



Variation in lip print pattern between two ethnic groups, Oraon tribals and Bengalee Hindus, residing in West Bengal, India

Archita Dey¹, Mahua Chanak², Kaustav Das³, Koel Mukherjee⁴, Kaushik Bose²

¹Department of Anthropology, University of Calcutta, Kolkata, India

²Department of Anthropology, Vidyasagar University, India

³Department of Anthropology, Bangabasi College, Kolkata, India

⁴Anthropological Survey of India, Andaman and Nicobar Regional Centre, Port Blair, India

ABSTRACT: Lip print pattern (LPP) is unique to each individual. For decades, forensic experts have used LPP for personal identification to solve criminal cases. However, studies investigating ethnic variation in LPP are scanty. Our study wanted to investigate variation in LPP between two ethnic groups, Oraon tribals and Bengalee Hindus, residing in West Bengal, India. A total of 280 participants included 112 Oraons and 168 Bengalee Hindus of both. Prints were taken using dark shaded lipstick and transparent cellophane tape and recorded into white A4 sheet. Prints were divided into four quadrants and examined by magnifying glass. For analysis of results, classification of Suzuki and Tsuchihashi was followed. A p value of 0.05 was considered to be statistically significant. It was observed that Type II pattern was dominant in first and second quadrants in both ethnic groups, irrespective of sex. Combination of Type II+III was found to be the most common pattern in males among both Oraons (16.2%) and Bengalee Hindus (12.2%) whereas in females Type II pattern (25.0%) among Oraons and Type III pattern among Bengalee Hindus (11.4%) was the most common. Chi square test showed statistically significant difference among females ($p < 0.05$) and in third and fourth quadrants among males ($p < 0.01$) of both ethnic groups. Our investigation clearly demonstrated sex and ethnic variations in LPP. Further studies are required to investigate ethnic variation in LPP among the various populations groups, both tribal as well as non-tribal, from different regions of India.

KEY WORDS: cheiloscropy, Oraon, Bengalee Hindu

Introduction

In forensic science lip prints are considered as very useful for individual identification as furrows and grooves present on the red portion of human lips are

unique for every person like finger prints except in monozygotic twins (Neville et al. 2002) and remain unchanged with the advancement of age (Gray 2005), even after an infections or injuries heal the original shape and grooves of lips returns (Tsuchihashi 1974). The study of lip

prints is called Cheiloscopy, derived from the Greek words, “cheilo” meaning lips and “skopein” meaning to see (Koneru et al. 2013). In 1902 the renowned anthropologist Fischer first noted the biological phenomenon of system of furrows on the red part of human lips (Cladas et al. 2007). Later famous French criminologist Edmond Locard in 1934 recommended the use of lip prints in personal identification and criminalization (Thomas and van Wyk 1988). Since then, several studies (Abdel Aziz et al. 2016; Ahamed et al. 2018; Ragab et al. 2013) from different parts of the globe have established the uniqueness of Cheiloscopy and its efficacy in use for personal identification. Suzuki and Tsuchihashi are among the first who classified human lips into six types and their classification has been widely used by many in later years (Suzuki and Tsuchihashi 1970; Williams 1991).

In recent years, several studies have been undertaken in India (Randhawa et al. 2011; Babel et al. 2013; Koneru et al. 2013; Kundu et al. 2016; Kapoor and Baidya 2017) to determine the predominance of lip print pattern (LPP) for sex identification from different communities. Most of these studies are from urban areas. Hitherto, investigations on tribal communities are very scanty.

According to 2011 census report, tribal people constitute 8.6% of total population in India. The Oraons are Dravidian speaking dependent on agricultural activity and concentrated in Chotonagpur plateau. They have also migrated to West Bengal, Orissa, Maharastra, Assam and many other states. They are the second largest tribal community in West Bengal constituting 14% of the total tribal population (Census of India 2001).

Our study attempted to determine and compare the predominant lip print

pattern within and between males and females among Oraons and Bengalee Hindus in West Bengal, India.

Materials and Methods

The sample consisted of 280 individuals from two distinct ethnic groups, one representing the Oraon tribal community living at Barpol village of Barasat Block II, suburb area 20 km away from Kolkata and the other Bengalee Hindus from Kolkata city of West Bengal, India. A total 112 Oraon (50 males; 62 females) and 168 Bengalee Hindu (88 males; 80 females) participants. Necessary permission was obtained from local administrative authorities and community leaders before commencement of the study. All the participants were first briefed about the objectives of work and the process and thereafter written consents were taken from them.

