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A research on developing latent fingerprints on human skin with cosmetic powders

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ABSTRACT

Background: Recovering latent fingerprints on human skin is challenging due to its continuous renewal, elasticity, and factors like body temperature and perspiration. Traditional fingerprint powders often fail on skin. This study explores using cosmetic powders to develop latent prints on skin and assess their effectiveness under varying environmental conditions.

Aim: The study employed three cosmetic powders (talcum, eye shadow, and vermilion), a makeup brush, white paper tape, scissors, a glass slide, hand lens, and gloves. Latent fingerprints were intentionally deposited on the forearms and foreheads of 12 individuals of varying ages. These prints were developed with different powders, lifted using tape, and photographed for comparative analysis.

Results: The study assessed talcum, vermilion, and eye shadow powders for latent fingerprint development. Eye shadow powder proved most effective, especially for individuals aged 10-30, yielding clear patterns in over 80% of cases. Vermilion showed promise for younger age groups but less effectiveness for those over 30.

Conclusion: The research evaluated talcum, vermilion, and eye shadow powders for latent fingerprints on living individuals. Eye shadow powder proved most effective, highlighting friction ridges well. Despite limitations, cosmetic powders show potential for forensic use, requiring consideration of skin adherence and hypoallergenic properties in future studies.

1. Introduction

A fingerprint is a representation of the friction ridges found on the tip, middle, and base of the finger's phalange regions. Fingerprint analysis aids in criminal investigations and suspect identification. These fingerprints consist of grooves and friction strips that ensure a firm grip. These unique structured ribs develop in the womb and continue to grow and consist of tiny dots that help wick away sweat. Signature points in a fingerprint, such as bifurcation, trifurcation, ridges, and others, determine its individual uniqueness for comparison.[1]

In the mid-1960s and mid-1970s, researchers tried various techniques to reveal hidden marks on human skin, such as optical methods and powders, but the success rate was limited.[2] In 2011, Wilkinson conducted experiments involving both live specimens and cadavers, focusing on non chilled and unwashed skin, an area less studied in previous studies. Four European countries, Germany, Austria, Great Britain and Denmark, conducted the experiments according to the ethical guidelines of the 1983 Declaration of Helsinki. They put 250 latent fingerprints on 10 dead people in each country, a total of 40 corpses, and used magnetic and regular black fingerprints, as well as Isomark R and gelatin sheet, for analysis. The study sought to identify factors that increase the visibility of fingerprints on skin, emphasizing youth, cleanliness, and specific environmental

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conditions. They successfully developed latent fingerprints using cyanoacrylate vaporization, magnetic black powder, and the ThermaNin method. In addition, the use of 1, 2-indanedione with HFE-7100 on thermal paper produced clearer edge detail compared to the ThermaNin method.[3]

This research centers around the utilization of cosmetic powders and adhesive tape to develop and lift hidden fingerprints on a living person's skin. The study also involves comparing various powders to assess their effectiveness.

2. Materials and Methods

In this research, various materials were employed, including three branded cosmetic powders namely talcum powder (Pond's), eye shadow powder (Swiss Beauty), and vermilion powder (Blue Heaven). Additionally, a cosmetic brush, white paper adhesive tape, scissors, glass slides, hand lens, and gloves were utilized. These diverse powders were selected to evaluate their effectiveness in unveiling hidden fingerprints on different skin surfaces, mainly forehead and forearm of individuals, and to determine which one yields optimal outcomes for forensic purposes. The methodology is depicted in Figure 1, outlining the process used in the study.

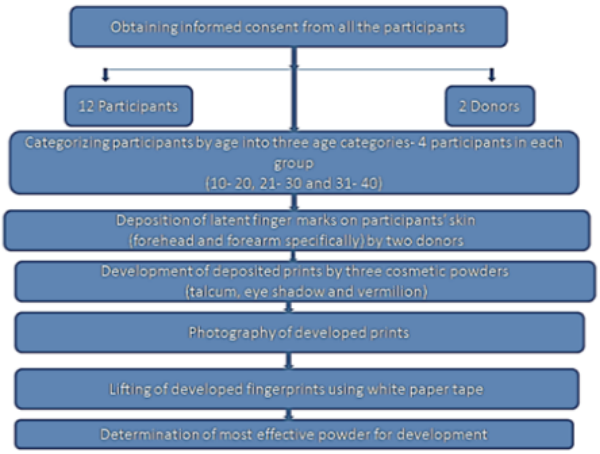

Figure 1: Illustration of the methodology used in the present study.

