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Kertas Asli/*Original Articles*

Sex Determination Using Direct Photography Technique: a Mobile-phone Camera: A Digital Approach for Lip Prints Analysis in Malaysian Malay Population (Klang Valley)

(Penentuan Jantina Menggunakan Teknik Fotografi Terus: Kamera telefon bimbit: Pendekatan Digital untuk Analisis Cetakan Bibir dalam Penduduk Melayu Malaysia (Lembah Klang)

ABSTRACT

Cheiloscopy may not be as well-known as other techniques of identification, such as fingerprint or DNA analysis, but it has its own impact in the appropriate circumstances. Cheiloscopy has been recognized as an important tool for human identification. A manual approach of studying lip prints was utilised by many researchers (magnifying glasses). Nonetheless, the current study relied solely on a mobile phone camera to visually capture lip prints for sex determination. 377 samples of lip prints were analysed with Adobe Photoshop software and classified into six different types of lip print patterns, according to Suzuki and Tsuchihashi classifications. Lip prints were divided into six sections including upper left, upper middle, upper right, lower left, lower middle and lower right. Pearson's Chi-square test revealed significant differences between male and female lip prints ($p < 0.05$) among the Malaysian Malay population of the Klang Valley, with Type V (irregular pattern) lip prints being the most prevalent. In comparison to magnifying glasses, our studies proved the ability to record and examine lip prints utilising a digital approach.

Keywords: Cheiloscopy, Suzuki and Tsuchihashi classification, sex determination, lip print, direct photograph technique, digital

ABSTRAK

Analisis cap bibir bukanlah teknik identifikasi yang terkenal seperti analisis cap jari atau DNA namun ia juga boleh memberi impak dalam keadaan yang bersesuaian. Analisis cap bibir telah diterima sebagai alat yang penting untuk identifikasi manusia. Kebanyakan penyelidik menggunakan kanta pembesar untuk analisis cap bibir. Sebaliknya, kajian ini menggunakan kemera telefon mudah alih untuk mengambil gambar cap bibir bagi membezakan jantina. 377 sampel cap bibir telah dianalisis menggunakan perisian Adobe Photoshop dan diklasifikasikan kepada enam corak cap bibir yang berbeza berdasarkan pengkelasan Suzuki dan Tsuchihashi. Cap bibir telah dibahagikan kepada enam bahagian iaitu kiri atas, tengah atas, kanan atas, kiri bawah, tengah bawah dan kanan bawah. Ujian khi-square Pearson menunjukkan perbezaan signifikan antara cap bibir lelaki dan wanita ($p < 0.05$) dalam populasi Melayu Malaysia di Lembah Klang, dengan Jenis V (corak tidak teratur) adalah prevalen. Kajian ini telah menunjukkan bahawa kaedah digital boleh digunakan untuk merekod dan memeriksa cap bibir berbanding dengan penggunaan kanta pembesar.

Kata Kunci: Analisis cap bibir, klasifikasi Suzuki dan Tsuchihashi, pengesahan jantina, cap bibir, teknik fotographi langsung, digital

INTRODUCTION

Over the years, personal identification has always been associated with fingerprint, DNA analysis, and dental record as well-known approaches (Venkatesh & David 2011). The latest approaches also include iris and retina scans, face recognition, voice analysis and palm vein authentication (Bhatia 2013). Use of multiple identification markers will reduce likelihood of false positive identification (Deshmukh 2015). Occurrence of mass disaster is a typical example where every possible mean of identification is crucial in victim identification. Thus, it is important to have ample preparation for a critical situation.

One of the viable disciplines in human identification is cheiloscopy. Cheiloscopy is the study of the groove patterns and furrows that form on the red part of the lip, within the vermillion border. This biological phenomenon

was first described by an anthropologist, R. Fischer in the 1902 (Kasprzak 1990), however, only after 1950s, extensive researche regarding the lip print pattern was carried out. One of these studies was led by two Japanese scientists, Yasuo Tsuchihashi and Tazuo Suzuki with examination of 1364 samples in Tokyo (Multani et al. 2014). With the continuous progress in this research field, it can be concluded that the lip print patterns are unique to each and every person (Multani et al. 2014; Nagrale et al. 2014; Tsuchihashi 1974), even in monozygotic twins (El Domiaty et al. 2010; Jaishankar et al. 2010; Kapoor & Badiye 2017; Tsuchihashi 1974). It is also proven that the lip prints are permanent in chronological development of individual (Eldomiaty et al. 2014; Tsuchihashi 1974), making it suitable for human identification.

