COMPARATIVE STUDY OF FINGERPRINTS AND LIP PRINTS AMONG DIFFERENT ETHNIC GROUPS, SEX AND SEASONS OF BIRTH IN ZARIA, NIGERIA

BY

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DECEMBER, 2012

DECLARATION

I hereby declare that the work in this thesis titled "***Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria***" was performed by me in the department of Human Anatomy, Faculty of Medicine, ABU, Zaria, under the supervision of Prof. S. A. Ojo and Dr. W. O. Hamman.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree at any institution.

_____ _____

Adamu, Lawan Hassan **Date**

CERTIFICATION

This thesis entitled "***Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria***" by Adamu, Lawan Hassan meet the regulation governing the award of Masters of Science (MSc.) degree in Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria, under the supervision of Prof. S. A. Ojo and Dr. W. O. Hamman. It is therefore approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to Almighty **ALLAH**, His mercy, love and comfort is incomparable. Also to our noble prophet **MUHAMMAD** (SAW), his companions and those who fellow his right path to the day of resurrection

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ABSTRACT

The study was designed to determine the association between lip prints and fingerprints, the pattern of distribution of lip prints and their association with sex, ethnicity and season of birth in the study population. Eight hundred and twenty subjects (414 males and 406 females) participated in the study. The lip prints were obtained on microscopic glass slide and developed using carbon black powder, after which the prints were divided into 10 compartments and analyzed using magnifying lens. Conventional method of using ink pad was used to collect fingerprints of the 10 digits and analysis was done using chi square test, and a P. value less than or equal to 0.05 was considered as level of significance ($P \leq 0.05$). The results of the study showed that left thumb prints were associated with lip prints in the Lower Left Lateral (LLL) and Lower Right Medial (LRM) compartments. The association of lip prints with sex, showed high statistically significant association ($P< 0.001$) with all the lip compartments except with the Lower Right Lateral (LRL) and Upper Median (UM) compartments. For the ethnic groups, only ULL compartment showed statistically significant association ($P= 0.02$). These indicate some level of sexual dimorphism and ethnic variation which may be linked to differences in genetic make up. The result showed that lip print pattern type V (31.39%) was predominant, followed by type III (24.18%), type IV (18.70%), type I (14.87%), type II (10.29%) and the least was type I' (0.57%). The result also showed that the fingerprint pattern of loops had the highest percentage of 63.77%, followed by whorls with 32.35%, then the arches with least percentage of 4.07%. In conclusion, the lip print was found to be associated with sex, ethnicity and left thumb prints. Hence, lip prints hold potential promise as a supplementary tool in personal identification of suspects or unknown identity.

TABLE OF CONTENTS

Title Page……. I

Declaration…….. II

Certification…… III

Dedication…… IV

Acknowledgement…… V

Abstract…… VII

Table of contents…….VIII

List of Tables……XII

List of figures …….....XIII

List of Plates…….XIV

List of Appendices…….XV

List of Abbreviation…….XVI

CHAPTER ONE

1.0 Introduction…….1

1.1 Background……..1

1.2 Statement of research problems……...5

1.3 Justification……..6

1.4 Research Hypothesis……6

1.5 Aims and objectives ……7

CHAPTER TWO

2.0 Literature Review……..8

2.1 Historical overview of fingerprints……8

2.2 Classification of fingerprints……9

2.3 Fingerprints types……..9

2.4 Embryology of fingerprints……...10

2.5 Formation of fingerprints…….10

2.6 Hypotheses of ridge formation……12

2.7 Factors influencing fingerprints pattern……..15

2.8 Global distribution of pattern of fingerprint……18

2.9 Fingerprints and psychology……..22

2.10 Prediction potentials and uses of fingerprints……..24

2.11 Historical overview of lip prints……28

2.12 Anatomical aspect…….30

2.13 Lip print classification……..31

2.14 Embryology of lip print……32

2.15 Global distributions of pattern of lip prints.....…….33

2.16 Practical application of lip prints…….39

2.17 Challenges in the study of lip prints……..40

CHAPTER THREE

3.0 Materials and Methods…….42

3.1 Equipments……...42

3.2 Study Location and Duration……42

3.3 Subject……..42

3.4 Inclusion Criteria……..42

3.5 Exclusion Criteria…….43

3.6 Study Design…….43

3.7 Ethical Approval and Informed consent ……..43

3.8 Methodology…….44

3.9 Limitations……55

3.10 Statistical Analysis……55

CHAPTER FOUR

4.0 Results…….56

CHAPTER FIVE

5.0 Discussion……71

CHAPTER SIX

6.0 Summary, conclusion and Recommendations ……..……77

6.1 Recommendations ……...78

References ……79

Appendix…….89

LIST OF TABLES

Tables **Pages**

Table 4.1: Percentage distribution of the pattern of fingerprints on different digits (10) on both hands according to sex……....57

Table 4.2: Percentage distribution of the types of lip prints on upper lip compartments according to sex……..……...59

Table 4.3: Percentage distribution of the types of lip prints on lower lip compartments according to sex….....61

Table 4.4: Percentage distribution of the types of lip prints on upper lip compartments according to ethnic group …….....63

Table 4.5: Percentage distribution of the types of lip prints on lower lip compartments according to ethnic group…….....65

Table 4.6: Percentage distribution of the types of lip prints on upper lip compartments according to season of birth..…….....67

Table 4.7: Percentage distribution of the types of lip prints on lower lip compartments according to season of birth …….……...68

Table 4.8: Chi square statistic for association between left and right thumb prints with lip prints…….……...70

LIST OF FIGURES

Figures **Pages**

Figure 1.1: (A) Three basic patterns of fingerprints, (B) Minutiae of Fingerprints …..2

Figure 1.2: Lip prints type based on Suzuki and Tsuchihashi classification……..….4

Figure 2.1: Stages in spread of epidermal ridges……11

Figure 2.2: Processes of ridges formation…….……..13

Figure 2.3: Different nature of volar pad……16

Figure 3.1: Division of the lips into ten compartments…….…....48

LIST OF PLATES

Plates **Pages**

Plate I: Placement of finger (thumb) on the already made stained ink pad ……45

Plate II: Collection of the finger (thumb) prints on the participant questionnaire……46

Plate III: Placement of microscopic slide on lip to pick the lip prints……..49

Plate IV: Development of lip prints on microscopic slide using carbon black powder……..50

Plate V: A well developed lip prints on microscopic slide……,51

Plate VI: Placement of well developed lip print on participant questionnaire…….52

Plate VII: Placement of cello tape on well developed lip print for permanent preservation…….53

Plate VIII: A well divided lip prints into ten compartments ready for analyses……54

LIST OF APPENDICES

Appendices **Pages**

Appendix I:

Questionnaire for Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria ……...…...86

Appendix II: Consent letter for Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria….88

Appendix III: Consent form for Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria…….…89

LIST OF ABBREVIATIONS

ABU: Ahmadu Bello University

DNA: Deoxyribonucleic Acid

I: Index

L: Little

LLL: Lower Left Lateral Compartment

LLM: Lower Left Medial Compartment

LM: Lower Median Compartment

LRL: Lower Right Lateral Compartment

LRM: Lower Right Medial Compartment

M: Middle

PII: Pattern Intensity Indexes

R: Ring

SKP: Scanning Kelvin Probe

SMARCAD 1: SWI/SNF-related matrix-associated actin-dependent regulator of chromatin subfamily A containing DEAD/H box 1

T: Thumb

TRC: Total Ridge Counts

ULL: Upper Left Lateral Compartment

ULM: Upper Left Medial Compartment

UM: Upper Median Compartment

URL: Upper Right Lateral Compartment

URM: Upper Right Medial Compartment

CHAPTER ONE

1.0 INTRODUCTION

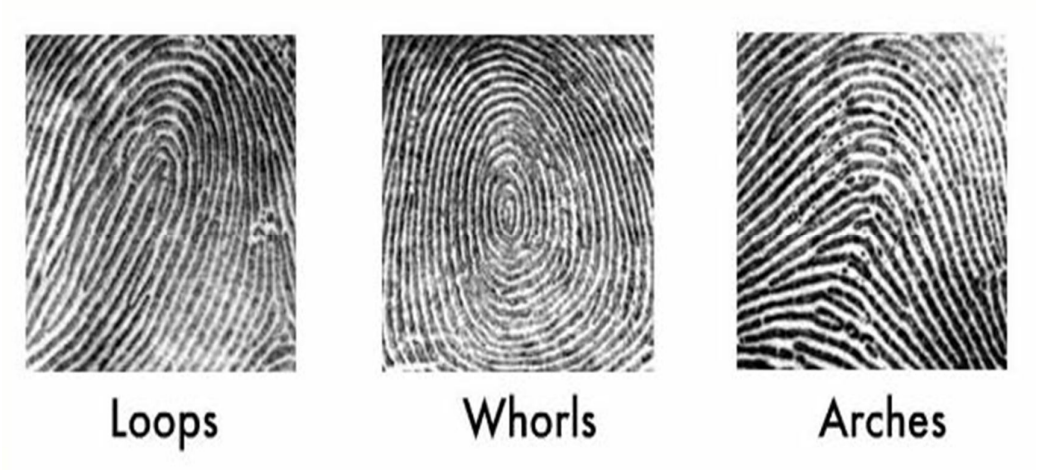
1.1 BACKGROUND

Personal identification is much necessary for unknown deceased persons in homicide, suicide, accidents, and most disasters. It is also necessary for living individuals who are missing persons due to amnesia and culprits hiding his identity (Saraswathi *et al.,* 2009). The use of prints as means of personal identification is one of the common methods in forensic anthropology and the most popular prints are fingerprints.

Fingerprint in its narrow sense is an impression left by the friction ridges of human finger. An international recording of friction ridges is usually done with black printer ink rolled across a contrasting white background, normally a white card friction ridge can also be recorded digitally using techniques called live scan. The science of fingerprints acclaimed and reputed as panacea for individualization particularly in forensic investigations (Adebisi, 2009). The analysis of finger prints for matching purpose generally requires the comparison of several features of the print pattern. These include patterns, which are aggregate characteristics of ridges and minutiae points which are unique features found within the patterns (Jain *et al.,* 1999).

The three basic patterns of fingerprint ridges are arch (plain and tented), loop (radial and ulna), and whorl (plain and others). An arch is a pattern where the ridges enter from one side of the finger, rise in the centre forming an arc, and then exit the side of the finger and the loop is a pattern where the ridge enters from one side of a finger, form a curve and tend to exit from the same side they entered from. Whereas, in the whorl pattern ridges form circularly around a central point on the finger. (Langerberg, 2005)

A



B

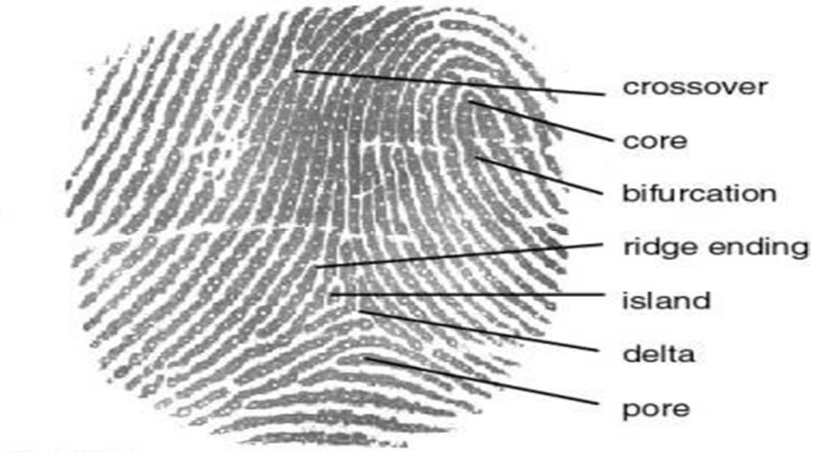


Figure 1

Figure 1.1 (A) Three basic patterns of fingerprints, (B) Minutiae of Fingerprints

The major minutia (as shown in figure 1.1) features of fingerprint are: ridge ending bifurcate and shorter ridge (or dot). The ridge ending is the point at which a ridge terminates. Bifurcate are points at which a single ridge split into two ridges. Short ridges (or dot) are ridges which are significantly shorter than the average ridge length on the finger print. Minutiae and patterns are very important in the analysis of finger print since no two fingers have been shown to be identical (Thornton, 2000)

The second prints of interest is lip prints, which are normal lines and fissures in the form of wrinkles and grooves present in the zone of transition of human lip between the inner labial mucosa and outer skin. The appearance of lip prints, like fingerprints vary from persons to persons (Caldas *et al.,* 2007).

