ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE

DEPARTMENT OF ANATOMY

PREVALENCE AND ASSOCIATED FACTORS OF DIGITAL RIDGE AND PALMAR CREASE PATTERN TYPES AMONG HIGH SCHOOL STUDENTS IN DESSIE TOWN, NORTHEAST ETHIOPIA.

MSC THESIS

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ADDIS ABABA ETHIOPIA

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Prevalence of digital ridge and palmar crease pattern types and associated factors among high school students in Dessie town, Northeast Ethiopia.

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A thesis submitted to Addis Ababa University, college of health sciences, school of medicine, and department of anatomy for the partial fulfillment of the requirements for the degree of masters of Science in anatomy.

Addis Ababa Ethiopia

August, 2020

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Declaration

I, Destaye Tirit, the Human anatomy MSc student declare that this thesis is my original work. It is being submitted for the partial fulfillment of the degree of Master of Science in human anatomy in the department of Anatomy at Addis Ababa University. I also declare that it has not been presented in this or any other university and that all resources and materials used in this thesis were well acknowledged. I strongly agree to accept responsibility for the scientific, ethical and technical conduct of the research project and for provision of the required process report as per terms and conditions of the research and publications office of Addis Ababa University. I will be subjected to prepare the manuscript and will not include the name of another scholar who did not participate in this thesis work.

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List of abbreviations

AAU……Addis Ababa university

IRB .....Institutional Review Board

SD……..Standard deviation

SPSS.....Statistical package for social science

TFRC……Total finger ridge count

UoG…….University of Gondar

Abstract

Introduction: The term dermatoglyphics is composed of two Greek words, "derma" and "glyphic" meaning skin and curves respectively. It indicates the study of the epidermal ridge configuration on the fingers, palms and soles. Palmar creases or lines are epidermal flexure lines present on palmar surface of the hands .These are unique, permanent and genetically controlled morphological variables. Dermatoglyphics and palmar creases are important tools for diagnosis of congenital diseases, personal identification, and criminal investigations.

Objective: This study aims to assess prevalence and associated factors of digital ridge and palmar crease pattern types, among high school students in Dessie town, Northeast Ethiopia**.**

Methods and materials: A cross- sectional survey qualitative and quantitative study was conducted. Systematic random sampling technique was used to select study subjects. The data was collected using self-administer structured questionnaires and by observational checklist after taking photograph of fingers and palms of students. A Pearson *chi*-square test, Independent t-test, bivariable and multivariable multinomial logistic regression models were employed using SPSS (version 20). Significance was set at p value less than 0.05.

Results: : Most of the study participants had loop type digital ridge pattern which accounts 60.2%, whereas whorl and arch types accounted 32.2% and 7.6% respectively. Females were less likely to have arch pattern (AOR=0.57; 95%CI: 0. 40, 0.82) and loop pattern (AOR=0.69; 95%CI: 0.61, 0.8) than whorl pattern, when the rest variables are kept constant. Being right hand had higher loop pattern (AOR=1.19; 95%CI: 1.04, 1.36) than whorl pattern. The mean difference of ridge count was significantly higher among male students (0.005) and whorl pattern types (0.001). Among variant palmar crease types Simian crease pattern (5.9%) was the most common followed by Suwon crease pattern (3.5%), and Sydney crease pattern was the least (2.7%). Normal palmar crease was significantly higher among females but variant palmar creases are significantly higher among males (0.03).

Conclusion: The loop type was the most prevalent type of digital ridge pattern. The mean of ridge count of male was higher than female students. Among the palmar crease pattern, Normal crease pattern was the most prevalent type and the common type among the variant palmar crease patterns was Simian crease.

Keywords: Dermatoglyphics**,** Arch, Loop, Whorl, Simian crease, Sydney crease, Suwon crease.

1. Introduction

1.1 Background

The term, “Dermatoglyphics” was coined by Cummins and Mildo in 1926 and is composed of two Greek words, “derma” and “glyphic’’ meaning skin and curves respectively. It indicates the study of the epidermal ridge configuration on the fingers, palms, and soles(1). The differentiation of dermal ridge takes place early in fetal development. Dermatoglyphic ridge pattern development begins with the appearance of fetal pads in the 6th week of gestation and ends with the appearance of actual patterns on the surface of the skin in 24 weeks of gestation and remains unchanged throughout life(2, 3).

Digital ridge patterns are classified based on their primary pattern as arches, loops, and whorls(4, 5). Although numerous sub-classifications have been subsequently offered, this simple classification is still recognized and are used by majority of investigators today(4). The three basic dermatoglyphic landmarks on finger tips are triradius, core, and radiant: Triradius is formed by the confluence of three ridge systems. Core is the approximate center of ridge pattern. Radiant is a line between core and triradius (fig. 2)(6).

Arch pattern is the simplest pattern found on fingertips. It is formed by succession of more or less parallel ridges, which traverse the pattern area and form a curve that is concave proximally (figure1). The arch patterns are sub-divided into two types known as simple (plain) and tented arch. Simple (plain) arch pattern is composed of ridges that cross the fingertips from one side to the other without recurring. The tented arch is formed when ridges meet at a point and there smooth sweep is interrupted(6).

Loop pattern is a series of ridges that enter the pattern area on one side of the digit, recurve abruptly, and leave the pattern area on the same side (Figure 1). Loops are sub-classified into ulnar and radial loops. Ulnar loop is formed when the ridge opens on the ulnar side. Radial loop is formed when the ridge opens toward the radial margin(6).

Whorl pattern is any finger ridge pattern which contains two or more triradius (figure 1). There are four sub-types of whorls these are concentric whorl, double loop whorl, central pocket whorl and composite whorl. Concentric whorl is formed when the ridges are arranged in concentric rings

around the core. Double loop whorl is formed when the ridges spiral around the core in clockwise or anticlockwise direction. Central pocket whorl is formed when the whorl contained within a small pocket of loop and composite whorl is formed when different types of pattern types combined(6, 7).

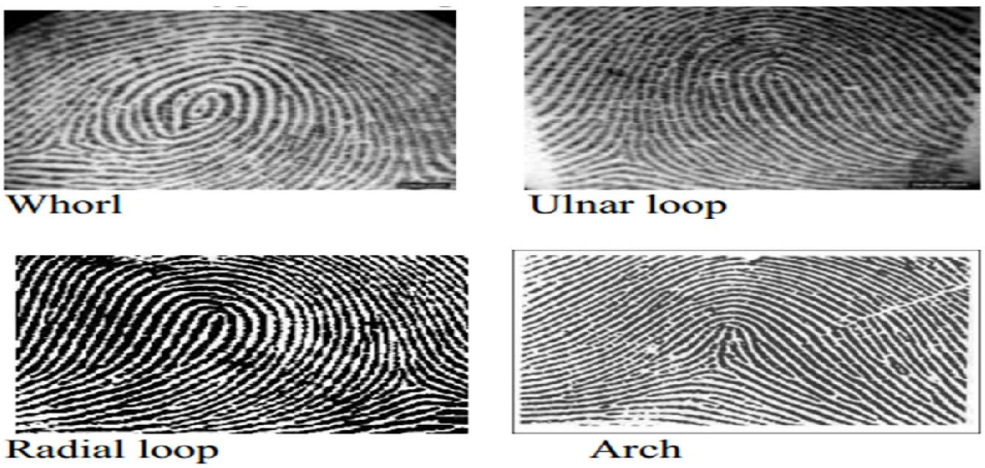

Figure 1.Arch, ulnar loop, radial loop and whorl patterns of the finger ridges(8).

