Evaluating Pore Count and Pore Shape in Fingerprints Across Professional Cohorts

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ABSTRACT

This study investigates the relationship between occupation and poroscopic characteristics in the context of forensic science. Pores are the small openings found within the ridges of fingerprints from which the sweat is released. Fingerprint samples were collected from individuals representing 5 different occupations using a live scanner, with observation total pore count and shape count were analysed. The results reveal significant differences in pore characteristics among occupations, suggesting that environmental and lifestyle factors associated with different occupations may influence pore development and morphology. There are noticeable differences in pore count and distorted shape of pores. Manual labour has the highest number of distorted pores among the professions.

The observed differences in pore characteristics among occupations can be used to enhance fingerprint identification and provide contextual information for investigators. Gives an option where the occupation can be estimated and the number of suspects can be reduced or could work as circumstantial evidence to identify a particular person.

The findings have implications for fingerprint analysis, occupational inference, and forensic investigations. This research contributes to the growing body of knowledge on Poroscopy and its applications in forensic science, highlighting the potential for occupation-based analysis to enhance fingerprint identification and investigation.

keywords: Poroscopy, Fingerprint identification, Sweat pores, Occupational biometrics, Ridge detail, Forensic science, Pore count, Pore shape, Friction ridges, Manual labour, Biometric authentication

Highlights

- Pore characteristics (count, shape) vary significantly across professions.
- Manual laborers (e.g., construction workers, farmers) showed higher pore distortion.
- Data suggests that occupation may influence skin ridge and pore morphology.
- Poroscopy provides supplementary data for forensic investigations when ridge-level details are unclear.
- Use of 5×5 mm area for standardized pore analysis.
- Potential to reduce suspect pools by inferring occupation through fingerprints.

Data Statement

- Sample Size: 50 individuals across 5 occupational groups:

    1. Typist
    2. Construction Workers
    3. Farmers
    4. House Helps
    5. Carpenters

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- Data Collected: Pore count, pore shape (circular, elliptical, distorted), ridge zones, and ridge pore distribution.
- Data Collection Tool: SecuGen Hamster Pro20 optical live scanner.
- Region of Interest: 5×5 mm area of fingerprint ridge detail (central or peripheral zones).
- Ethical Measures: Informed consent obtained, hygiene ensured, voluntary participation.

INTRODUCTION

Fingerprints have long been recognized as a reliable method of identification due to their unique and permanent patterns[1]. They are commonly used in forensic investigations and accepted as strong evidence in court. Traditionally, fingerprint analysis includes examining ridge patterns, minutiae points, and more detailed features like sweat pores[2], [3].

This project focuses on Poroscopy, the study of sweat pores on fingerprint ridges. These tiny pores, which release sweat, vary in shape, size, and number from person to person[4]. Interestingly, external factors such as a person's occupation may influence how these pores appear. This research explores how different jobs may impact pore structure, aiming to use these subtle differences as a tool in forensic identification[5], [6], [7].

Poroscopy, introduced by Dr. Edmond Locard in 1912, is the study of sweat pores found on fingerprint ridges[8], [9]. These pores, which form during early fetal development, vary in size, shape, and placement making them unique to each individual[10].

Aim and Purpose of Study

This project aims to explore how sweat pores in fingerprints can reflect a person's occupation. By studying pore patterns across different known professions, the goal is to see if poroscopy can support forensic investigations by narrowing down suspects based on their work-related fingerprint traits. The research hopes to strengthen poroscopy's role in forensic science by showing its potential in occupational profiling and even in estimating the age of fingerprint donors.

Objectives

1. Study of Pores collected from samples.
2. Observing pores are mostly visible in which part of the pattern clearly.
3. In which occupation the pores are clear, property visible and in which not Why (rough hands).
4. Counting the number of pores present in 5 by 5mm square.
5. Shapes of pores present in the given area of the sample.
6. Matching the Data with same occupation samples.

Hypotheses: If the number of pores of a particular occupation falls in the same band gap, then it will help experts to categorise suspects on the basis of their occupation. And it will be giving precise data about the occupation.

Significance

- It helps in forensic studies and analysis.
- Identification of suspects is easier because of standard data.
- Criminal investigations: Poroscopy can be used to identify criminals when other methods fail, such as when fingerprints are partial, blurred, or overlapping.
- Gives an option where the occupation can be estimated and the number of suspects can be reduced or could directly help in finding a particular person.
- Age estimation: Poroscopy can be used to estimate the age of a fingerprint donor.

