Section: FMT

Original Research Article

FORENSIC UTILITY OF CHEILOSCOPY IN PERSONAL IDENTIFICATION: A POPULATION-BASED STUDY FROM DAKSHINA KANNADA DISTRICT

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Received *: 15/01/2026*
Received in revised form *: 04/03/2026*
Accepted *: 19/03/2026*

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DOI: 10.70034/ijmedph.2026.2.8

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 42-47

ABSTRACT

Background: Cheiloscopy, the study of lip print patterns, has been increasingly explored as an adjunct method for personal identification in forensic investigations. The characteristic grooves and fissures present on the vermilion border of the lips form distinct morphological patterns that may assist in identifying individuals. The present study aimed to evaluate the distribution of lip print patterns and assess the forensic utility of cheiloscopy in a population from Dakshina Kannada district.

Materials and Methods: A population-based cross-sectional study was conducted on 300 individuals aged 12–60 years residing in suburban areas of Dakshina Kannada district. Lip prints were recorded using the cellophane tape method after applying lipstick and were analyzed according to the Suzuki and Tsuchihashi classification. Descriptive statistics were used to determine the frequency distribution of lip print patterns, and the Chi-square test was applied to assess the association between gender and lip print pattern distribution.

Results: Among the five lip print patterns identified, Type I pattern was the most predominant (32.0%), followed by Type V (20.7%), Type IV (16.3%), Type II (15.7%), and Type III (15.3%). Gender-wise comparison showed that Type I pattern was the most common pattern in both males and females. However, statistical analysis revealed no significant association between gender and lip print pattern distribution ($\chi^2 = 5.236$, $p = 0.264$). A majority of lip prints (79.3%) exhibited identifiable patterns (Type I–IV), indicating their potential usefulness for forensic identification.

Conclusion: The findings of this study demonstrate that a large proportion of lip prints possess identifiable morphological patterns, supporting the use of cheiloscopy as a supplementary method for personal identification in forensic investigations.

Keywords: Cheiloscopy; Forensic identification; Personal identification; Suzuki and Tsuchihashi classification; Dakshina Kannada.

INTRODUCTION

Establishing the identity of an individual is a fundamental component of forensic investigations and medico-legal practice. Conventional identification methods such as fingerprints, dental records, and DNA profiling are considered highly reliable; however, in certain circumstances these methods may not always be available. Situations involving decomposed bodies, mutilated remains, or absence of identifiable fingerprints may require the use of supplementary identification techniques. Consequently, forensic scientists have explored alternative biological markers that may assist in personal identification when primary methods are limited or unavailable.[1]

Cheiloscopy, the study of lip prints, has emerged as one such adjunct tool in forensic science. Lip prints consist of characteristic grooves and wrinkles present on the vermilion border of the lips, forming distinct morphological patterns. These grooves develop during early intrauterine life and are believed to remain relatively stable throughout life, similar to dermatoglyphic patterns.[2] The uniqueness of lip prints among individuals has been highlighted in several studies, suggesting that no two individuals possess identical lip print configurations.[3] Because of these characteristics, lip prints have been investigated as a potential method of personal identification in forensic casework.

Lip impressions may be deposited unintentionally at crime scenes through contact with surfaces such as glasses, cigarette butts, clothing, cutlery, or other objects. These impressions may be visible or latent and can be developed using various forensic techniques, including powder methods and chemical reagents similar to those used in fingerprint detection.[4] In forensic investigations, such traces can provide valuable information regarding the presence of individuals at a crime scene and may assist in linking suspects to criminal activities.

Previous studies have demonstrated that lip prints may provide additional information beyond personal identification. Cheiloscopic analysis has been explored for its potential role in determining sex, studying hereditary traits, and examining population-specific variations in lip groove patterns.[5–7] The development of classification systems, particularly the widely used Suzuki and Tsuchihashi classification, has further facilitated systematic study of lip print patterns in different populations.[8] Despite these advancements, the forensic applicability of cheiloscopy remains an area requiring further validation through population-based studies.

