

Forensic Application of Poroscopy: Determination of Age and Sex Through Sweat Pore Characteristics

Saba Noor¹, Amaan Amir^{1*}, Ravi Kumar²

¹M.Sc. Student, Department of Forensic Science, Teerthanker Mahaveer University, Moradabad, Uttar, Pradesh, India

²Head of Department, Department of Forensic Science, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

DOI: <https://doi.org/10.36348/sijap.2026.v09i02.002>

Received: 20.01.2026 | Accepted: 14.03.2026 | Published: 24.03.2026

*Corresponding author: Amaan Amir

M.Sc. Student, Department of Forensic Science, Teerthanker Mahaveer University, Moradabad, Uttar, Pradesh, India

Abstract

The fingerprint examination is one of the most reliable methods of personal identification in forensic science due to the uniqueness and permanence of friction ridge patterns. In addition to primary ridge characteristics and minutiae, microscopic features such as sweat pores (level 3 fingerprint details) provide valuable information for detailed Forensic analysis. The present study was conducted to evaluate the potential of sweat pores characteristics in determining the age and sex of individuals through Poroscopic examination of fingerprints. A total of 150 participants were included in the study and categorized into three different age groups, each consisting of 25 males and 25 females. The fingerprint samples collected from all participants were examined under a digital microscope at 50x magnification, and specific pore parameters such as pore size, pore shape, interspacing between pores, and pore density were analysed. The combined analysis of these pore parameters indicates that poroscopy can provide useful microscopic information that may assist forensic examiners in estimating the approximate age group and differentiating between individuals based on sweat pore characteristics.

Keywords: Poroscopy, Sweat pores, Forensic science, Personal identification, third level details.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC 4.0) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

Fingerprint examination has long been recognized as one of the most reliable and widely Accepted methods of personal identification in forensic science.[1] The uniqueness, permanence, And universality of friction ridge patterns make fingerprints a crucial form of physical evidence In criminal investigations.[2] Traditionally, fingerprint identification is based on the analysis of Ridge characteristics such as ridge endings, bifurcations, islands, and enclosures.[3] However, when Partial or fragmentary fingerprints are encountered at crime scenes, these primary ridge features May not always be sufficient for accurate identification.[4- 5] In such situations, the examination of Finer microscopic details of the friction ridge skin becomes highly valuable. One such advanced Method of analysis is poroscopy, which involves the study of the size, shape, number and Distribution of sweat pores present along the friction ridges.[6]

The scientific study of fingerprints is generally based on various ridge characteristics, which are

categorized into three hierarchical levels of detail, commonly known as Level 1, Level 2, and Level 3 fingerprint features.[7] Each level plays a crucial role in the fingerprint identification and comparison process during forensic investigations.

LEVEL 1 Fingerprint Features:

Level 1 features pertain to the overall flow of ridges and the general patterns of fingerprints, including arches, loops, and whorls, along with their variations. Additionally, these features encompass significant landmarks such as cores and deltas.[8] The details at Level 1 are primarily utilized for the classification and initial comparison of fingerprints, as seen in the Henry Classification System; however, they are inadequate for individual identification.

LEVEL 2 Fingerprint Features:

Level 2 features, often referred to as minutiae, consist of ridge characteristics including ridge endings, bifurcations, dots (islands), enclosures, bridges, and short ridges. The unique arrangement and spatial relationships of these minutiae are distinctive to each individual and serve as the fundamental basis for

fingerprint identification.[9] Forensic experts and Automated Fingerprint Identification Systems (AFIS) extensively employ these features for the comparison of latent and known fingerprints.

LEVEL 3 Fingerprint Features:

Level 3 features illustrate the microscopic details of the friction ridge structure, which include ridge edge shapes, ridge width, scars, incipient ridges, and sweat pores. Sweat pores are tiny openings of eccrine

glands situated along the ridges, responsible for secreting sweat that aids in the formation of latent fingerprints. Level 3 features are especially valuable when fingerprints are either partial or unclear, as they offer additional points of comparison for precise identification.[10] Among these microscopic characteristics, sweat pores hold considerable forensic significance due to the fact that their size, shape, position, and distribution can be scrutinized for identification purposes.