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METHODOLOGY

Sample Collection

As part of research sample collection from different participants of different occupations with precaution, standard process and rights of the participants. Prior to data collection each participant was informed about the purpose process and nature of the project.

Fingerprint collection was carried out with a digital scanner in a non-invasive, safe, and hygienic manner[11], [12].This ethical approach to sample collection is not only to ensure complication, compliance and academic standards but also builds a sense of trust and cooperation among the participants therefore enchanting the integrity and reliability of the research work[13], [14]. The participants were selected on the basis of manual workers who regularly use their fingers for their daily good to get a better information, 5 different occupations which are:

1. TYPIST
2. CONSTRUCTION WORKER
3. FARMER
4. HOUSEHELP
5. CARPENTER

The device used during this project is SecuGen Hamster Pro20 a compact device with USB connection, an optical fingerprint reader with high quality designed for identification and authentication of different fingerprints. It uses optical technology to capture fingerprints, secure biometric features with water resistant capacity.

Analysis of Samples

The study included a total of 50 participants, categorized into five occupational groups: Typist, Construction workers, Farmers, Domestic workers, and Carpenters, with 10 individuals representing each group.

Prior to fingerprint acquisition, the participants' fingers were thoroughly cleaned to ensure clarity and accuracy in the imaging process. Each finger was then carefully placed on a fingerprint scanner, and the resulting prints were appropriately labelled according to the individual and occupational group [15], [16], [17]. A 5 mm^2 box was marked on the area of the print where ridge details were most visible, and manual pore counting was subsequently conducted within this defined region [9], [18].

- Zone of fingerprint
- Total pore count in 5mm box
- Number of pores on single ridge
- Shapes were observed - Circular, Elliptical and Distorted.

The scanner screen was measured according to that, the image dimensions were set length 2.3cm and width 1.8 cm. Then a 5*5mm box was placed to the pertaining zone i.e. centre or peripheral that has a better clarity and visibly of pores[18]. Manually counting of pore was conducted with a total number of pore and on a single ridge, as well as observing the shapes of pores and entering a table. Accordingly, graphs were prepared to present the summarised picture of statistical data[19], [20].

The graphical section presents data derived from each table, illustrating the practical values associated with each factor. These visual representations provide a clear statistical overview to support the analysis and interpretation of the observations[21].

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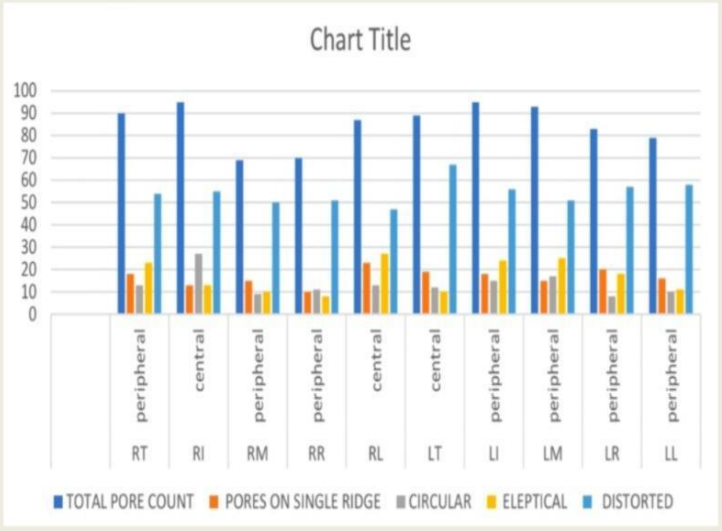
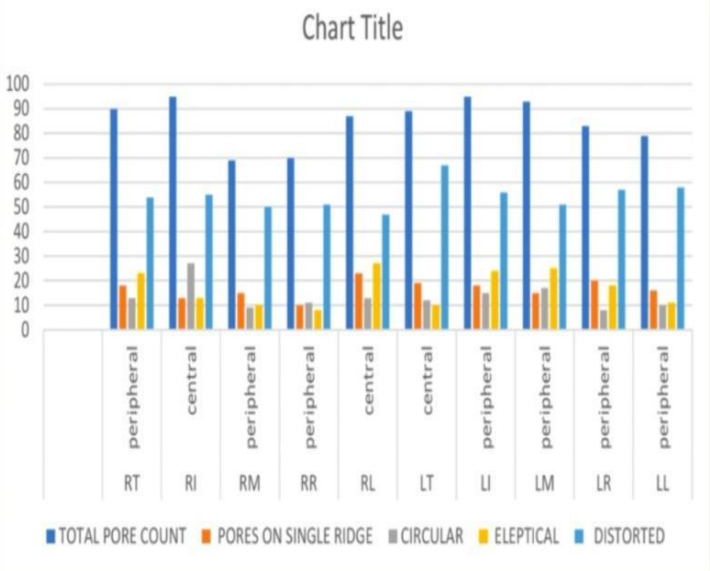
Tables showing the values from the analysis part of Sample 1 (Typewritist)with graphical representation