In India, several regional studies have examined the distribution of lip print patterns among different populations; however, the use of cheiloscopy as a practical tool for forensic identification still requires additional evidence supported by larger population datasets. Establishing population-specific databases is particularly important because pattern distribution may vary according to genetic, environmental, and ethnic factors.[9] Such databases may enhance the reliability of cheiloscopy when used in medico-legal investigations.

Dakshina Kannada district in Karnataka represents a geographically and demographically diverse region with a mixed population background. Studying lip print patterns in this population can contribute valuable information to the existing forensic literature and help evaluate the practical utility of cheiloscopy in personal identification. Therefore, the present study was aimed to assess the forensic utility of lip print analysis in a population-based sample from Dakshina Kannada district and to evaluate its potential application as an adjunct method for human identification.

MATERIALS AND METHODS

Study Design and Setting: The present study was a population-based descriptive cross-sectional study conducted to evaluate the forensic applicability of cheiloscopy in personal identification among residents of Dakshina Kannada district, Karnataka, India. The study was carried out over a period of two years among individuals residing in suburban areas of the district. Dakshina Kannada represents a heterogeneous population comprising individuals from different socio-cultural backgrounds, making it suitable for studying population-level variation in lip print patterns. The study was approved by the Institutional Ethics Committee of Yenepoya University prior to the commencement of data collection.

Study Population: The study population consisted of 300 healthy individuals aged between 12 and 60 years residing in suburban areas of Dakshina Kannada district. Participants were selected from the general population after obtaining voluntary consent. Both males and females were included in the study to represent the population adequately. Individuals with congenital abnormalities of the lips, traumatic injuries, inflammatory conditions, or previous reconstructive surgery involving the lips were excluded from the study in order to prevent distortion of lip print patterns. Participants with known hypersensitivity to lipstick or active lesions affecting the lips were also excluded. The selection criteria ensured that only individuals with normal lip morphology were included for accurate cheiloscopic analysis.

Recording of Lip Prints: Lip prints were recorded using a standardized technique commonly employed in cheiloscopic studies to ensure consistency and reproducibility. The materials used for recording lip prints included dark red colored lipstick, a lip brush, transparent cellophane tape, scissors, white bond paper, cotton, and a magnifying lens for examination. Prior to recording the prints, the lips of each participant were examined for any deformity, inflammation, or injury that could affect the pattern of grooves.

The lips were first cleaned gently using cotton soaked in water to remove dust, debris, or cosmetic residues. A uniform layer of dark red lipstick was then applied to the participant's lips using a lip brush, beginning at the midline and extending laterally to cover the entire vermilion border. Participants were asked to rub their lips together gently to ensure even distribution of the lipstick. The lipstick was allowed to dry for approximately two minutes. A strip of transparent cellophane tape was then carefully placed over the lips in their natural resting position and pressed evenly to obtain the lip impression. The tape was subsequently removed and affixed to a sheet of white bond paper to create a permanent record of the lip print. In cases where the impression appeared

unclear or smudged, the procedure was repeated to obtain a clear print suitable for analysis.

Classification of Lip Print Patterns: The recorded lip prints were examined using a magnifying lens and classified according to the Suzuki and Tsuchihashi classification system, which is widely used in cheiloscopic studies. According to this classification, lip prints are categorized into five major types based on the arrangement of grooves. Type I consists of clear vertical grooves running across the entire lip, while Type I′ represents partial vertical grooves. Type II includes branched grooves, Type III consists of intersecting grooves, Type IV represents reticular patterns, and Type V represents undetermined patterns that do not fall into the other categories. For the purpose of analysis, the predominant groove pattern observed in the central portion of the lip print was considered, as this region is most commonly encountered in trace evidence recovered from crime scenes.

