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Sexual dimorphism in the lip size and finger pattern by digital method- A cross-sectional study

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This article has post-publication language corrections.

Abstract

Background: Human lips recognition is most intriguing and growing method in human identification. The lip prints are unique among individuals and shown to have a prospective role in sex identification. The fingerprints of an individual can be used in instances like criminological, civil cases due to their inimitable property for absolute identity. The study aims to identify fingerprint pattern and lip size for identification of gender.

Methods: This study involved 100 dentistry students from our college (50 male and 50 female). The thumb, lip photos were recorded by using a digital camera. The lip size was calculated by using Adobe photoshop software. The fingerprints patterns were by read by using the classification given by Michael and Kucken's.

Results: Males had more lip length and width when compared to females which are statistically significant ($p=0.000$). The predominant fingerprint pattern in the entire study was loop (67%) followed by whorl (23%) and then arch (10%). The arch pattern of fingerprint showed a statistical significance between males and females ($p=0.008$).

Conclusion: In the present study, lip length, lip width and fingerprint pattern showed a significant difference in males and females which can be used to determine an individual's gender. Moreover, employing digital method in analysing the fingerprints and lip-prints is very convenient in terms of accessibility and storage.

Introduction

Every human person is unique and distinct in that they each have their own set of qualities [1]. A number of well-known implanted techniques of human identification are based on their characteristics of which lip assessment is most intriguing methods of identification in human [2]. Lip-prints are essential for crime and law enforcement investigations [3]. They are individually unique as well as heritable, enabling personal identification [4]. They may play a role in sex identification because they have remained constant over time and are always unique to each individual, including twins [5]. Although considerable controversy about the validity and reliability of the procedures utilised, lip print identification was offered as a supplemental tool for criminal investigation due to the anatomical distinctiveness of the labial grooves [3]. Lips are distinctive anatomically as patterns could recuperate after any changes caused by slight stress or injury. Furthermore, in cases of major trauma, lip length and pattern may be difficult to recuperate owing to formation of scar. Likewise, surgery for pathologies on the lips might alter their form and normal size [6].

Lip morphology, like in anthropometry, can provide information on identity and gender in human population. Lips have a genetic predisposition that influences gender dimorphism in lip length [7].

Owing to a fact that lip prints are good basis of variation among people, most investigations does not look for them at the sites of crime. A simple lip print can help to infer an individual's sex, cosmetic products used, and occupational attribute at the scene of crime [8]. Lip prints could possibly be found in a rape scene as well as in scenes of crime where glass could be used, such as in a burglary [9,10]. As lips are frequently moisturised by saliva, lip prints could possibly be left on materials such as glasses, paper, butt of cigarette, dishes, clothes, and skin [11]. The problem is that when any lip smear identified at a scene of crime, it is frequently dismissed as an unrecognisable fingerprint. It is critical to remember that lip prints obtained at scene of crime can be an incredibly valuable aid. It has to be noted that convicts had realised that fingerprints that are left at crime scenes may be used for identifying them [3].

The usage of lip prints and fingerprints has become critical as other methods of personal identification like DNA analysis, may not be found in rural areas and the developing countries [12].

According to Michael and Kucken's classification, fingerprint patterns are represented by lines on the fingertip, which are classified into three types: arch, loop, and whorl [13]. Due to their unique quality of absolute identity, an individual's fingerprints can be utilised as an essential part of identification in both criminal and civil actions [14]. During the years, finger

ridges evolved to help humans to grip and grasp objects [15]. These epidermal ridges develop from their derivative forms through the 3- 4 months of foetus and are not altered thereafter until death.[16] Fingerprint ridges, like everything else in the human body, are created by a blend of genetic and environmental variables. For this reason, even the twins are different in fingerprint pattern [17]. Personal identification and tracking of criminals by Fingerprinting remained as best and very commonly used method.

There are few studies that established the fingerprint patterns whereas the studies on lip print sizes are very scanty. Criminals might use gloves so that no fingerprint marks are left to conceal their identity. So, other methods need to be employed to solve a crime. Studies on lip print size are relatively in southern states of India. So, the purpose of our research design is to ascertain differences in lip print sizes and fingerprint patterns among our dental academy pupils.