Researche in the field of cheiloscopy was once carried out thoroughly by Suzuki & Tsuchihashi in the 1970s, but currently, it has once again become a popular research interest, especially in India. A summary of cheiloscopy studies conducted around the world is shown in Table 1. Cheiloscopy studies in Malaysia are progressing very slowly, although there is an insight provided by Neo et al. when they studied the lip print patterns of students in Universiti Kebangsaan Malaysia, Kuala Lumpur Campus, Malaysia (Neo et al. 2012). It is suggested that there are possibilities to differentiate students of opposing sex based on their lip print patterns but not between races. In this current study, the relationship between sexes and lip print patterns in Malay population was therefore analysed. The dominant pattern of the lip in each section was recorded. The outcome of this research will hopefully be used in future regarding sex differentiation in Malaysian Malay population using lip print pattern. Some modifications were added into current research where the lip prints from the samples were collected using a digital approach: the direct photograph technique. This modification was intended to increase the effectiveness of result analysis and the storage of data, as suggested by these authors (Margot 2011; National Academy of Sciences 2009). The use of the digital method is more favourable instead of relying on a subjective approach for lip print impressions, such as using a magnifying glass for lip print visualisation. Every quadrant of the lip prints can be captured using a mobile-phone camera compared to the lifting the lip prints using cellophane tapes. In addition, photographs from the lip prints can be viewed (enlarged) for better visualisation of the groves compared to magnifying glasses. Hopefully the outcome of the current research would be useful for human identification and determination of sex in future.

TABLE 1. Comparison of cheiloscopy studies from previous researches and the result from the current study

Authors	Population	No. of subject	Lifting technique	Area of study	Dominant pattern found
Multani S et al. (Multani et al. 2014)	Indian	200 (100 males+100 females)	Lipstick-cellophane tape technique	Middle part only	I
Kinra M et al. (Kinra et al. 2014)	Indian	40 (20 males+20 females)	Lipstick-cellophane tape technique-bond paper	Middle part only	III
Remya S et al. (Remya et al. 2016)	Indian	200 (100 males+100 females)	Lipstick-cellophane tape technique – scanning technique	Middle part only (lower)	IV
Verghese AJ et al. (Verghese et al. 2010)	Indian	100 (50 males+50 females)	Lipstick-cellophane tape technique-bond paper	Middle part only (lower)	IV
Kumar A et al. (Kumar et al. 2016)	Indian	90 (45 males+45 females)	Lipstick-bond paper technique	Whole lips	IV
Vijay Kautilya D et al. (Kautilya et al. 2013)	Indian	100 (50 males+50 females)	Lipstick-cellophane tape technique-bond paper	Whole lips	I
Ishaq et al. (Ishaq et al. 2018)	Pakistan	250 (125 males+125 females)	Lipstick-cellophane tape technique-bond paper	Whole lips	I
Koneru et al. (Koneru et al. 2013)	Indian	60 (30 males+30 females)	Lipstick-cellophane tape technique	4 quadrants	I