Data Recording and Statistical Analysis: All observations were systematically recorded in a master data sheet prepared using Microsoft Excel. The frequency and percentage distribution of different lip print patterns were calculated for the entire study population. Descriptive statistical analysis was performed to determine the prevalence of various lip print patterns and to assess their distribution within the population. Statistical analysis was carried out using SPSS software version 22. The results were expressed in terms of frequencies and percentages to evaluate the usefulness of lip prints as a population-based identification marker in forensic investigations.

Ethical Considerations: Ethical approval for the study was obtained from the Institutional Ethics Committee of Yenepoya University. Written informed consent was obtained from all adult participants prior to the recording of lip prints. For participants below 18 years of age, consent was obtained from the head of the institution or guardian. Participants were informed about the purpose of the study and assured that all information collected would be used solely for research purposes while maintaining confidentiality.

RESULTS

A total of 300 individuals were included in the study, comprising 150 males (50.0%) and 150 females (50.0%). The equal representation of both genders ensured balanced evaluation of lip print patterns in the population and allowed meaningful comparison of pattern distribution between males and females [Table 1].

Table 1: Gender Distribution of the Study Population.

Gender	Frequency	%
Male	150	50
Female	150	50

Among the five types of lip print patterns identified, Type I pattern was the most predominant, observed in 96 individuals (32.0%). This was followed by Type V pattern in 62 individuals (20.7%). The remaining patterns included Type IV in 49 individuals (16.3%), Type II in 47 individuals (15.7%), and Type III in 46 individuals (15.3%). These findings indicate that vertical groove patterns (Type I) were the most common lip print pattern in the studied population [Table 2 and Figure 1].

Table 2: Overall Distribution of Lip Print Patterns in the Study Population.

Lip Print Pattern	Frequency	%
Type I	96	32
Type II	47	15.7
Type III	46	15.3
Type IV	49	16.3
Type V	62	20.7

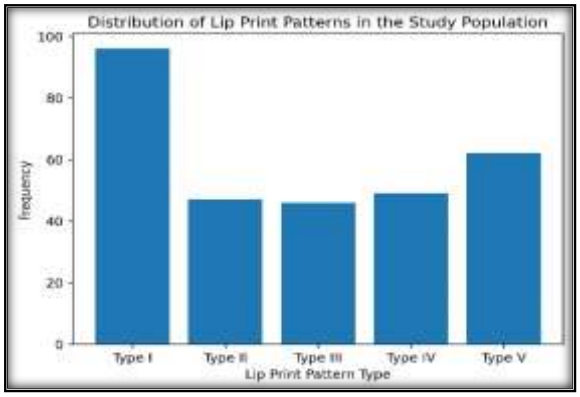

Figure 1. Distribution of Lip Print Patterns in the Study Population.

Type I pattern was the most common pattern in both males and females, observed in 29.3% of males and 34.7% of females. Type IV pattern was relatively more frequent in males (20.7%) compared with females (12.0%), whereas Type V pattern showed slightly higher prevalence among females (22.7%) than males (18.7%). Type II and Type III patterns showed relatively comparable distribution between genders. However, statistical analysis using the Chi-square test demonstrated no significant association between gender and lip print pattern distribution ($\chi^2 = 5.236$, df = 4, p = 0.264) [Table 3 and Figure 2].

Table 3: Gender-wise Distribution of Lip Print Patterns.

Lip Print Pattern	Male (n=150)	Female (n=150)	P value
	Frequency (%)		
Type I (n=96)	44 (29.3%)	52 (34.7%)	$\chi^2 = 5.236$, df = 4, p = 0.264
Type II (n=47)	22 (14.7%)	25 (16.7%)	
Type III (n=46)	25 (16.7%)	21 (14.0%)	
Type IV (n=49)	31 (20.7%)	18 (12.0%)	
Type V (n=62)	28 (18.7%)	34 (22.7%)	

χ^2 – Chi-square statistic; df – degrees of freedom.