The most commonly used classification scheme of lip-prints invented by Suzuki and Tsuchihashi are: Type I; a clear-cut groove vertically across the lips, type I'; a partial-length groove of type I, type II; a branched groove, type III; an intersected groove type IV; a reticular pattern and finally type V; other types. (Suzuki and Tsuchihashi, 1970)

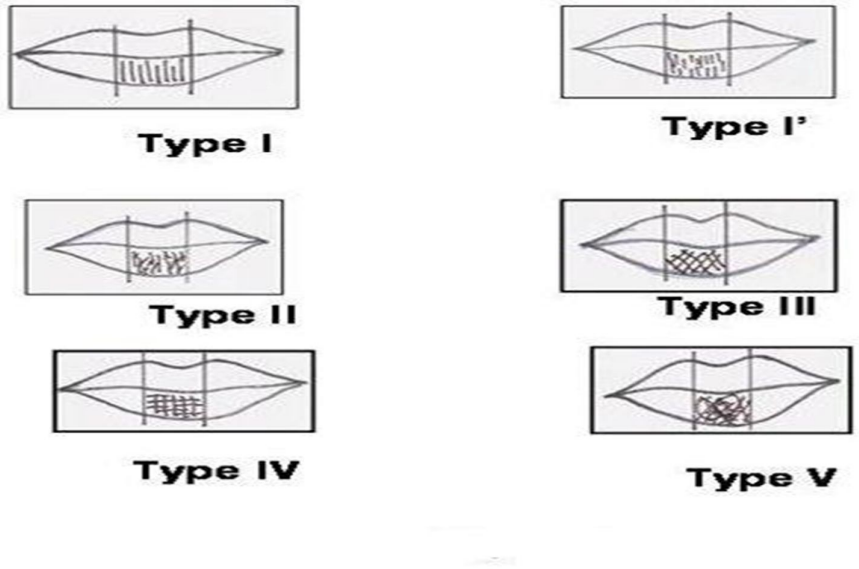


Figure 1.2: Lip prints types based on Suzuki and Tsuchihashi classification

Cottene and Standish in 1981, reported in their book "Outline of forensic dentistry", that cheiloscopy (study of lip prints) is one of its special techniques used for personal identification. Ball (2002) has also reported the history of lip prints and importance of its evidence in the courts as well as its status as a source of forensic evidence. Hence, it was proved beyond doubt that lip prints are as good as fingerprints in criminal identification and can definitely be used when no other means of traditional method of identification are not available (Aggrawal, 2004).

1.2 STATEMENT OF RESEARCH PROBLEM:

Case report or research publications concerning lip prints are scanty in Nigerian population. Also according to Saraswathi (2009) research studies and information regarding the use of lip prints as evidence in personal identification and criminal investigation, although age old, are scanty.

El Domiaty *et al.* (2010) reported the need to establish a database of lip prints for all individuals in a certain locality hoping to be a reference in civil litigation and criminal cases.

Despite the popularity and accuracy of finger print, some individuals, such as leprosy patients, amputees etc. cannot use it as a means of personal identification, as seen in just recently concluded elections in Nigeria. Therefore an alternative simple means of identification such as lip prints can be handy. Comparative studies of fingerprint and lip prints are scanty in Nigerian literature.

1.3 JUSTIFICATION:

The use of conventional methods such as use of fingerprints, lip prints etc. are of paramount importance, since personal identification by other means such as DNA analysis is sophisticated and not available in rural and developing countries.

Establishment of the association between two methods of personal identification such as fingerprints and lip prints will serve as way of further confirmation of personal identity. The lip prints can give some individual chance of personal identity in case other methods fail or not available.

Reference data on various form of personals identification such as fingerprints, lip prints etc are of paramount importance in solving criminal cases.

1.4 RESEARCH HYPOTHESIS:

1. There is association between lip prints and fingerprints since, the mechanisms that control the formation of ridges on fingers may be the same as in lips. And lip print was proved to be constant like fingerprint (Tsuchihashi, 1974; Shilpa *et al.,* 2010).
2. There is sex variation in the pattern of lip prints among Nigerian population
3. There is ethnic variation in the pattern of lip prints among Nigerian population
4. Environmental factors such as season of birth may play an important role on the pattern of lip prints

1.5 AIMS AND OBJECTIVES:

1.5.1 Aim of the Study

The aim of the study is to determine the association between lip print and finger prints (left and right thumb) among Nigerian population

1.5.2 Objectives of the Study

The specific objectives of the study are to determine among Nigerian population

1. The pattern of fingerprints and lip prints
2. The association between lip print and sex
3. The effect of season of birth on the pattern of lip prints
4. The association between lip print and ethnicity (tribe)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORICAL OVERVIEW OF FINGERPRINTS

The scientific study of papillary ridges of the hands and feet is credited as beginning with the work of Purkinje. In 1892 Sir Galton published his classic treaties on fingerprint. He also explored studies of the hereditary aspects of fingerprints, investigating comparisons of siblings, twins and genetically unrelated individuals and was the first to report concordance of papillary ridge patterns among relatives. This opened the field as a useful tool in anthropology (Norris and Charis, 1990).

The early twentieth century marked the first serious study of palmar and plantar dermatoglyphic. Further important genetic studies of fingerprints in the first quarter of the twentieth century were made by the Norwegian Bonnevie publishing in 1924 (Bonnevie, 1924).

In the second quarter of the twentieth century, the field was dominated by Cummins, sometime professor of Microscopic Anatomy at Tulane University. In 1926 he coined the word dermatoglyphics and used it at the annual meeting of the American Association of Anatomist (Norris and Chris, 1990).

Toward the end of the twentieth century the field of dermatoglyphic received attention of numerous scientists especially the anthropologist which led to numerous researches and publications in this area

2.2 CLASSIFICATION OF FINGERPRINTS

The most popular ten-print classification systems include the Roscher system, the Vucetich system, and the Henry Classification System. Of these systems, the Roscher system was developed in Germany and implemented in both Germany and Japan, the Vucetich was developed in Argentina and implemented throughout South America, and the Henry system was developed in India and implemented in most English-speaking countries (Engert, 1964).

In the Henry system of classification, there are three basic fingerprint patterns: Loop, Whorl and Arch, which constitute 60–65%, 30–35% and 5% of all fingerprints respectively. There are also more complex classification systems that break down patterns even further, into plain arches or tented arches, and into loops that may be radial or ulnar, depending on the side of the hand toward which the tail points. Whorls may also have sub-group classifications including plain, accidental, double loop, peacock's eye, composites and central pocket loop (Engert, 1964).

2.3 FINGERPRINTS TYPES

Base on the enhancing source of impression, fingerprints could be classified into various types such as Exemplar prints, or known prints, which the name is given to fingerprints deliberately collected from a subject. Latent prints mean any chance or accidental impression left by friction ridge skin on a surface, regardless of whether it is visible or invisible at the time of deposition. Patent prints are chance friction ridge impressions which are obvious to the human eye and which have been caused by the transfer of foreign material from a finger onto a surface. Plastic prints are frictions ridge impression left in a material that retains the shape of the ridge detail (Zabell, 1982)

2.4 EMBRYOLOGY OF FINGERPRINTS

The crucial events for the establishment of the epidermal ridge pattern take place from the 10^{th} to 16^{th} week of development. At 10^{th} week, embryonial volar skin consists of the layered epidermis on top of more amorphous fibrous dermis. At that moment the epidermis consists of three layers; periderm on the outside, the intermediate layer and the basal layer at the interface of the dermis (Okajima, 1975; Babler, 1991)

During 11^{th} week the basal layer of the epidermis consists of columnar cells whose axis is perpendicular to the skin surface. It's observed that the basal layer become undulated, which quickly become prominent and form fold of the epidermis into dermis. These folds are called primary ridges. These established the future surface patterns which become well pronounced at the 16^{th} week. Because fingerprints patterns are encoded at the interface between dermis, the pattern cannot be destroyed by superficial skin injuries (Babler, 1991; Kucken and Newell, 2004).

2.5 FORMATION OF FINGERPRINTS

Primary ridge formation does not occur simultaneously on volar skin surface. The formation usually starts at a certain area in the middle of volar pad (which is called the ridge anlage) and along nail furrow, little later along the interphalengeal flexion creases.

The area of the ridge anlage usually coincides with the centre of the whorl and loops if such pattern shows up. In this way we have three ridge system on the fingertips (starting from the ridge anlage, the nail furrow and the flexion creases), which slowly spread over the fingertip. At the location where these ridge systems finally meet, triradii arises (Kucken and Newell, 2004).

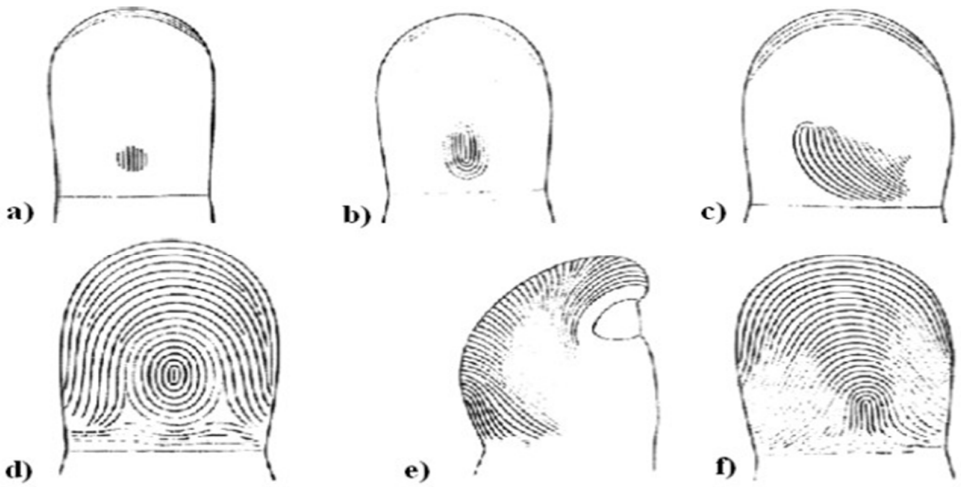


Figure 2.1: Stages in spread of epidermal ridges

2.6 HYPOTHESES OF RIDGE FORMATION

Although no commonly accepted mechanism for ridge formation exist to date, the following hypotheses prove to be very important in the understanding of fingerprints formation

2.6.1 The Folding Hypotheses and other Mechanical Hypotheses

In 1883 it was speculated that the ridge pattern is established as a result of folding process, which is induced by differential growth

In 1926 it was stated that the ridges form as a result of folding process which parallel to the largest growth stress.

1n 1927 and 1932 the folding process idea was promoted with a lot of histological evidence. She argues that there is intense cell proliferation in the basal layer of the epidermis resulting in cylindrical cells, which evade the stress by folding toward the dermis, thus resulting in the formation of primary ridges

Unfortunately, until now it has never been attempted to identify the sources of stress that produces the observed patterns of finger prints (Kucken and Newell, 2005).

