Forensic Studies on Occupational Fingerprint Marks Analysis of Workers of Jewellers in Uttar Pradesh

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ABSTRACT:

All human beings have fingerprints since their birth and it accurately identified because of their uniqueness, no one has ever been found same fingerprints. A fingerprint is vital evidence in any legal case and helps police investigations. Its uniqueness, versatility, and lifetime existence make the fingerprint a good human identification tool. These marks are never changed throughout life. However, a person's skin develops occupational marks in reaction to any kind of business; these marks are acquired during a person's work and rely on the labour an individual performs.

A total of 60 participant samples were collected from skilled jewellery makers in Uttar Pradesh where 58 were male (96%) and only 2 female (4%) and for comparison, a total of 60 shopkeeper standardised samples were collected. All the participants are informed about the research purpose, aim, procedure and significance in bilingual language. We analysed and observed the callosity, scars, unusual gaps between two phalanges, bumpy creases, small blisters etc. We concluded the fingerprints of jewellery makers and gave a conclusion so that the occupational marks of jewellery makers could be used in the investigation to solve the cases as soon as possible.

KEYWORDS: *Fingerprint, Occupational Marks, Identification, Jewellery Workers, Forensic Evidence, Investigation.*

INTRODUCTION:

From the Latin word “forensis” we get the word “forensic.” “Science” is the collection of orderly techniques to bring the physical world progressively. “Forensis” means “suitable to legal proceedings, general discussions or debates” [1]. Every police officer knows the importance of factors such as height, weight, sex, eye and hair color, scars, tattoo marks, defects etc [2,3]. Various methods, including sex, age, stature, religion, ethnicity, lip print, somatometric measurement, assessment of personal appearance, evaluation of serological markers, and analysis of footprint, handwriting, lip print, fingerprint and observation of gait patterns identify a person [4]. Forensic scientists collect, preserve, and analyze various types of evidence including biological (such as DNA), chemical (such as drugs or trace evidence), digital (such as computer files or emails), and physical (such as fingerprints or firearms) [5]. They assess evidence, make conclusions, and present their results in court using specific methods and tools [6].

Papillary ridges on the fingertips and thumbs produce impressions known as fingerprints. Fingerprints are formed by sweat secretion on ridges [7]. Individuals' fingerprints are distinct, and no two people have been observed to have fingerprints that are the same; therefore, a reliable way to identify a person is by their fingerprints [8,9]. During fetal development, fingerprints develop and remain the same throughout a person's lifetime [10]. Even in cases of self-denial, assumed identities, or physical appearance changes caused by illness, ageing, plastic surgery, or accidents, fingerprints can still be used to identify a person. Law enforcement agencies have been using fingerprint recognition to identify both suspects and the victims of crime for many years [11]. Latent (invisible), patent (visible), and plastic (3D) fingerprints are three distinct types that can be discovered at crime scenes [12]. These fingerprints are found on porous (paper, wood, cardboard, etc.) and non-porous surfaces (plastic, glass, metal, etc.) [13]. Moreover, there are three different kinds of fingerprint patterns: whorl, loop, and arch and whereabouts 60% form loops, 35% whorls, and 5% form arches [14]. In addition, composite patterns other than (loops, whorls, and arches), can be observed in fingerprints as - central pocket loops, lateral pocket loops, twinned loops or double loops, and accidental [15,16].

Hand biometrics has gained significant attention in various domains, including security, forensics, and healthcare [17,18]. "Adermatoglyphia" is a rare disorder that affects fingerprints and causes them to disappear also referred to as "getting deferral disease." It can have serious medicolegal implications [10]. One crucial methodology in forensic science is the collection of partial fingerprints from a crime scene. A finger's grease and moisture cause fingerprints on many surfaces [7]. Wounds, scratches, and mild burns do not change the epidermal papillae or the ridge form, and any newly formed skin immediately reproduces the previous pattern. An injury that removes the dermal papillae will irreversibly destroy the ridges [19,20].