The lips were first cleaned and dried with the help of the wet wipes. Then a single coat of lipstick is applied evenly on the whole lip with a brush, after that the single glued transparent cellophane tape was used for recording the lip impression. The impression was recorded on the glued side of the tape and after putting a uniform pressure over the lip; the tape was pulled out with a single jerk and pasted on the white sheet. After recording the impression of the total lip, impressions of the upper lip and lower lip were again recorded separately. Lipsticks were reapplied (if needed) before taking the impressions again. Participants were asked to open their mouth a little so that the corner of the lips could be traced as well and after that the impression of the upper lip and lower lip were recorded on the cellophane tape by following the same process.

Selection criteria of the participants

Participants below 15 years were excluded. People who had chapped lip or any type of allergic reaction to lipstick were excluded. Men having large moustache covering the whole upper lip were also excluded.

We analyzed LPP following the classification of Suzuki and Tsuchihashi (1971) (Figure 1). The classification is:

1. Type I: Clear cut grooves running vertically across the lips.
2. Type I': Straight grooves which disappear half way instead of covering the entire breadth of the lips.

3. Type II: Grooves that fork in their course or branched groove or Y shaped groove.
4. Type III: Intersecting grooves/X shaped groove/diamond grooves.
5. Type IV: Reticular grooves.
6. Type V: Grooves that do not fall into above categories and cannot be differentiated morphologically.

During analysis, we observed the significant presence of more than one pattern in each quadrant in both ethnic groups. Therefore, in order to present the findings more accurately and minutely, the combinations of LPP have been documented in a single quadrant. For example, if Type II and III were predom-

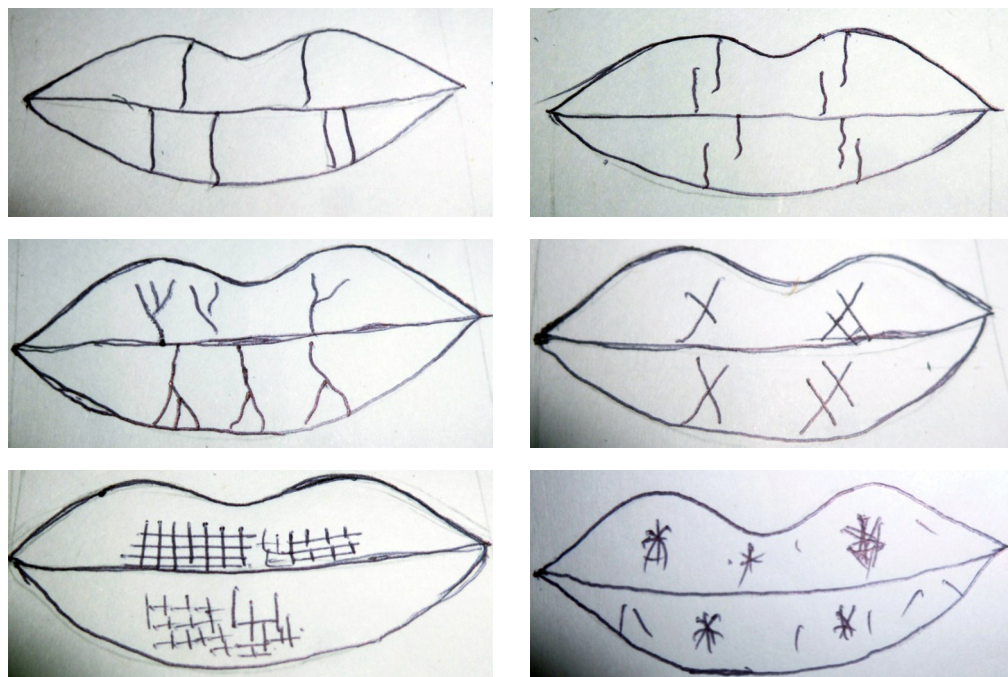


Fig. 1. Classification of lip pattern after Suzuki and Tsuchihashi (1971)

Type I: Clear cut grooves running vertically across the lips.

Type I' Clear vertical grooves but do not run across the entire lip (incomplete).

Type II: Branched groove (branched y pattern).