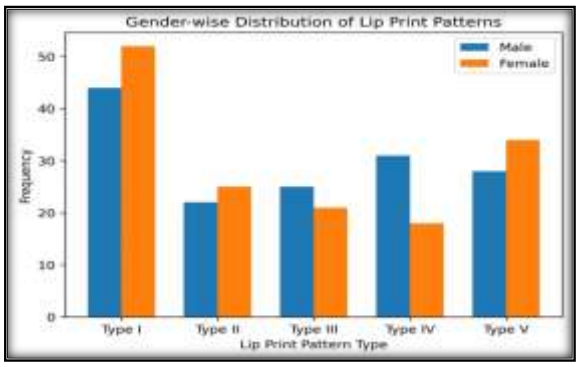

Figure 2: Gender-wise Distribution of Lip Print Patterns.

The majority of lip prints (238 out of 300; 79.3%) belonged to identifiable groove patterns classified as Type I–IV, which possess well-defined morphological features useful for forensic comparison. In contrast, Type V patterns, categorized as undetermined patterns, were observed in 62 individuals (20.7%). These findings indicate that a substantial proportion of lip prints exhibit identifiable morphological patterns, supporting the potential usefulness of cheiloscopy as an adjunct method for personal identification in forensic investigations [Table 4 and Figure 3].

Table 4: Forensic Applicability of Lip Print Patterns for Personal Identification.

Pattern Category	Frequency	%
Identifiable patterns (Type I–IV)	238	79.3
Undetermined pattern (Type V)	62	20.7

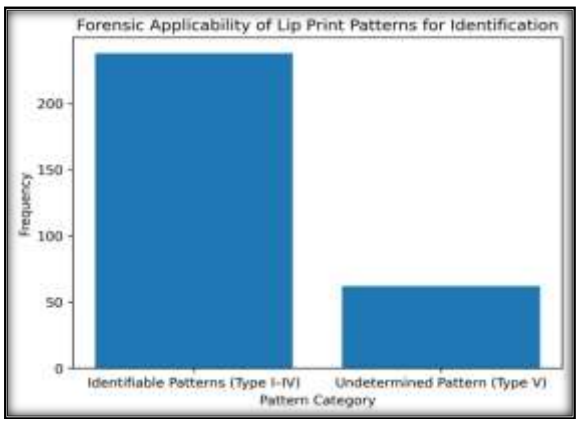

Figure 3: Forensic Applicability of Lip Print Patterns for Identification.

DISCUSSION

Identification of individuals plays a crucial role in forensic investigations, particularly in situations involving crime scene reconstruction, unidentified bodies, or cases where conventional identification methods such as fingerprints or DNA analysis are not readily available.[10] Cheiloscopy, the study of lip prints, has emerged as a useful adjunct technique in forensic science because of the unique arrangement of grooves and fissures present on the vermilion border of the lips.[11] These grooves form distinct patterns that are considered individualistic and relatively stable over time, thereby providing a potential tool for personal identification.[11]

In the present study, the study population consisted of 300 individuals with equal representation of males and females (50% each), which allowed balanced evaluation of lip print patterns between genders. The overall distribution of lip print patterns showed that Type I pattern was the most predominant pattern (32.0%), followed by Type V (20.7%), Type IV (16.3%), Type II (15.7%), and Type III (15.3%). The predominance of Type I pattern observed in the present study is consistent with several earlier investigations conducted in Indian populations. Misra et al., also observed Type I as the predominant pattern among individuals in Uttar Pradesh.[12] Vahanwala et al., reported Type I as the most common lip print pattern in a study conducted in Mumbai.[13] Similarly, Randhawa et al., in a large population-based study involving 600 individuals, also identified Type I as the most common lip print pattern,[14] while Sandhu et al. reported Type I as the most frequent pattern in a Punjabi population.[15] The consistency of these findings across studies by Kumar et al., and Upadhyaya et al., suggests that vertical groove patterns may represent a commonly occurring morphological feature in many Indian populations.[16,17]