A ridge count is the number of ridges intervening between the triradius and the core which touches a straight line joining these two points in a fingertip pattern. Each digital ridge pattern has a unique method of obtaining the total finger ridge counts (TFRCs). Arch patterns have a zero ridge count. Loop pattern ridge count is obtained by counting the number of ridges between the triradius and the center of the pattern. Whorl pattern ridge count is made from each triradius to the center of the pattern and higher of the possible counts is recorded. Adding all the ridge counts of the ten fingers makes up the TFRCs(7, 8).

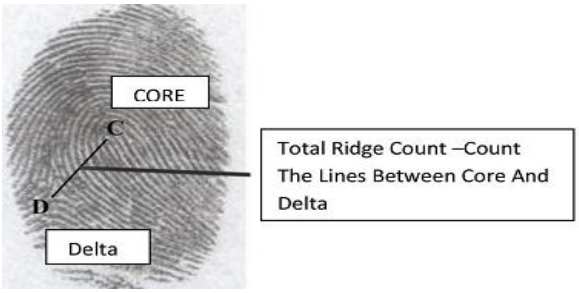

Figure 2. Core, delta and radiant of finger ridge patterns(7).

Palmar creases or lines are epidermal flexure lines which are unique, permanent and genetically controlled morphological variables present on palmar surface of the hand. The major palmar creases develop between 9 to12 weeks of gestation(2, 3) and remains unchanged throughout life(9, 10). The resulted ridge and crease configurations are genetically determined and influenced by environmental forces during the developmental stages(10, 11). Dermatoglyphics and palmar creases are used as a diagnostic aid in a number of diseases which have strong hereditary basis and used as a method for screening of congenital anomalies(1, 12). In addition to predict the diagnosis of genetic disease; dermatoglyphics and palmar creases are also used in forensic medicine, in individual identification, physical anthropology, human genetics and medicine(5, 12).There are three primary or major and several minor palmar creases on the surface of palm. The major palmar creases run from near the metacarpophalangeal joint of the index finger toward the wrist and transversely toward the medial border across the palm. This major palm creases are radial longitudinal crease (RLC), proximal transverse crease (PTC), and distal transverse crease (DTC) (fig. 3a, b). The RLC begins at the radial border of the palm and runs proximally to the wrist(13). PTC extends from the radial edge of the palm and slope proximally to medial border of the hypothenar eminence (14). The DTC extends from the area between the second and third metacarpophalangeal joints to the ulnar border of the palm(14). Normally, both the proximal and the distal transverse creases do not span the entire width of the palm (15).

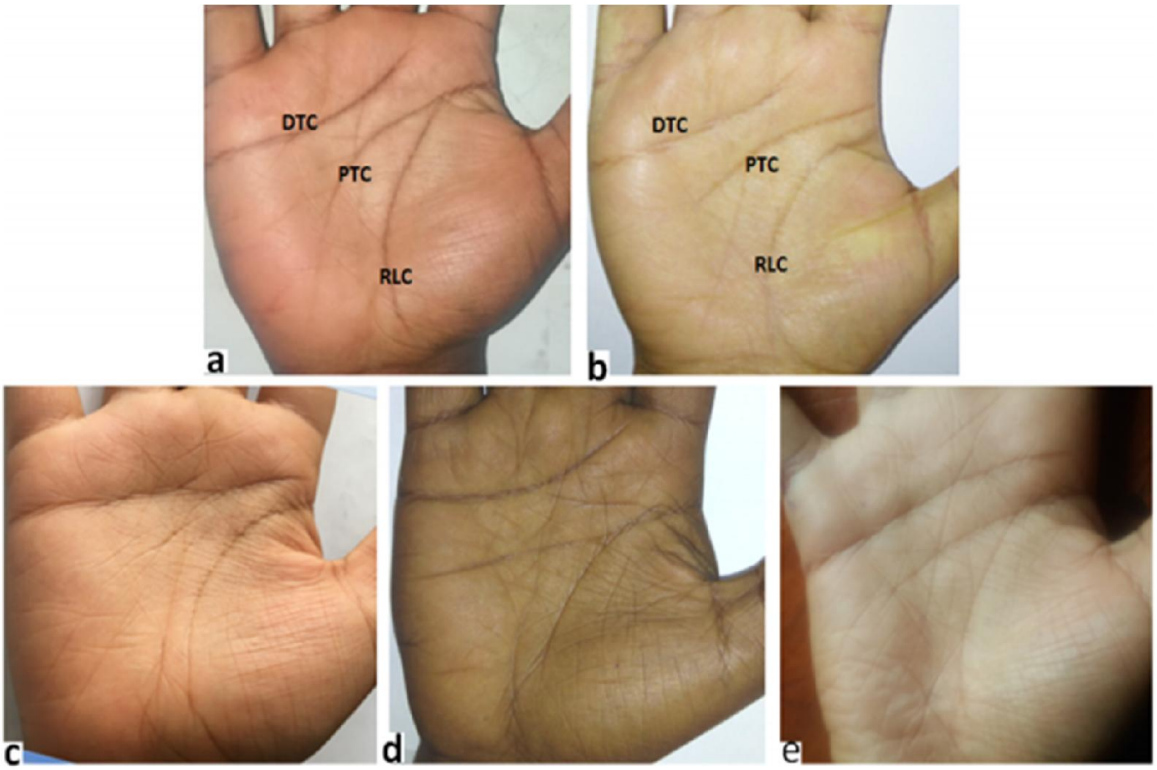

Figure 3.Types of palmar creases and crease pattern types based on the relationship between PTC and DTC(16). a &b: Normal creases, c: Simian crease, d: Sydney crease, e: Suwon crease. DTC: distal transverse crease; PTC: proximal transverse crease; RLC: radial longitudinal crease.

Based on the relationship between the PTC and DTC there are four palmar crease pattern types: Normal, Simian, Sydney and Suwon crease. Simian, Sydney, and Suwon creases are considered as variant types of palmar creases, and they are mainly associated with chromosomal abnormalities and congenital disease(13, 14).

Normal crease is formed when PTC and DTC do not meet and no crease line crosses the full palm (fig.3a, b). It has two subtypes; Normal i: is formed when PTC and DTC do not meet absolutely. Normal ii: is formed when PTC and DTC meet by recurrent branches of PTC and DTC(Fig.4) (13, 14).

The simian crease is a single transverse crease formed by the fusion of the two primary transverse palmar creases and extends the entire width of the palm. It resembles the usual conditions of non-human simians (primates) (Fig.3c). It has five subtypes; simian i: is formed when branch of PTC or DTC does not exist. Simian ii: is formed when proximal branch of PTC exists. Simian iii: is

formed when distal branch of DTC exists. Simian iv: is formed when proximal branch of PTC and distal branch of DTC exist. Simian v: is formed when PTC and DTC meet by the branches of PTC and DTC (fig.4)(13, 14).