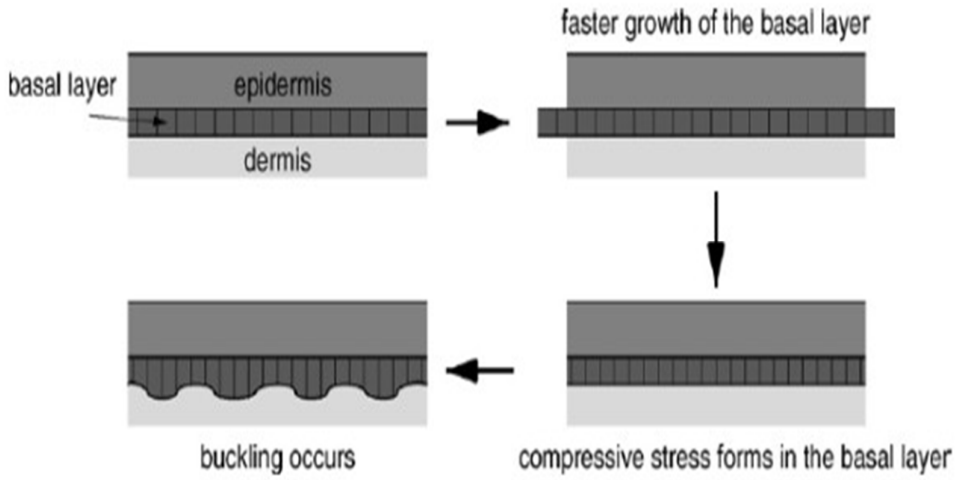


Figure 2.2: Processes of ridge formation

2.6.2 The Nerve Hypothesis

In 1986 and 1989 Dell, Munger and Moore linked the fingerprints pattern to the nervous system. They stated that the fingertips are innervated before ridge formation start by hexagonal pattern of axons whose wavelength roughly equals to the one of fingerprints (Dell and Munger, 1986; Moore and Munger, 1989). Arguments against the ideas, are the fact that a hexagonal platform cannot establish a ridge direction and ridge formation when innervations was prevented (Morohunfola *et al.,* 1992).

2.6.3 The fibroblast hypothesis

In 1993 it was observed that topological properties of fingerprints pattern and cultivated fibroblast cell pattern are similar, due to this similarity they suggested that fingerprints are induced by pre pattern of the fibroblast in the dermis. On the basis of interactions between extracellular matrix, haptotaxis and other processes a model was developed (Bentil and Murray, 1993)

2.6.4 The Biochemical Hypothesis

It was stated that the existence of reactive system (activator-inhibitor) on the skin surface give an explanation for the pattern found. The high stability of the emergence of the pattern can be explained that is the repetition of the pattern was due to a specialized biochemical system allowing formation of the wrinkles in the fingerprints. The biochemical factors involved is called Morphogens. Although, mechanical growth factors also play roles in the formation of fingerprints but the exact influence of each biochemical and mechanical factor on the formation of surface pattern become an experimental challenge that will reveal the morphogenesis of fingerprints (Diego and Angelica, 2011).

2.7 FACTORS INFLUENCING FINGERPRINTS PATTERN

Various factors were suggested by numerous scientists to be the major driving forces in the pattern and formation of fingerprints, such factors includes:

2.7.1 Volar Pad

Volar pad are temporary eminences of the skin surface that form during the 7^{th} week of development and start to digress at about the 10^{th} week corresponding to the crucial period of fingerprints developments. The pads are found at the fingertips, in the interdigetal areas and sometimes in the hypothener and thener regions as well.

From the studies of embryo, monkeys and malformed hands it's constantly been observed that highly rounds symmetrical pads (that is large curved pad) at the fingertips exhibit whorls; less well developed asymmetric pad (that is medium high pad) show loops, where the direction of the loop opening is determined by the asymmetry of the pad. Pad slanted to the right give rise to loop opening to the left and vice versa; small indistinct pad (flat pad) give rise to arches (Cummins, 1929).

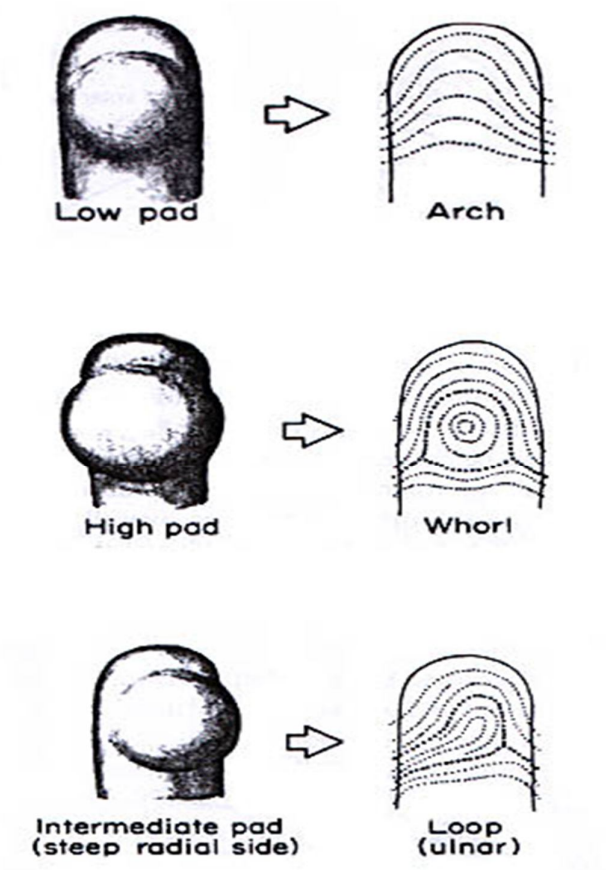


Figure 2.3: Different nature of volar pad

2.7.2 Genetic Factor

There is a rare genetic mutation that causes only a handful of people around the world to be born without fingerprints. Now, geneticists have identified the gene that they believe causes this strange disorder. All of the people with the disorder had a mutation of the gene called *SMARCAD1* gene.

The SMARCAD 1(SWI/SNF-related matrix-associated actin-dependent regulator of chromatin subfamily A containing DEAD/H box 1) is a protein that in humans is encoded by the SMARCAD gene which contain 1026 amino acids; 117.402 kDa. Proper expression of SMARCAD1 may be important to fingerprint development, and the disruption of its expression is believed to cause adermatoglyphia, the absence of fingerprints (Adra, 2001).

2.7.3 Boundary Effects

The boundaries on the fingertips include; nail furrow, flexion creases and margin of the fingertips. It was observed that primary ridges lines are parallel to the nail furrow and major flexion creases as well as perpendicular to the outline of the fingertip. This implies that furrows and creases act as obstacles to expansion and greatest stress form perpendicular to these obstacles (Kunken and Newell, 2005).

2.7.4 Markel Cells

The merkel cells are cells in the epidermis which are in contact with nerve endings. Origin and function is still controversial. The cells form in the hexagonal pattern and are found later at the base of the epidermal ridges. The location of the markel cells determines the minutiae of fingerprints (Kunken and Newell, 2005).

2.8 GLOBAL DISTRIBUTION OF PATTERN OF FINGERPRINTS

Several studies show little variation in the distribution of pattern of fingerprints across the continent as follows;

2.8.1 African Continent

The pattern of fingerprint varies in individuals, the studies of fingerprints among annangs ethnic group in Nigeria shows that the most prevalent digital ridge pattern type was ulnar loops (44.9%) followed by whorls (31.2%), arches (11.3%) and the least having 1.4% were radial loops (Ekanem *et al.,* 2009).

Jaja and Igbigbi (2008) in their work on digital and palmer dermatoglyphic of Ijaw of southern Nigeria reported that ulna loop as being the most prevalent pattern. According to Oguranti and Sorgia (1984) studies of dermatoglyphic pattern in the southern Nigeria population of 859 people of Bodo city, the predominant patterns are whorls followed by ulna loops, arches and radial loops.

The data obtained in a study on the dermatoglyphic patterns of Okrika and Ikwerre ethnic group of Nigeria by Osunwoke *et al.* (2008) showed that the ulnar loop for Okrika population was 46.42%, whorl 37.77%, arch 14.12% and radial loop 1.71%. The Ikwerre population had the ulnar loop of 56.46% which was higher than that of the Okrika population, whorl 24.42%, arch 15.89% and radial loop 3.23%. The pattern intensity index was calculated as the total number of triradii/sample size. The pattern intensity index for Okrika was 11.69 while that of Ikwerre was 10.91.

According to Danborno and Idris (2007) it was observed that Hausa males had 30.15% as whorls, 65.91% as loops and 3.95% arches. In females 29.33% were having whorls, 61.27% were having loops and 9.29% were having arches. In both sexes, a loop exhibited the highest frequency and arches the lowest. Male had more abundant whorls and loops then females, while the females had more abundant arches than males.

Digital dermatoglyphics of two ethnic groups in Nigeria, the Yoruba and the Igbo using 383 Yoruba (250 males, 133 female) and 390 Igbo (250 males, 140 female) showed with regards to sexual dimorphisms that only the Igbo showed a significant difference in the rather unusual direction of male having fewer whorls and more arches then the females. Among the Yoruba arch frequency was found to be 10.1 in male and 10.9 females. Radial loop as 2.3 in males and 1.7 in the females, Ulnar loop was 60.0 in male and 62.90 in female while whorls was 27.60 in male and 24.5 in females. Among the Igbo arches was 12.9 in male and 12.1 1n females, ulnar loop was 61.7 in male and 57.0 in female , radial loop was 2.5 in males and 2.6 in females while whorls were 23.3 in male and 28.2 in females. The PII was 11.74 in male, 11.36 in female Yoruba while in Igbo it was 11.03 in male and 11.60 in females (Igbigbi *et al.,* 1994).

Another finding also on the Yoruba ethnic groups of the Nigeria brought that a sample of 250 Yoruba males and 250 Yoruba females had their arch as 10.12%, whorl as 27.54% and 62.34% as loop. PII in the Yoruba was 11.79. The means ridge count in the males was 106.31 and in the females 97.86. Dankmeijers index was higher in the female (42.73) than male (31.35) Yoruba while the Furuhatas index was higher in male (46.74) than in female (41.65) Yoruba.

2.8.2 Asian Continent

Dermoglyphics sexual dimorphism in 372 male and 208 females of Israelis showed that female have lower frequency of whorls and radial loops and higher number of arches and ulnar loops then the males. In finger traits, females presented a lessened degree of bimanual asymmetry. At the same time it is known that these distinctions may be equalised or even reversed in some populations (Schauman and Alter, 1976).

Analysis of the fingerprints of the Tibetans showed that whorls (60.24%) were more abundant than loops (38.98%) in males. However, the females exhibited a much frequency of whorl (48.6%) and a higher frequency of loop (40.13%). The frequency of ulnar loop (47.13%) and arches (2.2%) were higher in female than among males who showed them as 36.83% and 0.76% respectively. The Tibetans posses a high pattern intensity index (is the average number of triridii summed over all digit of an individual's), the index value of 15.28 which fall essentially within the Mongloid range. This reflects the abundant of whorls and reduced frequency of arches (Tiwari and Chattopadhyay, 1968).

All Mongoloids have a very low arch/whorl frequency index (< 10). The Tebetans with mean value of Dankmeijer's index (is the total frequency of arch over total frequency of whors times 100) of 2.88 for both sex fall in the Mongoloid group. Furuhatas' index (is the total frequency of whorls over total frequency of loops times100) is 154.50 in male and 99.06 in the female which indicates large number of loops in the female compared to male (Furuhatas, 1927; Dankmeijer, 1947).

2.8.3 South American Continent

In the fingerprint patterns of the Jivaro Indians in Estern Ecuador, the Dankmeijers index was 4.1for male and 2.1 in female. Pattern intensity index (PII) was 13.71 in male and 13.01 in females. The Furuhata's index was 85.6 in male and 71.1 in female (Sunderland and Ryman, 1968).

2.8.4 Europe Continent

In 211 males and 209 female Italians, loops were most common pattern with frequency of 63.33%, the followed by whorls 31.20% and arches were 5.47%. Male PII (12.81) was slightly higher than females (12.33). Same trends were shown by the Furuhatas index 50.00 for males and 48.51 for females. Dankmeijers index on the conterary was higher for females (23.25) then for males (12.81) due to much higher frequency of arches among the females then the male (Gualdirusso *et al.,* 1982)

The dermoglyphics affinities of the Lithuanians showed that 83 men and 102 women of the Lithuanians origin obtained from United Kingdom had low frequency of arch and high mean total ridge counts (TRC). Whorl was slightly higher in female then in the males. However, contrary to the expected trend of the sex differences, there were low frequency of loops and greater frequency of the pattern with two triradii (the whorl) among the females. The excess was confined to the bi centric patterns (Hervey and Suter, 1983).