Occupational marks are distinct characteristics that appear on the palms and fingertips of people who work in specialised jobs. According to the field of activity, occupational markings can also form on any part of the human body, such as the teeth, bones, hands, feet, or toes [21]. This research investigates the influence of occupation-associated activities on fingerprint quality for forensic science purposes [22].

These markings are the repercussions of repeatedly using tools, equipment, or performing tasks related to a certain field of employment [23]. Callus formation, scars, wounds, and scratches are a few examples; they are bodily manifestations of people's occupations and daily physical challenges [24,25]. Ageing and lifestyle factors can also influence fingerprint patterns. This becomes important when it comes to identifying a deceased corpse that has not been identified, a missing case, or a criminal. Therefore, occupational marks are very distinctive and particular [26]. Occupational markings are also utilised to prove personal identity and play a major part in forensic science recognition [27]. When visual identification is not feasible, they are useful to recognise unknown deceased bodies from mass disasters, airline accidents, earthquakes, fire explosions, or any other circumstance so that they may be identified using a variety of tactics including forensic radiography, anthropometric measures, DNA profiling, fingerprinting, etc. [21,28].

Those who craft jewellery with metals like gold, silver, and platinum, additionally gemstones such as diamonds, rubies, and emeralds have extremely coarse hands. Their hands become bruised when they beat gold, silver etc. with a hammer, their fingers get slashed when they pan it and their fingers burn too when they cook and melt gold and silver. Tools used in jewellery-making that might injure hands and fingers include solder, jewellery hammers, flush cutters, wire cutters, polishing machines, and pliers. Whatever a jeweller does that puts damage on his hands while creating jewellery, their hands still bear the marks of all of them. These marks are referred to as occupational marks. We can determine an individual's linked occupation thanks to these occupational marks. Aside from being very helpful in identifying unclaimed bodies fast, occupational marks also play a major role in forensic science investigations, criminal capture, and case resolution.

Understanding the unique characteristics of jewellery workers' fingerprints can provide context to forensic analyses. For example, identifying residues from specific materials used in jewellery making on a suspect's fingerprints could strengthen the link between them and a crime scene. Fingerprint databases can be searched periodically against new evidence or developments in cold cases. If a jewellery worker's fingerprints match those found at a previously unsolved crime scene, it could lead to new leads or breakthroughs in long-dormant investigations. The forensic expert's report is submitted to the court, and the experts are invited to testify and provide clarification on the report, which also helps the judge deliver the appropriate judgement. This research purpose is to find out the jewellery workers' occupational marks, how they are different from shopkeepers' fingerprints and used in future for investigation.

MATERIAL AND METHODOLOGY:

This study is observational, where fingerprint samples were collected from jewellers of different places in Uttar Pradesh. A total of 60 participants samples were gathered from skilled jewellery makers including 58 males (96%) and 2 females (4%), between the age group 22-75 years of age. A total of 60 standardised samples of shopkeepers were also collected for comparative analysis with the name, age, gender and work experience. Consent for the data collection was taken in a bilingual language and explained the research's purpose in the native language.

In the inclusion criteria, the participation spanning all age groups, belonging to the jewellery-making occupational and having experience of 3 to 50 years of work was essential for the research endeavour. Exclusion criteria included amputated fingers and no detection of finger pattern or barely damaged pattern.

For the study, both plain and rolled prints were used to collect the 10-digit fingerprint. A fingerprint ink, fibreglass plates, roller, A4 sheet, scale, pencil, pen and magnifying lens were used for observation. We found some clear, partially clear, smudged, and unclear samples among these samples. A comprehensive visual examination of fingerprints was done by using a magnifying lens to achieve the research objective. In the observation, we observe the occupational marks developed with the work experience and find occupational marks where abrasion indicated as 1, bumpy creases indicated as 2, small blisters indicated as 3, the unusual gap between two phalanges indicated as 4, scars indicated as 5, unclear prints indicated as 6 in the analysis.

