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## ORIGINAL ARTICLE

# A study of distribution, sex differences and stability of lip print patterns in an Indian population

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**Abstract** Lip prints are very useful in forensic investigations. The objective of this study is to determine predominant lip print pattern found among a central Indian population, to evaluate whether any sex difference exists and to study the permanence of the pattern over a 6 month duration. This study included 200 healthy adult subjects comprising of 100 males and 100 females in the age group of 18–25 years. A convenient and easier method of data collection i.e., digital photography was used instead of the traditional lipstick methods. Lip prints were then divided into four quadrants and recognized as per Suzuki and Tsuchihashi's classification.

Type I (30.63%) was found to be most predominant overall in the Marathi population. Type I (29.75%) and Type III (35.75%) were found most prevalent in males and females respectively. Applying the Chi-Square test, statistically significant differences ( $p < 0.05$ ) were observed between male and female lip print patterns in each of the quadrants individually and all quadrants taken together. The lip print patterns remained stable over a period of six-months. Being stable and with significant sex differences, lip prints can be effectively used as an important tool in forensic investigations for individualization as well as identification of sex of the donor, thus, narrowing down the scope of investigation to almost half.

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## 1. Introduction

In various civil, criminal and mass disaster cases, positive identification of a person can be very difficult. Out of the many existing techniques implied for the purpose, comparison of fingerprints, DNA and dental records are probably the most common techniques used in this context. However, 'human lip recognition' also known as cheiloscopy, is one of the most interesting emerging fields which find its roots in criminal and forensic practices (Caldas et al., 2007; Sharma et al., 2009; Reddy and Reddy, 2011). Previous studies have shown to establish the fact that lip prints can positively distinguish individuals and hence have potential use in human identification

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(Venkatesh and David, 2011; Prabhu et al., 2012, 2013; Dwivedi et al., 2013).

The term “Cheiloscopy” is derived from the Greek words *cheilos* meaning ‘lips’ and *e skopein* meaning ‘to see’ and is defined as the study of the characteristic patterns of the wrinkles and grooves present on the labial mucosa (sulci laborium), called as lip prints (Sivapathasundharam et al., 2001; Molano et al., 2002; Rajendran and Sivapathasundharam, 2006; Shafer et al., 2009). R. Fischer was among the first to take notice of the biological phenomenon of systems of furrows on the red part of human lips in the year 1902 (Thomas and Van Wyk, 1988; Kasprzak, 1990, 2000). Use of lip prints in personal identification and criminalization was first recommended in France by Edmond Locard as early as 1932 (Warren, 1976; Thomas and Van Wyk, 1988). Le Moyne Snyder was the first to introduce a case in which lip prints helped the crime investigators in an unusual way (Suzuki and Tsuchihashi, 1970a,b; Williams, 1991; Ball, 2002). Santos, Suzuki and Tsuchihashi were among the first to classify the various patterns present on the human lips (Suzuki and Tsuchihashi, 1970a,b; Tsuchihashi, 1974; Williams, 1991).

The importance of cheiloscopy is linked to the fact that the lip prints are unique to one person, except in monozygotic twins (Neville et al., 2002), like fingerprints and palatal rugae, the lip grooves are permanent throughout life (Tsuchihashi, 1974). It is possible to identify lip patterns as early as the 6th week of uterine life (Caldas et al., 2007; Koneru et al., 2013).

The oily and moist secretions from sebaceous and salivary glands located at the vermilion border and subsequent moisturization from the tongue enables the formation of a latent lip print whenever there is contact (Ball, 2002) and is likely to be encountered and should be suspected to be present on the scene of the crime of burglary, sexual assault, house tress-pass, homicide, rape, etc. Depending upon the scenario of/at the crime scene, lip prints may be found on various physical evidences at the crime scene, such as shirt, handkerchief, tissue paper/wipes, cups, photographs, letters, glass, window panes, cutlery, fruit skin/peel, cigarette butts, clothing, and even biological materials such as skin (Kavitha et al., 2009; Vats et al., 2012).

Lip prints are very useful in forensic investigations and are considered to be important forms of transfer evidence, and are analogous to fingerprints (Tsuchihashi, 1974). Apart from identification and evidential use, lip prints may also be used in detection work, being the source of tactical and criminalistic information. Being unknowingly left at the scene of the crime, lip prints can directly and effectively be helpful in placing the suspect on the scene (Satyanarayana et al., 2011). A lip print at the scene of crime can be a basis for conclusions as to the character of the event, the number of the people involved, sexes, cosmetics used, habits, occupational traits, and the pathological changes of lips themselves (Vahanwala and Parekh, 2000). If a complete match or identification is not possible, proper examination of lip prints may help in establishing other relative facts like sex identification of the donor, hence reducing the burden of the forensic examiner to half.

The objective of this study is to determine predominant lip print pattern found among a central Indian population, to evaluate whether any sex difference exists and to study the permanence of the same over a 6 month duration.

## 2. Methodology

### 2.1. Sample

The study comprised of 200 healthy individuals (100 males and 100 females), in the age group of 18–25 years and belonged to Marathi population of the Nagpur region of the Maharashtra state, India. Informed consent was obtained from all the subjects.

### 2.2. Inclusion criteria

Only healthy subjects, free from any oral pathologies, inflammation, abnormalities or deformities such as cleft lip, cut marks, surgical scars or lesions of the lip were included in the study.

### 2.3. Recording the lip prints

Recording of the data is an extremely important step for the success of this study; still digital photography was used, as the mobile nature of the human lips can affect the accuracy of the lip print impressions even with slight variations in the strength or the direction of the pressure applied (Tsuchihashi, 1974). The subjects were made to stand erect with the head positioned in Frankfurt plane. From a fixed distance, lips of volunteers in ‘natural condition’ (without the application of lipstick, lip fillers, lip gloss or any other cosmetic product) were photographed twice using a digital camera (Nikon D3100-14.2 MP-AF-S NIKKOR 18–55 mm lens kit). This method is relatively easier and involved nil physical contact with the volunteers in terms of application of lip gloss or lipstick as previously used and suggested by others, which can be quite laborious and unhygienic (if the same lipstick is used for all the subjects).

### 2.4. Classification used

In this study, we followed (Fig. 1) the classification of patterns of the lines on the lips proposed by Suzuki and Tsuchihashi (Suzuki and Tsuchihashi, 1971; Tsuchihashi, 1974).

- Type I: Long vertical (Clear-cut vertical grooves that run across the lips).
- Type I': Short vertical (Partial length groove of type I).
- Type II: Branched grooves (Branching Y-shaped pattern).
- Type III: Intersected grooves (Criss-cross/'x' pattern grooves).
- Type IV: Reticular pattern (Grooves that forms rectangular shape).
- Type V: Mixed/Indefinite (Grooves that do not fall into any of the above categories, combination of two or more patterns and/or cannot be differentiated morphologically/undetermined).

### 2.5. Examination of the prints

After transferring the photographs of the lips on a computer, lip prints (Fig. 2) were divided into four quadrants namely

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