Table 1: Number of individuals belonging to different age groups

Serial No.	Age group	Number of individuals
1.	10- 20 years	4
2.	21- 30 years	4
3.	31- 40 years	4

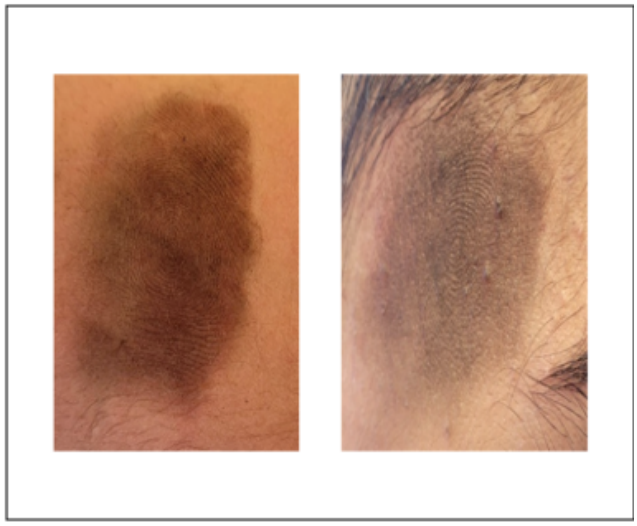

Figure 2: Latent fingerprints developed on the forearm and forehead of an individual belonging to age group 10- 20 years. **a.** Eye shadow powder (forearm). **b.** Eye shadow powder (forehead).

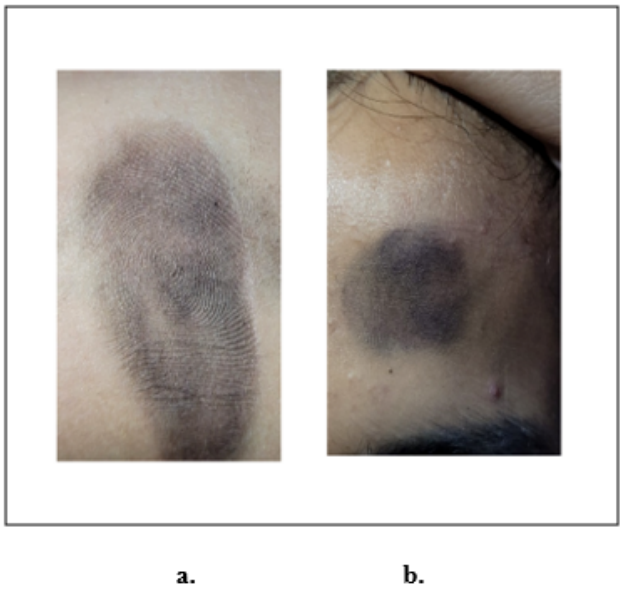

Figure 3: Latent fingerprints developed on the forearm and forehead of an individual belonging to age group 21- 30 years. **a.** Eye shadow powder (forearm). **b.** Eye shadow powder (forehead).

Table 2: Grading of powders on the basis of percentage of pattern visibility for age group 10-20 years (on forearm).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Excellent

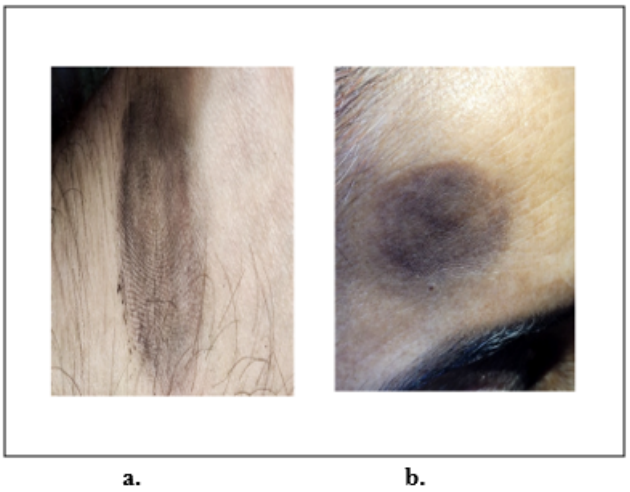

Figure 4: Latent fingerprints developed on the forearm and forehead of an individual belonging to age group 31- 40 years. **a.** Eye shadow powder (forearm). **b.** Eye shadow powder (forehead).