Type III: Intersected grooves or X shaped groove or diamond grooves.

Type IV: Reticular grooves.

Type V: Undetermined.



Fig. 2.

- A. Lip print pattern of Bengalee Hindu male showing combination of Type II+III pattern in all four quadrants
 B. Lip print pattern of Bengalee Hindu female showing combination of Type III+IV in the first quadrant; Type II in the second quadrant; combination of Type II+III in the third quadrant and combination of Type II+IV pattern in the fourth quadrant



Fig. 3.

- A. Lip print pattern of Oraon male showing combination of Type II+IV in the first quadrant; Type II in the second quadrant; combination of Type II+IV in the third quadrant and Type II in the fourth quadrant
 B. Lip print pattern of Oraon female showing combination of Type II+III pattern in all quadrants

inantly present in a single quadrant then we represented the pattern as a combination of Type II+III (Figure 2 and 3).

All the collected lip prints were analysed blindly by two authors (AD and KD).

Statistical analyses

All statistical analyses were undertaken by using the IBM SPSS Statistical Packages (version 16.0). Chi square (χ^2) test was performed to test significant difference in prevalence of different LPP in all four quadrants of the two communities (Fig. 2 and Fig. 3). A p value of 0.05 was considered to be statistically significant.

Results

Table 1 shows the LPP among Oraon tribal community of West Bengal. Type

II showed the highest frequency in first (61.6%) and second quadrant (53.6%) and combination of Type II+III in third (41.1%) and fourth quadrant (43.8%), respectively, in both sexes. In third quadrant Type II and Type II+III showed the highest frequency of 32.3% among females, whereas males had the highest frequency in Type II+III (52.0%). In fourth quadrant, combination of Type II+III was highest in case of males (60%) whereas Type II was highest in case of females (33.9%) followed by Type II+III (30.6%). Combination of Type III+IV was absent among males and only present among females in the fourth quadrant (3.2%). All the quadrants except, fourth quadrant ($p < 0.05$) showed statistically non-significant difference between sexes.

Table 2 demonstrates the distribution of LPP among Bengalee Hindus. In the first quadrant, both males and females

Table 1. Percentage distribution of lip print patterns among Oraons

Quadrant	Sex	Types of lip print							χ^2
		II	III	IV	I+II	II+III	II+IV	III+IV	
First	M	60.0	8.0	0.0	0.0	16.0	16.0	0.0	5.62
	F	62.9	1.6	3.2	1.6	11.3	19.4	0.0	
	T	61.6	4.5	1.8	0.9	13.4	17.9	0.0	
Second	M	56.0	6.0	0.0	2.0	18.0	18.0	0.0	3.33
	F	51.6	3.2	4.8	3.2	16.1	21.0	0.0	
	T	53.6	4.5	2.7	2.7	17.0	19.6	0.0	
Third	M	12.0	14.0	0.0	2.0	52.0	20.0	0.0	11.04
	F	32.3	9.7	3.2	6.5	32.3	16.1	0.0	
	T	23.2	11.6	1.8	4.5	41.1	17.9	0.0	
Fourth	M	12.0	10.0	0.0	2.0	60.0	16.0	0.0	14.39*
	F	33.9	6.5	0.0	6.5	30.6	19.4	3.2	
	T	24.1	8.0	0.0	4.5	43.8	17.9	1.8	

M= Male; F= Female; T= Total; * $p < 0.05$.

showed highest prevalence of Type II LPP (Male=36.4%; Female=30.0%) followed by the combination of Type II +IV pattern (Male=20.5% and Female=20.0%). Similar result was found in case of second quadrant where Type II pattern had the highest prevalence (28.0%) in both sexes (Male=28.4%; Female=27.5%) followed by combination of Type II+IV pattern i.e. 21.4% (Male=22.7%; Female=20.0%). The third quadrant displayed highest prevalence of combination of Type II+III pattern in case of males (29.5%) but in case of females Type II had the highest prevalence (38.8%). Again, fourth quadrant also demonstrated highest prevalence of Type II+III pattern for males (28.4%) and highest prevalence of Type III pattern in case of females (35.0%). It is also observed that combination of Type III+IV is significantly higher among males in third (25%) and in fourth (23.9%) quadrants. Furthermore, statistically significant sex differences were found in both third quadrant ($p < 0.05$) and fourth quadrant ($p < 0.01$).