Sl. no	TYPE OF FINGER	ZONE OF FINGERPRINT	TOTAL PORE COUNT	PORES ON SINGLE RIDGE	CIRCULAR	ELLIPTICAL	DISTORTED
1	RT	central	76	13	45	19	12
2	RI	peripheral	103	15	47	38	18
3	RM	peripheral	111	15	49	36	26
4	RR	central	86	17	31	40	15
5	RL	central	92	20	42	31	19
6	LT	central	83	17	29	37	17
7	LI	peripheral	78	10	38	28	12
8	LM	peripheral	98	11	47	32	19
9	LR	central	87	17	40	34	13
10	LL	central	84	16	35	30	15



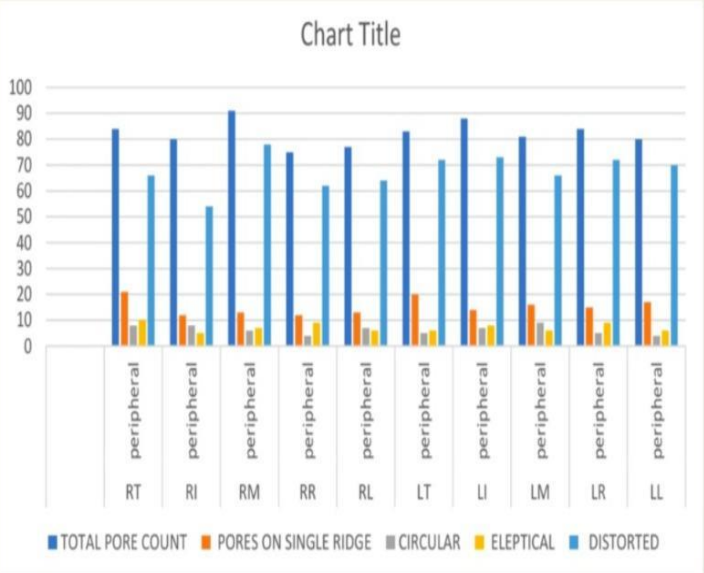
Tables showing the values from the analysis part of sample 11 (construction worker) with graphical representation

Sl. no	TYPE OF FINGER	ZONE OF FINGERPRINT	TOTAL PORE COUNT	PORES ON SINGLE RIDGE	CIRCULAR	ELLIPTICAL	DISTORTED
1	RT	peripheral	90	18	13	23	54
2	RI	central	95	13	27	13	55
3	RM	peripheral	69	15	9	10	50
4	RR	peripheral	70	10	11	8	51
5	RL	central	87	23	13	27	47
6	LT	central	89	19	12	10	67
7	LI	peripheral	95	18	15	24	56
8	LM	peripheral	93	15	17	25	51
9	LR	peripheral	83	20	8	18	57
10	LL	peripheral	79	16	10	11	58



Tables showing the values from the analysis part of Sample 22 (Farmer)with graphical representation

Sl. no	TYPE OF FINGER	ZONE OF FINGERPRINT	TOTAL PORE COUNT	PORES ON SINGLE RIDGE	CIRCULAR	ELLIPTICAL	DISTORTED
11	RT	peripheral	84	21	8	10	66
12	RI	peripheral	80	12	8	5	54
13	RM	peripheral	91	13	6	7	78
14	RR	peripheral	75	12	4	9	62
15	RL	peripheral	77	13	7	6	64
16	LT	peripheral	83	20	5	6	72
17	LI	peripheral	88	14	7	8	73
18	LM	peripheral	81	16	9	6	66
19	LR	peripheral	84	15	5	9	72
20	LL	peripheral	80	17	4	6	70