Sydney crease was first described in Sydney, Australia. It was formed when PTC and DTC meet, accompanied by accessory DTC (fig.3d). It has six sub-types; Sydney i: is formed when branch of PTC or DTC does not exist. Sydney ii: is formed when proximal branch of PTC exists. Sydney iii: is formed when distal branch of DTC exists. Sydney iv: is formed when proximal branch of PTC and distal branch of DTC exist. Sydney v: is formed when PTC and accessory DTC meet by the branches of PTC and accessory DTC. Sydney vi: is formed when PTC and accessory DTC meet by the recurrent branches of PTC and accessory DTC(fig 4)(13, 14).

Suwon crease pattern is so named because it was first described in Suwon, Korea. It is formed when the PTC and DTC meet, accompanied by accessory PTC (fig.3e). It has four subtypes; Suwon i: is formed when branch of PTC or DTC does not exist. Suwon ii: is formed when proximal branch of PTC exist. Suwon iii: distal branch of DTC exist. Suwon iv: both proximal branch of PTC and a distal branch of DTC exists(fig 4)(13, 14) .

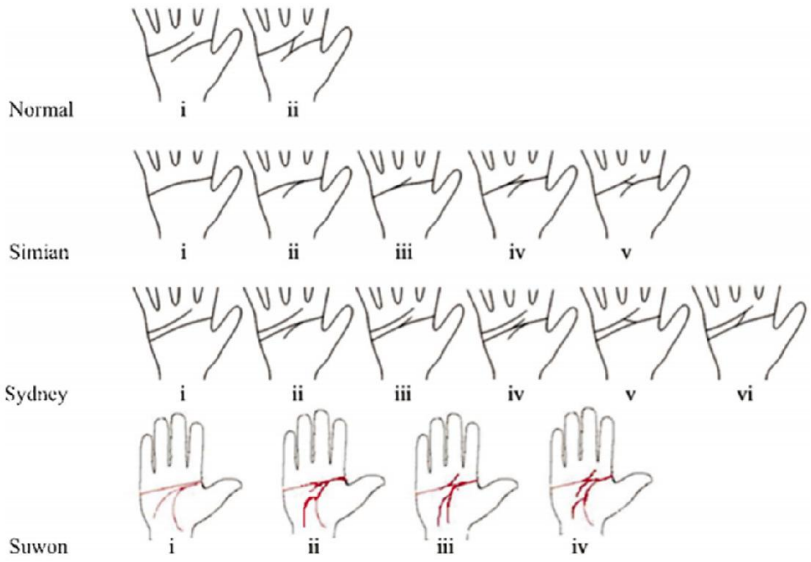

Figure 4.Subtypes of Normal, Simian, Sydney and Suwon palmar crease patterns(13, 14).

1.2 Statement of the problem

At present, different researches have shown that analysis of digital dermatoglyphics and palmar crease patterns are an important diagnostic tools for some diseases especially those with obscure etiology and mysterious pathogenesis (1, 17, 18). The dermatoglyphic analysis is important in the studies of populations(19). Different studies have suggested correlations between number of digital ridge patterns and ridge counts with different diseases and psychological conditions(20). High finger ridge count is commonly recorded with trisomy of X chromosome(20). Mathew et al. found an increased frequency of loops than the arches and whorls in cleft lip with patients compared to controls(21). Sontakke et al 2010. found significant reduction of loops in Klinefelter's syndromic patients as compared to that of controls(22). Ramesh et al. observed TFRC with a significant increase in a sickle cell anemia patients (23). Padmini et al. observed an increased incidence of ulnar loops, simple arches, composite whorls, and double loop whorls in diabetic patients than in the controls(24). Bukelo et al. reported an increase of arches and a decrease of ulnar loops in the fingertips of a group of patients with acute blast cell leukemia(25). Apart from predicting the diagnosis of genetic diseases; it is also used in forensic medicine, in individual identification, physical anthropology, human genetics and medicine(18). Palmar crease patterns are genetically determined variants which differ from population to population(14, 26). They are helpful in discovering the anthropologic characteristics of a population(13, 27) and ethnic groups(14, 28). Various studies have suggested correlations between abnormal patterns of Simian and Sydney creases and different diseases and psychological conditions(12, 29), such as e Down's syndrome(30), trisomy(31), Cri du-chat syndrome(32), congenital deafness(33), epileptic disease(34) and mental retardation(35). Thus, knowing about the prevalence of variant crease is helpful to assess the magnitude of the population which are at risks developing the disease of chromosomal abnormalities and congenital disease later in life(34). The presences of these variant palmar crease patterns do not necessarily always signify abnormality in genetic property as it has been observed in some normal individual (36). It is thus speculated that deviations in the patterns of dermatoglyphics and palmar creases could give clue to various congenital anomalies. For the identification of abnormal digital dermatoglyphics and palmar creases, awareness of the normal frequency must be first recognized. Therefore, information on dermatoglyphic and palmar crease configurations and variation in normal population is important. Although, digital dermatoglyphics

and palmar crease and there characteristic variability among populations have been studied widely in different region of the world, there is limited studies reported in Ethiopia (16, 27, 37) in general and not in the study area in particular. Therefore, this study aims was to assess prevalence of digital ridge patterns, digital ridge counts and palmar crease patterns, and to identify associated factors among healthy high school students in Dessie town, Ethiopia.

1.3 Literature review

1.3.1 Prevalence of digital ridge patterns

There are several studies that investigated the digital ridge patterns in different populations(19). It also differs between ethnic groups of a country as evidenced by studies from Nigeria(38), Basque(19), Morocco(39) and Tanzania(40). Loop was the most commonly occurring finger ridge pattern followed by whorl while arch was the least common (27, 41, 42).

The prevalence of loop pattern in studies conducted among students of University of Gondar was 53.9% as reported by Taye M et al.(27). It was 61.9% in Bologna Apennine(43), 61.7% in Esan ethnic group of Nigeria(38) and 61.0% among medical students of Kasturba Medical College of India(41). It was 63.3% in Italian population as reported by Emanuela G et al.(44) and 70.2% in Berber population of Marrakesh as reported by Sabir B et al.(39).

The prevalence of whorl pattern was 32.7% in Bologna Apennine (43), 30.4% among students of University of Gondar(27), 32.6 % among Ijaw students of University of port Harcourt, Nigeria(42) and 31.2% in Italian population(44). It was 32.6% among medical students of Kasturba Medical College of India(41), 34.9% in Port Harcourt Residents, Rivers State, Nigeria(45), 37.6% in India(46) and 40.6% in Berber population of Marrakesh as reported by Sabir B et al.(39).

Arch pattern was relatively high in Esan ethnic group of Nigeria (12.8%)(38), Ijaw ethnic group of Nigeria (14.3%)(42) and Igbo ethnic group of Nigeria (17.7%)(47). It was relatively low in the Berber population of Marrakesh (7.7%)(39), India (8.4%)(46) and among medical students of Kasturba Medical College of India(6.5%)(41).

1.3.2 Prevalence of digital ridge count

The study carried out among students of University of Gondar showed that the mean total digital ridge count of male students was 85.9 and that of female students was 77.8(27). The loop type pattern ridge count was 18095 and that of whorl pattern ridge count was 14136 as reported by Taye

M et al.(27). Study conducted in Bologna Apennine showed that the mean total digital ridge count of males was 147.6 and that of females was 135.0(43). A study done in Ireland showed that the mean total digital ridge count of males was 130.1 and that of females was 122.2(48). A study carried out in Italia showed that the mean total digital ridge count of males was 143.7 and that of females was 128.3 as shown by Emanuela G et al.(44).