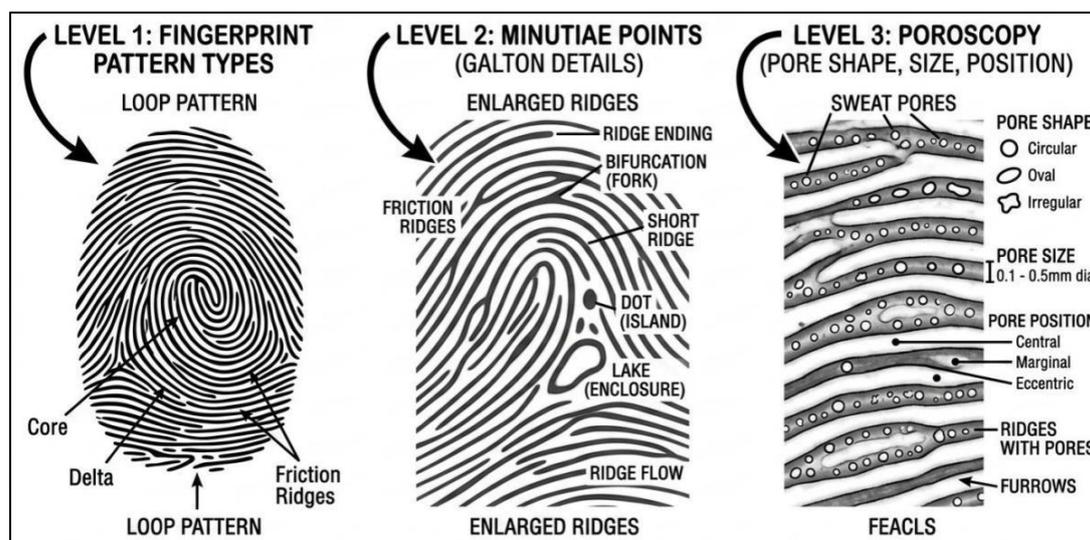


Figure 1: Levels of Fingerprint Features

Poroscopy was first introduced by Dr. Edmond Locard in 1912, who recognized that the arrangement and characteristics of sweat pores present on friction ridges are unique to every individual and remain relatively stable throughout life.[11] Sweat pores are minute openings of eccrine sweat glands located along the ridges of the epidermis. These pores play an essential role in the secretion of sweat, which contributes to the formation of latent fingerprints when the finger comes in contact with a surface. Under magnification, these pores appear as small openings on the ridge surface and their characteristics such as position, size, shape, and inter pore distance can be studied for forensic identification.[12]

Pore size:

The pore size refers to the diameter or width of the sweat pore opening present on the friction ridges of the skin. Under the microscope these pores appear as small circular or oval openings along with the ridge surface.[13] The average diameter of pore in human friction ridge skin ranges approximately from 80 μm to 250 μm . Variation in pore size may occur due to biological factors such as sex, age. Skin thickness and physiological conditions.

Pore shape:

The pore shape refers to the structural form or appearance of the sweat pore openings observed along

the friction ridges. When examined under the microscope, these may appear in various shapes such as circular, oval, or slightly elongated depending on the ridge structure and deposition of sweat.[14] Among these, the circular and oval shapes are most commonly observed in fingerprint examination.

Interspacing of pores:

the interspacing of pores are the distance between two adjacent sweat pores located along the friction ridges. These parameters indicates how closely or widely the pores are distributed on the ridge surface.[15] The typical interspacing between sweat pores generally ranges from approximately 200 μm to 500 μm along with the friction ridges. However the distance may vary among individuals depending on factors such as ridge width, skin structure, and glandular distribution.

Pore density:

the pore density refers to the number of sweat pores present within a defined area or a specific length of friction ridge. The pore density is commonly measured by counting the numbers of pores per square millimetre (pores/ mm^2) or number of pores per millimetre of ridge length (pores/mm).[16] In human fingerprints, the average pore density generally range from approximately 9-18 pores per millimetre of ridge length, although slight

variations may occur depending on individual, sex, and age group.

Over time, poroscopy has gained importance as a supplementary to conventional fingerprint examination, particularly in cases where only small fragments of ridge detail are available. The microscopic features of pores can provide additional points of comparison, thereby increasing the reliability of fingerprint identification.[17] With the advancement of imaging technologies and digital analysis, the study of sweat pore characteristics has also opened new possibilities in forensic research, including the potential use of pore features for demographic profiling, such as age and sex estimation.

Age and sex determination are important aspects of forensic identification especially in situations involving unknown individuals, disaster victim identification, or incomplete biological evidence. Traditionally, these determinations rely on skeletal analysis, dental examination, or DNA profiling. However recent studies suggest that certain morphological characteristics of friction ridge skin, including sweat pore density, size, and distribution, may exhibit variations associated with biological factors such as age and gender. For instance, physiological differences in skin structure, hormonal influences and glandular activity may lead to observable variations in pore The examination of sweat pores for age and sex estimation is still an emerging area of research in forensic science. [18-21] Understanding these variations can enhance the scope of fingerprint analysis beyond simple identification and contribute to the development of additional investigative tools. By analyzing parameters such as pore diameter, pore density, and spatial distribution, researchers aim to explore whether consistent patterns exist that can assist in differentiating individuals based on demographic characteristics.