2.9 FINGERPRINTS AND PSYCHOLOGY

Considering different classes of fingerprints the scientist especially palmist began to speculate about the psychological connections of fingerprints and individuals. Some notable palmist and their observations are as follows;

2.9.1 Katakkar's Observations (1992)

Loop indicates a person with a high degree of emotional elasticity. Such a person can be expected to be very active and ready responses to his environment. However his versatility will make it difficult for him to stick to any one thing and he lacks concentration. This subject will be emotionally impulsive.

Tented arch which he believes indicates more nervous activity than the loop. He finds subjects with this print as high strung, nervous and too easily responsive to emotional stimulation. He also finds them naturally affected by musical tunes (melody?) and so idealistic as to expect too much from life. By contrast the simple arch represents a secretive type of individual who represses his emotions and sentiments. He will have the appearance of a strong willed person, but in fact is uncertain, bewildered and hesitant. This inhibits him so he may exhibit obstinate characteristics and these mechanisms make him appear to be awkward.

Whorl is a sign of one with definite independence in thought and action. Such persons are original in ideas and independent, resenting dominance of others. While they tend to be better listeners than talkers, they are quite eloquent and clear in their expressions. These self confident subjects follow their own whims and are quite secretive.

Composite indicates the practical type individuals. He finds that such people can have good judgment but lack common sense. He finds such people too materialistic and lack consideration for the emotional aspects of life. He finds these subjects lack an understanding or appreciation for the ideal visions or plans of life. He also finds such persons lack mental elasticity and are everywhere narrowly limited.

2.9.2 Douglass' Observations (1995)

Whorl represented independent, self-contained and somewhat dogmatic characteristics. Loop represented the versatile, mercurial mind and quick emotions. High arch also indicated quick, responsive minds as well as being impulsive and over sensitive. Low arch represented the skeptical and guarded characteristics and the composite the dual personality

2.9.3 Campbell's Observations (1998)

Persons with whorl prints on their thumb will tend to fight rather than fly whereas those with loops will tend to try to avoid the fight. People with composites (incomplete whorls or double loops) will tend to suffer from self doubt when it comes to completing their own plans and often fail to complete through hesitation or reverse their own decisions.

Persons with whorl prints on their index fingers tend to be goal oriented whilst those with loops, especially ulnar loops, are more process oriented (drawn toward addressing immediate concerns of life). Radial loops will indicate more "mothering" qualities, good team players and support people.

Persons with whorl prints on their middle fingers tend to be judgmental in that they look at appropriate behaviour as "their way or the highway." They may tend to write their own rules. Those with loops tend to be more "live and let live".

Persons with whorl prints on their ring fingers tend to be highly concentrated when at work, and do not take interruption easily. Those with loops on the same finger tend to handle interruption far more easily and can handle tasks with many interruptions but they may be less focused on any single task at hand.

Persons with whorl prints on their little fingers tend to interrupt conversations to bring out matters they believe are important even if those matters have nothing to do with the current topics under consideration. Those with loop fingerprints on the same fingers will tend to go with the flow of the conversation and make efforts to fit in even in uncomfortable situations.

2.10 PREDICTION POTENTIALS AND USES OF FINGERPRINTS

2.10.1 Sex Prediction

Females have more arches and ridges per cm^2, and males have more whorls. Men's prints tending to have higher levels of urea than women's (Charles, 2007).

2.10.2 Detection of Fire Detonated Bodies

One problem for the early twenty-first century is the fact that the organic component of any deposited material is readily destroyed by heat, such as occurs when a gun is fired or a bomb is detonated, when the temperature may reach as high as 500°C. Encouragingly, however, the non-volatile inorganic component of eccrine secretion has been shown to remain intact even when exposed to temperatures as high as 600°C.

A technique has been developed that enables fingerprints to be visualized on metallic and electrically conductive surfaces without the need to develop the prints first. This technique involves the use of an instrument called a Scanning Kelvin Probe (SKP), which measures the voltage, or electrical potential, at pre-set intervals over the surface of an object on which a fingerprint may have been deposited. These measurements can then be mapped to produce an image of the fingerprint. A higher resolution image can be obtained by increasing the number of points sampled, but at the expense of the time taken for the process. A sampling frequency of 20 points per mm is high enough to visualize a fingerprint in sufficient detail for identification purposes and produces a voltage map in 2–3 hours (McMurray and Williams, 2010)

This technique had been shown to work effectively on a wide range of forensically important metal surfaces including iron, steel and aluminium. While initial experiments were performed on flat surfaces, the technique has been further developed to cope with irregular or curved surfaces, such as the warped cylindrical surface of fired cartridge cases (Ward, 2006; SkyNews, 2006).

2.10.3 Diet and Life Style Prediction

Gelatin based tape and high-tech chemical analysis under spectroscopic microscope reveals the chemical and metabolic make-up found on a fingerprint. The study revealed that specific amino acids indicated whether the “suspect” was a vegetarian or meat-eater.

Spectroscopic microscope method based on the study of chemicals and metabolic featured with a fingerprint can also reveal the use of substances, including: cigarettes, drugs, grooming products etc (Charles, 2007).

2.10.4 Disease Risk Prediction

Patients with Alzheimer disease showed a significantly increased frequency of ulnar loops on their fingertips and a decreased frequency of whorls and arches. The positive predictive value of 6 or more digital whorls is an indicator of breast cancer (D'Adamo, 2011)

It was reported dermatoglyphic correlated with diabetic's mellitus (Shield *et al.* 1995; Oladipo and Ogunnowo, 2004). Nearly all chromosomal disorders have been known to show characteristic dermatoglyphic patterns useful in the diagnosis of such disorders (David and Ajdukiewicz, 1972). The dermatoglyphic patterns of obese patients are dependent on such inherited or genetic tendencies towards obesity (Bray, 1998; Bray and Ryan, 2000).

Several studies have explored the relationship of dermatoglyphics alopeci (Oladipo and Akanigha, 2005), mental retardation, congenital heart defects and diabetes mellitus (Shield *et al.,* 1995; Oladipo and Ogunnowo, 2004). Autosomal trisomies - trisomy 21, trisomies 13-18 and trisomy 8 (mosaiacism) - have been the subject of many studies in relation to dermatoglyphic patterns (Schaumann and Alter, 1976).

Studies examining dermatoglyphics in relation to cancer patients have generally shown an increase in whorls (Baines *et al.,* 1986). In addition, some studies have confirmed a correlation between the digital whorl subtype and breast cancer (Saltzer *et al.,* 1982). However, others have demonstrated that ulnar loops are associated with breast cancer. Observations in other study were inconsistent with those reported on Down's syndrome, breast cancer and prostate cancer (Oladipo *et al.,* 2009).

A work conducted by Sohil *et al.* (2010) shows that, loop fingerprint pattern, like control group, is the most common type of fingerprint in thalassemic patients. However, whorl type fingerprint is more frequent in thalassemic patients compared with normal individuals and the loop type fingerprints in thalassemic patients counted less than normal individuals. Furthermore, arch type fingerprint occurs less frequently in major thalassemic patients than minor thalassemic ones. Russian researchers, for instance, found that whorl type fingerprint occurs more frequently than other patterns in thalassemic patient (Mutalimova and Kurdiumova, 1975).

Dogramaci *et al.* (2009) also found that although the frequency of different patterns of fingerprints may differ between the control group and major and minor thalassemic patients this difference is not significant. Saha *et al.* (1973) also shows that only the abnormal loop pattern of the fingerprint on the fifth finger of women's left hand was significantly different from those of male patients, their minor thalassemic parents and the control group. These could be the use of different fingerprinting methods and interpretations.

Abnormality of patients' fingerprints has been examined in diseases such as Down's syndrome, psychiatric diseases, glaucoma, multiple sclerosis, Alzehimer's disease, uterus cancer, Wilson's disease, psoriasis, vitiligo, brachial plexus palsy, congenital cardiac diseases, borderline personality disorders, schizophrenia, and autism (Hale *et al.,* 1961; David and Ajdukiewicz, 1972; Iqbal *et al.,* 1985; Supe *et al.,* 1997; Pour-Jafari *et al.,* 2003; Novak-Laus *et al.,* 2006; Polovina *et al.,* 2006).

2.10.5 Other Uses of Fingerprints

Some scientists believe that fingerprints improve grip, but others believe that it actually reduces friction between the skin and the surface of objects. One other idea is that fingerprints increase the sensitivity of touch.

The fingerprints prove to be of paramount importance in forensic community but other forensic method such as study of lip can also add value to the forensic community

2.11 HISTORICAL OVERVIEW OF LIP PRINTS

The biological phenomenon of systems of furrows on the red part of human lips was first noted by anthropologists, R. Fischer who was the first to describe it in 1902. Use of lip prints in personal identification and criminalization was first recommended in France by Edmond Locard (Kasprazak, 1990).

In 1950 the idea of using lip print for identification was suggested. An investigation was conducted on a traffic accident and proved that the characteristics of lips formed by lip grooves are as individually distinctive as the ridge characteristics of finger prints (Synder, 1950). Since 1950 the Japanese have carried out extensive research in the matter. In the period 1968-1971 two Japanese scientists, Tsuchihashi and Suzuki examined 1364 persons at the Department of Forensic Odontology at Tokyo University. Based upon that research it was established that the arrangement of lines on the red part of human lips is individual and unique for each human being. This statement led to the conclusion that there is the possibility of using the arrangement of furrows (on a trace, in a linear form) on lips for the identification of a person. In further research the Japanese scientists examined the principles of the heredity of furrows on the red part of lips (Suzuki and Tsuchihashi, 1970; Tsuchihashi, 1974).

In Poland the interest in lip prints started in 1966 when a lip print was revealed on window glass at the scene of a burglary. Research was carried out, and its results were comparable to those achieved in Japan and Hungary. The research was only of preliminary character and did not allow for practical application of results as yet. A project aiming at that objective was launched in 1982**,** in the Forensic Institute of Warsaw University Criminal Law Department, in cooperation with the former Forensic Institute of Militia in Warsaw. The material for study was collected in the former Military Training Centre at Minsk Mazowiecki. Lip prints were collected from 1500 persons (including 107 women), coming from various locations around the country. The age of the volunteers varied from 5 to 60 years. Altogether more than 7000 traces of the red part of the lips were examined. As a result of the examination the individuality of lines in the red part of lips and their unchangebility within the limits practicable for identification was proven (Vahanwalla and Parekh, 2000).

Since 1985, in Poland, the methods of finding and recovery of lip traces, recovering comparative material, and the techniques employed to carry out that expertise have been introduced into casework of the Fingerprint Department, of the Central Forensic Laboratory of Police in Warsaw. During the years 1985-1997, cheiloscopic (lip print study) techniques have been used in 85 cases, including 65 burglary cases, 15 cases of homicide, and five cases of assault. In 34 cases the identification was positive, which means that cheiloscopic techniques were equal in value to other types of forensic evidence. It has also been included in evidence for presentation in court (Reddy, 2011).

2.12 ANATOMICAL ASPECT

Lips are two highly sensitive mobile folds, composed of skin, muscle, glands and mucous membrane. They surround the oral orifice and form the anterior boundary of the oral cavity. Anatomically, whether covered with skin or mucosa, the surface that forms the oral sphincter is the lip area.

There is an upper lip (from under the nose and extending laterally toward the cheek from the nasolabial sulcus) and a lower lip (bound inferiorly by a prominent groove, the labiomental sulcus); the two lips are joined at the corners of the mouth - the comissures - and separated by the buccal fend (Utsuno, 2004; Warwick and Williams, 1979).

There are two different kinds of lip covering skin or mucosa. When the two meet, a white wavy line is formed - the labial cord - which is quite prominent in Negroes. Where identification is concerned, the mucosal area holds the most interest. This area, also called Klein's zone is covered with wrinkles and grooves that form a characteristic pattern of the lip print (Sivapathasundharam *et al.,* 2001). However, this is not the only area that deserves careful study. In fact, in cheiloscopy, one should also analyse lip anatomy, considering their thickness and the position. The lips can be horizontal, elevated or depressed and, according to their thickness, it is possible to identify the following four groups:

1. Thin lips (common in the European Caucasian);
2. Medium lips (from 8 to 10 mm, are the most common type);
3. Thick or very thick lips (usually having an inversion of the lip cord and are usually seen in negroes);
4. Mix lips (usually seen in Orientals) (Chiu and Clark, 1992).