Methods

Study design

A cross-sectional study was carried out in the southern state of India. Sample size calculation was done by G-power 3.1 software with an effect size of 0.371, alpha level of 0.05 and a desired power of 80%, an estimated sample total size was 100 (50 were male and 50 were female). Students from our dental college within an age range of 18 - 28 are involved. The physiological rest position of lips and the thumb print was recorded by clicking an image using a digital camera. The lip size was calculated by using Adobe photoshop software. The fingerprint patterns were studied according to the classification given by Michael and Kucken's.

Any participants with developmental/ traumatic/ corrected/ pathological anomalies of lips, finger, and participants worried about giving their lip and fingerprint details were excluded. The study procedure was explained clearly, and written consent was obtained in both vernacular and English.

Data collection

Lip and finger photos were obtained by using a digital camera (Canon EOS 3000 D DSLR) from Students of our dental college within an age range of 20-30 years. While taking photographs all the participants were instructed to position their feet parallel to the floor and head straight for lip prints, and the palmar portion of the upper arms parallel to the floor for the fingerprint photos. To avoid photographic errors in lip size capture, a fixed camera settings and distance were followed for all the samples in the study. The approval from institutional ethical committee was provided on 17/02/2021 (IECVDC/2021/PG01/OP/IVV/03).

Statistical analysis

All the analysis were done utilizing SPSS software, version 22.0), statistical data 2013 SPSS, Inc., an IBM company, Armonk, New York, USA. For all the demographic variables, descriptive statistics were used. The Kolmogorov–Smirnov test was carried out for checking normality distribution of sample. Chi-square test is used to know the prevalence of fingerprint pattern based on Gender. Comparison of mean scores of the fingerprint pattern and lip size (Lip length and Width) based on gender was evaluated by Mann-Whitney U test. Comparison of lip size based on the type of the fingerprint pattern was done by Kruskal Wallis test. For all the values, statistical significance $p < 0.05$ was considered.

Results

Males had more lip length and width when compared to females which are statistically significant ($p=0.000$) (Figure 1). Predominant fingerprint pattern of the entire study was loop (67%) followed by whorl (23%) and then arch (10%). The arch pattern of fingerprint showed a statistical significance between males and females ($p=0.008$) (Table 1). Predominant fingerprint pattern amongst males is loop (62%) followed by whorl (20%) and arch (18%). The predominant finger pattern in females was loop (72%) followed by whorl (26%) and arch (2%). When lip length is compared with the fingerprint pattern, loop and whorl patterns showed a statistically significant values (Loop, $P= 0.000$) (whorl $p=0.012$) (Table 2). When lip width is compared with the fingerprint pattern, loop and whorl patterns showed a statistically significant value. (Loop $P= 0.000$) (whorl $p=0.000$) (Table 3).

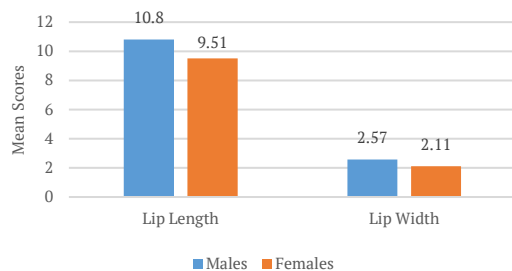


Figure 1: Mean comparison of lip length and width based on gender. *The length and width of lips was higher in males than females.

Fingerprint Pattern	Gender	n	%	p value
Loop	Males	31	46.3	0.198
	Females	36	53.7	
Arch	Males	9	90	0.008*
	Females	1	10	
Whorl	Males	10	43.5	0.318
	Females	13	56.5	

n= number

Table 1: Comparison of type of fingerprint pattern based on gender.

Fingerprint Pattern	Gender	Lip Length			Mann-Whitney U	p value
		n	Mean	SD		
Loop	Males	31	11.1719	1.13566	274	0.000*
	Females	36	9.6442	1.55561		
Arch	Males	9	9.9844	0.96469	8	0.212
	Females	1	11.0800	-		
Whorl	Males	10	10.7260	1.09669	25	0.012*
	Females	13	9.0408	1.59928		

n= number, SD= standard deviation

Table 2: Comparison of lip length with fingerprint pattern based on gender.

Fingerprint Pattern	Gender	Lip Width			Mann-Whitney U	p value
		n	Mean	SD		
Loop	Males	31	2.5974	0.27953	144	0.000*
	Females	36	2.1444	0.33246		
Arch	Males	9	2.5044	0.06064	0	0.076
	Females	1	2.2600	-		
Whorl	Males	10	2.5440	0.23210	10	0.000*
	Females	13	2.0338	0.32377		

n= number, SD= standard deviation

Table 3: Comparison of lip Width with fingerprint pattern based on gender.