Therefore, the present study focuses on the forensic significance of poroscopy in determining the age and sex of individuals through the analysis of sweat

pores present on friction ridges. By systematically examining pore characteristics from fingerprint samples belonging to individuals of different age groups and genders this research aims to evaluate whether measurable variations exist and assess their potential application in forensic investigations.[22] The finding of this study may contribute to the expanding role of microscopic fingerprint features in forensic identification and provide further insights into the scientific value of poroscopy in modern forensic practice.

MATERIALS & METHODS

The present research was conducted to evaluate the Forensic applicability of Poroscopy in determining the age and sex of individuals through the analysis of sweat pores characteristics present on friction ridges. The study was carried out in Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India, and involved the systematic collection of fingerprint samples from selected participants followed by microscopic examination and measurement of sweat pores characteristics. The collected data were analysed to identify possible variations in pore features among different age groups and between male and female individuals.

Selection of participants:

For the purpose of this study, a total of 150 participants were selected. The participants were chosen from different age groups and includes both male and female individuals in order to examine possible variations in sweat pores characteristics with respect to age and sex. The selected participants were categorised into three different age groups, and each category consists of 25 males and 25 females as:

- Category 1: Age group (18-28) 25 males and 25 females
- Category 2: age group (28-38) 25 males and 25 females
- Category 3: Age group (38-50) 25 males and 25 females

Table 1: Distribution of participants based on age group and sex

Categories	Age Group (Years)	Male Participants	Female Participants	Total Participants
Category 1	18-28	25	25	50
Category 2	28-38	25	25	50
Category 3	38-50	25	25	50
TOTAL		75	75	150

This categorization was designed to ensure a balanced representation of both sexes across different age ranges, allowing a comparative analysis of sweat pores characteristics. The individuals with visible injuries, scars, skin disease, or abnormalities on the fingers were excluded from the study to avoid any alteration in the natural structure of friction ridges and sweat pores. Prior to the collection of fingerprint

samples, the participants were informed about the purpose of the research, and their voluntary consent was obtained. All the Fingerprint samples collected during the study were used strictly for the academic and research purposes, and the identity of the participants was kept confidential.

Sample collection:

The collection of fingerprint samples was carried out under controlled conditions to ensure the clarity and accuracy of friction ridges and sweat pore details. Before collecting the fingerprints, each participant was instructed to wash their hands thoroughly with soap and distilled water to remove any dirt, grease, sweat residue or other contaminants that could interfere with the ridge patterns and sweat pores. After washing, the participants asked to dry their hands using a clean napkin to ensure that the fingers were free from moisture before the fingerprint impressions were taken.

For the recording of fingerprints, the rolled fingerprints was taken to obtain the complete ridge patterns of each finger to be captured clearly. All ten digit fingerprint of each participant were collected using a ten digit fingerprint collection form, in this method, each finger was gently placed on the fingerprint ink pad and then rolled from one side of the nail to the other ensured that the entire ridge pattern of the finger was transferred onto the form without distortion. Care was taken to apply uniform pressure while recording the Fingerprints in order to avoid smudging or overlapping of ridge details.



Figure 2: Collection of fingerprint samples from participant

The collected Fingerprint samples were then used for microscopic examination and Poroscopic analysis, where sweat pore characteristics such as pore density, pore size, pore Shape and interspacing were studied for the determination of age and sex difference among the participants.

Sample observation:

After the successful collection of fingerprint samples, the obtained impressions were subjected to detailed observation for the analysis of sweat pores characteristics. The examination of fingerprints was carried out using a digital microscope at a magnification of 50x, which allow the clear visualization of the microscopic level 3 fingerprint features. During the observation process, each fingerprint sample was carefully placed under the digital microscope and examined systematically. Special attention given to the region near the core of the fingerprint patterns, as this area generally contains well defined and stable ridge structures, selecting a similar region in each fingerprint helped to maintain uniformity and reliability in the observations.

Table 2: Parameters selected for analysis

Parameters	Denoted By
Pore size	P1
Pore shape	P2
Interspacing of pores	P3
Pore density	P4

These pores were carefully identified and marked within the selected ridge areas near the core in order to observe their characteristics clearly. The marking of pores helped in identifying variations and changes in pore structure, particularly distinguishing between open and closed pores. The marked pores and their observed chrematistics were carefully documented for each fingerprint sample. These observations formed the basis for further comparison and analysis of pore properties among individuals belonging to different age groups and sexes, which contributed to evaluation of Poroscopy as a potential tool for Forensic age and sex determination.