1.3.3 Factors associated with digital ridge patterns

Digital ridge patterns have significant association with respect to sex(19, 44) and body side(38, 43, 49).

In both sex groups loop pattern has the highest frequency distribution followed by whorl and the least was arch pattern (41, 43, 44, 46). Different literature showed that loop pattern was more common among females (41, 43, 46). In studies conducted in India and Bologna Apennine showed statistically more common among females(43, 46). Study carried out among medical students of Kasturba Medical College, Mangalore, India, it was found that 52.4% in females and 47.6% in males(41). In Port Harcourt Residents, Rivers State, Nigeria, it was 46.8% on females and 44.5% in males(45).

The prevalence of whorl pattern among Basque population was significantly higher among males as reported by M.I. ARRIETA et al.(19). In Berber population of Marrakesh it was found in 35.4% in males and 31.2% in females(39). Studies conducted in Bologna Apennine and Igbo tribe of, Nigeria showed statistically more common among males(43, 47). In contrast, studies conducted in Faisalabad and Ijaw students of University of port Harcourt, Nigeria it was more common among males(8, 50).

Arch pattern was more common among females as shown by studies conducted in Berber population of Marrakesh and Bologna Apennine(39, 43). In a study conducted in Igbo tribe of southeast, Nigeria, it was 13.6% among females and 10.4% that of males(47). In Italia, 7.1% of females and 3.9% of males had arch pattern(44). On the other hand study conducted in Port Harcourt Residents of Nigeria showed arch pattern was more common among males(45).

Various studies showed that loop pattern was more prevalent on the left digits(43, 49). In Basque population it was observed that loop pattern was more prevalent on left digits (63.9%) than on right hand (62.3%)(39). In Bologna Apennine there was 63.0% on left digits and 60.8% on right

digits(43). A study conducted among indigenous black Zimbabweans, it was found more on left digits than right digits(49). Unlike these, a study done in India showed, it was more on right digits (54.7%) than left digits (52.5%)(46).

The prevalence of whorl pattern was more common on right digits (31.3%) of the body than left digits (27.6%)(19). It was also higher on right digits of the body as shown by studies done in indigenous black Zimbabweans and India(46, 49). In a study conducted in Berber population showed that it had equal distribution on right (33.8%) and left digits (33.3%)(39).

A study conducted in Esan ethnic group of, Nigeria reveals that the males had more arches on the right digits (53%) and females have more arches on the left digits (57.1%)(38). Studies conducted in Basque population and Bologna Apennine showed that it was more common on left hand of the body(19, 43). On the other hand, it had equal distribution on both hands as shown by studies conducted in India and indigenous black Zimbabweans(49, 51).

The study carried out among students of University of Gondar showed that the mean total digital ridge count of male students (85.9) was significantly higher than that of female students (77.8)(27). The study conducted in Bologna Apennine showed that the mean total digital ridge count of males was 147.6 and that of females was 135.0(43). Studies carried out in Ireland and Italia also showed that the mean total digital ridge count of males were significantly higher among females(44, 52).

1.3.3 Prevalence of palmar crease patterns

The prevalence of palmar crease patterns varies among populations in the different regions of the world(14). It also differs between ethnic groups of a country as evidenced by studies from Nepal(26), India(14) and Iran(53). The frequencies of Normal, Simian, and Sydney crease are different between Caucasians and Negroes(14). A significantly higher incidence of the Sydney line was seen among white females than black females(54). It was also more often found on the continent of Australia, and less in Asia, whereas Simian crease was more found in Asians(14).

The prevalence of normal palmar crease in studies conducted among Medical and Dental Students in Addis Ababa, Ethiopia was 86.2%(16) and 90.8% among Students of University of Gondar, Ethiopia(37). It was 84.4% in Suwon Korea(13) and 79.6% in central India(14).

Among the aberrant palmar creases Simian crease was the most frequent (16, 37). Studies conducted among Medical and Dental Students in Addis Ababa, Ethiopia showed the prevalence of Simian crease was 6.3% as reported by Afework 2019(16) and 5% among Students of University of Gondar, Ethiopia as reported by Gashaneh D 2019(37). Simian crease pattern was relatively high in Indian (14.4%), Chinese (13%), Korean (11.2%) and Pygmies (34.7%), but low in,Germans (2.8%), Duchess (1.5%) and Nigerian (4.1%)(36).

Sydney crease pattern was first discovered in Sydney Australia which was 9%(55). Studies conducted in Hausa ethnicity of Nigeria showed the prevalence of Sydney crease was 1.85% and 1.3% as reported by Taura et al.(34) and Alhaji et al. (28), respectively. It was 0.19% in Ijaw ethnic group of Nigeria(36), 3.6% in Central India(14) and 2.5% in Suwon Korea(13).

The prevalence of Suwon crease pattern was 4.1% among Medical and Dental Students in Addis Ababa, Ethiopia (16),2.4% in central India(14) and 0.5% in Suwon Korea(13). In studies conducted in Hausa ethnicity of Nigeria, it was 2.8% as reported by Taura et al.(13) and 1.95% by Alhaji et al.(28).

1.3.4 Factors associated with palmar crease patterns

Palmar crease patterns have significant association with respect to sex(14, 34), body sides(14) and symmetryness between two palms(14, 56).

Different kinds of literature stated that Simian crease pattern was more common among males(14, 28). In studies conducted among Medical and Dental Students in Addis Ababa, Ethiopia(16), Suwon Korea and among Zoroastrians ethnic group of Iran showed statistically more common among males(13, 53). In India, it was found in 16.8% of males and 12% of females(14). It was supported by a study conducted in Nigeria which showed 17.7% among males and 14.1% among females(28). In Nepalese, 15.1% of males and 14.2% of females had Simian crease(26).

The prevalence of Sydney crease among Nigeria Ijaws ethnic group was 0.19% and all were males(36). A study carried out among Medical and Dental Students in Addis Ababa, Ethiopia showed that it was more common in females than in males(16) and in Central India it was also more common in females (5.4%) than males (1.8%)(14).

The presence of Suwon crease pattern in central India was statistically common among males (3.4%) than females (1.4%)(28), but in Central India it was more common among females (5.4%)

than males (1.8%)(28). In Hausas ethnic group of Nigeria, it was showed a more equal distribution across gender(28).

The prevalence of variant palmar creases patterns varies with respect to different age groups(54). A higher incidence of Simian creases in newborn populations as compared with school-age children(54). A study conducted in New York America shown that 9.2% of palms of the female newborn had Sydney crease but only 1.5% of the palms of older aged 3-8 year girls showed this feature(54). These were because of cases of stillbirths, neonatal deaths and newborns with congenital malformations were included in these reports(54).