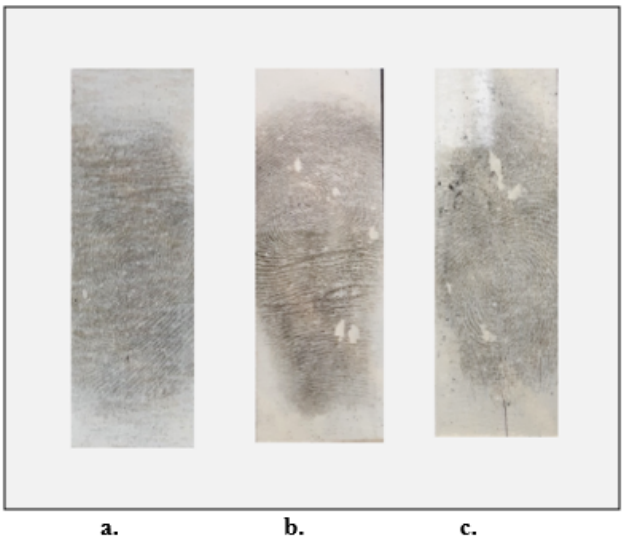

Figure 5: Fingerprint developed by eye shadow powder lifted from the forearm of the individuals **a.** Lifted fingerprint of an individual belonging to age group 10- 20 years. **b.** Lifted fingerprint of an individual belonging to age group 21- 30 years. **c.** Lifted fingerprint of an individual belonging to age group 31- 40 years.

Table 3: Grading of powders on the basis of percentage of pattern visibility for age group 10- 20 years (on forehead).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Good

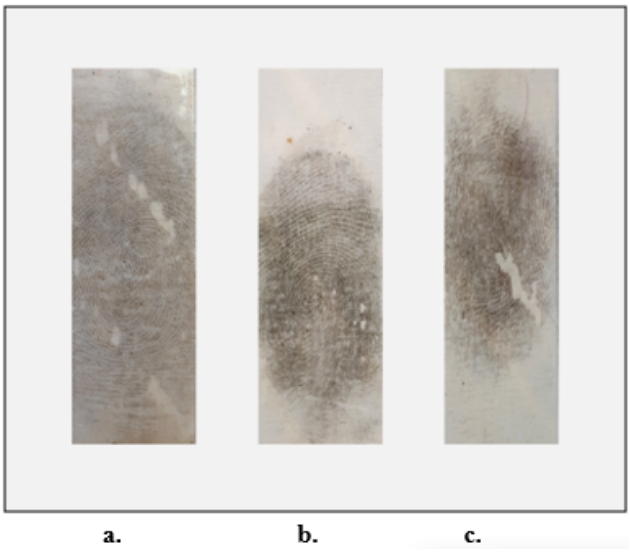

Figure 6: Fingerprint developed by eye shadow powder lifted from the forehead of the individuals **a.** Lifted fingerprint of an individual belonging to age group 10- 20 years. **b .** Lifted fingerprint of an individual belonging to age group 21- 30 years. **c.** Lifted fingerprint of an individual belonging to age group 31- 40 years.

Table 4: Grading of powders on the basis of percentage of pattern visibility for age group 21- 30 years (on forearm).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Good

Table 5: Grading of powders on the basis of percentage of pattern visibility for age group 21- 30 years (on forehead).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Good

Table 6: Grading of powders on the basis of percentage of pattern visibility for age group 31- 40 years (on forearm).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Average

Table 7: Grading of powders on the basis of percentage of pattern visibility for age group 31- 40 years (on forehead).