RESULT:

The fingerprint samples from jewellery workers were analysed in 60 samples including 58 males (96%) and 2 females (4%) where we got 7 samples (12%) of 1-10 years of work experience and found mainly 2 types or less of occupational marks, 21 samples (35%) of 11-20 year of work experience found mostly 2-3 types of occupational marks, 17 samples (28%) of 21-30 year of work experience found primarily 3-4 types of occupational marks, 9 samples (15%) of 31-40 year of work experience found mostly 4-5 types of occupational marks, 6 samples (10%) of 41 - 50 year of work experience found 5-6 types of occupational marks. In this, occupational marks may be small, medium and large in dimension.

Table 1: Age, Gender, Work Experience and Size of the Occupational Marks Found on the Fingerprints of these Samples.

S.NO.	AGE	GENDER	WORK EXPERIENCE	SIZE
	70	Male	45	1",2"',3',3",3"',4",5',5",6"
	75	Male	50	1"',2",3',3",4",4"',5',5",6'
	49	Male	31	1",2',3',3",4"
	35	Male	15	2",3',3"
	40	Male	21	1',2",3'
	42	Male	22	1",2',5'
	34	Male	13	2',4"
	41	Male	22	1',2",3',4",5'
	46	Male	25	1",2"',3',3",4",5'
.	33	Male	14	1',2",3',4"
.	22	Male	3	2',4'
.	29	Male	10	2"',3',3",4"
.	31	Male	12	2"',4"
.	35	Male	16	1',2",3',4",5'
.	26	Male	4	2',4"
.	68	Male	48	1",2",3',3",4",5",6'

.	35	Male	15	1',2",3',3",4'
.	44	Male	25	1',2",3',4",5'
.	42	Male	23	1',2',3'
.	51	Male	32	1",2",4",5"
.	48	Male	26	1',2",3',3",4',5'
.	31	Male	12	2",4"
.	36	Male	15	1',3',5'
.	28	Male	9	2",3',4"
.	27	Male	7	1',3',4"
.	36	Male	16	2"',3',3",4"
.	50	Male	32	1",2"',3',3",4"
.	52	Male	33	1",2",3',3",4',5"
.	48	Male	28	2",3',3",4",5'
.	42	Male	23	2"',3',3",4"
.	58	Male	38	1",2",3',3"',4',5"
.	39	Male	18	1',2",3',4",5'
.	35	Male	15	2',4'
.	72	Male	50	1",2",3',3",3"',4",5',5",6'
.	52	Male	33	1',2",3',4",5'
.	38	Male	15	2",3',3",4'
.	50	Male	30	1',2"',3',3",4",5'
.	30	Male	12	2",3',4'
.	55	Male	35	1",2"',3',3",5'
.	30	Male	11	2',4'
.	52	Male	27	2",3',4',5'
.	40	Male	21	1',2",4"
.	45	Male	26	2",3',4",5'
.	37	Male	18	1',2",3',4',5'
.	34	Male	13	2",3',4"
.	51	Male	31	1',2"',3',3",4',5'
.	43	Male	24	1',3',4"
.	50	Male	27	1',2"',3',3",4',5'
.	24	Male	5	2',4'
.	46	Male	23	1',2",3',4"
.	40	Female	17	1',2",3',4",5'
.	29	Male	8	3',4'
.	39	Male	20	1',2",4',5'
.	59	Male	37	1",2",3',3",4"
.	74	Male	49	1",2"',3',3",3"',4",5',5",6'
.	42	Male	22	1',2",4"
.	37	Female	15	2",3',4'
.	39	Male	18	2",3',4"

.	72	Male	48	1',2",3',3",3'",4",6'
.	41	Male	20	1',2",3',4",5'

- ❖ ['] is used for less or smaller occupational marks.
- ❖ ["] is used for medium-size occupational marks.
- ❖ ['"] is used for more or larger occupational marks.

Table 2: Number of Males and Females According to Work Experience.

S.NO.	WORK EXPERIENCE	MALE	FEMALE
	1 – 10	7	0
	11 – 20	19	2
	21 – 30	17	0
	31 – 40	9	0
	41 – 50	6	0

Table 3: Number of Creases, Blisters and Scars According to Work Experience.