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Kapoor N et al. (Kapoor & Badiye 2017)	Indian	200 (100 males+100 females)	Direct photography technique (Nikon D3100 14.2 MP)	4 quadrants	I
Bindal U et al.	Indian	50 (25 males+25 females)	Lipstick-bond paper technique	4 quadrants	II
Manipady (Manipady 2001-2002)	Indian and Chinese origin students	50 Indian + 50 Chinese	Not Available	Not Available	II
Gondivkar et al. (Gondivkar et al. 2009)	Indian	140 (70 males+70 females)	Lipstick-bond paper technique	4 quadrants	II
Nagrale et al. (Nagrale et al. 2014)	Indian	500 (250 males+250 females)	Lipstick-bond paper technique	4 quadrants	III
Prabhu RV et al. (Prabhu et al. 2013)	Indian dental students	100	Lipstick-cellophane tape technique– scanning technique (300dpi scanner)	4 quadrants	V
Durbakula et al. (Durbakula et al. 2015)	Indian and Malaysian dental students	64 (Indian: 16 males+16 females, Malaysian: 16 males+16 females)	Lipstick-cellophane tape technique-bond paper technique	4 quadrants	II (Indians) I' (Malaysians)
Neo et al. (Neo et al. 2012)	Malaysian Malays	88 (44 males+44 females)	Lipstick-cellophane tape technique	4 quadrants	I'
Wan Rafiuddin et al. (Wan Rafiuddin et al. 2018)	Malaysian Malays	360 (180 males + 180 females)	Lipstick-cellophane tape technique	6 sections	II
Mohd Seliman et al. (Mohd Seliman et al. 2020)	Malaysian Chinese	412 (203 males + 209 females)	Lipstick-cellophane tape technique	6 sections	II
Nur Sabrina et al. (Nur Sabrina Sarah et al. 2019)	Malaysian Malays	360 (180 males + 180 females)	Photograph on lipstick- cellophane tape technique (13MP mobile-phone camera)	6 sections	V
(Noor Hazfalinda et al. 2020)	Malaysian Chinese	412 (203 males + 209 females)	Photograph on lipstick- cellophane tape technique (14MP digital camera)	6 sections	II and IV
(Jamaludin et al. 2021)	Malaysian Malays	360 (180 males + 180 females)	Lipstick-cellophane tape technique– scanning technique (300dpi scanner)	6 sections	V
(Noor Hazfalinda et al. 2021)	Malaysian Chinese	412 (203 males + 209 females)	Lipstick-cellophane tape technique– scanning technique (300dpi scanner)	6 sections	II
Current study	Malaysian Malays	377 (200 males +177 females)	Direct photography technique (16MP mobile-phone camera)	6 sections	V

MATERIALS AND METHOD

SUBJECT

A total of 200 Malaysian Malay males and 177 Malaysian Malay females were selected through convenient sampling for lip print collection. This was an arbitrary decision of the subject population. Informed consent was obtained from all of the subjects and ethic approval was received from the institutional ethics committee (Code: UKM PPI/111/8/JEP-2018-133).

INCLUSION EXCLUSION CRITERIA

Inclusive criteria were the Malaysian Malay population (for three consecutive generations, Malaysian identity card needed to be shown before the acquisition of lip prints), females and males. Only subjects without oral pathologies, inflammation, abnormalities or deformities such as cleft lips, cut marks, surgical scars or lip lesions were selected for this study. Subjects who exhibited hypersensitivity to lipsticks were excluded from the study (Augustine et al. 2008; Neo et al. 2012). Age was not a concern because lip prints do not change in life unless major trauma or disease occurs (Gondivkar et al., 2009).

ACQUISITION OF LIP PRINT

The direct photography method was selected for the acquisition of lip prints due to its simplicity. Briefly, a single layer of SilkyGirl code 03 Siren Red color lipstick (less greasy, non-glossy and red coloured) was applied across the lip after cleaning it with wet tissue to identify the area of the lip containing an impression (Neo et al. 2012). This lipstick was chosen because it was recommended by Neo et al., (2012) in their studies for better visualisation of the grooves on the lip prints. All subjects were required to be at ease with lips closed during the photography session, so that the unique pattern of their lips was due to the way muscle relaxed in each individual (Augustine et al. 2008). Each photograph was taken so that the groove on the lips was clearly visible for the whole lip. A Xiaomi Redmi Note 3 mobile-phone with 16 a mega pixels camera was used for images acquisition. All subjects were sit on a chair (similar chair was used during this entire study), the mobile-phone camera was set with auto focus and grid were applied, image of whole quadrant of the lip prints were captured within the grid of the camera. Mobile-phone was fixed onto a tripod, in upright position, for stabilization and adjusted according to height of the lips of subjects.

CLASSIFICATION OF LIP PRINT

Suzuki and Tsuchihashi classification of lip prints (Tsuchihashi 1974) was used in this study due to thorough research data available on this classification technique (Augustine et al. 2008). Lip print pattern in each section was classified into one of the six patterns proposed: type I is clear-cut grooves running vertically across the lip, type I' for the grooves that are straight but disappeared half-way instead of covering the entire breadth of the lip, type II – the grooves fork in their course, type III – the grooves intersect, type IV – the grooves that are reticulate and type V – the grooves do not fall into any of the previous types (I-IV) and cannot be differentiated morphologically (Fig. 1).