However, variations in predominant lip print patterns have also been reported in different populations. Prabhu et al., using digital image analysis, reported Type V pattern as the most frequent pattern in their study population.[18] Sivapathasundaram et al., reported Type III pattern as the most common in an Indo-Dravidian population,[19] whereas Augustine et al., found a higher prevalence of Type III patterns in certain segments of the lips.[20] Such variations may be attributed to differences in population genetics,

environmental influences, methodological variations in recording lip prints, or differences in sample size and demographic characteristics.[21,22] These findings indicate that lip print pattern distribution may vary across populations and highlight the importance of establishing regional cheiloscopic databases.[21,22]

Gender-wise analysis in the present study showed that Type I pattern was the most common pattern in both males (29.3%) and females (34.7%), while Type IV pattern appeared relatively more frequent in males (20.7%) and Type V pattern showed slightly higher prevalence in females (22.7%). However, statistical analysis demonstrated no significant association between gender and lip print pattern distribution ($\chi^2 = 5.236$, $p = 0.264$). Similarly, Sandhu et al. reported that lip print patterns were comparable between genders and could not be used as a reliable parameter for sex determination.[15] Patel et al. also observed no significant correlation between gender and lip print pattern distribution in their study.[23] These findings are consistent with the results reported by Saraswathi et al., who concluded that lip print patterns did not show statistically significant variation between males and females.[24] The absence of significant gender differences suggests that lip print patterns may serve primarily as an identification marker rather than a reliable indicator of sex.[25]

One of the important observations in the present study was the high proportion of identifiable lip print patterns (Type I–IV), which constituted 79.3% of the total patterns observed. These patterns possess distinct morphological features that can be clearly visualized and compared during forensic examination. Only 20.7% of lip prints were categorized as Type V (undetermined pattern), which lack clearly distinguishable groove configurations. The high prevalence of identifiable lip print patterns observed in this study supports the forensic applicability of cheiloscopy in personal identification. Similar conclusions have been reported in earlier studies by Chada et al., Poudel et al., and Gondivkar et al.[26-28] Suzuki and Tsuchihashi, who developed one of the most widely used classifications of lip prints, demonstrated that lip prints possess sufficient individuality to assist in identification.[29] Thermadam et al., also reported that lip prints can provide valuable forensic evidence and may be used as supportive evidence in criminal investigations when other forms of identification are unavailable.[30]

From a forensic perspective, lip prints may be encountered at crime scenes on objects such as glasses, cups, cigarette butts, clothing, or envelopes. These prints may be visible or latent and can be developed using conventional fingerprint development techniques.[31] Once recorded and analyzed, lip prints can help establish the presence of an individual at a particular location and may assist in linking suspects to criminal activities. The high proportion of identifiable lip print patterns observed in the present study further strengthens the role of cheiloscopy as a supplementary method for personal identification.[31]

Limitations: The present study was conducted on a limited sample of individuals from a single suburban population in Dakshina Kannada district, which may restrict the generalizability of the findings to other regions and ethnic groups. Lip print analysis was performed using conventional visual examination rather than advanced digital image analysis techniques, which could provide greater precision. In addition, environmental or lifestyle factors that may influence lip morphology were not evaluated in the present study.

CONCLUSION

The present study evaluated the distribution of lip print patterns and their potential forensic applicability in a population from Dakshina Kannada district. Type I pattern was the most predominant lip print pattern observed in the study population, followed by Type V and Type IV patterns. The majority of lip prints (79.3%) exhibited identifiable patterns (Type I–IV), highlighting the potential usefulness of cheiloscopy in personal identification. Although slight variations in pattern distribution were observed between males and females, no statistically significant association was found between gender and lip print pattern distribution. The findings of this study support the concept that lip prints can serve as a valuable supplementary tool in forensic investigations and may aid in establishing personal identity when conventional methods are unavailable.

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