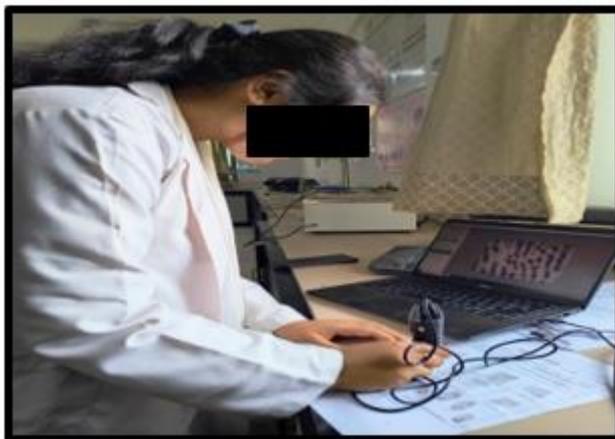


Figure 3: Observation of collected Fingerprints using microscope at 50x magnification

RESULT

The present study was conducted to evaluate the potential of sweat pores characteristics in determining the age and sex of individuals through Poroscopic examination of fingerprints. A total of 150 participants were included in the study and categorized into three different age groups, each consisting of 25 males and 25 females. The fingerprint samples collected from all participants were examined under a digital microscope at 50x magnification, and specific pore parameters such as pore size, pore shape, interspacing between pores, and pore density were analysed.

Parameter 1: size of pores

The analysis of pore size revealed observable differences among the different age groups and between male and female participants. In general the male participants exhibits comparatively larger pore diameter than female participants. Additionally, variations in pore size were observed across three age categories. The participants belonging to the younger age group (18-28years) generally showed relatively smaller pore size i.e (0.045mm) as compared to the individuals in higher age group. Followed by the second age category (28-38years), the average pore size increased to 0.049mm, suggesting a moderate increase in pore diameter with increase age. Further observation in third age category (38-50years) showed a higher average pore size is approximately 0.058mm. this indicates the individuals belonging to the higher age group exhibits relatively larger pore openings compared to those in the younger age groups. This variation may be attributed to physiological changes in skin structure and glandular activity that occur with increasing age.

Parameter 2: Shape of pores

During microscopic examination, sweat pores appeared in different shapes, primarily in circular, elliptical and irregular form. Most of the pores observed in the fingerprint samples exhibited circular shapes followed by elliptical and irregular depending on the ridge structure and deposition of sweat. In the first age

category (18-28years) the majority of the pores were observed to be circular in shape, accounting for approximately 82% of the total pores examined. Elliptical pores constituted around 14%, while irregular pores were relatively less common, representing about 4% of the observed pores. In second age category (28-38 years), circular pores remained most commonly observed type, although their proportion slightly decreases to 72%. The percentage of the elliptical pores increased to approximately 20%, while irregular pores accounted for about 8% of the total pores observed. In third age category (38- 50years), a further change in pore shape distribution was observed. Circular pores constituted around 60% of the total pores examined, while elliptical pores increased to approximately 25%. Additionally, irregular pores were observed in about 15% of the sample, this indicates a noticeable increase in elliptical and irregular pore shape in the higher age group.

Parameter 3: Interspacing of pores

The interspacing between adjacent pores was another important parameter examined during the study. Inter-pore distance was measured by observing the spacing between two successive pores along the friction ridges. The result indicated that inter-pore spacing varied among individuals and age groups. In several samples, males demonstrated slightly greater inter-pore distances compared to females. Minor difference were observed among the age groups, where the spacing between pores appeared to decrease slightly with age. In the first age category (18- 28years), the average inter-pore distance was observed to be approximately 0.46mm, indicating comparatively wider spacing between adjacent pores in the younger age group. In second age category (28-38 years), the average interspacing between pores was found to be 0.42mm. while on the observation of third age category (38-50years) revealed an average inter-pore distance of approximately 0.39mm. this indicates relatively closer spacing between pores in individuals belonging to the higher age group.

Parameter 4: Pore density

The result showed notifiable difference in pore density between male and female participants. In general, female participants demonstrated relatively higher pore density, meaning a greater number of pores were observed within the same ridge length when compared to males. In the first age category (18-28years), the average pore density was observed to be approximately 94 pores/cm², relatively higher

concentration of sweat pores in the younger age group. In the second age category 28-38years, the average pore density decreased to approximately 82 pores/cm². Further observation in third age category 38-50years), showed a lower average pore density of approximately 68 pores/cm². This suggest that the individuals belonging to the higher age group exhibited comparatively fewer pores within the same ridge area.