Table 3 shows the distribution of LPP in males of both ethnic groups. Type II pattern was highest in both first (Oraon = 60%, Bengalee Hindus = 36.4%) and second quadrant (Oraon = 56.0%, Bengalee Hindus = 28.4%). Third and fourth quadrants showed highest frequency of combination of Type II+III among both Oraons (37.7%) and Bengalee Hindus (39.9%). Statistically significant ($p < 0.01$) ethnic difference was observed in third and fourth quadrants. Surprisingly, in third and fourth quadrants, combination of Type III+IV was absent among Oraons but significantly present among Bengalee Hindus (25.0% and 23.9%, respectively).

Similarly Table 3 revealed LPP of females of both ethnic groups. It was observed that the frequency of Type II pattern was highest in first (44.4%) and second quadrant (38.0%) in both groups. The third quadrant Type II+III showed the highest frequency (26.8%) followed by Type III (26.1%) in both groups. Interestingly, fourth quadrant demonstrated highest frequency of Type II and Type

Table 2. Percentage distribution of lip print patterns among Bengalee Hindus

Quadrants	Sex	Type of lip print										χ^2						
		I	I'	II	III	IV	V	I+I'	I+II	I+III	I+IV		I'+III	I'+IV	II+III	II+IV	III+IV	
First	M	1.1	0.0	36.4	4.5	5.7	1.1	1.1	1.1	0.0	1.1	0.0	1.1	0.0	2.3	14.8	20.5	9.1
	F	1.2	0.0	30.0	12.5	7.5	0.0	3.8	1.2	1.2	0.0	1.2	0.0	0.0	0.0	10.0	20.0	10.0
	T	1.2	0.0	33.3	8.3	6.5	0.6	2.4	1.2	1.8	0.6	0.6	0.0	0.6	1.2	12.5	20.2	9.5
Second	M	0.0	0.0	28.4	6.8	5.7	1.1	2.3	2.3	0.0	1.1	0.0	1.1	0.0	2.3	20.5	22.7	6.8
	F	0.0	2.5	27.5	10.0	6.2	0.0	3.8	1.2	2.5	0.0	0	0	0.0	1.2	16.2	20.0	8.8
	T	0.0	1.2	28.0	8.3	6.0	0.6	3.0	1.8	1.2	0.0	0.6	0.6	0.0	1.8	18.5	21.4	7.7
Third	M	1.1	0.0	4.5	21.6	3.4	0.0	0.0	2.3	0.0	1.1	1.1	1.1	0.0	1.1	29.5	10.2	25.0
	F	1.2	0.0	10.0	38.8	1.2	0.0	0.0	5.0	2.5	3.8	0.0	0.0	2.5	0.0	22.5	5.0	7.5
	T	1.2	0.0	7.1	29.8	2.4	0.0	0.0	3.6	1.2	2.4	0.6	0.6	1.2	0.6	26.2	7.7	16.7
Fourth	M	1.1	0.0	4.5	21.6	2.3	0.0	0.0	3.4	0.0	2.3	1.1	1.1	0.0	0.0	28.4	11.4	23.9
	F	0.0	1.2	20.0	35.0	0.0	0.0	0.0	3.8	1.2	2.5	0.0	0.0	1.2	0.0	22.5	5.0	7.5
	T	0.6	0.6	11.9	28.0	1.2	0.0	0.0	3.6	0.6	2.4	0.6	0.6	0.6	0.0	25.6	8.3	16.1

M = Male; F = Female; T = Total; * $p < 0.05$, ** $p < 0.01$.

Table 3. Comparison of the lip print patterns percentage distribution between the two ethnic groups Oraons and Bengalee Hindu