The lips were then divided equally into 3 sections using Adobe Photoshop. At both the upper and lower parts of lips, each section was labeled accordingly from left to right as upper left section (UL), upper middle section (UM), upper right section (UR), lower right section (LR), lower middle section (LM) or lower left section (LL) in a clockwise rotation for the whole lips (Fig. 2). Each section was then examined separately to determine the dominant pattern in the lips. Lips were divided into 6 sections in this study, opposing to the 4 quadrants used in other past research, after taking consideration of the lip print availability at crime scenes. A complete lip print is rarely found at crime scenes, whereby only some portions of the lip could be seen more frequently than the other portion (Kautilya et al. 2013). Indeed, lower middle section (LM) was found more regularly at crime scenes considering that the location of the lip print observed is usually at a drinking glass or a can (Kumar et al. 2016).

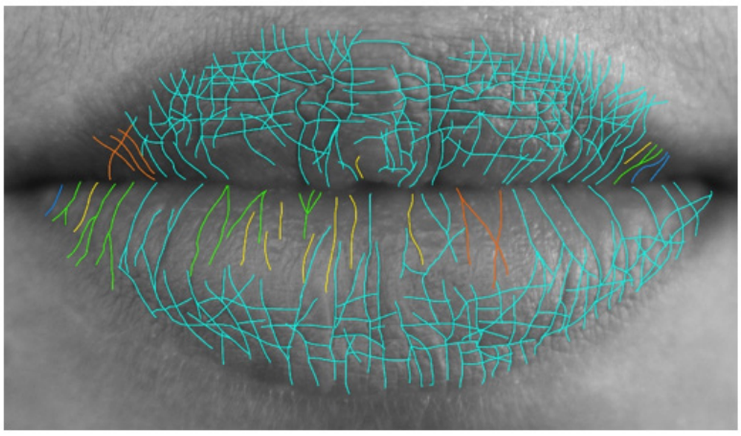

FIGURE 1 Colour representation of lip print pattern: type I (blue), type I' (yellow), type II (green), type III (orange), type IV (turquoise) and type V (purple). However type V was not seen here

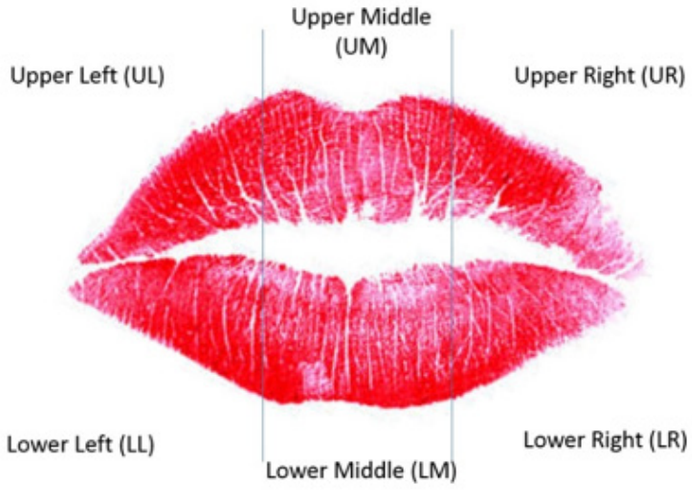

FIGURE 2 Section of lips named accordingly from left to right as upper left section (UL), upper middle section (UM), upper right section (UR), lower right section (LR), followed by lower middle section (LM) and finally lower left section (LL) in a clockwise rotation for whole lips

STATISTICAL ANALYSIS

Chi-Square test was used to determine the significant differences in lip print patterns between sexes and $p < 0.05$ was considered statistically significant.

RESULTS

The dominant pattern in each section was determined and recorded respectively for both male and female groups. The result was then tabulated (Table 2). Pearson's chi-square test showed significant differences in lip print pattern between sexes for all sections of lip ($p < 0.05$) except for the UM section ($p > 0.05$), as shown in Table 3.