In various literatures variant palmar creases were more prevalent on right sides of the body(14). In Nigeria, the prevalence of Simian, Sydney and Suwon creases were 2.8%, 2.8% and 3.7%, on right palm and 1.8%, 0.9%, and 1.8% on left palm respectively(34). In central India 5.7%, 0.8% and 0.9%, on right hand, and 3%, 0.9%, and 0.6% on left hand respectively, and specifically Simian crease was associated significantly with unilateral right side of the body(14). Study in Ijaws population of Nigeria showed that all variant creases were found equally in both hands which are 2.16%(36).

The symmetry of the palmar creases have significant relation with epileptic diseases(34). Palmar creases asymmetry was significantly higher among epilepsies (38.5%) than controls (22.9%)(34). In Nigeria, the presence of variant crease patterns was more common in unilateral or asymmetrically (58.3%) than bilateral or symmetrically (41.6%)(14).

In general there is significant difference in the prevalence of types of digital ridge count, digital ridge and palmar crease patterns among different populations in the world and sociodemographic factors like age, sex, ethnicity, and other factors like body sides had significant association with specific types of digital ridge pattern, digital ridge count and palmar creases patterns among populations in different region of the world. So this study can determine the prevalence of digital ridge pattern, digital ridge count and palmar crease pattern types and factors associated with them among high school students of Dessie town, Ethiopia.

1.4 Justification of the study

Although, there are various studies carried out regarding digital dermatoglyphic and palmar crease characteristic variability among populations in the developed world, whereas there is limited studies reported in Ethiopia in general, and none in the study area in particular. Hence, the present study determines the normal dermatoglyphic and palmar crease variability among high school students of Dessie town, Ethiopia. This could be used as a base line for the determination of aberrant variables. When unusual configurations are present, such study alert the possibility of anomalies or confidence in making an early diagnosis of congenital anomalies. Digital dermatoglyphic and palmar crease studies are a noninvasive technique which are; easily applicable, inexpensive, and analyzed quickly in the identification of at risk population and diagnosis of several hereditary diseases.

2. Objectives of the study

2.1 General objective

 To assess the prevalence and associated factors of digital ridge and palmar crease pattern types among high school students in Dessie town, Northeast Ethiopia, 2019.

2.2 Specific objectives

 To determine prevalence of digital ridge pattern type.

To count the number of TFRCs.

 To determine the prevalence of palmar crease pattern types.

To identify factors associated with digital ridge and palmar crease pattern types.

3. Methods and materials

3.1 Study area

The study was conducted among high school students in Dessie town which is found in Amhara region, North East Ethiopia. Dessie town is located at Northeast direction 401 Km away; from Addis Ababa, the capital city of Ethiopia. It is 478 km far from Bahirdar which is the capital city of Amhara regional state. The town has an elevation of 2470 meters above sea level.

3.2 Study design and period

- Qualitative and quantitative cross- sectional study design was conducted from May -June 2019 GC.

3.3 Source population

- Students which were enrolled in all high schools of Dessie town and attending class in 2018/2019 GC academic year.

3.4 Study populations

- Students which are enrolled in the selected high schools in Dessie town 2018/2019 GC academic year.

3.5 Inclusion and exclusion criteria

3.5.1 Inclusion criteria

- Students which are enrolled in all high schools of Dessie town.

3.5.2 Exclusion criteria

- Students with injury to the hand and deformed hands.
- Students whose mother and father were not from Amhara ethnically.

3 .6 Sample size determinations and sampling procedure

3.6.1 Sample size determination

The sample size was calculated by single population proportion formula as follows.

$$n = (Z_{a/2})^2 pq / w2$$

Where, n=the required sample size for the study

Z= Standard normal distribution at 95 % CI which is 1.96;

p=proportion of the study population estimated to have a particular characteristic of hand images (since there was no other study conducted in the area, we use a 50%);

W=the margin of error, taken as 5%.

q=1-p which is 1-0.5=0.5

n= (1.96)2(0.5×0.5)/ (0.05)2=384

The calculated sample is 384 but considering 10% non-response rate, the required total sample size is 422.

3.6.2 Sampling procedure

Dessie town has five high schools which were used as a frame for selecting sampled students. Two out of five high schools were selected using the simple random sampling by lottery method. There are a totals of 673 students in Memihir Akalewold and 540 students in Hote high school. The number of sampled students were distributed for each selected high schools by proportion allocation formula from the total sample size (422), which was 234 for Memihir Akalewold and 188 for Hote high school. Then, the study subject selection interval (k) was calculated using a formula; k = N/n, N = number of all students who were enrolled in each selected high schools and n =sample size. Therefore: Memihir Akalewold: k_1=673/234=2.88, Hote: K_2= 540/188=2.87. The 1ststudent was selected using simple random sampling from the first three students of selected high schools by lottery method. The other students were selected using the systematic random sampling method in every 3nd interval until the required sample size was achieved in each high school.

3.7 Study variables

3.7.1 Dependent variable

- Digital ridge pattern
  - ✓ Arch
  - ✓ Loop
  - ✓ Whorl
- TFRC

- ❖ Palmar crease patterns
  - ✓ Normal
  - ✓ Simian
  - ✓ Sydney
  - ✓ Suwon

3.7.2 Independent variable

- ✓ Sex
- ✓ Body side (right or left) hand
- ✓ Symmetryness or unilateral /bilateral occurrences of patterns

3.8 Operational definitions

- Body side –the palm or digit which found ipsilateraly on right or left side of the body.
- Unilateral (asymmetry)–the occurrences of specific digital dermatoglyphic and palmar crease pattern on one hand only.
- Bilateral (symmetry)-the occurrences of specific digital dermatoglyphic and palmar crease pattern on both hands.
- Arch pattern- is formed by succession of more or less parallel ridges, which traverse the pattern area and form a curve that is concave proximally.
- Loop pattern- is a series of ridges that enter the pattern area on one side of the digit, recurve abruptly, and leave the pattern area on the same side.
- Whorl pattern- is any finger ridge pattern which contains two or more triradius.
- Triradius- is formed by the confluence of three ridge systems.
- Core- is the approximate center of ridge pattern.
- Radiant- is a line between core and triradius

3.9 Data collection procedures and tools

The eligible students who fulfill the inclusion criteria were included in the study after explaining the purpose of the study and taking informed verbal consent. Two methods of data collection were used; structured questionnaires were used to assess the sociodemographic characteristics of students and observational checklist which had been filled after observing the palmar digital images. Students were requested to wash hands with soap to make the hands clean. The procedure is to capture the photograph of the subject's right and left digital and palmar areas of hands by digital photo camera as described by StelinWersely et al.2016(57) and Park et al. 2010. The hand was placed on well labeled surface and the camera is adjusted to obtain better clarity pictures. The captured photographic images were observed and the checklists were filled to assess, digital ridge pattern, TFRC and palmar crease patterns.

3.10 Data processing and analysis

The collected data were checked for completeness, and clarity before analysis. Data was entered to Epi info version 7.1.and exported to SPSS version 20 to be cleaned, edited and analyzed. Data cleaning was performed to check for missed values and variables. Any logical and consistency error identified during data entry was corrected after the revision of the originally completed questionnaires. Chi-square test was used to determine the minimum expected frequency. Independent t-test were used to assess relation of digital ridge count with sex and digital ridge pattern. Variables that were valid in the assumption of chi-square test was analyzed using both bivariable, and multivariable multinomial logistic regression to assess the association between outcome and explanatory variables. Associations between dependent and independent variables were assessed and its strength was presented using adjusted odds ratios and 95% confidence intervals. P value of <0.05 was considered as a statistically significant association. The result presented in the form of tables, figures, and text using frequencies and summary statistics to describe the study population in relation to relevant variables.