Quadrants	Ethnic Group	Type of lip print										χ^2						
		I	II	III	IV	V	I+I'	I+II	I+III	I+IV	II+III		II+IV	III+IV				
Males	Oraons	0.0	60.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.92
	Beng. Hindu	1.1	36.4	4.5	5.7	1.1	1.1	1.1	0.0	1.1	2.3	14.8	20.5	9.1	0.0	0.0	0.0	14.46
Second	Oraons	0.0	56.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.82**
	Beng. Hindu	0.0	28.4	6.8	5.7	1.1	2.3	2.3	0.0	1.1	2.3	20.5	22.7	6.8	0.0	0.0	0.0	28.98**
Third	Oraons	0.0	12.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.0	20.0	0.0	0.0	0.0	0.0	25.82**
	Beng. Hindu	1.1	4.5	21.6	3.4	0.0	0.0	2.3	0.0	1.1	1.1	29.5	10.2	25.0	0.0	0.0	0.0	28.98**
Fourth	Oraons	0.0	12.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	16.0	0.0	0.0	0.0	0.0	28.98**
	Beng. Hindu	1.1	4.5	21.6	2.3	0.0	0.0	3.4	0.0	2.3	1.1	28.4	11.4	23.9	0.0	0.0	0.0	28.98**
Females	Oraons	0.0	0.0	62.9	1.6	3.2	0.0	1.6	0.0	0.0	0.0	11.3	19.4	0.0	0.0	0.0	0.0	26.72**
	Beng. Hindu	1.2	0.0	30.0	12.5	7.5	3.8	1.2	2.5	1.2	0.0	10.0	20.0	10.0	0.0	0.0	0.0	26.72**
Second	Oraons	0.0	0.0	51.6	3.2	4.8	0.0	3.2	0.0	0.0	0.0	16.1	21.0	0.0	0.0	0.0	0.0	20.03**
	Beng. Hindu	0.0	2.5	27.5	10.0	6.2	3.8	1.2	2.5	0.0	0.0	16.2	20.0	8.8	0.0	0.0	0.0	20.03**
Third	Oraons	0.0	0.0	32.3	9.7	3.2	0.0	6.5	0.0	0.0	0.0	32.3	16.1	0.0	0.0	0.0	0.0	37.36**
	Beng. Hindu	1.2	0.0	10.0	38.8	1.2	0.0	5.0	2.5	3.8	2.5	22.5	5.0	7.5	0.0	0.0	0.0	37.36**
Fourth	Oraons	0.0	0.0	33.9	6.5	0.0	0.0	6.5	0.0	0.0	0.0	30.6	19.4	3.2	0.0	0.0	0.0	28.01**
	Beng. Hindu	0.0	1.2	20.0	35.0	0.0	0.0	3.8	1.2	2.5	1.2	22.5	5.0	7.5	0.0	0.0	0.0	28.01**

Statistically significant difference at ** $p < 0.01$.

II+III (26.1%) in both groups. In third quadrant, tribal females demonstrated highest prevalence of Type II and Type II+III (32.3%) but Bengali Hindu females showed the highest prevalence of Type III (38.8%) followed by Type II+III (22.5%). Fourth quadrant also showed similar results as Oraon female had highest prevalence of Type II (33.9%) followed by Type II+III (30.6%). Bengalee Hindu females demonstrated the highest frequency of Type III (35.0%) followed by Type II+III (22.5%). Chi square test of all four quadrants demonstrated significant ethnic differences ($p < 0.05$).

Discussion

The present study investigated the prevalence of LPP of Oraons and Bengalee Hindus of West Bengal. The upper lip of Oraons of both sexes showed type II pattern predominantly but lower lip showed some mixed character such as presence of more than one pattern in each quadrant. Similarly, upper lip of Bengalee Hindus showed highest prevalence of type II pattern. Statistically significant sex difference ($p < 0.01$) was observed in lower lip of Bengalees. Furthermore, the comparison of upper lip among Oraon and Bengalee males showed statistically non-significant difference whereas lower lips showed statistically significant difference. Interestingly, both upper and lower lip of Oraons and Bengalee Hindu females demonstrated statistically significant difference. Among Oraons, Type III+IV pattern (3.2%) was found in the fourth quadrants of the females but not males. In case of Bengalee Hindus, Type I' (second quadrant 2.5%, fourth quadrant 1.2%) and combination of Type I'+III (third quadrant 2.5%, fourth quadrant 1.2%) pattern was observed among

females, particularly Type I'+III pattern in lower lips. Specifically Type I'+IV pattern is seen only in second quadrant (Male 2.3%, Female 1.2%) in both sexes. Interestingly, combination of Type I+I' was not observed from any quadrants of lower lip among Bengalees.