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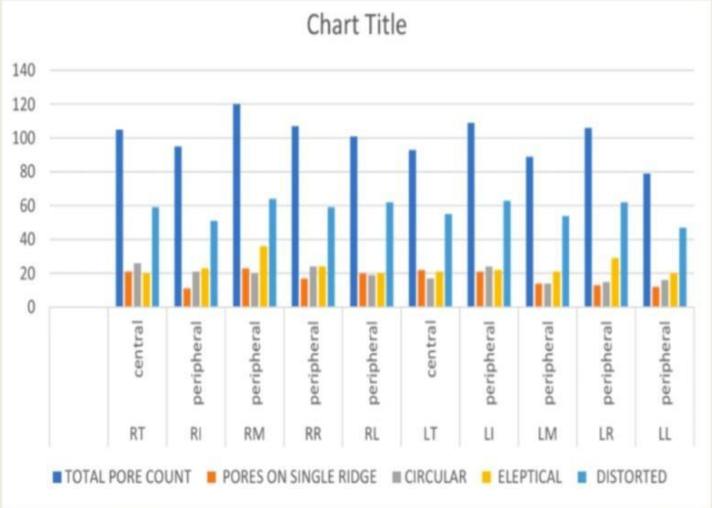
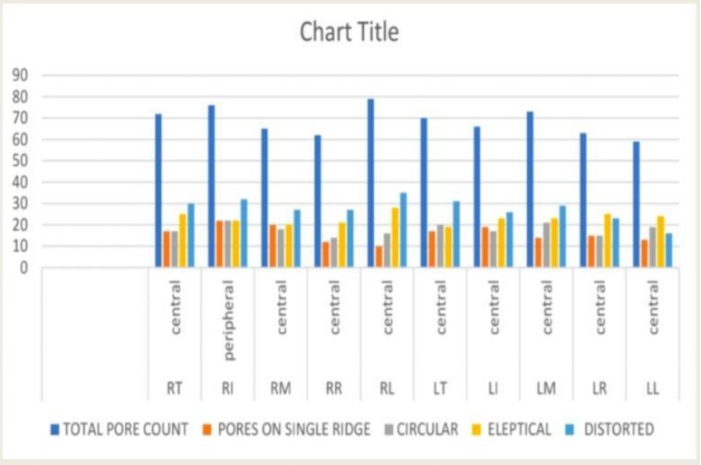
Tables showing the values from the analysis part of Sample 31 (House Help)with graphical representation

Sl. no	TYPE OF FINGER	ZONE OF FINGERPRINT	TOTAL PORE COUNT	PORES ON SINGLE RIDGE	CIRCULAR	ELLIPTICAL	DISTORTED
1	RT	central	105	21	26	20	59
2	RI	peripheral	95	11	21	23	51
3	RM	peripheral	120	23	20	36	64
4	RR	peripheral	107	17	24	24	59
5	RL	peripheral	101	20	19	20	62
6	LT	central	93	22	17	21	55
7	LI	peripheral	109	21	24	22	63
8	LM	peripheral	89	14	14	21	54
9	LR	peripheral	106	13	15	29	62
10	LL	peripheral	79	12	16	20	47



Tables showing the values from the analysis part of Sample 41 (Carpenter)with graphical representation

Sl. no	TYPE OF FINGER	ZONE OF FINGERPRINT	TOTAL PORE COUNT	PORES ON SINGLE RIDGE	CIRCULAR	ELLIPTICAL	DISTORTED
1	RT	central	72	17	16	15	41
2	RI	peripheral	76	22	22	22	32
3	RM	central	65	20	18	20	27
4	RR	central	62	12	14	16	36
5	RL	central	79	10	16	28	35
6	LT	central	70	17	20	19	31
7	LI	central	66	19	17	23	26
8	LM	central	73	14	21	23	29
9	LR	central	63	15	15	25	23
10	LL	central	59	13	19	24	16



Observation and Interpretation

Based on the data presented in the tables and graphs, following details are observed about the poroscopic examination of different fingerprints from various occupations. Considering few, Then the research is carried out to get more information about poroscopic analysis. Pores get affected by environmental factors, which sometimes depend on work that we are occupied with regularly. As we take

- Farmer is a manual labour exposed to harsh weather and frequently hands are in contact with soil, water, pesticides many more leading to worn out fingerprints and distortion.
- House help are the domestic workers majorly hands are in contact with dust, hard surfaces, regularly washing hands leading to constant dryness.
- Construction worker a physical labour exposed to cement, bricks, meshes, sand etc potentially hand get rough and worn out
- Carpenter mostly the hands get exposed to wooden dust as well as the uneven wooden surface which leads to damage to skin.
- Typist less labour work mostly in contact with keys of typewriter leads to sweaty hands but comparatively less wear and tear.