3.11 Data Quality Control and Management

Data was collected by the principal investigator and trained assistant data collectors. The quality of data was assured through designing proper data collection material and through continuous supervision and involvement. The completed data collection forms were examined for completeness and consistency during the data collection period, storage, and analysis. Data were entered using Epi info then exported to SPSS to increase data entry quality.

3.12 Ethical considerations

The proposal was submitted for approval and ethical clearance to the Department of Anatomy and IRB of the College of Health sciences of Addis Ababa University. Informed verbal consent was taken from school directors and from the study participants. The objective of this research was explained to the study participants and only those willing to participate were included. To ensure confidentiality of data, study subjects were identified using codes, and confidentiality was maintained.

3.13 Dissemination of the result

A copy of the study was offered to Department of Anatomy, College of Medicine and Health Sciences, and to all relevant institutions and respective schools. The findings of this study will finally be disseminated for the scientific community through publications, presentation on annual scientific meetings and conferences.

4. Results

4.1 Sociodemographic characteristics of study participants

A total of 413 students were involved in this study with a response rate of 97.9 % (413/422). Among the study participants 218(52.8%) were males and 195 (47.2%) were females. The age distribution ranged from 14-22years old with a mean of 16.5.

4.2 The frequency distribution of digital ridge patterns.

Among the total of 4130 digital ridge patterns the frequency of the loop type were 2488(60.2%) [95%CI: 58.6, 61.7] followed by the whorl type 1330(32.2%) [95%CI: 30.8, 33.7], and the least was arch type 312(7.6%) [95%CI: 6.8, 8.4] [Figure 5].

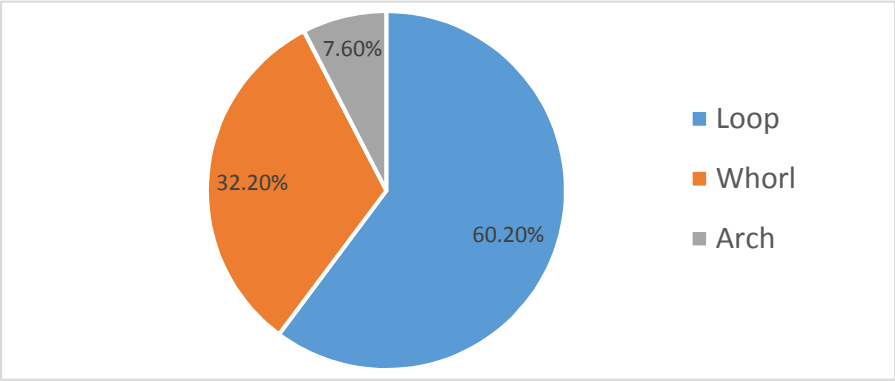

Figure 5. The frequency distribution of digital ridge patterns among high school students of Dessie town, northeast Ethiopia, 2019.

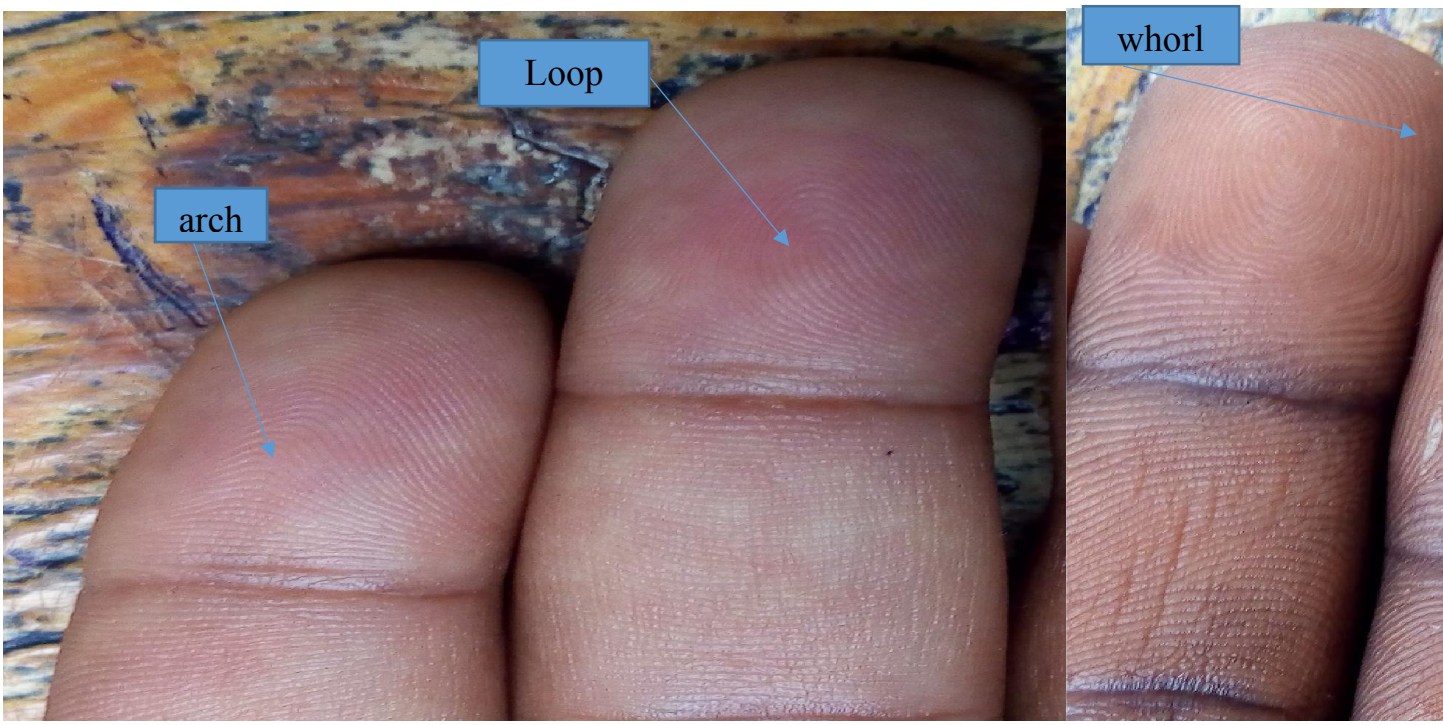

Figure 6. Major finger ridge patterns captured from high school students of Dessie town, northeast Ethiopia, 2019.

4.3 The frequency distribution of digital subtype patterns

Among the total of 312 arch patterns, 195(62.5%) were tented arch which was higher among females (63.8%) and on the right side (63.3%). Subtypes of arch pattern had no significant relation with sex (p=0.31) and body side (p=0.67) [Table1].

Among the total of 2488 loop pattern type, 2413(97.0%) was ulnar loop which was significantly higher among females (97.2%) and on left side (98.2%), however radial loop was more predominant among males and on right side. Subtype patterns of loop pattern had significant relation with sex (p=0.03) and body side (p=0.01) [Table1].

Among whorl pattern types central pocket whorl (77.0%)and double loop whorl(11.0%)were the most frequent subtype patterns on both sex and body side but subtype patterns of whorl pattern type did not fulfil the assumption of chi-square test and unable to assess the presence of association with sex and body side [Table1].