S.NO.	WORK EXPERIENCE	CREASES	BLISTERS	SCARS
	1 – 10	5	4	0
	11 – 20	20	15	7
	21 – 30	16	14	10
	31 – 40	9	8	6
	41 - 50	6	6	5

Figure 1: It Shows the Injury Which is Caused by Repetitive Tasks of Jewellery Making.

Figure 2: It Shows the Occupational Marks that were Observed in the Worker's Samples.

This graph shows the number of participants on the X-axis and work experience on the Y-axis, it was observed that the number of female participants was much less than males.

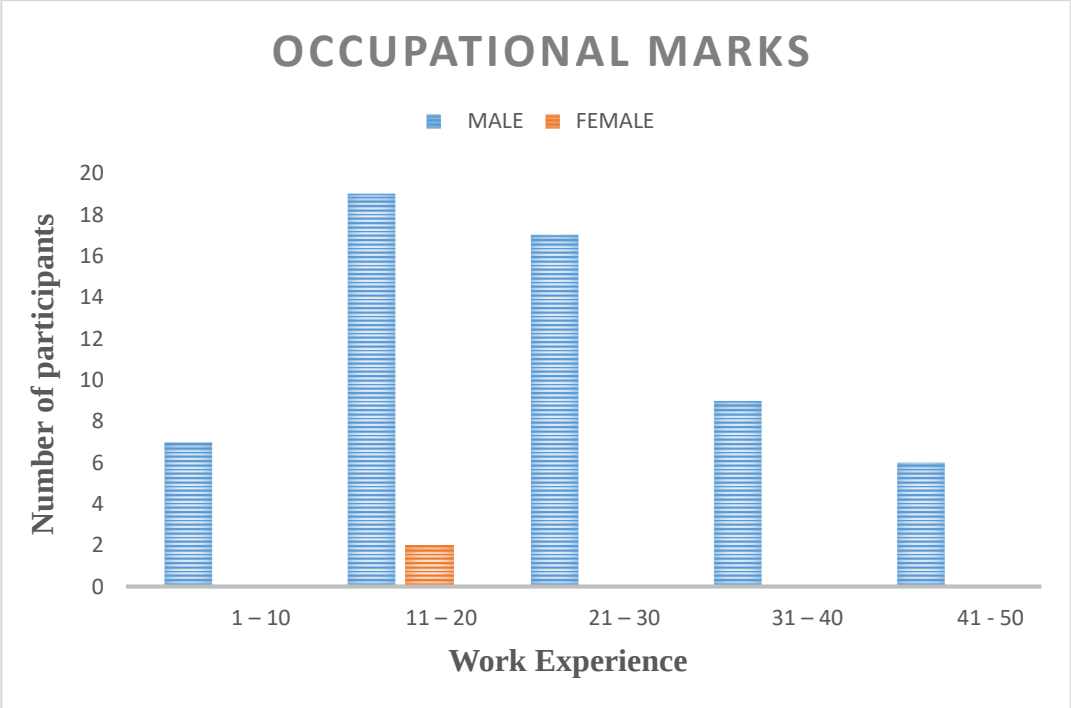

Figure 3: The Number of Males and Females Who have Occupation Marks.

Based on these parameters, jewellery workers' occupational marks are increasing with the time of work experience like the increase of small blisters, scars, bumpy creases, gaps between two phalanges etc.