2.13 LIP PRINT CLASSIFICATION

2.13.1 Santos Classification (1967)

This author divides the lip grooves into two groups: (1) Simple, when they are formed only by one element; this element can be a straight line R-1, a curve C-2, an angular form A-3or sinusoidal S-4; (2) Compound, when they are formed by several elements; in this case, they can be bifurcated B-5, trifurcated T-6 or anomalous An-7.

2.13.2 Suzuki and Tsuchihashi Classification (1971)

These authors considered six different types of grooves, as seen below

Classification	Groove type
Type I	Complete vertical
Type I'	Incomplete vertical
Type II	Branched
Type III	Intersected
Type IV	Reticular pattern
Type V	Irregular/other types

2.13.3 Hassan and Fahmy Classification (1977)

Hassan and Fahmy introduced their classification of lip prints into 7 types where they differentiated the branched type (type II) into proximal (a) and distal (b) branches. They also divided the lip into six areas for perfect estimation of lip prints pattern.

2.13.4 Nagasupriya *et al.* (2011)

Although there are simple classifications proposed by Santos (1967), and Suzuki and Tsuchihashi (1970) for lip prints, another more simplified classification was introduced as follows:

1. Type A - Vertical pattern (Grooves running vertically to the full length or partially across the lips)
2. Type B - Branched pattern (Grooves exhibiting branching)
3. Type C - Reticular pattern (Grooves intersecting or criss-crossing one another)

2.14 EMBRYOLOGY OF LIP PRINT

The various processes from which the face (including lips) develops can be identified at the end of 4^{th} week. During development the mandibular processes of the two sides grow toward each other and fused in the midline to form the inferior margin of stomatodaeum which give rise to lower lip. The superior margin of the stomatodeum is bounded by upper lip which formed from the maxillary process and frontonasal process. The overlying skin is derived from the ectoderm and musculature is derived from mesoderm of the second pharangeal arch (Singh, 2005). The lip prints develop in the same first weeks of embryological life as the lip (Tsuchihashi, 1974).

2.15 GLOBAL DISTRIBUTION OF PATTERN OF LIP PRINTS

2.15.1 African Continent

Hassan and Fahmy (1977) in their studies of the pattern of lip print in Egyptians found that Type IIa was the most frequent one in the upper lip in males with a percentage of 39%. Type IV was the most frequent type in the upper lip in females with a percentage of 44.4%. Type Ia and IIc were of a higher percentage (32.2%) in the lower lip in males. Type Ia was the most frequent one in the female lower lip.

Weal *et al.* (2005) also reported that, inheritance of lip prints in cleft lip and plate in children shows the following pattern among the parents. In fathers: Type IIa is significantly higher in the upper lip of the study group and was not presented in the lower lip of the control. Type Ib was not presented in the lower lip of the control. Type IIc was significantly higher in the control. In mothers: Type IIa was significantly higher in both the upper and lower lips.

A new pattern Type O: We found areas devoid of grooves; in the upper lip, in the central area. They called it O because it is almost circular in arrangement. It was not recorded before in the literature and was not found to be linked to any congenital anomaly or any disease as a lip print. Type O was significantly higher in mothers than fathers.

2.15.2 Asian Continent

Hirth *et al.* (1975) conducted a study in 500 persons, including 76 families with 133 children, 22 mono and 17 dizygote twins in India. Lip prints were recorded for the study of variability and genetical basis of ridge pattern in the region of mucous membrane of the lips. It was observed that branched pattern is more frequently present in the upper lip and simple pattern in lower lip were commonly seen.

It was also reported that 30% of the lip prints showed whirling figures at the upper lip. Investigations during several months showed stability against environmental factors. Applications of cheiloscopy to genetical investigation are reported based on the results of twins and families.

In 2000, Vahanwalla and Parekh conducted a study of lip pattern of 50 male and 60 female subjects in the age group of 19-21 years in Mumbai to promote the importance of cheiloscopy in forensic science. They reported that type I was dominant in females in the lower lips and that males tends to have different patterns in all compartment and the female tend to have the same patterns in all compartments.

The aim and objectives of their study were to confirm the permanence of lip pattern of the same individual over a period of time, to evaluate whether any peculiar pattern exist in relation to sex of an individual and also to discover the most common patterns in the Indian population. The lip prints were recorded using lipstick and paper with central portion dabbed first and then pressing it uniformly on both the corners of the lips and then studied with magnifying lens. Four-month follow up of the lip print was done to confirm the un-changeability of the lip pattern. The inference of the study is that lip prints are unique and that Y-shaped and end-to-end pattern is frequently seen in the first compartment. The study has attempted to differentiate the lip pattern between the sexes by concluding that Type-I was dominant in females in 3rd and 4th compartment and that Type-II is common in males in 2nd compartment and not seen in upper lip. The study also revealed that 52% individuals had at least same pattern in two compartments, equally distributed in both males and females. Individuals with all compartment having different patterns were common in males and, in females same pattern in all compartment were commonly seen.

In 2001, Sivapathasundharam *et al.* studied the incidence of particular lip print pattern in Indo-Dravidian population and found that type III was predominant.

In 2005, Mahaswari studied the lip print of a total number of 750 individuals and she found Type II lip print to be highest in number among male, females and in both. It was observed that each lip, either upper or lower have different types of lip prints in different parts of the lips. In the study, among males it is recorded that the maximum number of individuals have Type II lip prints (31.61%) and the minimum number of individuals have Type IV lip print (0.57%). It is recorded that among females maximum number of individuals has Type II lip prints (43.79%) and minimum of individuals have Type IV (0.99%). She concluded that no change in the lip prints, in different period in the observation of one year and no similarities of lip prints were found between parent and twins and between the twins as well as among triplets.

Further analysis carried out by Mahaswari and Gnanasundaram (2011) in the department of oral medicine and radiology, Saveetha, Dental College, Chennai, India shows that Type V has circular shaped area with minute dots, oval shaped area with horizontal lines and small leaf like structure with a branched central line.

In 2009, Gondivkar *et al.* studied 70 male and 70 female subjects in Maharashtra and were able to predict the sex with high degree of accuracy. He also reported that criss cross lip pattern was 51.05% in males and 37.06% branch lip print pattern in females.

Saraswathi *et al.* (2009) studied a sample of 100 individuals comprising 50 males and 50 females and in overall study, no individual had single type of lip print in the entire four compartment and no two or more individuals had similar type of lip print pattern.

When the overall pattern was evaluated among all the lip compartments of the study subjects, it was found that intersecting pattern was most common, both among males and females having 39.5 and 36.5%, respectively. However, the least common was the reticular pattern seen in 11.0% males and 13.0% females. The analysis of lip print type in each compartment was done. Among males, it was found that intersected pattern was most common in compartments 1-4 having 34, 32, 50, and 42%, respectively, while the least common pattern in lip compartments 1, 2, and 4 was the reticular pattern having 6, 10, and 12%, respectively. However, in compartment 3, males showed branched pattern as the least common (4%). On evaluation of the lip prints of the females, compartments 1, 2, and 3 exhibited intersected pattern predominantly having 38, 48, and 38%, respectively. However, in compartment 4, branched pattern was commonest (24%). Lip compartments 1, 3, and 4 of the females showed the reticular pattern as the least common having 8, 10, and 20%, respectively, while compartment 2 had vertical lip prints least in number (10%).

In 2010, Shilpa *et al.* studied lip print in relation to gender and blood group and the result of their study showed, in boys, the Type I (complete vertical- 30%), in girls, Type II (branched- 26%) and among both, type II (branched) lip print pattern to be most prominent pattern. The Type I' (incomplete vertical- 14%), Type III (intersecting- 8%) and Type V (irregular- 6%) are least common. The study also showed a good consistency of the lip print pattern when observed for a period of six months consecutively and no any statistical correlation of lip print with family members or even any correlation between blood group and lip prints.

El-Domiaty *et al.* (2010), in a study of morphological pattern of lip prints in Saudi Arabia at Almadinah Almonawarah in 966 individual including 13 identical twins and 19 families, showed that no identical lip prints pattern were recorded. Few prints (9.63% in both sexes) showed one type of the lip prints in all of the areas of the lips (12.59% of female and 5.87% in males), but two or more type of grooves were commonly seen in different areas of the prints. A total of 72.67% of lip prints showed the same groove pattern in the upper right and upper left areas (78.89% of females and 64.79% of males), while 75.36% of the prints showed the same groove pattern in the lower right and lower left areas (74.81% of females and 76.06% of males).

Nine types of grooves were recorded in Saudi lips. The groove type, horizontal with other forms was the highest recorded (68.7% in females and 42.7% in males) followed by the complet bifurcated, complete branched, reticular, complete vertical, incomplete bifurcatated X or coma form, incomeplete verticals in descending order. The horizontal type was the least recorded and appeared only in females. Dissimilar lips prints pattern were detected among different individuals of families. Non-identical lip prints pattern were recorded in identical twins.

A preliminary study of lip-print in Sri Lanka by Goonerathne (2010) using 25 volunteers (15 males and 10 females) established the initial idea about lip print pattern in Sri Lankan and the common lip prints types observed are Type I, I', II and III.

Annie *et al.* (2010) also study a lip print types among people of Keraleand. It was recorded that type IV was the most frequently observed in both sexes and in the entire compartment.

In 2011, Ramandeep *et al.* ascertain the use of lip prints for sex determination of an individual and also determine the most common lip prints patterns in the Punjab population. The most predominant pattern in the entire study population was Type III (22.8%). This was followed in order by Type I (21.6%), Type I' (16%), Type IV (11.6%) and Type II (9.2%). In females, Type I (43.2%) lip pattern was commonly found followed by Type I (32%), Type II (18.4%). In males, Type III (45.6%) lip pattern was predominant, followed by Type IV (23.2%) and Type V (10.4%). Therefore, the most common lip print pattern for female is Type I/I'/II (93.60%) and the most common lip pattern for males is Type III/IV/V (79.20%).

Satyanarayana *et al.* (2011) also reported that Type I and I' were most commonly seen pattern in female, whereas type IV was seen most commonly in males in Kamataka, India. Vijay *et al.* (2011) reported that type I and I' lip prints are most predominant in female and type III, type IV and type V was most commonly seen in male.

In the studies of heritability of lip print pattern among Northern Indian population by Vats *et al.* (2011) show that there is persistent similarity of lip print pattern among parents and their offspring but no association was found in lip prints pattern of monozygotic twins.

The study of lip print pattern of 25 males and 25 females by Singh *et al.* (2011) in Amballa revealed the following observations: It is recorded that in males 25.29% were having Type I, 31.61% with Type II, 14.94% with Type III, 0.57% with Type IV and 27.59% with Type V lip prints. In females 22.89% were having Type I, 43.79% with Type II, 12.94% with Type III, 0.99% with Type IV and 19.40% with Type V lip prints. In both males and females 24% were having Type I, 38.13% with Type II, 13.87% with Type III, 0.8% with Type IV and23.2% with Type V lip prints.

They concluded that no two lip prints matched with each other, thus establishing the uniqueness of the lip prints, two lip prints of the same person matched thus establishing the repeatability and uniqueness of lip prints, and type II was most commonly seen in females, whereas Type IV was seen most commonly in females.

In the Andhra Pradesh population, the predominant pattern is branched, 49% in males and 40% in females followed by reticular pattern, 40% in males and 31% in females and vertical pattern 11% in males and 29% in females (Nagasupriya *et al.,* 2011).

2.16 PRACTICAL APPLICATION OF LIP PRINTS

1. A case of traffic accident investigated by Lelan V. Jones, Los Angeles police department in which the injured woman left her lip print on the left front fender of a car (Synder, 1950).

2. Suzuki and Tsuchihashi reported two cases where lip prints have proven useful in identification of the criminal. In first case while the lip prints were identified on an envelope and compared with those of the suspects. In the second case lip prints were noted on the undergarments and were studied with the help of colour test and ultraviolet rays (Suzuki and Tsuchihashi, 1975).

3. In 1987, FBI had successfully identified a male bank robber who used female disguises including lipstick. The FBI submitted the photographs and lifts of the lip prints that robber had left on the glass door while robbing a bank, which were identified to match with that of suspected robber. These cases suggest that lip print study can definitely be used for criminal identification (William, 1991).