Table 3: Summarizes average pore characteristics across age categories

PARAMETERS	18-28yrs	28-38yrs	38-50yrs
Mean pore size(mm)	0.045mm	0.049mm	0.058mm
Shape (%circular pores)	82%	72%	60%
Interspacing(mm)	0.46mm	0.42mm	0.39mm
Pore density(pores/cm ²)	94pores/cm ²	82pores/cm ²	68pores/cm ²

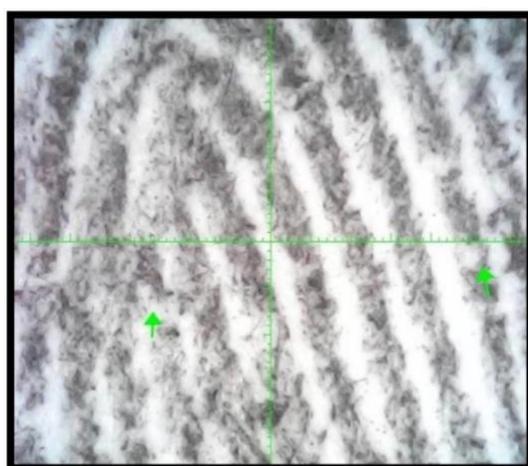
Age Determination from Pores

In the current research, it was observed that visibility and transparency of sweat pores on the Friction ridge skin significantly reduced with age. This reduction can be attributed to a variety of Physiological changes associated with aging, such as reduced activity of the sweat glands, Alterations in the dermal structure, and reduced skin flexibility. These changes can potentially Distort or blur the features of the pores and lose their clarity in the prints. In the 18–28 years age Group, sweat pores are very visible and distinct because of maximum skin hydration, elasticity, And functional sweat gland activity, and poroscopy is extremely effective for identification. In the 28–38 years group, initial signs of pore deterioration may start to show, but the clarity is usually Good enough for effective forensic analysis. Yet, at the age range of 38–50 years, more pronounced Aging effects e.g., diminished sweat secretion and structural skin alterations also lead to less Defined and more uneven pore appearances. Thus, the subject's age can significantly affect the Effectiveness of poroscopy as a

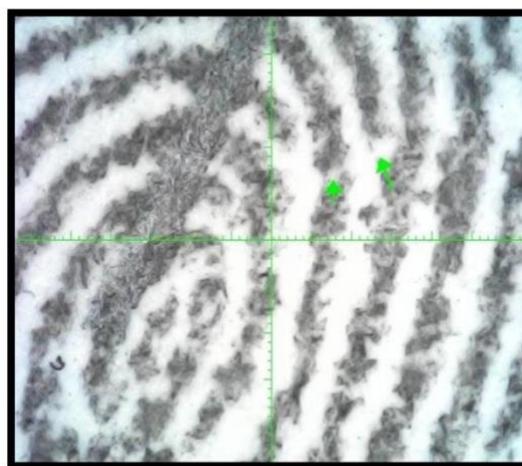
forensic method, especially when analyzing individuals over 38 Years of age, whose sweat pore characteristics are more challenging to properly observe and Analyze.

Sexual Dimorphism from Pores

In this study, it was shown that women's fingerprint ridges had more sweat pores than men's. Apart From to having a higher overall number of pores, the analysis showed that women had a much Higher number of open, visible sweat pores. The study points to a possible biological or Physiological difference in the sexes' skin types, which could be impacted by things like hormonal Variations or skin texture. When gender discrimination is needed based on fingerprint data, these Differences in pore appearance may have significant effects on how poroscopy is used in forensic Investigations. Poroscopic analysis may be accurate in identifying people from fragmentary or Ambiguous fingerprints if female participants consistently have more open pores.



Male participant



Female participant

Figure 4: Photomicrographs captured by digital microscope at 50x magnification showing the sweat pores of male and female participants of category 1

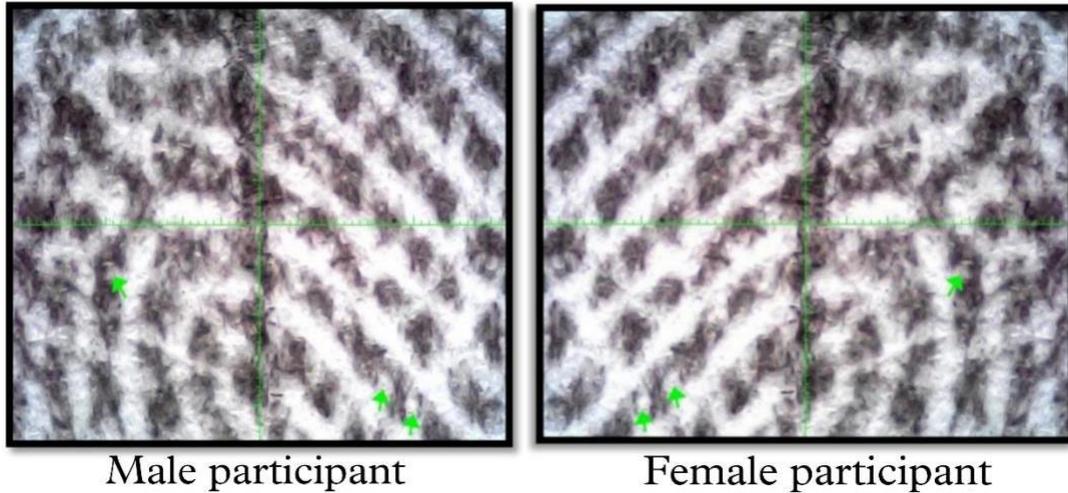


Figure 5: Photomicrographs captured by digital microscope at 50x magnification showing the sweat pores of male and female participants of category 2