TABLE 2 Percentage of distribution of lip print pattern in each section between male and female

		Lip print pattern						
		Type I	Type I'	Type II	Type III	Type IV	Type V	Total (%)
Male	UL	0.0	0.0	0.0	0.5	0.0	99.5	100
	UM	0.0	0.0	0.5	0.0	1.5	98.0	100
	UR	0.0	0.0	0.5	0.0	0.0	99.5	100
	LR	0.0	0.5	0.0	0.0	0.0	99.5	100
	LM	0.5	4.0	0.5	0.5	1.5	93.0	100
	LL	0.0	0.0	0.0	1.0	0.0	99.0	100
Female	UL	0.0	1.1	6.8	6.2	3.4	82.5	100
	UM	0.0	0.6	1.7	1.1	5.1	91.5	100
	UR	0.0	1.7	1.7	4.5	2.3	89.8	100
	LR	0.6	2.8	2.3	6.2	1.1	87.0	100
	LM	0.6	1.7	1.7	4.0	11.3	80.8	100
	LL	1.7	6.2	4.0	7.9	0.0	80.2	100

TABLE 3. Pearson chi-square test result

Section of lips	Significant value (p)	
Upper left	$p < 0.05$	Significant
Upper middle	$p > 0.05$	Not significant
Upper right	$p = 0.001$	Significant
Lower right	$p < 0.05$	Significant
Lower middle	$p < 0.05$	Significant
Lower left	$p < 0.05$	Significant

The most dominant lip print pattern found in both sexes in the Malaysian Malay population in Klang Valley was type V, ranging from 80.2% to 99.5% across different sections. The top three lip print patterns with thehighest percentage for both sexes in each section are shown in Table 4. Each and every section showed a different combination of the top three lip print patterns with the highest percentage among all male and female subjects.

TABLE 4. Top three highest percentage of lip print pattern in different sections between male and female

		Highest percentage lip print pattern		
		Most dominant	Second	Third
Upper Left (UL)	Male	V	III	-
	Female	V	II	III
Upper Middle (UM)	Male	V	IV	II
	Female	V	IV	II
Upper Right (UR)	Male	V	II	-
	Female	V	III	IV
Lower Right (LR)	Male	V	I'	-
	Female	V	III	I'
Lower Middle (LM)	Male	V	I'	IV
	Female	V	IV	III
Lower Left (LL)	Male	V	III	-
	Female	V	III	I'

At a glance, differentiating sexes based on overall lip print pattern seemed impossible since both sexes had type V as their most dominant pattern across different sections. On top of that, the insignificant findings in the UM region also made the differentiation of sexes based on lip print patterns more difficult. Nonetheless, there were still some lip print patterns that occurred more frequently at certain sections of lips than others. Table 5 shows the types of lip prints noted in sections of lip that were exclusive in male or female, as well as the non-exclusive lip print patterns.

TABLE 5. Frequency of subjects with specified lip print pattern

Lip Section	Type	Frequency			Possible Gender
		Male	Female	Total	
UL	II	0	12	12	Female (100%)
	III	1	11	12	Female (91.7%)
UR	II	1	3	4	Female (75.0%)
	III	0	8	8	Female (100%)
	IV	0	4	4	Female (100%)
LR	I’	1	5	6	Female (83.3%)
	III	0	11	11	Female (100%)
LM	I’	8	3	11	Male (72.7%)
	III	1	7	8	Female (87.5%)
	IV	3	20	23	Female (87.0%)
LL	I’	0	11	11	Female (100%)
	III	2	14	16	Female (87.5%)

DISCUSSION

Based on Table 5, for UL section, if a lip print is found at the crime scene, and type II or type III are the dominant lip print patterns found, there is a possibility that the lip print comes from a female. Females showed the highest frequency of both type II (100%) and type III (91.7%) lip print patterns in UL section. Females again displayed the highest frequency (100%) of having type III and IV lip print patterns in UR section, type III alone in LR section and type I’ in LL section. Conversely, males had the highest frequency (72.7%) of the type I’ lip print pattern in LM section. Although the percentage of males with type I’ pattern in LM section was not as high as the females for other sections (mostly 100% frequency), this finding showed that males could be identified exclusively, if type I’ lip print is found dominant for LM section on the lip print evidence. These results showed in overall that there is a possibility for sex determination with lip print patterns among the Malaysian Malay population in Klang Valley.

