Moorthy, T. (2017). Neglected physical evidence during crime scene investigation. *Foren Sci Addic Res*, *1*(2), 1-2.
13. Nataraja Moorthy, T., Inthira, S., Sairah, A. K., & Ahmad, S. (2018). Individual characteristics of footprints among Malaysia Indians for person identification in a forensic perspective. *Int J Med Tox & Leg Med*, *21*(3-4), 187-189.
14. Nataraja Moorthy, T., Khairulmazidah, M., Mohamad Hadzri, Y., & Jayaprakash. (2011). Estimation of stature based on foot length of Malays in Malaysia. *Australia J Foren Sci*, *43*(1), 13-26.
15. Nataraja Moorthy, T., Ang, Y. L., Saufee, A. S., & Nik, F. (2014). Estimation of stature from footprint and foot outline measurements in Malaysian Chinese. *Australia J Foren Sci*, *46*(2), 136-159.
16. Naples, V. L., & Miller, J. S. (2004). Marking tracks: the forensic analysis of footprint and footwear impression. *Anato Rec. B New Anato*, 279, 9-15.
17. Nataraja Moorthy, T., & Baskaran, M. (2021). Footprint-based gait analysis in a homicide case-Identified the culprit as the wife of the deceased, also the complainant: Challenging forensic podiatry crime scene report. *Scholars Int J Law Crime Jusrice*, *4*(3), 166-169.
18. Sharma, C, L. (1979). Ethnicity and education in the Philippines. *Philippine Social Review*, *27*(2), 117-129.
19. Bibha, K., & Eugene, K. (2012). Finger and Palmer dermatoglyphics in Muzeina Bodouin from South Sinai: A quantitative study. *Papers Anthrop*, XXI:110-122.
20. Offei, E. B., Abledu, J. K., Osabutey, C. K., & Kesse, D. K. (2014). Relationship between palmar dermatoglyphic pattern and academic performance of students in Ghanaian secondary school. *J Med Biomed Sci*, *3*(2), 24-31.
21. Nataraja Moorthy, T., Aidil Nur Liyana, M., Ivan Nikkimor, L. D., & Ariel Philip, I. P. (2021). Sexual dimorphism from fingerprint ridge density among Kagay-Anons of Philippines for forensic application. *Indian J Foren Sci Med Tox*, *15*(2), 1131-1137.
22. Nataraja Moorthy, T., Devina, K. D., Ivan Nikkimor, L. D., & Ariel Philip, I. P. (2021). Gender determination from toe prints among Kagay-Anons of Philippines for forensic application. *Indian J Foren Sci Mex Tox*, *15*(2), 1125-1130.
23. Healthfield. (2016). Comparison of footprint ridge density between two South African ethnic groups. *J Foren Inves*, *4*(4), 1- 4.
24. Nataraja Moorthy, T., & Hairunnisa, M. A. K. (2019). Gender variation from toe print ridge density among Melanau ethnic in Malaysia Borneo Island. *Int J Med Tox Leg Med*, *22*(1-2), 8-12.
25. Nataraja Moorthy, T., Nadiah, S., & Mohd Hadi, P. (2022). Sexual dimorphism from toe prints among Malaysian Malays for person identification. *J Krishna Inst Med Sci Univ*, *11*(1), 77-83.
26. Nataraja Moorthy, T. (2019). Footprint evidence solved the mystery in a suspicious death: A rare case report. *Peer Review J Foren Gene Sci*, *3*(2), 183-185.
27. Nataraja Moorthy, T. (2019). Malicious destruction of plantation and 3D footprint identified the perpetrator: A rare case report. *Foren Sci Addic Res*, *4*(3), 1-3.