Serial No.	Powder	Visibility of pattern (in %)	Grade
1.	Talcum powder	<50 %	Poor
2.	Vermilion powder	50- 80 %	Average
3.	Eye shadow powder	>80 %	Average

2.1. Deposition of latent fingerprints on the skin surface

This study involved obtaining informed consent from 12 individuals for the collection of latent fingerprints on their skin surfaces. Specific areas like the forearm and forehead were intentionally marked with latent fingerprints to create identifiable samples. Two donors were involved in this process. The individuals were categorized by age, resulting in 72 samples, with 4 participants in the 10-20 age group, 4 in the 21-30 age group, and 4 in the 31-40 age groups as shown in Table 1. Ethical practices were followed, emphasizing voluntary participation without any coercion. After securing consent, latent fingerprints were intentionally left on the participants' forearms and foreheads. This was done by two randomly chosen donors to ensure an unbiased and diverse distribution of fingerprints. The skin was not cleaned before imprinting, and the process prioritized participant comfort, with pressure adjusted to their preference. The duration of fingerprint placement ranged from 3 to 5 minutes, with a maximum cap of 5 minutes, ensuring a personalized and participant-friendly approach throughout the data collection procedure.[4–7]

2.2. Development of latent fingerprints

In the 10-20 age groups, talcum powder was effective in highlighting level 1 fingerprint patterns to a certain degree, with the forehead being more conducive for identification than the forearm. In the 21-30 age groups, talcum powder partially revealed level 1 characteristics on the forearms, but it effectively exposed fingerprint patterns on the forehead. In the 31-40 age groups, talcum powder successfully unveiled level 1 characteristic, especially on the forearms, with clear fingerprint patterns visible on the forehead as well.[8–10]

Within the 10-20 age groups, eye shadow powder proved effective in enhancing level 1 fingerprint patterns on both the forehead and forearm, making them clearly visible and easily recognizable. Among those aged 21-30, the use of eye shadow powder emphasized these patterns on the forearm but with some identification challenges due to uneven application, while the forehead remained a suitable area for fingerprint pattern identification. In the 31-40 age group, the application of eye shadow powder resulted in moderate enhancements of level 1 characteristic, with fingerprint patterns moderately discernible on both the forearm and forehead. In summary, eye shadow powder generally produced excellent results.[11,12]

In the 10-20 age group, vermilion powder yielded moderate results, moderately emphasizing level 1 fingerprint characteristics on the forearms, while the forehead exhibited satisfactory results with effective recognition of level 1 characteristic. In the 21-30 age group, vermilion powder once again yielded moderate outcomes for both the forearm and forehead regions. For the 31-40 age group, vermilion powder produced satisfactory to good results, with level 1 characteristic evident on the forearms, primarily hindered by uneven powder application, while the forehead displayed satisfactory development with clear level 1 characteristics across all samples.[13–15]

The excellent results were obtained from eye shadow powder as shown in Figures 2, 3 and 4.

2.3. Lifting of fingerprints

Fingerprint lifting with various cosmetic powders was carried out using white paper tape or masking tape. Lifting fingerprints created by talcum powder on both forearms and foreheads proved to be challenging with both white paper tape and black adhesive tape. This challenge stemmed from the lack of contrast between the talcum powder and white paper tape, as well as the fine texture of the powder and its limited adherence to the pattern. Across all age groups, fingerprints developed using eye shadow powder was easily lifted, although some minor imperfections and blemishes were present due to unwanted material on the masking tape. In all age groups, fingerprints created with vermilion powder were successfully lifted without issues, although they were not as distinct as the lifted fingerprints produced using eye shadow powder. Nevertheless, some minor imperfections and blemishes were present. The lifted patterns developed by eye shadow powder are illustrated in Figures 5 and 6.

2.4. Comparison of cosmetic powders

A comparison was conducted to assess three cosmetic powders based on specific criteria, including the presence of friction ridges and pattern visibility. The study's findings revealed that talcum powder yielded unsatisfactory results, showing the presence of friction ridges but poor pattern visibility across all age groups. In contrast, vermilion powder unveiled distinct friction ridges and moderate to average pattern visibility, with some samples displaying clearer patterns. Notably, individuals in the 10-20 age groups had better pattern visibility on the forehead compared to the forearms. Similarly, the 21-30 age group demonstrated results akin to the 10-20 age group, while the 31-40 age group had average outcomes due to increased sweat production affecting pattern visibility. Moreover, individuals over 35 years old with loose skin and wrinkles

encountered challenges in pattern development.