As stated earlier, the lip print patterns present in certain lip sections might suggest the involvement of a specific sex that might aid in forensic investigation, although the frequency of subjects with the combination of lip print region and lip print typing was relatively low compared to a total of 377 samples. However, the present study showed a significant difference in lip print patterns between male and female similar to other past researche (Augustine et al. 2008; Jeergal et al. 2016; Kapoor & Badiye 2017; Multani et al. 2014; Neo et al. 2012; Remya et al. 2016; Šimović et al. 2016). The dominant pattern for both genders in all sections of lips was type V; in agreement with two studies (Nur Sabrina Sarah et al. 2019; Prabhu et al. 2012) that noted type V as the most dominant lip print pattern. Prabhu et al. (Prabhu et al. 2012) lifted the lip prints of students at Goa Dental College & Hospital, Bambolim, using the lipstick-cellophane technique, scanned the lip print image using a 300dpi scanner and Adobe Photoshop software was used for visual comparison. Conversely, Nur Sabrina et al. (Nur Sabrina Sarah et al. 2019) analysed lip prints of 380 subjects (Malaysian Malay population of Klang Valley) from photographic images of lip prints, acquired by lipstick-cellophane tape technique, using a 13 mega pixels mobile-phone camera and Adobe Photoshop for visual comparison. The results of the current study were however different from Kapoor et al. (Kapoor & Badiye 2017), even though the similar method of image acquisition was used. Kapoor et al. used a 14.2 mega pixels Nikon D3100 camera to capture lip print of 100 Indian males and females in India and they discovered that type I was the dominant lip print in all 4 quadrants. Their results were probably different due to different sample sizes from current study, different geographical and ethnicity of subjects and only involvement of 4 quadrants instead of 6.

There are some researchers who previously analysed lip print pattern of Malaysian Malay population in Malaysia, such as Neo et al. (Neo et al. 2012) and Durbakula et al. (Durbakula et al. 2015). They noted that type I’ lip print was the most dominant type in Malay

population, different from the results of the current study (type V). One possible reason for such observation is the difference in sample size (377 Malays were studied in the current study compared to 88 Malays studied by Neo et al. and 32 Malays studied by Durbakula et al.). The method of lip print acquisition was also different between current and these past studies. Both Neo et al., (2012) and Durbakula et al., (2015) used lipstick-cellophane tape technique to obtain the lip print and visual comparison was done without using image analysis software. For the current study however, all lip print images were visualised digitally using Adobe Photoshop software, for a clearer view of the lip print images (Prabhu et al. 2013).

According to these researchers, the middle part of the lips is the most common part of crime scene lip printing (Kinra et al. 2014; Multani et al. 2014) and photography of the lip print is one of the methods used to present the evidence to the court (Osman et al. 2018). As a result, the method of image acquisition in this study can therefore be suggested for the collection of evidence at the crime scene in respect of part of the lip prints present at the crime scene. Furthermore, although some pressure is applied from the lips on the surface of the object, the use of software to visualize and scrutinize lip print patterns with the aid of digital photography can be used to better interpret the lip print evidence found on the crime scene.

Most cheiloscopy studies adopted lip print collections using lipstick-cellophane tape technique and analyzed them using magnifying glasses for visual comparison, however, lip print collection using the direct photograph method might provide certain advantages, namely easier lip print sample collection (Kapoor & Badiye 2017) and more convenient data storage (Neo et al. 2012). Unfortunately, there are several drawbacks concerning this method. The major concern is that the 3D structure of the lip will be a challenge for the photographer to capture with every detailed pattern of the groove and furrow form on the red part of the lip in different planes of focus, especially the central region of the lip (Prabhu et al. 2013). Besides photography, when lifting lip print from a different surface, other methods such as magna brush, chromatography, aluminum powder, cobalt oxide and lysochromes reagents might be worth a try (Nagrale et al. 2014). It should be noted however that the lysochromes dye technique is referred to as "labour-intensive and technique-sensitive" (Jeergal et al. 2016). It is recommended to digital scoring system as a method of analysis (Prabhu et al. 2012) on digital images to synthesize an individual score unique for each lip print. This scoring system is appropriate when developing a database or for use in a sorting system. The score might not serve the purpose when an unknown lip print sample obtained from the crime scene are incomplete, or the central region is not clear, leading to researchers being unable to score the unknown lip.