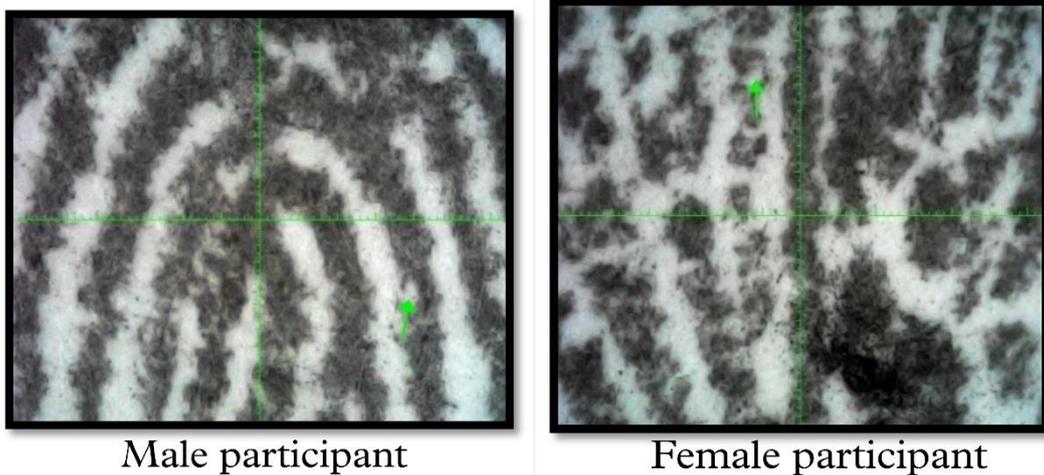


Figure 6: Photomicrographs captured by digital microscope at 50x magnification showing the sweat pores of male and female participants of category 3.

DISCUSSION

The current study aimed to assess the forensic relevance of poroscopy in determining the age and sex of individuals by analyzing the characteristics of sweat pores found on friction ridges. Poroscopy, which was introduced by Dr. Edmond Locard in 1912, entails a thorough examination of sweat pores that represent Level 3 fingerprint features. These microscopic characteristics are deemed significant in forensic science as they offer additional identifying traits when Level 1 and Level 2 features are inadequate or ambiguous. In this research, four primary pore parameters size, shape, interspacing, and density were analysed to evaluate their potential correlation with age and sex. The findings from this study reveal significant differences in sweat pore characteristics across various age groups, suggesting that certain pore parameters may be affected by physiological changes in the skin over time.

A key observation from this research was the variation in pore size among different age groups. The results indicated that the average pore size progressively increased with age, with individuals in the 18–28 years age group showing an average pore size of 0.42 mm, followed by 0.49 mm in the 28–38 years age group, and 0.58 mm in the 38–50 years age group. This gradual increase in pore diameter with age may be linked to age-related alterations in skin elasticity, collagen structure, and glandular function. As the skin ages, the structural integrity of the epidermal layer tends to diminish, potentially causing the openings of sweat glands to appear somewhat enlarged. These results support the notion that pore size could be a crucial parameter in age estimation through Poroscopic analysis. The investigation into pore shape has uncovered significant differences among the various age groups studied. The predominant shape of pores identified across all categories was circular, which is recognized as the most

prevalent morphological type of sweat pores found on friction ridges. In the youngest demographic (18–28 years), circular pores comprised 82%, elliptical pores made up 14%, and irregular pores accounted for 4%. Nevertheless, with advancing age, the proportion of circular pores steadily diminished, while the percentages of elliptical and irregular pores increased. In the 28–38 years age group, circular pores represented 72%, elliptical pores constituted 20%, and irregular pores reached 8%. In the subsequent age group of 38–50 years, circular pores decreased to 60%, whereas elliptical pores rose to 25% and irregular pores to 15%. These findings imply that pore morphology may experience subtle structural alterations with age, potentially due to changes in ridge elasticity and skin texture. Consequently, the examination of pore shape can provide valuable supplementary insights during Poroscopic evaluations.

Another critical aspect assessed in this study was the interspacing of pores, defined as the distance between two neighboring pores along the friction ridge. The findings revealed that the average distance between pores gradually lessened with increasing age. The youngest cohort (18–28 years) demonstrated an average interspacing of 0.46 mm, while the 28–38 years age group showed 0.42 mm, and the 38–50 years age group recorded 0.39 mm. The decrease in inter-pore spacing may be associated with alterations in ridge structure and skin elasticity that accompany aging. As the friction ridge skin experiences gradual physiological changes, the configuration of pores along the ridges may appear to be relatively closer together. These results suggest that pore interspacing may offer additional insights for distinguishing between age groups in Poroscopic assessments.