Table 1. Frequency distribution of subtype of digital ridge patterns by sex and body side, among high school students in Dessie town North East Ethiopia, 2019.

Digital pattern types [N]	Digital subtype patterns	Digit		Sex		Total n (%)=4130
		Right n (%)=2065	Left n (%)=2065	Male n (%)=2196	Female n (%)=1934	
Arch N=312	Tented arch	112(63.3)	83(61.5)	68(60.2)	127(63.8)	195(62.5)
	Plain arch	65(36.7)	52(38.5)	45(39.8)	72(36.2)	117(37.5)
Loop N=2488	Ulnar loop	1062(95.5)*	1351(98.2)*	1401(96.8)*	1012(97.2)*	2413(97.0)
	Radial loop	50(4.5)*	25(1.8)*	46(3.2)*	29(2.8)*	75(3.0)
Whorl N=1330	Double loop whorl	84(10.8)	62(11.2)	76(11.9)	70(10.1)	146(11.0)
	Central pocket whorl	612(78.9)	412(74.4)	478(75.2)	546(78.7)	1024(77.0)
	Composite whorl	56(7.2)	64(11.6)	64(10.1)	56(8.1)	120(9.0)
	Concentric whorl	24(3.1)	16(2.9)	18(2.8)	22(3.2)	40(3.0)

**statistical significant ($p<0.05$).*

4.4 Factors associated with digital ridge patterns.

Studied explanatory variables, sex, body side and symmetryness of digital ridge patterns were valid on the chi-square test. The frequency of the loop type and arch type were higher among female students and whorl type was higher among male students. Body side has no significant relation with digital ridge pattern (0.089). Bilateral occurrence was common in loop patterns but unilateral occurrence was common on both arch and whorl pattern types [Table2].

Table 2. Chi-square test of factors associated with digital ridge patterns among high school students in Dessie town, North East Ethiopia, 2019.

Variables		Digital ridge pattern type			P-value
		Arch	**Loop**	**Whorl**	
Sex	**Male**	143(6.6)	1276(58.4)	764(35.0)	0.001*
	Female	169(8.8)	1212(62.2)	566(29.0)	
Body side	**Right**	153(7.4)	1214(58.8)	698(33.8)	0.089
	Left	161(7.8)	1272(61.6)	632(30.6)	
Symmetryness of digital patterns	**Bilateral**	220(6.6)	2050(61.7)	1054(31.7)	0.001*
	Unilateral	94(11.7)	436(54.1)	276(34.2)	

****Statistical significant (p<0.05).***

Explanatory variables including sex, body side and symmetryness of digital ridge patterns which satisfied the assumption of chi-square test were analyzed using bivariable analysis of multinomial logistic regression. All these variables showed P value less than or equal to 0.2 at least for one of the outcome category in the bivariable analysis and then taken to multivariable analysis. On multivariable analysis sex, body side and symmetryness of digital ridge patterns had a statistically significant association with one or more types of digital ridge patterns [Table 3].

Being female was nearly two times more likely to have arch pattern [AOR=1.60; 95%CI: 1.26, 2.06] and 30% more likely to have loop pattern type [AOR=1.30; 95%CI: 1.13, 01.50] than whorl pattern type, when the rest variables are kept constant [Table 3].

Being right hand had 14% less likely to have loop pattern [AOR= 0.86; 95%CI: 0.76, 0.99] than whorl pattern. Body side had no significant association with arch pattern (p=0.14) (Table 3).

Students who have unilateral of digital ridge pattern between two hands were nearly two times more likely to have arch type [AOR=1.62; 95%CI: 1.23, 2.14] and 19% less likely to have loop pattern type [AOR=0.81; 95%CI: 0.69, 0.96] than whorl pattern [Table 3].

Table 3.Bivariable and multivariable analyses of multinomial logistic regression of sex, body side and symmetry with digital ridge patterns among high school students in Dessie town North East Ethiopia, 2019.

Outcomes	Explanatory variable		COR(95%CI)	AOR(95%CI)	P-value
Arch	Sex	Female	1.61(1.26,2.07)	1.60(1.26,2.06)	0.001*
		Male	1.00	1.00	
	Body side	Right	0.86(0.67,1.10)	0.83(0.65,1.07)	0.14
		Left	1.00	1.00	
	Symmetryness	Unilateral	1.63(1.24,2.15)	1.62(1.23,2.14)	0.001*
		Bilateral	1.00	1.00	
Loop	Sex	Female	1.28(1.12,1.47)	1.30(1.13,01.50)	0.001*
		Male	1.00	1.00	
	Body side	Right	0.86(0.76,0.99)	0.86(0.75,0.98)	0.03*
		Left	1.00	1.00	
	Symmetryness	Unilateral	0.81(0.69,0.96)	0.81(0.69,0.96)	0.02*
		Bilateral	1.00	1.00	

Statistical significant, Whorl pattern used us a reference, **AOR – Adjusted odds ratio, **COR**– Crude odds ratio*

4.5 Quantitative analysis of digital ridge Counts

The total digital ridge count of male students (20640) was higher than the total ridge count of female students(20473). The loop type pattern ridge count (27541) was higher than the whorl pattern ridge count (13572). The mean total digital ridge count of male students was 10.46 and that of female students was 10.12(Table 4).

Table 4. Student t- distribution of TFRC by sex and pattern types, among high school students of Dessie town, North East Ethiopia, 2019.

Variables		Ridge count(N)	mean	SD	Mean difference (95%CI)	p-value
Sex	Male	20640	10.46	3.90	0.34(0.10,0.57)	0.005*
	Female	20473	10.12	3.73		
Pattern type	Loop	27541	9.82	3.75	-1.55(-1.81,-1.30)	0.001*
	Whorl	13572	11.38	3.77		

**Statistical significant (p<0.05)*

4.6 Prevalence of palmar crease pattern types

Among the total of 826 palmar crease pattern types, normal type of palmar crease pattern was the most common 87.9% [95% CI: 85.5, 90.0]. Among variant palmar crease types Simian crease pattern 5.9% [95%CI: 4.5, 7.6] was the most common followed by Suwon crease pattern 3.5% [95%CI: 2.4, 4.9], and Sydney crease pattern was the least 2.7% [95% CI: 1.6, 3.9] (Table 5).

Table 5.Frequency distribution of palmar crease pattern types among high school students of Dessie town, northeast Ethiopia, 2019.