CONCLUSION

Cheiloscopy can be used for person identification (sex determination) especially in the forensic science. This current study suggested that cheiloscopy can assist in human identification but had room for improvement. As it is not an infallible approach, future research is crucial in validating the procedure of cheiloscopy in investigation and in database construction. Although cheiloscopy might have its own drawbacks compared to other types of identification methods which incorporate high-tech instruments such as fingerprint scannersand methods that are more popular in the public society in the era of technology advancement, however cheiloscopy might serve its purpose when the lip print is the only leading clue in an investigation.

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REFERENCE

Augustine, J., Barpande, S.R. & Tupkari, J.V. 2008. Cheiloscopy as an adjunct to forensic identification: a study of 600 individuals. *J Forensic Odontostomatol* 26(2): 44-52.

Bhatia, R. 2013. Biometrics and Face Recognition Techniques. *International Journal of Advanced Research in Computer Science and Software Engineering* 3(5): 93-99.

Deshmukh, R.A. 2015. Need for Newer Techniques for Personal Identification. *Journal of Forensic Research* 6(3).

Durbakula, K., Kulkarni, S., Prabhu, V., Jose, M. & Prabhu, R. 2015. Study and comparison of lip print patterns among Indian and Malaysian dental students. *Journal of Cranio-Maxillary Diseases* 4(1): 5.

El Domiaty, M.A., Al-gaidi, S.A., Elayat, A.A., Safwat, M.D. & Galal, S.A. 2010. Morphological patterns of lip prints in Saudi Arabia at Almadinah Almonawarah province. *Forensic Sci Int* 200(1-3): 179.e171-179.

Eldomiaty, M.A., Anwar, R.I. & Algaidi, S.A. 2014. Stability of lip-print patterns: a longitudinal study of Saudi females. *J Forensic Leg Med* 22: 154-158.

Gondivkar, S., Indurkar, A., Degwekar, S. & Bhowate, R. 2009. Cheiloscopy for sex determination. *Journal of Forensic Dental Sciences* 1(2): 56-60.

Ishaq, N., Malik, A.R., Ahmad, Z. & Ullah, S.E. 2018. Determination of Sex by Cheiloscopy as an Aid to Establish Personal Identity. *Annals of King Edward Medical University* 24(1).

Jaishankar, S., Jaishankar, N. & Shanmugam, S. 2010. Lip Prints in Personal Identification. *Journal of Indian Academy of Dental Specialist Researchers* 1(4): 23-26.

Jamaludin, U.K., Gabriel, G.F., Osman, K. & Noor Hazfalinda, H. 2021. Digital Approach for Lip Prints Analysis in Malaysian Malay population (Klang Valley): Scanning Technique. *Jurnal Sains Kesihatan Malaysia* 19(1): 31-38.

Jeergal, P.A., Pandit, S., Desai, D., Surekha, R. & Jeergal, V.A. 2016. Morphological patterns of lip prints in Mangaloreans based on Suzuki and Tsuchihashi classification. *J Oral Maxillofac Pathol* 20(2): 320-327.

Kapoor, N. & Badiye, A. 2017. A study of distribution, sex differences and stability of lip print patterns in an Indian population. *Saudi Journal of Biological Sciences* 24(6): 1149-1154.

Kasprzak, J. 1990. Possibilities of cheiloscopy. *Forensic Science International* 46(1): 145-151.

Kautilya, D.V., Bodkha, P. & Rajamohan, N. 2013. Efficacy of Cheiloscopy in Determination of Sex Among South Indians. *Journal of Clinical and Diagnostic Research : JCDR* 7(10): 2193-2196.

Kinra, M., Ramalingam, K., Sethuraman, S., Rehman, F., Lalawat, G. & Pandey, A. 2014. Cheiloscopy for Sex Determination: A Study. *Journal of Dentistry* 4(1): 48-51.

Koneru, A., Surekha, R., Nellithady, G.S., Vanishree, M., Ramesh, D. & Patil, R.S. 2013. Comparison of lip prints in two different populations of India: Reflections based on a preliminary examination. *Journal of Forensic Dental Sciences* 5(1): 11-15.

Kumar, A., Prasad, S.N., Kamal, V., Priya, S., Kumar, M. & Kumar, A. 2016. Importance of Cheiloscopy. *Int J Oral Care Res* 4(1): 48-52.

Manipady, S. (2001-2002). *A comparative study of lip print patterns among Indians and Chinese in Manipal* (Dissertation), Manipal Academy of Higher Education, Manipal, India.