The analysis of pore density further corroborated the impact of age on the characteristics of sweat pores. The findings indicated that the highest pore density was found in the younger demographic, while a gradual decline was noted in older age brackets. Individuals aged 18–28 years demonstrated an average pore density of 94 pores/cm², in contrast to the 28–38 years group which showed 82 pores/cm², and the 38–50 years group that exhibited 68 pores/cm². The reduction in pore density with advancing age may be linked to age-related physiological alterations in skin structure, glandular activity, and ridge morphology. Typically, younger skin has more active sweat glands and denser ridge structures, which may lead to a greater concentration of visible pores within a specified area.

When all the parameters analysed in this research are taken into account collectively, the results reveal a distinct trend of age-related variation in sweat pore characteristics. Younger individuals generally display smaller pore sizes, wider inter-pore distances, higher pore density, and predominantly circular pore shapes, while older individuals tend to have larger pore

sizes, relatively closer pore spacing, lower pore density, and a greater occurrence of elliptical and irregular pore shapes. These trends imply that the microscopic characteristics of sweat pores are affected by physiological changes that occur in the skin over time. From a forensic standpoint, these results underscore the potential value of Poroscopic analysis as a supplementary method for demographic estimation, especially in cases where fingerprint evidence is limited. Although the characteristics of sweat pores alone may not yield definitive conclusions regarding age or sex, the observed differences in pore parameters can aid forensic analysts in refining the possible age range of an individual and may provide additional insights during fingerprint analysis.

Consequently, this study endorses the perspective that poroscopy can broaden the horizons of fingerprint analysis beyond mere identification, offering significant microscopic details that could aid in forensic investigations. Through the examination of factors such as pore size, pore shape, pore interspacing, and pore density, forensic scientists can acquire a more profound understanding of the connection between sweat pore features and biological elements like age and sex. Additional research involving larger sample sizes and enhanced imaging methods may contribute to reinforcing the dependability of these findings and extending the forensic uses of Poroscopic research.

CONCLUSION

The present study was undertaken to explore the potential of Poroscopy in the determination of age and sex through the analysis of sweat pore characteristics present on friction ridges. The findings suggest that sweat pore characteristics exhibited observable variation with age. Which may be associated with physiological and structural changes in the skin over time. The combined analysis of these pores parameters indicates that Poroscopy can provide useful microscopic information that may assist Forensic examiners in estimating the approximate age group and differentiating between individuals based on sweat pores characteristics. Although Poroscopy alone may not provide absolute determination of age or sex. The result of this study demonstrated that sweat pore analysis can serve as a valuable supplementary tool in forensic identification. When used alongside other fingerprint features and forensic methods. Poroscopic analysis may enhance the accuracy and reliability of fingerprint-based examinations. In conclusion, the present research highlights the significance of sweat pores characteristics as an additional source of forensic information. The systematic analysis of pore size, pore shape, pore inter, and pore density provides meaningful insight that can contribute to the advancement of Poroscopy as a supportive technique in forensic science. Further studies with larger sample sizes and advanced imaging methods may Strengthen the applicability of sweat pores analysis

in forensic Investigations and help establish more standardized parameters for age and sex estimation.

Acknowledgment

We are thankful to Mr. Ravi Kumar, assistant professor, department of forensic science, Teerthanker Mahaveer University for his guidance, motivation and helping us all the time by his Immense knowledge.

Funding: This research received no external funding.

Consent for participation

The verbal consent was obtained from all participants for the publication of this report and any accompanying images.