Zones of fingerprint in the pattern are peripheral around 60% having clear pores visibility compared to central, because as we use our hands for several works the skin surface faces a lot of damage in the central part. Like scars, burns, cuts etc. But the other 40% of the prints has good visibility in the central part as well.

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Total Pore Count in 5mm square ranges as

- Typist- 80 to 110 pores
- Construction worker- 70 to 100 pores
- Farmer- 60 to 90 pores
- House help- 90 to 130 pores
- Carpenter- 60 to 80 pores

The number of pores on a single ridge varies from 10 to 30 within a 5 mm box. During this observation, it was noted that the number of pores is higher in a whorl pattern compared to a loop pattern. This is because, in a whorl pattern, the spiral ridges appear more continuous. The continuity of the ridges likely contributes to the increased pore count.

Circular shaped and elliptical shaped pores are constantly observed in samples which have less ware and tare marks that is in the following analysis observed in Typist finger print sample. The notable observations about distorted pores which are characterized by irregular shape, variation in size or disrupted arrangement have a specific number of range observed

- Typist- 16.16%
- Construction worker- 51.35%
- Farmer-72.78%
- House help- 60.84 %
- Carpenter- 31.11%

Additionally, some fingerprints were absent because the scanners could not detect them due to a high degree of roughness, wear, and tear. As a result, the live scanner was unable to capture these fingerprints properly. The majority of the affected fingerprints were from the thumb and index fingers, as these fingers typically experience more pressure and force compared to others.

DISCUSSION

Brief Summary of Project

The findings of the study direct a significant relationship between occupation and poroscopic characteristics, specifically total pore count and shape of pore with their count. The observed difference among the professions suggest that environmental and lifestyle factors are associated with pore number and shapes, may also influence pore development and morphology.

Regular contact with typewriter keys is less harmful to fingerprints compared to the harsh work performed by farmers or construction workers in the fields. Domestic workers, also known as house helps, often work at multiple locations in a single day, leading to wear and tear marks or distortion of pores on their fingertips. In the case of carpenters, their constant work with wood and tools such as cutters causes noticeable changes to the skin surface. Each of these occupations results in a different degree of impact on the condition of fingerprints.

Future Scope

As there is very little literature and data regarding poroscopic analysis, further research could focus on expanded occupation, studies investigating pore characters in diverse occupations, exploring the effects of environmental and genetic factors as well. Standard protocols developing guidelines for poroscopic analysis. Integrating poroscopy with other forensic disciplines. Investigating the stability and consistency of pore features over time could help with valuable information for fingerprint analysis.

Hypothesis Conclusion

According to the hypothesis the number of pores doesn’t have an exact range difference among the occupations

but it has been partially correct in the sense of manual workers as they have a good number of ranges among the distorted shapes and has gradually decreased according to profession.

CONCLUSION

This study has successfully explored the relationship occupation and poroscopic characteristics with forensic science. The finding reveals a significant difference in total pore count and shapes among individuals of different occupations underlining the potential of poroscopy as a valuable part in forensic identification. The peripheral zones of fingerprints exhibit more clearly visible pores compared to the central region. This is likely due to the central area of the fingertip experiencing greater wear and tear from frequent usage, leading to skin damage. It was also observed that fingerprint samples with a whorl pattern exhibited a higher number of pores compared to those with a loop pattern. This may be attributed to the continuous flow of spiral ridges within the 5 mm^2 area. Additionally, samples with minimal wear and tear such as those from typists tended to show a higher frequency of circular and elliptical-shaped pores. In contrast, a notable prevalence of distorted pores was observed in samples from individuals engaged in manual labour, such as farmers. These findings suggest that the extent of physical activity and occupational exposure may influence the clarity and shape of fingerprint pores.

The distinct pore feature observed in different occupations could be used to build information with finger print evidence there by providing investigators with additional contextual information to aid criminal investigation.

This research contributes to the growing body of knowledge on poroscopy and its application in forensic science following the occupation factor in fingerprint analysis and identification.

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