Findings of present study were compared with other recent studies from different parts of India and presented in Table 4. It was observed that the most common lip patterns among males were Type IV (36%) (Rao and Kiran 2016) and Type III (34.92%) (Sharma et al. 2017) and among females is Type I (39.4%) (Rao and Kiran 2016) and IV (34%) (Kumar et al. 2016). In our study, combination of Type II+III (12.2 % and 16.2%) among males of both ethnic groups, for females Type III (11.4%) pattern among Bengalee Hindu group and Type II (25%) among Oraon community were the most common patterns. An earlier investigation had reported that the least common lip print type for both males (1.5%) and females (2%) was Type V (Rao and Kiran 2016). We found that a combination of Type I'+II (0.1%) in males and Type I'+IV (0.1%) in Bengalee females and a combination of Type I+II (0.6%) in males and Type III+IV (0.4%) among Oraon females were least common.

Cheiloscopy has attracted attention of many scientists as a new tool for human identification specifically dealing with criminal cases. Many studies (Domiaty et al. 2010; Sharma et al. 2014) have confirmed that the LPP is unique for each individual, even in twins and within families. The stability of LPP over time has tested, validated and recommended for secure use in civil and criminal investigations (Domiaty et al. 2014). More importantly, lip print can be a useful aid for assessing ethnic variability. This

Table 4. Comparison across different Indian studies on the prevalence of lip print patterns

Study population	Study area	Sample size	Age group (years)	Most common pattern		Least common pattern		References
				Males	Females	Males	Females	
Medical and dental students	Telengana	300	17-25	IV 36.0%	I 39.0%	II 4.0%	V 5.0%	Rao and Kiran 2016
Rural and urban localities	Patna, Bihar	90	15-57	IV 32.5%	IV 34.0%	V 1.5%	V 2.0%	Kumar et al. 2016
Indian population	India	400	-	III 32.0%	II 33.0%	IV 10.0%	I 7.5%	Gupta et al. 2016
Medical students	Hyderabad	100	17-19	I 66.0%	I and II 44.0%	III and IV 2.0%	III 0%	Alazapur et al. 2017
Students of dental studies and technologies	Uttar Pradesh	500	18-30	III 34.9%	I 35.9%	II 5.1%	V 3.6%	Sharma et al. 2017
Bengalee Hindus	West Bengal	168	15-70	II+III 12.2%	III 11.4%	I+II 0.1%	I+IV 0.1%	Present study
Oraons	West Bengal	112		II+III 16.2%	II 25.0%	I+II 0.6%	III+IV 0.4%	

has immense applications in biological anthropology.

One of the major limitations of our study is the small sample size. Regardless of this constraint, to the best of our knowledge, this study is the first endeavor to investigate LPP variation between tribal and non-tribal populations of West Bengal. Considering the fact that India is a country with vast ethnic heterogeneity, we recommend that further studies be undertaken with larger samples sizes from different population groups in India. From the biological anthropology viewpoint, of particular interest would be the indigenous populations of India. Data generated from such investigations would be useful for studying human variation. Hitherto, such studies are lacking from India.

Conclusion

Our study clearly demonstrated that there existed sex and ethnic variations in LPP among Oraons and Bengalee Hindus of West Bengal, India.

Acknowledgements

The authors gratefully acknowledge all the study participants for their co-operation. Authors would also like to acknowledge Alok Kumar Chanak, Nakul Oraon and Nirapada Oraon for their help.

Authors' contribution

AD, MC, KD and KM designed the study and collected the data. Data entry and analysis were performed by AD and MC. Review of literature and preparation of first draft of the manuscript were done by MC, KD and KM. KB designed the study and critically revised the manuscript.

Conflict of interest

None declared.

Corresponding author

Kaushik Bose, Department of Anthropology, Vidyasagar University, Midnapore, West Bengal, India – 721 102
e-mail: kaushikbose@cantab.net