4. In an investigation, Aggrawal has proved beyond doubt that lip prints are as good as finger prints in criminal identification and can definitely be used when no other means of traditional methods of identification are available. He found a lip prints on a drinking glasses and it happened to be the only available sign of identity during his criminal investigation which he used to confirm the suspect (Aggrawal, 2004).

2.17 CHALLENGES IN THE STUDY OF LIP PRINTS

The lip print is produced by a substantially mobile portion of the lip. This fact alone explains the reason why the same person can produce different lip prints, according to the pressure, direction and method used in taking the print. If lipstick is used, the amount can also affect the print. This problem however, can be solved if recordings are made until all of the substance is used (Ball, 2002)

Manual register of the overlay structure is another problem, due to the possibility of some subjectivity (Ball, 2002). Another factor to be considered is the existence of some pathological conditions, which can invalidate the cheiloscopic study. One must also consider the possibility of post-mortem changes of lip prints from cadavers with various causes of death. Utsuno (2004) have studied these changes and concluded that a satisfactory identification rate was achieved. However, this study was carried out under a laboratory environment and what happens to lip prints obtained from cadavers exposed to the natural environment is still not known.

It should also be pointed out that only in very limited circumstances, is there antemortem data referring to lip prints, which obviously impairs a comparative study where necro identification is concerned. The main feature for dental identification is the existence of antemortem data (Adams, 2003; Pretty and Sweet, 2001; Valenzuela *et al.,* 2000; Taylor *et al.,* 2002) which cannot be expected in cheiloscopy. Therefore, the only use of cheiloscopy will be to relate lip prints to the lips that produced them.

Considering the two important forensic methods (fingerprints and lip prints) the relationship between the two will be considered using appropriate materials and methodology.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EQUIPMENT

Microscopic glass slides, fine carbon black powder, cello tape, magnifying glass, ink pad, scissors, hand gloves, questionnaires.

3.2 STUDY LOCATION AND DURATION

The study was conducted in the Demonstration Secondary School, Samaru, Zaria, Kaduna state, Nigeria, for periods of four weeks (One month).

3.3 SUBJECTS

The subjects comprised both males and female students of Demonstration secondary school. The data was collected from 1050 distributed questionnaires, out of which a total of 820 subjects consisting of 414 males and 406 females were used for the study. For ethnicity, 764 subjects consisting of 287 Hausas, 106 Yorubas, 71 Igbos and 300 other ethnic groups were used. With respect to seasons of birth a total of 506 subjects comprising of 207 and 299 subjects borne in dry and wet seasons respectively were used.

3.4 INCLUSION CRITERIA

The following subjects were included in the study;

1. The subjects must be Nigerians by Parentage
2. The subjects whose lips and finger tips were free from any inflammation, deformity or pathological changes

3.5 EXCLUSION CRITERIA

The following subjects were excluded from the study;

1. Subjects without fingers (although not encountered in the research)
2. Subjects with any inflammation on finger tips
3. Those who are having inflammation or pathological changes or cleft on their lips

3.6 STUDY DESIGN

The study involved the use of questionnaire. The data of each subject was collected using questionnaire as follows

1. The questionnaire was distributed to the subjects
2. Then the subjects were asked to fill in the required information in the questionnaire
3. A brief explanation of the five fingers was made, and then the students were asked to make an imprint of their fingers in a space provided on the questionnaire
4. After that, the lip prints of the subject was taken using glass slide and finally attached to the space provided on the questionnaire using cello tape.
5. That completed the questionnaire with the required information

3.7 ETHICAL APPROVAL AND INFORMED CONSENT

Before the commencement of the research, Ethical approval letter was sought from the Ethical Committee of the Faculty of Medicine, Zaria. A Letter of introduction was also obtained from Department of Human Anatomy, Faculty of Medicine, A.B.U., Zaria, which was addressed to the Principal of Demonstration secondary school for easy access to the students. Informed consent was sought from the students whose age is 18 years and above, and from class teachers for the students whose age fall below 18years

3.8 METHODOLOGY

The sex, ethnicity, season of birth, fingerprints and lip prints were collected in the questionnaires as follows

3.8.1 Sex

The subjects were divided based on gender into male and female.

3.8.2 Ethnicity

The subjects were divided based on their Parent's tribes into Hausa, Yoruba, Igbo and others (this comprised Igala, Ebira, Kataf, Nupe) ethnic group. The subjects were placed in a particular ethnic group if their both Parents' father belonged to same ethnic group.

3.8.3 Seasons of Birth

The subjects were divided based on the month of birth into dry and wet season of birth. The season of birth was defined as wet season (from April to October) and dry season (from November to March).

3.8.4 Fingerprints Collection and Analysis

After brief description of the five fingers was made to the subjects, the fingers were cleaned with tissue paper. The subjects were made to roll the tip of their fingers and thumb one after the other from side to side across the surface of an already made ink-stained pad, ensuring that the ink covered the entire pattern area. The finger was then transferred to a white paper to obtain the print. Each finger was given a name in a columns starting from Thumb (T), Index (I), Middle (M), Ring (R) and Little (L) for both left and right fingers according to the method of Oladipo and Akanigha, (2005) as shown in plate I and II



Plate I: Placement of finger (thumb) on the already made stained ink pad



Plate II: Collection of the finger (thumb) prints on the participant questionnaire

3.8.5 Lip Prints Collection and Analysis

The subjects were made to stand in a relaxed position and asked to clean his/her lip with the tissue paper, a clear new microscopic glass slide was placed on the relaxed lips of the subject in a single motion. The glass slide was then removed from the surface of the lip and carbon black powder was poured on the surface of the slide that was in contact with the lips, then the excess powder was dusted by mouth blow, resulting in the production of well developed lip prints on the slide ready for preservation and analysis.

The glass slide was placed on an area provided on the questionnaire with left and right, superior and inferior sides in consideration. Finally, a transparent cello tape was used to cover the print as well as attached the slide to the questionnaire. Care was taken to avoid formation of any bubble and wrinkles on the glass slide (Shilpa *et al.,* 2010).

For the analysis of the prints, the print was divided into ten compartments for both lower and upper lip for perfect estimation. This is modified Hassan and Fahamy (1977) method in which they divided the lips into six estimation areas or compartments as shown in figure 3.1 and plates III to VIII

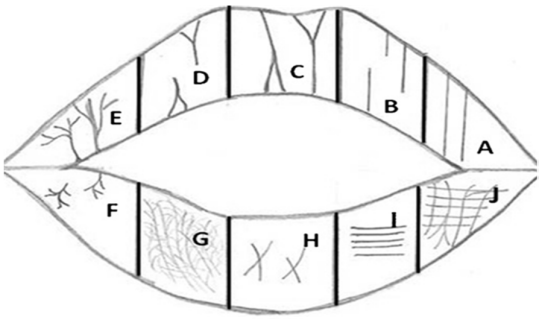


Figure 3.1; Division of the lips into ten compartments

Keys:

A: Upper Left Lateral (ULL) Compartment

B: Upper Left Medial (ULM) Compartment

C: Upper Median (UM) Compartment

D: Upper Right Medial (URM) Compartment

E: Upper Right Lateral (URL) Compartment

F: Lower Right Lateral (LRL) Compartment

G: Lower Right Medial (LRM) Compartment

H: Lower Median (LM) Compartment

I: Lower Left Medial (LLM) Compartment

J: Lower Left Lateral (LLL) Compartment



Plate III: Placement of microscopic slide on lip to pick the lip prints



Plate IV: Development of lip prints on microscopic slide using carbon black powder



Plate V: A well developed lip prints on microscopic slide



Plate VI: Placement of well developed lip print on participant's questionnaire



Plate VII: Placement of cello tape on well developed lip print for permanent preservation

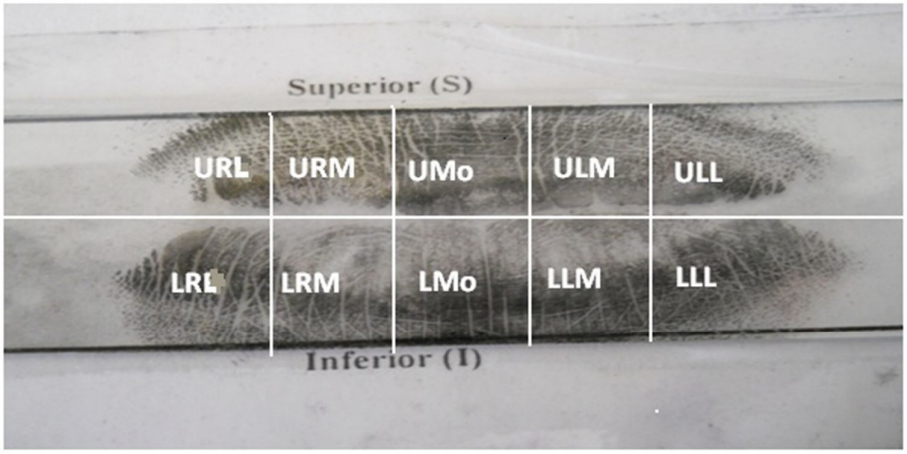


Plate VIII: A well divided lip prints into ten compartment ready for analyses

Keys:

Upper and lower left lateral (ULL and LLL), upper and lower left middle (ULM and LLM), upper and lower median (UM and LM), upper and lower right middle (URM and LRM), upper and lower right lateral (URL and LRL) compartments.

3.9 LIMITATIONS

The problems encountered during the studies include;

1. Shyness of the girls during the lip prints collection
2. Smudging (blurring) of the prints leading to the unidentified marks
3. Loss of questionnaire
4. Incomplete questionnaires (despite the attempt to ask for the completion of any incomplete information)
5. Only 80-90% of the lip prints can be taken in a single motion using glass slide
6. During estimation of lip pattern in each compartment, some lip prints overlap, in such a case dominant type of lip prints is considered

3.10 STATISTICAL ANALYSIS

The chi-square test was used to test for association of sex, ethnicity, and season of birth and thumb prints with lip prints. Statistical significance was considered when a P. Value was less than or equal to 0.05($P \leq 0.05$). Analyse- It statistical software for Microsoft excel, version 2.26, 2012 was used for the statistical analysis.

CHAPTER FOUR

4.0 RESULTS

Table 4.1 shows the percentage distribution of the pattern of fingerprints on the 10 different digits on both hands according to sex. In males (n= 414) the most common fingerprints pattern were loops (61.99%), followed by whorls (34.19%) and arches (3.88%). Similar patterns were seen in females (n=406) as Loops (65.55%), Whorls (30.59%) and Arches (4.26%). In both sexes loops exhibit high percentage of occurrence while arches was the least.

Table 4.1: **Percentage distribution of the pattern of fingerprints on different digits (10) on both hands according to sex**

		MALE (n= 414)			FEMALE (n= 406)		
FINGERS	SIDE	L (%)	W (%)	A (%)	L (%)	W (%)	A (%)
THUMB	RIGHT	4.71	4.76	0.53	5.47	3.92	0.62
	LEFT	5.48	3.99	0.8	5.2	3.94	0.86
INDEX	RIGHT	5.34	4.11	0.55	6.18	3.33	0.49
	LEFT	5.79	3.72	0.48	5.89	3.52	0.99
MIDDLE	RIGHT	6.91	2.63	0.46	7.34	2.36	0.3
	LEFT	6.79	2.68	0.53	6.77	2.88	0.34
RING	RIGHT	5.72	4.06	0.02	6.53	3.23	0.25
	LEFT	5.92	3.79	0.29	6.43	3.3	0.27
LITTLE	RIGHT	7.58	2.32	0.1	7.86	2.07	0.07
	LEFT	7.75	2.13	0.12	7.88	2.04	0.07
TOTAL		61.99	34.19	3.88	65.55	30.59	4.26

In table 4.2 the percentage distribution of lip print in males upper lip shows that the most frequent lip pattern in the upper lip was type III (34.35%) this was followed by type V (28.36%), type IV (14.49%), type I (14.11%), type II (8.11%) and the least was type I' (0.58%). For females subject type V (33.35%) was the most frequent, this was followed by type III (25.22%), type IV (22.27%), type I (11.58%), type II (6.86%) and the least was type I' (0.68%).