Eye shadow powder exhibited superior performance among the three powders. It adhered effectively to latent fingerprint residue and exhibited high pattern visibility. Nevertheless, individuals aged 31-40, characterized by wrinkles and sagging skin, displayed reduced pattern quality compared to other age groups. The comparison of these powders involved assessing pattern visibility percentages in different age groups and assigning corresponding grades. Powders that resulted in less than 50% pattern visibility were categorized as poor, indicating that the pattern was not clearly visible and could not be identified. Powders providing 50% to 80% pattern visibility were labelled as average, signifying the presence of maximum ridges but less prominent identifiable characteristics. Finally, powders yielding over 80% visibility were rated as good to excellent since the pattern was entirely visible. The grading of samples based on powder comparison for all the age groups is detailed in Tables 2, 3, 4, 5, 6 and 7.

3. Discussion

The study's primary focus was on developing latent fingerprints on the forearms and foreheads of 12 individuals using three different cosmetic powders: talcum powder, eye shadow powder, and vermilion powder. Talcum powder, though somewhat effective at highlighting level 1 characteristic, demonstrated consistent results across all age groups. Eye shadow powder proved highly efficient, especially for individuals aged 10-20 and 21-30, although it was less effective for those in the 31-40 age groups due to skin characteristics. Vermilion powder showed promising results for the younger age groups but had moderate effectiveness for those over 30. The development process was faster and more effective on younger skin, as previously reported by Wilkinson et al., 2011, and Sears et al., 2012. Whorl patterns were the most commonly identified.

In terms of fingerprint lifting, talcum powder did not yield successful results, while eye shadow powder allowed for successful lifting with recognizable patterns. Vermilion powder enabled lifting, but the patterns lacked clarity, and both methods showed minor spots and imperfections on the masking tape. The research evaluated three cosmetic powders: talcum powder, vermilion, and eye shadow powder. Eye shadow powder emerged as the most promising option, offering excellent pattern visibility, strong contrast against the skin, and ease of application, with fingerprint patterns being identifiable in over 80% of cases.

This study represents an initial exploration, with no prior research existing on the application of cosmetic powders on human skin. Cosmetic powders are finely milled to a much smaller particle size than traditional forensic powders, allowing for better adherence to the fine details of fingerprints on the textured and moist surface of human skin. They are tailored for skin application, being hypoallergenic and designed to reduce skin irritation. This makes them particularly suitable for forensic use on living individuals without causing any harm. They typically include additives that enhance their ability to stick to the oils and moisture present in fingerprint residues. This increases the chances of successfully developing fingerprints on the naturally oily and sweaty surface of human skin.

4. Conclusions

The research investigated the development of latent fingerprints on a living human body using three cosmetic powders: talcum powder, vermilion powder, and eye shadow powder. The study evaluated the effectiveness of these powders in highlighting friction ridges and improving pattern visibility across various age groups. Results showed that eye shadow powder demonstrated superior performance, effectively adhering to latent fingerprint residue and providing high pattern visibility. The study's significance lies in uncovering the potential of cosmetic powders in forensic fingerprint development, offering insights into age-related variations and informing future investigative practices. The present study has some limitations as a limited sample size of 12 individuals may not fully represent the general population and the study did not account for variables like skin type, health conditions, or environmental factors, which could impact the efficacy of the cosmetic powders and the assessment was conducted on a controlled setting, and real-life scenarios. The future research should involve a larger and diverse sample size, considering variables like skin type, health conditions, and environmental factors to enhance the study's applicability as well as exploring and testing new cosmetic powders or innovative techniques to improve the development of latent fingerprints, especially considering challenging surfaces or conditions.

This study marks an initial foray, and there hasn't been any preceding investigation into the utilization of cosmetic powders on human skin. Using cosmetic powders for developing latent fingerprints on human skin introduces effective methods for challenging surfaces like human skin and enhancing visualization with varied colours. It offers safe, hypoallergenic, and non-invasive options, ensuring better adhesion and clearer prints due to advanced chemical formulations. The approach is eco-friendly and cost-effective, expanding its use across various conditions and skin types. It serves as a more affordable alternative to traditional fingerprint powders. Overall, it significantly improves the reliability, safety, and ethical standards of forensic fingerprint analysis.

5. List of Aabbreviations

1. Et al: ET alia / or others
2. HFE: Hydrofluoroether

3. e.g.: exempli gratia or for example
4. Vs : versus
5. Fig : Figure

6. Source of Funding

None.

7. Conflict of Interest

None.

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