References

- Abdel Aziz MH, Badr El Dine FM, Saeed NM. 2016. Regression equations for sex and population detection using the lip print pattern among Egyptian and Malaysian adult. *J Forensic Leg Med* 44:103–11.
- Ahmed SA, Salem HE, Fawzy MM. 2018. Forensic dissection of lip print as an investigative tool in a mixed Egyptian population. *Alexandria J Medicine* 54:235–39.
- Alzapur A, Nagothu RS, Nalluri HB. 2017. Lip prints – A study of its uniqueness among students of MediCiti Medical College. *Indian J Clin Anat Physiol* 4:68–70.
- Babel H, Gandrade PR, Jain LK. 2013. Anthropometric study of craniofacial parameters of adult population of tribals of Mewar region in Southern Rajasthan. *JMHS* 2:27–30.
- Caldas IM, Magalhães T, Afonso A. 2007. Establishing identity using cheiloscopy and palatoscopy. *Forensic Sci Int* 165:1–9.
- Census of India. 2001. Office of the Registrar General and Census Commission. Government of India. New Delhi. Available at: http://www.censusindia.gov.in/Tables_Published/SCST/dh_st_westbengal.pdf Accessed on July 21, 2019.
- Census of India. 2011. Office of the Registrar General and Census Commission. Government of India. New Delhi. Available at: <http://www.censusindia.gov.in> Accessed on July, 21, 2019.
- Domiatty MAE, Al-gaidi SA, Elayat AA, Safwat MDE, Galal SA. 2010. Morphological patterns of lip prints in Saudi Arabia at Almadinah Almonawarah province. *Forensic Sci Int* 179:1–9.
- Domiatty MAE, Anwar RI, Algaidi SA. 2014. Stability of lip-print patterns: a longitudinal study of Saudi females. *J Forensic Legal Med* 22:154–58.
- Gray. 2005. *Gray's Anatomy-The anatomical basis of clinical practice*. 39th ed. London: Elsevier Churchill Livingstone. 497–98.
- Gupta A, Sharma N, Jain SK, Khatun SS. 2016. CHEILOSCOPY: A Tool for Sexual Dimorphism in India. *Int J Anat Res* 4:2579–83.
- Kapoor N, Badiye A. 2017. A study of distribution, sex differences and stability of lip print patterns in an Indian population. *Saudi J Biol Sc* 24:1149–54.
- Koneru A, Surekha R, Nellithady GS, Vanishree M, Ramesh D, Patil RS. 2013. Comparison of lip prints in two different populations of India: Reflections based on a preliminary examination. *J Forensic Dent Sci* 5:11–15.
- Kumar A, Prasad SN, Kamal V, Priya S, Kumar M, Kumar A. 2016. Importance of cheiloscopy. *Int J Oral Care Res* 4:48–52.
- Kundu S, Gangrade P, Jatwar R, Rathia D. 2016. Chiloscopy – A diagnostic and deterministic mirror for establishment of person identification and gender discrimination: A study participated by Indian Medical Students to aid legal proceedings and criminal investigations. *J Exp Clin Anat* 15:31–42.
- Neville B, Damm D, Allen C, Bouquot J. 2002. *Oral and Maxillofacial Pathology*. 2nd ed. Philadelphia. WB Saunders Company. 763–74.
- Ragab AR, El-Dakroory SAEA, Rahman RHA. 2013. Characteristic patterns of lip prints in Egyptian population sample at Dakahlia Governorate. *Int J Legal Med* 127:521–27.
- Randhawa K, Narang RS, Arora PC. 2011. Study of the effect of age changes on lip print pattern and its reliability in sex determination. *J Forensic Odontostomatol* 29:45–51.
- Rao GV, Kiran G. 2016. Assessment of lip print pattern in South Indian population

- role in forensic medicine. *Asian Pac J Health Sci* 3:224–27.
- Sharma BS, Gupta V, Vij H, Sharma E, Tyagi N, Singh S. 2017. Cheiloscopy: A tool for antemortem identification. *Indian J Dent Sci* 9:176–80.
- Sharma NA, Domiaty MAE, Gutiérrez-Re-domero E, George AO, Garud RS, Sánchez-Andrés A, et al. 2014. Diversity of human lip prints: a collaborative study of ethnically distinct world populations. *Ann Hum Biol* 41:568–78.
- Suzuki K, Tsuchihashi Y. 1971. A new attempt of personal identification by means of lip print. *Can Soc Forensic Sci* 4:154–58.
- Suzuki K, Tsuchihashi Y. 1970. New attempt of personal identification by means of lip print. *J Indian Dent Assoc* 42:8–9.
- Thomas CJ, van Wyk CW. 1988. The palatal rugae in identification. *J Forensic Odontostomatol* 6:21–7.
- Tsuchihashi Y. 1974. Studies on personal identification by means of lip prints. *J Forensic Sci* 3:233–48.
- Williams TR. 1991. Lip prints – another means of identification. *J Forensic Ident* 41:190–94.