Discussion

One of the most difficult aspects of forensic examination is the personal identification. In the case of deceased remains, disaster relief, and crime scenes, establishing personal identification is very time-consuming task [9]. When two items come into touch, there will always be a trace of material from each other, according to Locard's Exchange Principle. This notion is critical for crime scene investigation; material exchange can include fibres, shoe prints, or even fingerprints [18]. Analysis of fingerprint is a gold standard approach in identification of a person. The various forensic odontology approaches include teeth morphology, bite marks, rugae pattern of palate, dental materials, jaw bone, lip print, and other molecular procedures that aid in personal identification [9]. The comparison of fingerprint and lip analyses in identification of gender is a growing field in forensic dental study [19].

Lip prints can be used to confirm a person's involvement in a crime if certain liquids or drinks were drunk or some garments, tissue or napkin, and so on were used by the suspect or victim. Apart from bite imprints on food, lip prints are frequently found on window panes, doors, paintings, plastic bags, and other surfaces [20]. Lip doesn't grow in same pattern at all ages, certain areas show more growth and others less, for this reason we have chosen an age group of 20-30 years in the study [21].

Lip forensics has been used successfully to put offenders behind bars on multiple occasions since they are unique and permanent, like fingerprints, and are admissible in court [22,23]. Lip prints with saliva can also be successfully used for DNA typing [24].

A lip print collected at a crime scene can identify the corpus delicti, the number and gender of people

involved, the type of cosmetics used, habits or occupational qualities, and pathological conditions (if any) present in the lips [25]. But there is always a difficulty for the forensic science practitioner in smudging the lip impressions, unless a victim/suspect wear a high-quality lip stick [18].

It is found that females had relatively short lip lengths over males, which is consistent with our findings [25]. A similar type study on gender differences in mouth and lip dimensions found that men's mouth width, philtrum width, lip volumes and total lip height were considerably larger than women's [3,21]. According to Goncalves RD et al, lips have a genetic predisposition towards gender and appear to be longer in males, probably due to activity of hormones like testosterone and somatotrophic. Females had a shorter converse length throughout their lives [26].

Chadha et al. showed that the length and width of lips are larger than the females which are consistent to our study [27]. In a study conducted by Neo et al. among Indian, Indian Malay, and Malaysian Chinese showed that lip length and width can be used to determine the sex. Samal A et al, Little AC et al demonstrated a statistical difference between adult females and males on morphometric analysis of facial features such as eyes, orbits, head, lips, ears, nose and mouth [28,29].

Ferrario VF et al did an anthropometric investigation of lip measurements and found that the mean length and overall thickness of lips in men were more than in females, while the lower lip mean width of was greater than the upper lip in two genders [30].

According to study done by Nandan SR et al, the most prevalent finger print pattern among males (44%), and females (42%), was simple loop, which are consistent with our study (males 46.3%, females 53.7%). [2] Amita Negi et al in their study also showed loop pattern as the predominant finger pattern [15].

Ayuba John et al found that lip sizes among males of Uganda with the ones from Somalia and Kenya are statistically significant [3]. Nagasupriya et al. in their study found a positive correlation between the finger patterns and lip for gender determination, that were statistically significant [18]. The correlation among finger pattern and lip length in females and males showed weaker correlation [2]. In our study, males showed a significant correlation of lip length with finger print pattern ($p=0.032$) and no significant correlation of lip width with finger print pattern in both the sexes.

In the present study, lip length, lip width and finger print pattern showed a significant difference in males and females which can be used for determine the sex of an individual thereby narrowing the search gap in criminal investigations. The digital method of analysing both lip and finger print is very convenient in terms of accessibility and storage. Measures to retrieve/ search

for hidden lip prints by forensic science practitioner at crime scenes would help draw conclusions in victim identification, especially when other conventional methods of identification were missing/not found. We recommend conducting these types of studies by using a large sample and people of different ages.

Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

Rt, SP conceived and designed the study, Rt collected the data; and SP, RM performed data analysis and interpreted the results. Rt, SP wrote initial and final drafts of manuscript, and RM, SA, SB, JK provided a logistic support. All authors discussed the findings and provided feedback on the text. All authors have critically examined and approved the final text and are responsible for the manuscript's content and similarity index.

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