Table 4.2: **Percentage distribution of the types of lip prints on upper lip compartments according to sex**

		Lip print types							
Compartment	Sex	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
ULL	Male (n= 414)	12.08	0.24	10.14	45.41	4.83	27.29	27.01	**<0.0001**
	Female (n= 406)	8.87	0.00	8.37	33.99	10.84	37.93		
ULM	Male (n= 414)	13.04	0.97	10.63	38.89	16.18	20.29	28.28	**<0.0001**
	Female (n= 406)	10.59	0.74	8.87	25.37	25.62	28.82		
UM	Male (n= 414)	21.74	0.97	4.35	8.45	33.09	31.40	6.6	0.25
	Female (n= 406)	18.23	1.48	2.46	9.61	39.16	29.06		
URM	Male (n= 414)	14.98	0.48	8.45	36.47	13.77	25.85	21.12	**0.0008**
	Female (n= 406)	12.32	0.99	6.40	26.85	23.89	29.56		
URL	Male (n= 414)	8.70	0.24	7.00	42.51	4.59	36.96	23.2	**0.0003**
	Female (n= 406)	7.88	0.25	8.37	30.30	11.82	41.38		

From table 4.3 it was observed that, in males the most frequent pattern in the lower lip was type V (34.20%), followed by type III (18.89%), type I (17.88%), type IV (14.39%),type II (14.11%) and the least was type I' (0.53%). In females the type V (29.65%) was predominant, followed by type IV (23.79%), type III (18.69%), type I (15.86%), type II (12.02%) and the least was type I' (0.49%).

For association between sex and all compartment (10) of the lips. The tables (4.2 and 4.3) show statistically significant association between lip prints and sex as follows ULL (P< 0.0001), ULM (P< 0.0001), URM (P= 0.0008), URL (P=0.0003), LLM (P=0.004), LM (P= 0.01), LRM (P=0.0001), while the LRL and UM show no statistical significant association (P=0.21) and (P=0.25) respectively.

Table 4.3: **Percentage distribution of the types of lip prints on lower lip compartments according to sex**

		Lip print types							
Compartment	Sex	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
LLL	Male (n= 414)	12.56	0.72	20.05	27.78	3.86	35.02	19.8	**0.0014**
	Female (n= 406)	9.11	0.49	18.23	27.83	11.82	32.51		
LLM	Male (n= 414)	16.43	0.48	14.01	19.57	18.84	30.68	17.23	**0.0041**
	Female (n= 406)	17.73	0.49	11.58	14.53	30.30	25.37		
LM	Male (n= 414)	33.82	0.72	4.35	4.59	28.50	28.02	14.26	**0.014**
	Female (n= 406)	24.14	0.74	4.43	5.91	38.92	25.86		
LRM	Male (n= 414)	15.94	0.24	13.04	19.08	15.70	35.99	24.84	**0.0001**
	Female (n= 406)	17.49	0.49	9.85	17.73	28.57	25.86		
LRL	Male (n= 414)	10.63	0.48	19.08	23.43	5.07	41.30	7.17	0.21
	Female (n= 406)	10.84	0.25	16.01	24.88	9.36	38.67		

In table 4.4 the percentage distribution of lip prints according to ethnic groups in the upper lip shows that in Hausa ethnic group the most frequent lip print pattern in the study population was type III (31.78%), followed by type V (30.59.68%), type IV (19.09%), type I (9.62%), type II (8.43%) and the least was type I' (0.49%), and there was absence of type I' in the ULL compartment. For Yoruba ethnic group the most frequent lip pattern in the study population was type V (33.78%), followed by type III (31.51%), type IV (15.47%), type I (13.59%), type II (5.09%) and type I' (0.56%). And there was absence of type I' in the ULL and LRM compartment. In the Igbo ethnic group the most frequent lip print pattern in the study population was type V (38.31%), followed by, type III (24.23%), type IV (16.05%), type I (14.93%) and the least was type II (6.48%) and there was absence of type I' in all the compartments. For other ethnic group the most frequent lip prints pattern in the study population was type III (29.60%), type V (27.53%), type IV (19.33%), type I (14.47%), type II (6.48%) and the least was type I' (1.00%).

Table 4.4: **Percentage distribution of the types of lip prints on upper lip compartments according to ethnic group**

		Lip print types							
Compartment	Ethnicity	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
ULL	Hausa (n= 287)	7.67	0.00	9.76	43.21	8.01	31.36	28.1	**0.02**
	Yoruba (n= 106)	11.32	0.00	6.60	36.79	4.72	40.57		
	Igbo (n= 71)	11.27	0.00	2.82	28.17	7.04	50.70		
	Others (n= 300)	11.67	0.33	11.00	41.33	9.33	26.33		
ULM	Hausa (n= 287)	9.41	0.35	10.80	34.49	20.91	24.04	20.68	0.15
	Yoruba (n= 106)	13.21	0.94	6.60	35.85	16.04	27.36		
	Igbo (n= 71)	19.72	0.00	4.23	25.35	18.31	32.39		
	Others (n= 300)	11.00	1.67	11.33	30.00	23.33	22.67		
UM	Hausa (n= 287)	16.38	1.05	3.48	10.45	37.98	30.66	23.27	0.08
	Yoruba (n= 106)	18.87	0.94	0.94	12.26	33.96	33.02		
	Igbo (n= 71)	16.90	0.00	7.04	2.82	32.39	40.85		
	Others (n= 300)	24.33	2.00	3.67	8.33	36.67	25.00		
URM	Hausa (n= 287)	9.06	0.70	9.41	34.84	18.47	27.53	14.99	0.45
	Yoruba (n= 106)	16.04	0.94	5.66	35.85	15.09	26.42		
	Igbo (n= 71)	18.31	0.00	9.86	25.35	15.49	30.99		
	Others (n= 300)	16.00	1.00	6.33	30.00	19.67	27.00		
URL	Hausa (n= 287)	5.57	0.35	8.71	35.89	10.10	39.37	7.81	0.93
	Yoruba (n= 106)	8.49	0.00	5.66	36.79	7.55	41.51		
	Igbo (n= 71)	8.45	0.00	8.45	39.44	7.04	36.62		
	Others (n= 300)	9.33	0.00	8.00	38.33	7.67	36.67		

From table 4.5 the percentage distribution of lip print according to ethnic group in the lower lip shows that in Hausa ethnic group the most frequent lip print pattern in the study population was type V (31.57%), followed by type IV (21.05%), type III (19.58%), type I (13.87%), type II (13.45%) and the least was type I' (0.49%). For Yoruba ethnic group the most frequent lip pattern in the study population was type V (36.98%), followed by type III (20.57%), type IV (17.36%), type I (15.85%), type II (8.87%) and type I' (0.38%). There was absence of type I' in the LLM LM and LRL compartments. In the Igbo ethnic group the most frequent lip print pattern in the study population was type V (31.55%), followed by, type III (19.33%), type I (18.31%), type IV (17.18%) and the least was type II (13.80%) and there was absence of type I' in all the compartments. For other ethnic groups the most frequent lip prints pattern in the study population was type V (29.33%), followed by type I (19.33%), type IV (18.20%), type III (18.20%), type II (14.30%), and the least was type I' (0.80%) and there was absence of type I' in the LRL compartment.

From the tables (4.4 and 4.5) statistically significant association was observed between ethnicity and ULL (P=0.021) only. While no statistically significant association was observed with the rest of the compartments in both upper and lower lips

Table 4.5: **Percentage distribution of the types of lip prints on lower lip compartments according to ethnic group**

		Lip print types							
Compartment	Ethnicity	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
LLL	Hausa (n= 287)	8.01	0.70	21.25	27.18	10.10	32.75	19.01	0.21
	Yoruba (n= 106)	6.60	0.94	13.21	34.91	5.66	38.68		
	Igbo (n= 71)	15.49	0.00	16.90	29.58	2.82	35.21		
	Others (n= 300)	13.67	0.67	19.00	26.33	7.67	32.67		
LLM	Hausa (n= 287)	12.54	0.35	12.89	19.16	26.13	28.92	17.87	0.27
	Yoruba (n= 106)	16.98	0.00	6.60	19.81	23.58	33.02		
	Igbo (n= 71)	18.31	0.00	15.49	11.27	25.35	29.58		
	Others (n= 300)	20.33	1.00	14.33	17.33	23.33	23.67		
LM	Hausa (n= 287)	27.18	0.70	2.79	5.92	36.59	26.83	18.75	0.23
	Yoruba (n= 106)	29.25	0.00	1.89	3.77	32.08	33.02		
	Igbo (n= 71)	25.35	0.00	2.82	5.63	39.44	26.76		
	Others (n= 300)	31.33	1.33	7.33	5.67	30.33	24.00		
LRM	Hausa (n= 287)	14.29	0.35	11.85	19.51	25.44	28.57	14.35	0.5
	Yoruba (n= 106)	16.04	0.94	8.49	19.81	18.87	35.85		
	Igbo (n= 71)	18.31	0.00	8.45	25.35	12.68	35.21		
	Others (n= 300)	19.00	0.33	13.00	17.33	22.00	28.33		
LRL	Hausa (n= 287)	7.32	0.35	18.47	26.13	6.97	40.77	12.01	0.68
	Yoruba (n= 106)	10.38	0.00	14.15	24.53	6.60	44.34		
	Igbo (n= 71)	14.09	0.00	25.35	23.94	5.63	30.99		
	Others (n= 300)	12.33	0.67	17.00	24.33	7.67	38.00		

Table 4.6 shows the percentage distribution of lip print in upper lip according to season of birth. For wet season, type III (31.02%), was predominant, followed by type V (28.02%), type IV (16.71%), type I (14.30%), type II (9.66%) and the least was type I' (0.29%). While for dry season, type III (34.58%) was predominant, followed by type V (26.22%), type IV (17.53%), type I (13.78%), type II (7.56%) and the least was type I' (0.33%).

In table 4.7 the percentage distribution of lip print in lower lip according to season of birth showed that for wet season, type V (29.50%), was predominant, followed by type I (19.32%), type III (19.13%), type IV (17.68%), type II (13.62%) and the least was type I' (0.68%). While for dry season, type V (27.56%) was predominant, followed by type III (20.60%), type IV (118.99%), type I (18.53%), type II (14.18%) and the least was type I' (0.13%). In tables 4.6 and 4.7 the season of birth shows no statistically significant association with all compartments in both upper and lower lips

Table 4.6: **Percentage distribution of the types of lip prints on upper lip compartments according to season of birth**

		Lip print types							
Compartment	Season	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
ULL	Dry (n= 207)	10.14	0.00	12.08	42.03	7.25	28.50	2.82	0.73
	Wet (n= 299)	11.04	0.33	8.36	45.15	6.69	28.43		
ULM	Dry (n= 207)	13.04	0.48	12.56	30.92	17.87	25.12	4.96	0.42
	Wet (n= 299)	14.72	0.67	9.70	36.79	19.40	18.73		
UM	Dry (n= 207)	23.19	0.48	2.90	12.56	31.88	28.99	4.21	0.52
	Wet (n= 299)	20.07	0.67	5.35	10.03	37.12	26.76		
URM	Dry (n= 207)	14.49	0.48	9.66	32.37	17.39	25.60	4.15	0.53
	Wet (n= 299)	15.05	0.00	7.69	38.80	16.39	22.07		
URL	Dry (n= 207)	10.63	0.00	11.11	37.20	9.18	31.88	5.04	0.28
	Wet (n= 299)	8.03	0.00	6.69	42.14	8.03	35.12		

Table 4.7: **Percentage distribution of the types of lip prints on lower lip compartments according to season of birth**

		Lip print types							
Compartment	Season	I (%)	I' (%)	II (%)	III (%)	IV (%)	V (%)	χ^2	P
LLL	Dry (n= 207)	13.04	0.97	23.19	28.02	6.76	28.02	4.36	0.50
	Wet (n= 299)	10.37	0.00	22.07	30.10	8.36	29.10		
LLM	Dry (n= 207)	21.26	0.97	12.08	15.46	24.64	25.60	8.14	0.15
	Wet (n= 299)	18.06	0.00	15.38	22.07	21.40	23.08		
LM	Dry (n= 207)	30.43	0.48	2.90	6.76	29.95	29.47	5.05	0.41
	Wet (n= 299)	31.77	0.67	3.01	5.02	37.12	22.41		
LRM	Dry (n= 207)	21.74	0.48	9.66	18.36	20.77	28.99	2.36	0.80
	Wet (n= 299)	20.07	0.00	11.71	19.40	21.74	27.09		
LRL	Dry (n= 207)	10.14	0.48	20.29	27.05	6.28	35.75	2.15	0.83
	Wet (n= 299)	12.37	0.00	18.73	26.42	6.35	36.12		

The association between lip prints and finger print is shown in table 4.8. The left thumb show statistically significant association with LLL (P=0.02) and LRM (P= 0.0002) compartments.