Margot, P. 2011. Commentary on the Need for a Research Culture in the Forensic Sciences. 58: 795-801. http://www.uclalawreview.org/pdf/58-3-6.pdf. (accessed date).

Mohd Seliman, A.F.F., Noor Hazfalinda, H., Gabriel, G.F. & Osman, K. 2020. Lip Print Analysis in Malaysian Chinese Population (Klang Valley): Lipstick-Cellophane Tape Technique. *Jurnal Sains Kesihatan Malaysia* 18(2): 31-38.

Multani, S., Thombre, V., Thombre, A. & Surana, P. 2014. Assessment of lip print patterns and its use for personal identification among the populations of Rajnandgaon, Chhattisgarh, India. *J Int Soc Prev Community Dent* 4(3): 170-174.

Nagrale, N., Bipinchandratirpude, Murkey, P. & Patond, S. 2014. Establishing Cheiloscopy as a Tool for Identification: An Assessment on 500 Subjects In Central India. *Al Ameen Journal of Medical Sciences* 7(3): 201-206.

National Academy of Sciences. 2009. *Strengthening Forensic Science in the United States: A Path Forward*. National Academies Press.

Neo, X.X., Noor Hazfalinda, H., Osman, K. & Amir Hamzah, S.P.A. 2012. Lip Prints in Sex and Race Determination. *Jurnal Sains Kesihatan Malaysia* 10(1): 29-33.

Noor Hazfalinda, H., Gabriel, G.F., Osman, K., Leng, M.F. & Md Isa, N.M. 2020. Gender Discrimination Based on Lip Prints Analysis in Malaysian Chinese Population (Klang Valley): Photograph on Lipstick-Cellophane Tape Technique. *Buletin SK* 4(2): 1-10.

Noor Hazfalinda, H., Gabriel., G.F., Haron, N.S., Osman, K. & Md Isa, N.M. 2021. Digital approach for gender discrimination from lip prints analysis in Malaysian chinese population (Klang valley). *International Journal of Medical Toxicology & Legal Medicine* 24(1 & 2): 229-233.

Nur Sabrina Sarah, A.R., Noor Hazfalinda, H., Nur Hamizah, M.U. & Gabriel, G.F. 2019. Digital Approach for Lip Prints Analysis in Malaysian Malay Population (Klang Valley): Photograph on Lipstick-Cellophane Tape Technique. *Jurnal Sains Kesihatan Malaysia* 17(2): 43-49.

Osman, K., Noor Hazfalinda, H. & Gabriel, G.F. 2018. *Penyiasatan Forensik: Pengecaman Identiti Penjenayah*. UKM: Penerbit UKM.

Prabhu, R.V., Dinkar, A. & Prabhu, V. 2012. A study of lip print pattern in Goan dental students - A digital approach. *J Forensic Leg Med* 19(7): 390-395.

Prabhu, R.V., Dinkar, A. & Prabhu, V. 2013. Digital method for lip print analysis: A New approach. *Journal of Forensic Dental Sciences* 5(2): 96-105.

Remya, S., Priyadarshini, T., Umadethan, B., Gopalan, M. & Jeyaseelan, N. 2016. Cheiloscopy – A Study of Lip Prints for Personal Identification. *IOSR Journal of Dental and Medical Sciences* 15(2): 101-103.

Šimović, M., Pavušk, I., Muhasilović, S. & Vodanović, M. 2016. Morphologic Patterns of Lip Prints in a Sample of Croatian Population. *Acta Stomatologica Croatica* 50(2): 122-127.

Tsuchihashi, Y. 1974. Studies on personal identification by means of lip prints. *Forensic Science* 3: 233-248.

Venkatesh, R. & David, M.P. 2011. Cheiloscopy: An aid for personal identification. *J Forensic Dent Sci* 3(2): 67-70.

Verghese, A.J., Somasekar, M. & Umesh Babu, R. 2010. A Study on Lip Print Types among the People of Kerala. *Journal of Indian Academic of Forensic Medicine* 32(1): 6-7.

Wan Rafiuddin, W.A., Sri Pawita Albakri, A.H. & Noor Hazfalinda, H. 2018. Sex Differentiation by Lip Print Analysis in Malays: Lipstick-Cellophane Tape Techniques. *ARC Journal of Forensic Science* 3(1): 18-21.

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