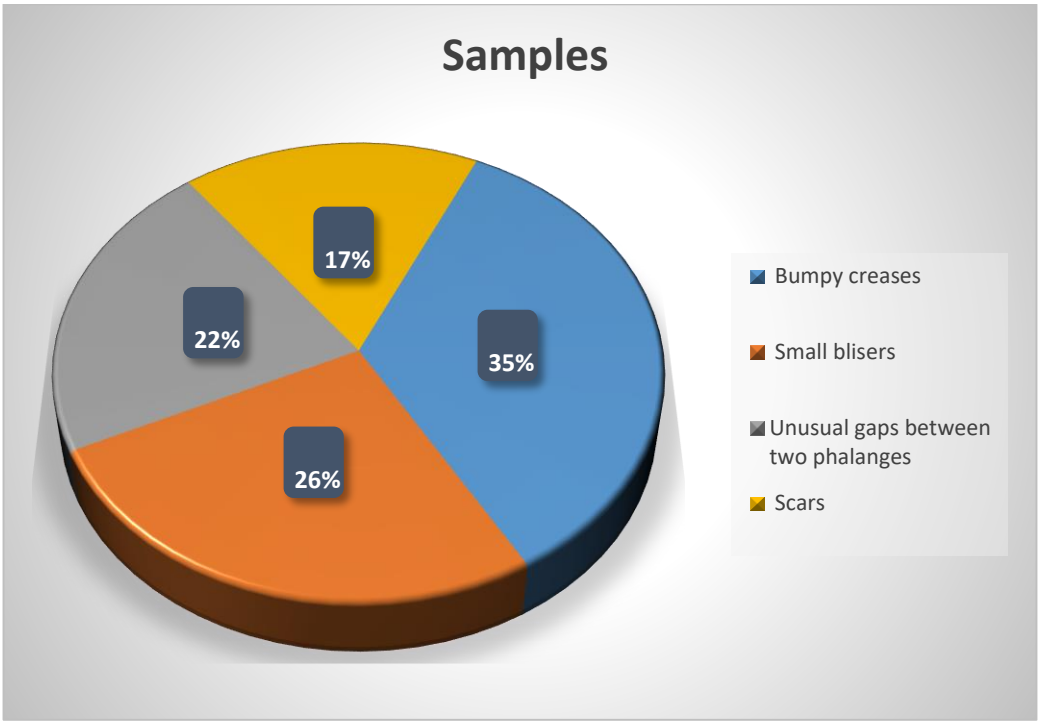

Figure 4: Percentage of Distinctive Marks of Jewellery Workers.

DISCUSSION:

India is also progressing very fast in the field of forensic science; occupational marks study will be useful for us. Variation in fingerprints due to occupation is one of the major focus areas for the field of forensic dermatoglyphics. We collected a total of 60 participants' samples of fingerprints from skilled jewellery makers, including 58 men (96%) or only 2 women (4%) and a total of 60 standardized samples of shopkeepers on A4 sheets for comparative analysis. Fingerprints showing signs of wear and tear from the use of tools in jewellery-making that might injure hands and fingers include a plier, polishing machine, flush cutters, solder etc. People who use chemicals or dye have stains or discolourations on their fingertips. The changes in fingerprints of jewellery artisans also depend on the type of jewellery they make, whether they do gold and silver in furnace smelting, fine workmanship, rolling gold and silver through machines to make jewellery or polish it etc. Jewellery workers have been fingerprints affected by residues from metals, gemstones, and cleaning chemicals used in jewellery making. Jewellery worker's fingerprints have also been influenced by the indoor environment of workshops, including temperature and humidity levels. The long or continuous work of these occupations also causes these occupational marks.

After observation and analysis, we concluded that the hands of every experienced person were sampled, indicating the impact of repetitive tasks on skin texture. The print's clarity was found to decrease. Some workers exhibit spots on their fingerprints and bumpy creases than usual. Scars of indentation and cuts were visible, particularly in areas corresponding to fingerprint ridges.

Abrasions were shown on the skin by rubbing or dragging against the rough surfaces and blisters were in the fingerprints of some more experienced workers (small pockets of bodily fluid, brought on by friction or manual work known as blisters). Long-term worker's fingerprint patterns were not always noticeable or identifiable on all their fingers. There was greater space than usual between the two phalanges in the fingers of jewellery makers and fine or intricate marks from working with small, delicate jewellery pieces.