Table 4.8: **Chi square statistic for association between left and right thumb prints with lip prints**

	Left thumb (n= 820)		Right thumb (n= 820)	
Variables	χ^2	P	χ^2	P
Thumbs and ULL	11.49	0.32	11.90	0.29
Thumbs and ULM	10.23	0.42	11.35	0.33
Thumbs and UM	11.75	0.30	16.37	0.09
Thumbs and URM	8.16	0.61	11.15	0.35
Thumbs and URL	5.41	0.86	14.59	0.15
Thumbs and LLL	20.91	**0.02**	7.16	0.71
Thumbs and LLM	5.22	0.88	6.17	0.80
Thumbs and LM	11.31	0.33	15.28	0.12
Thumbs and LRM	33.41	**0.0002**	16.64	0.08
Thumbs and LRL	10.96	0.36	6.87	0.74

CHAPTER FIVE

5.0 DISCUSSION

The descriptive statistics of finger prints according to sex shows that males had 61.99% lops patterns, 34.19% whorls patterns and 3.88% arches patterns. For the females the loops also had highest percentage of 65.55%, followed by whorls with 30.59%, then the arches with least percentage of 4.26%. When comparing both sexes the males had high percentage of whorls than the females, while the females on the other hand had high percentage of loops and arches. This result falls within the expectation of 25-35% of the finger prints as whorls, 60-65% as loops and arches as 5% and also not far from suggested value for Negroid population which shows the percentage as 7% arches, 28.35% whorls and 64.55% loops (Cummins and Midlo, 1976).

The finding is also not far from the findings of Danborno and Idris (2007) in Hausa ethnic group with a result showing that Hausa males had 30.15% as whorls, 65.91% as loops and 3.95% arches. In females 29.33% were having whorls, 61.27% were having loops and 9.29% were having arches. Osunwoke *et al.* (2008) on Okirika and Ikwerre ethnic group of Nigeria also showed that the ulnar loops for Okrika population were 46.42%, whorls 37.77%, arches 14.12% and radial loops 1.71%. The Ikwerre population had the ulnar loops of 56.46% which was higher than that of the Okrika population, whorl 24.42%, arches 15.89% and radial loops 3.23%

The percentage distribution of the lip prints according to sexes show that in the upper lip male had high percentage of type III (34.35%) this was followed by type V (28.36%), type IV (14.49%), type I (14.11%), type II (8.11%) and the least was type I' (0.58%), and for lower lip the most frequent was type V (34.20%), followed by type III (18.89%), type I (17.88%), type IV (14.39%), type II (14.11%) and the least was type I' (0.53%). In the female subjects the type V (33.35%) was the most frequent, this was followed by type III (25.22%), type IV (22.27%), type I (11.58%), type II (6.86%) and the least was type I' (0.68%). For lower lip the type V (29.65%) was predominant, followed by type IV (23.79%), type III (18.18.69%), type I (15.86%), type II (12.02%) and the least was type I' (0.49%).

The results are not in line with other findings such as Hassan and Fahmy (1977) in their studies of the pattern of lip print in Egyptians populations showed that type IIa was the most frequent one in the upper lip in males with a percentage of 39%. Type IV was the most frequent type in the upper lip in females with a percentage of 44.4%. Type Ia and IIc were of a higher percentage (32.2%) in the lower lip in males. Type Ia was the most frequent one in the female lower lip.

It was reported that inheritance of lip prints in cleft lip and plate in children shows the following pattern among the parents. In fathers: type IIa is significantly higher in the upper lip. In mothers: type IIa was significantly higher in both the upper and lower lips. Type O which is under Type V was significantly higher in mothers than the fathers (Weal *et al.* 2005)

It was also reported that type I was dominant in females in the lower lips and that males tends to have different patterns in all compartment and the female tend to have the same patterns in all compartment. The study has attempted to differentiate the lip pattern between the sexes by concluding that Type-I was dominant in females in 3rd and 4th compartment and that type-II is common in males in 2nd compartment and not seen in upper lip (Vahanwalla and Parekh, 2000)

The study also revealed that 52% of individuals had at least same pattern in two compartments, and equally distributed in both males and females. Individuals with all compartments having different patterns were common in males and, in females same pattern in all compartment were commonly seen.

According to Mahaswari (2005) males recorded the maximum number of Type II lip prints (31.61%) and the minimum numbers of type IV lip print (0.57%). It is recorded that among females maximum numbers of individuals have type II lip prints (43.79%) and minimum of individuals have type IV (0.99%).

In 2009, Gondivkar *et al.* reported that criss cross lip pattern was 51.05% in males and 37.06% branch lip print pattern in females. Saraswathi *et al.* (2009) also noted that males and females have 39.5 and 36.5% intersecting pattern, respectively. However, the least common was the reticular pattern seen in 11.0% males and 13.0% females.

El Dormaty *et al.* (2010), stated that a total of 72.67% of lip prints showed the same groove pattern in the upper right and upper left areas (78.89% of females and 64.79% of males), while 75.36% of the prints showed the same groove pattern in the lower right and lower left areas (74.81% of females and 76.06% of males). Nine types of grooves

were recorded in Saudi lips. The groove type, horizontal with other forms was the highest (68.7% in females and 42.7% in males).

Singh *et al.* (2011) in Amballa revealed the following observations: It was recorded that in males 25.29% were having Type I, 31.61% with Type II, 14.94% with Type III, 0.57% with Type IV and 27.59% with Type V lip prints. In females 22.89% were having Type I, 43.79% with Type II, 12.94% with Type III, 0.99% with Type IV and 19.40% with Type V lip prints.

In the Pradesh population in India, the predominant pattern was branched type, 49% in males and 40% in females followed by reticular pattern, 40% in males and 31% in females and the least was vertical pattern 11% in males and 29% in females (Nagasupriya *et al.,* 2011).

These findings were not similar with the present results. These variations of distribution of the lip prints in both sexes may be link to the genetic influences which varies with respect to different sexes. Hence, this can add value to lip print in the forensic science community as an additional tool in personal identification

The present study also described the lip print according to ethnic groups and the result showed that in the upper lip of Hausa and other ethnic groups had type III as the predominant lip print pattern. Whereas Yoruba and Igbo ethnic groups have type V as the most predominant lip prints pattern. This may indicate a close ancestral decent between the ethnic groups. The absence of type I' in all compartments of Igbo ethnic group and most compartment of Yoruba ethnic group may also indicate proximity o the two ethnic groups. Likewise the absence of type I' in only one compartment in both Hausa and other ethnic group may indicate proximity of the ethnic groups

Establishment of association between two variables in the forensic science is of paramount importance. When considering sex and lip prints, the present study observed that sex was statistically associated with all compartments (upper and lower) of the lip with the exception of UM and LRL compartment. This finding is similar to the results observed by Vijay et al. (2011), Satyanarayana *et al*. (2011) and Ramandeep *et al.* (2011), in Indian population. Although in their studies they considered the LM compartment only as the study area, since it was the most frequently encountered lip part in the criminal scene according to Sivapathasundram *et al.* (2001). In the present study the rest of the compartments were analysed and found most of them to be statistically associated with sex. These showed high level of sexual dimorphism in the pattern of lip prints which may be linked to the difference in genetic make-up between males and females especially in sex chromosomes. Thus it can be use in forensic science in sex determination.

Another important variable considered was the ethnic groups and it was found that tribe had statistically significant association with ULL compartment. This association may be due to variation in the genetic make-up of the different ethnic groups; therefore, this is an important breakthrough in forensic science, since there is lack of comparative study between the lip prints and ethnicity. For the season of birth, there was no statistically significant association between the seasons of birth and all the compartments of the lips. This may be due to less influence of environmental factor in the determination of the lip print patterns.

For example Shilpa *et al.,* (2010) and Tsuchihashi, (1974) demonstrated the consistency of lip prints over periods of six months and five years respectively. This indicates

minimal effect of the environmental factors. Hence, recommending the use of lip print as a forensic tool.

The left thumb print was shown to be statistically associated with LLL and LRM compartments but there was no statistically significant association between right thumb and lip print. This implies significant relationship between thumb print and lip print. The importance of this is that lip print may be used as a genetic marker in some congenital anomalies and clinical findings just like fingerprints. The finding is in agreement with that of Nagasupriya *et al.,* (2011), despite the different lip prints classification and methodology with respect to collection of the lip prints and division of the lip into quadrants adopted in this research.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMONDATIONS

In the study, the pattern of fingerprints and lip print patterns were studied and the association of lip print and fingerprints (left and right thumb), sex, ethnic groups and seasons of birth were also investigated and it was observed that lip prints were statistically associated with thumb prints, sex and ethnic groups.

Regarding the pattern of finger prints the expected frequency was obtained. For lip prints the pattern of the entire population showed a different result from other findings. Further division of the lip prints according to sex, had similar pattern of predominance and least pattern of frequency in both males and females which was in agreement with other findings by different workers.

Analysis of the pattern of lip prints according to the ethnic groups showed important findings in which types I' were absence in all compartments in Igbo ethnic group, ULL compartment in Hausa ethnic group, ULL, URL, LLM, LM and LRL compartments in Yoruba ethnic group, and URL compartment in other ethnic group. Environmental factors have some influences on the majority of anthropological variables, but in this research the season of birth as environmental factor, has no influence on the lip prints, hence no association was observed between lip prints and season of birth.

In conclusion, lip prints can hold potential promise as supplementary tool in personal identification of suspects or unknown identity.

6.1 RECOMMONDATIONS

1. There is also need for similar research with larger sample size for each ethnic group separately in order to establish and give detailed explanation of lip print pattern among the ethnic groups in Nigeria.

2. Moreover, the Nigerian law enforcement agents should learn to utilise this type of work in scientific criminal detection

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APPENDIX I

Questionnaire for Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria

S/No……

Bio Data

1. Name (in full) …….

   ……

2. Class (e.g. 2A) …… 3. Location of birth ……

3. DATE OF BIRTH (DAY/MONTH/YEAR)……..

4. SEX……

5. Ethnicity (a) Paternal…… (b) Maternal ……

6. Do you have relative in this school? If yes, state his/her

   (a) Name……..

   (b) Class……..

   (c) Status (e.g. Twins, step brother/sister, blood brother/sister etc)……

Prints Recording

- **Fingerprints**

Right fingers (R)

Thumb (T)	Index (I)	Middle (M)	Ring (R)	Little (L)

Left fingers (L)

Thumb (T)	Index (I)	Middle (M)	Ring (R)	Little (L)

- **Lip prints**

Superior

Left  **Right**

Inferior

APPENDIX II

Consent letter

Department of Human Anatomy,

Faculty of Medicine,

ABU, Zaria.

Dear respondent

I am Lawan Hassan Adamu, a master's student of department of Human Anatomy, conducting a research on comparative studies between fingerprints and lip prints in secondary schools student in Zaria.

Participation is voluntary. It involves collection of your fingerprints, lip prints and certain information about you.

The prints and information collected will only be used for above objectives and scientific publication

I assure you that your prints and information will be kept in strict confidence.

Yours faithfully

Lawan Hassan Adamu

APPENDIX III

Consent form for Comparative Study of Fingerprints and Lip Prints among Different Ethnic Groups, Sex and Seasons of Birth in Zaria, Nigeria

I……
……, have been duly informed of the procedure, aims and objectives of the study to be carried out on me. I also agreed to participate in the study

Sign……

Date……...