REFERENCES

- Bhatia, Ashna; Mathur, Surbhi. Evaluating the Effectiveness of Sweat Pore Features. *Journal of Forensic Science and Medicine* 11(3):p 200-208, Jul-Sep 2025. | DOI: 10.4103/jfsm.jfsm_65_24
- Kaur, J., & Dhall, M. (2023). Useless or used less? Poroscopy: The evidence of sweat pores. *Heliyon*, 9(7), e17927. <https://doi.org/10.1016/j.heliyon.2023.e17927>
- Sharda, S., & Mondal, P. R. (2023). A bimanual comparison of variation in sweat pores with sex and age: a brief dermatoglyphic survey of population in Delhi-NCR. *Egyptian Journal of Forensic Sciences*, 13(1). <https://doi.org/10.1186/s41935-023-00372-z>
- U, K. (2023). Forensic importance of poroscopy in age estimation of the fingerprint donor and in criminal profiling. *International Journal of Forensic Sciences*, 8(2), 1–8. <https://doi.org/10.23880/ijfsc-16000305>
- U, K., & Babu, R. G. (2026). Dermatoglyphic analysis on the morphology of pores and Gungadin, S. (2007). Sex Determination from Fingerprint Ridge Density. *Medical Update - EJOURNAL*, 2(2).
- Gungadin, S. (2007). Sex Determination from Fingerprint Ridge Density. *Journal of Medical Update - EJOURNAL*, 2(2). <https://doi.org/10.4314/ijmu.v2i2.39847>
- Shetage, S.S., Traynor, M.J., Brown, M.B., Raji, M., Graham-Kalio, D. And Chilcott, R.P. (2014), Effect of ethnicity, gender and age on the amount and composition of residual skin surface components derived from sebum, sweat and epidermal lipids. *Skin Res Technol*, 20: 97-107. <https://doi.org/10.1111/srt.12091>
- Chovancová, M., Beňuš, R., Šváblová, P., & Masnicová, S. (2023). Sexual dimorphism Bhagwat, V., Kumar, D. M., & Lakshmi, K. N. V. (2020). Poroscopy – The Study of Sweat Pores among Central Indian Population. *Scholars International Journal of Anatomy and Physiology*, 3(6), 53–56. <https://doi.org/10.36348/sijap.2020.v03i06.001>
- Bhagwat, V., Kumar, D. M., & Lakshmi, K. N. V. (2020). Poroscopy – The Study of Sweat Pores among Central Indian Population. *Scholars International Journal of Anatomy and Physiology*, 3(6), 53–56. <https://doi.org/10.36348/sijap.2020.v03i06.001>
- Tafazoli, M., Shahri, N. M., Ejtehad, H., Haddad, F., Nooghabi, H. J., Shahri, M. M., & Naderi, S. (2013). Biological Variability of Sweat Gland Pores in the Fingerprints of a Fars Iranian Family from Khorasan Razavi Province, Iran. *SHILAP Revista De Lepidopterología*. <https://doaj.org/article/c87f1d82a0984b349ef34d520efa076a>
- Amir, A., Sharma, D., Zeeshan, M., & Tripathi, S. (2025). Difference between Fingerprint Patterns among the South Indian and North Indian Population. *Journal of Forensic Science and Research*, 9(2), 210–215. <https://doi.org/10.29328/journal.jfsr.1001105>
- Jadeja, H., Vaishali, & Babu, G. R. (2021). Comprehensive dermatoglyphics study on ridge dimensions, pore size and assessment of the sweat composition among the industrial workers. *Medicine*, 24(1and2), 223–228.
- Urapen, R., & Witchuvanit, W. (2024). Gender differences on data of palm sweat pores in Myanmar and Cambodian nationality. *Indian Journal of Forensic Medicine & Toxicology*, 18(3), 145–149. <https://doi.org/10.37506/hxejzd32>
- Sankaran, A., Vatsa, M., & Singh, R. (2014). Latent fingerprint matching: a survey. *IEEE Access*, 2, 982–1004. <https://doi.org/10.1109/access.2014.2349879>
- Anjana, C., Priyatha, C., & Prasad, S. (2024). A comparative study on friction ridge pore features of males and females. *International Journal of Biometrics*, 16(2), 158–175. <https://doi.org/10.1504/ijbm.2024.137089>
- Kaur, J., & Dhall, M. (2022). Reproducibility of fingerprint microfeatures. *Egyptian Journal of Forensic Sciences*, 12(1). <https://doi.org/10.1186/s41935-022-00266-6>
- Egli, N., Moret, S., Bécue, A., & Champod, C. (2013). Fingermarks and other Impressions, Review 2010–2013. *SERVAL* (Université De Lausanne), 745–820. https://serval.unil.ch/notice/serval:BIB_C4ACD1295F80
- Popa, G., Potorac, R., & Preda, N. (2010). Method for fingerprints age determination. 154. <https://doi.org/10.4323/rjlm.2010.149149>
- Sánchez-Andrés, A., Barea, J. A., Rivaldería, N., Alonso-Rodríguez, C., & Gutiérrez-Redomero, E. (2018). Impact of aging on fingerprint ridge density: Anthropometry and forensic implications in sex inference. 323–334., 58(5), <https://doi.org/10.1016/j.scijus.2018.05.001>
- Preethi, D. S., Nithin, M. D., Manjunatha, B., & Balaraj, B. M. (2012). Study of poroscopy among

- South Indian population*, 57(2), 449–452.
<https://doi.org/10.1111/j.1556-4029.2012.02058.x>
21. Bindra, B., Jasuja, O. P., & Singla, A. (2000). Poroscopy: A method of personal identification revisited. *Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology* 1(1).
<https://www.indianjournals.com/ijor.aspx?target=ijor:aajfmt&volume=1&issue=1&article=003>
22. Gupta, A. (2008). The reliability of fingerprint pore area in personal identification. In Wolverhampton Intellectual Repository and E-Theses (University of Wolverhampton) <http://hdl.handle.net/2436/39857>