The number of occupational marks found in males and females with work experience of jewellery workers (Figure 3). In this field, we observe that the number of female participants was much less compared to males. Bumpy creases, small blisters, unusual gaps between two phalanges, scars –these 4 were found in most samples where 35% bumpy creases, 25% small blisters, 22% unusual gaps between two phalanges, and 18% scars were present (Figure 4). Each sample contained a combination of 2 or 3 types of occupational marks. Occupational marks in the fingerprints of jewellery workers were higher when compared with shopkeeper's fingerprints. Due to not doing hard physical labour occupational marks were missing from the shopkeepers' fingerprints.

Calluses and creases can be observed in the thenar region of the palm in potters', masons and brick klin labourers' fingerprints [24]. However, we found occupational marks mainly on their fingers because maybe they mostly use their fingers in their work. Blisters, scars, and unusual creases were found in fishermen caused by fishing hooks or spurs [26] although in jewellers, including these, we also found abrasions and unusual gaps between two phalanges. The high number of creases and lines disappeared and blister formation was observed on both hands of the mechanic, and in electrician cuts, blisters or callosity were observed in the index, middle, and thumb in the right hand [21] although in our observation we found the more occupational marks in the thumb, index and middle finger than other fingers of working hands may be caused of working of gold and silver furnace smelting, fine workmanship etc. We observed that 44 were right handy and had occupational marks in their right hands, 12 were left handy and had occupational marks in their left hands and 4 had occupational marks similar in both hands.

This research might prove useful in various situations, such as forensic evidence and will lift the recognition of unspecified bodies and the identification of possible culprits in theft or counterfeiting cases. This research is similar to others in the form of occupational marks increasing with age and work experience and some marks are also similar to others such as scars and abrasions but some distinct features were also found such as unusual gaps between two phalanges, small blisters, bumpy creases etc. In future, there will be scope to collect more fingerprints of workers for analyse the pattern and work on ridge counting, ridge tracing, minutiae, etc.

CONCLUSION:

The objective of this study was to characterize the occupational marks present in the fingerprints of jewellery workers in Uttar Pradesh caused by long or continuous work occupations. The jewellery worker's work with such delicate materials resulted in occupational marks on fingerprints such as scars, line disappearing, blisters, abrasions etc. Such occupational marks become prominent only after at least 5-10 years of work experience.

This research helps to understand the occupational marks used as forensic evidence and it will improve the recognition of unidentified bodies. By recognizing the features, law enforcement agencies can utilize these marks to help in the investigation process.

REFERENCES:

[1] M. M. Houck and J. A. Siegel, *Fundamentals of forensic science*. Academic Press, 2009.

[2] G. Forbes, "Some observations on occupational markings," *Journal of Criminal Law and Criminology (1931-1951)*, vol. 38, no. 4, pp. 423–436, 1947.

[3] V. Kumar, P. Kumar, and S. Sharma, "Study of Fingerprint Patterns as an Absolute Identification Tool for Human Identification," *Indian Journal of Forensic Medicine & Toxicology*, vol. 11, no. 1, pp. 124–129, 2017.

[4] M. Kulshreshtha and P. R. Mondal, "Acquired body marks: A mode of identification in Forensics," *J Forensic Leg Med*, vol. 52, pp. 98–109, 2017.

[5] C. Roux, F. Crispino, and O. Ribaux, "From forensics to forensic science," *Current Issues in Criminal Justice*, vol. 24, no. 1, pp. 7–24, 2012.

[6] T. A. Brettell, J. M. Butler, and J. R. Almirall, "Forensic science," *Anal Chem*, vol. 83, no. 12, pp. 4539–4556, 2011.

[7] S. Cadd, M. Islam, P. Manson, and S. Bleay, "Fingerprint composition and aging: A literature review," *Science & Justice*, vol. 55, no. 4, pp. 219–238, 2015.

[8] R. M. Bolle, A. W. Senior, N. K. Ratha, and S. Pankanti, "Fingerprint minutiae: A constructive definition," in *Biometric Authentication: International ECCV 2002 Workshop Copenhagen, Denmark, June 1, 2002 Proceedings 1*, Springer, 2002, pp. 58–66.

[9] K. Karu and A. K. Jain, "Fingerprint classification," *Pattern Recognit*, vol. 29, no. 3, pp. 389–404, 1996.

[10] T. Kanchan and K. Krishan, "Loss of fingerprints: forensic implications," *Egypt J Forensic Sci*, vol. 8, no. 1, p. 19, 2018.

[11] S. Yoon, J. Feng, and A. K. Jain, "Altered fingerprints: Analysis and detection," *IEEE Trans Pattern Anal Mach Intell*, vol. 34, no. 3, pp. 451–464, 2012.

[12] B. Wilshire, "Advances in fingerprint detection," *Endeavour*, vol. 20, no. 1, pp. 12–15, 1996.

[13] L. Magro, C. Shoemake, A. Serracino-Inglott, and L. M. Azzopardi, "Chemical enhancement of fingerprints on various porous and non-porous surfaces," 2015.

[14] A. K. Jain, S. Prabhakar, and L. Hong, "A multichannel approach to fingerprint classification," *IEEE Trans Pattern Anal Mach Intell*, vol. 21, no. 4, pp. 348–359, 1999.

[15] N. Kaushal and P. Kaushal, "Human identification and fingerprints: a review," *J biomet biostat*, vol. 2, no. 123, p. 2, 2011.

[16] S. Bell, *Forensic science: an introduction to scientific and investigative techniques*. CRC press, 2019.

[17] E. Yörük, H. Dutağaci, and B. Sankur, "Hand biometrics," *Image Vis Comput*, vol. 24, no. 5, pp. 483–497, 2006.

[18] P. Varchol and D. Levicky, "Using of hand geometry in biometric security systems," *Radioengineering-Prague-*, vol. 16, no. 4, p. 82, 2007.

[19] J. D. Glover *et al.*, "The developmental basis of fingerprint pattern formation and variation," *Cell*, vol. 186, no. 5, pp. 940–956, 2023.
[20] K. L. Monson *et al.*, "The permanence of friction ridge skin and persistence of friction ridge skin and impressions: A comprehensive review and new results," *Forensic Sci Int*, vol. 297, pp. 111–131, 2019.
[21] S. S. Nikita, "Forensic Examination of Occupational Marks in Fingerprint and Palm Print of Electrician and Mechanic Workers," *Ann Rom Soc Cell Biol*, pp. 4960–4967, 2021.
[22] A. Batool, F. Shehzad, and I. Gul, "Identification and comparison of fingerprint damages among different occupations in Punjab, Pakistan for forensic casework," *International Journal of Natural Medicine and Health Sciences*, vol. 2, no. 2, pp. 21–26, 2023.
[23] D. S. S. Mansi Singh, "Occupational Alteration: Examination Of Fingerprints And Psychological Behaviour On Carpenters," *SJIS-P*, vol. 35, no. 3, pp. 278–283, 2023.
[24] M. Rajput and S. Manhas, "COMPARISON OF OCCUPATIONAL MARKS IN FINGER AND PALMPRINT IMPRESSIONS OF POTTERS, BRICK KLIN LABOURERS & MASONS WITH REFERENCE SAMPLES," *Pakistan Heart Journal*, vol. 56, no. 3, pp. 395–405, 2023.
[25] A. S. Sharma and S. Sharma, "Occupation marks and their Forensic Significance," *Ann Rom Soc Cell Biol*, pp. 4489–4493, 2021.
[26] P. Annie and S. Sharma, "Occupational Marks in Fingerprints and Palm Prints of Fishermen of Kerala (Coastal Regions)," *Ann Rom Soc Cell Biol*, pp. 4494–4498, 2021.
[27] C. J. Davis and E. M. Hufnagel, "Through the eyes of experts: A socio-cognitive perspective on the automation of fingerprint work," *Mis Quarterly*, pp. 681–703, 2007.
[28] R. Kaur, S. Sharma, and R. Singh, "A study on occupational marks on teeth of tailors," *Indo-Pacific Academy of Forensic Odontology*, vol. 5, 2014.