Type of palmar crease pattern	Frequency	%
Normal	726	87.9%
Simian	49	5.9%
Sydney	22	2.7%
Suwon	29	3.5%
Total	826	100%

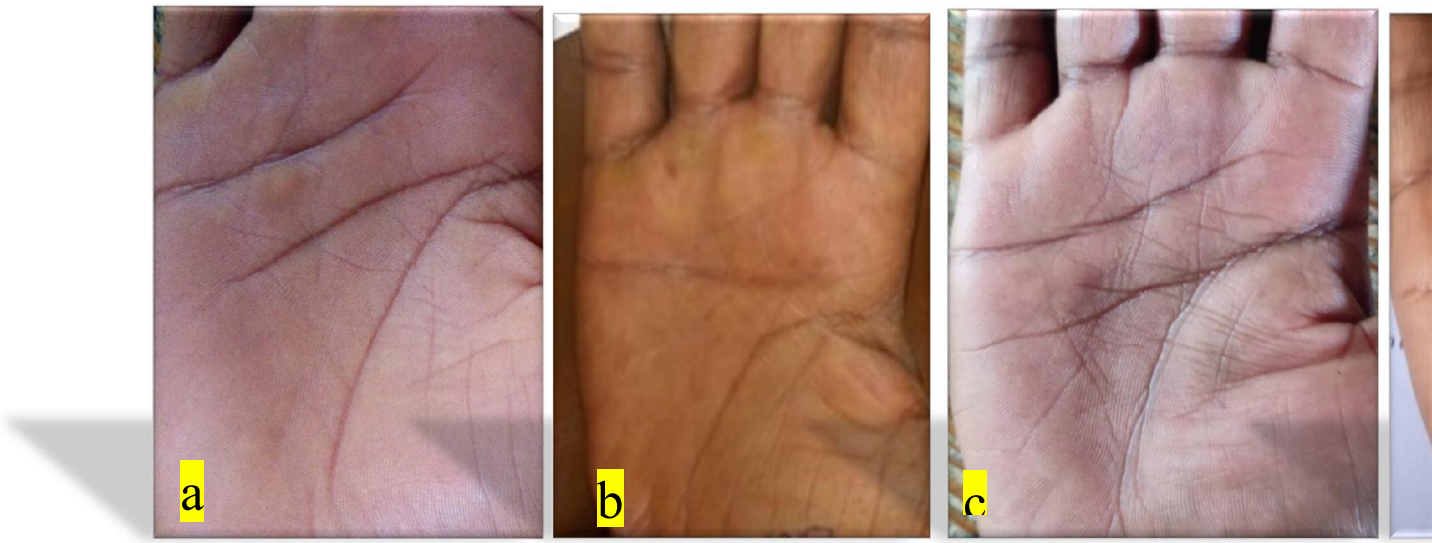

Figure 7. Types of Palmar Crease patterns based on the relationship between proximal and distal transverse creases. **a:Normal crease, b:Simian crease, c:Sydney crease and d:Suwon crease.**

4.7 Prevalence of subtypes of palmar crease pattern type

Among the total 726 normal palmar crease patterns, 562(77.4%) were normal i subtype which was higher among males (79.7%), however Normal ii subtype was more in females (24.9%). Subtypes of Normal palmar crease patterns had no statistically significant association with sex (p=0.34) and body side (p=0.13). Simian i (63.3%), Simian ii (18.4%) and Simian iii (10.2%) were the most frequent among Simian crease subtype patterns. Sydney i and iii together accounts 77.2% of total Sydney. Among Suwon crease subtypes Suwon I (55.2%) and iii (17.2%) were more frequent. All subtypes of variant palmar crease patterns did not fulfill the assumption of chi-square test and unable to assess the presence of association with sex and body side [Table 6].

Table 6. Frequency distribution of sub types of palmar crease patterns by body side and sex among high school students of Dessie town, North East Ethiopia, 2019.

Type of palmar crease pattern	**Subtypes of palmar crease patterns**.	Digit		Sex		Total
		Right n[%]=413	Left n(%)=413	Male n[%]=410	Female n[%]=416	
Normal =726	Normal i	269(74.3)	293(80.5)	287(79.7)	275(75.1)	562(77.4)
	Normal ii	93(25.7)	71(19.5)	73(20.3)	91(24.9)	164(22.6)
Simian =49	Simian i	12(48.0)	19(79.2)	13(61.9)	18(64.3)	31(63.3)
	Simian ii	6(24.0)	3(12.5)	2(9.5)	7(25.0)	9(18.4)
	Simian iii	4(16.0)	1(4.2)	4(19.0)	1(3.4)	5(10.2)
	Simian iv	3(12.0)	1(4.2)	2(9.5)	2(7.2)	4(8.2)
	Simian v	0	0	0	0	0
Sydney =22	Sydney i	6(50.0)	6(60.0)	6(46.2)	6(66.7)	12(54.5)
	Sydney ii	1(8.3)	0	1(7.7)	0	1(4.5)
	Sydney iii	3(25.0)	2(20.0)	3(23.1)	2(22.2)	5(22.7)
	Sydney iv	2(16.7)	2(20.0)	3(23.1)	1(11.1)	4(18.2)
	Sydney v	0	0	0	0	0
	Sydney vi	0	0	0	0	0
Suwon =29	Suwon i	7(50.0)	9(60.0)	9(56.3)	7(53.8)	16(55.2)
	Suwon ii	2(14.3)	2(13.3)	2(12.5)	2(15.4)	4(13.8)
	Suwon iii	3(21.4)	2(13.3)	3(18.8)	2(15.4)	5(17.2)
	Suwon iv	2(14.3)	2(13.3)	2(12.5)	2(15.4)	4(13.8)

4.8 Factors associated with palmar crease patterns

Normal crease was significantly higher among females (90.6%) than males (84.1%) (P=0.03); in contrast, the simian, Sydney, and Suwon creases were significantly higher among males .Body side has no significant relation with palmar crease patterns (P=0.84) [Table 7].

Table 7. Chi-square test of factors associated with palmar crease patterns, among high school students in Dessie town, North East Ethiopia, 2019.

Explanatory variable		Palmar Crease patterns				P-value
		Normal n(%)=726	**Simian n(%)=49**	**Sydney n(%)=22**	**Suwon n(%)=29**	
Sex	Male	292(84.1)	25(7.2)	14(4.0)	16(4.6)	0.03*
	Female	434(90.6)	24(5.0)	8(1.7)	13(2.7)	
Body side	Right	369(87.0)	26(6.1)	12(2.8)	17(4.0)	0.84**
	Left	357(88.8)	23(5.7)	10(2.5)	12(3.0)	
Symmetryness	Bilateral	327(93.7)	11(3.2)	6(1.7)	5(1.4)	***
	Unilateral	30(46.9)	16(25.0)	8(12.5)	10(15.6)	

** A variable which was significantly associated (p=0.03).*

***A variable which was not significantly associated (p=0.84).*

***Variables which were not valid in chi-square test (> 20% of cells had expected count <5 and/or a cell value =0).*

5. Discussion

Researches showed that analysis of digital dermatoglyphics and palmar creases are important diagnostic tool for various diseases, especially those with obscured etiology, and mysterious pathogenesis (14, 17, 58). In addition to predicting the diagnosis of genetic diseases; they are also used in forensic medicine, in individual identification, physical anthropology, human genetics and medicine(4, 5). Because of this awareness of the normal dermatoglyphic and palmar crease patterns in the population should be known. The findings from the present study, therefore, reveal these in a relatively homogenous population among the Amhara.

5.1 Digital ridge pattern

Among the digital ridge patterns observed in this study, loop pattern was the most frequent 60.2% [95%CI: 58.6, 61.7]. This is in line with the findings of study conducted in Bologna Apennine (61.9%)(43), Esan ethnic group of Nigeria (61.7%)(38) and among medical students of Kasturba Medical College of India (61.0%)(41). This study also showed that being female was 30% more likely to have loop than whorl pattern type. A study conducted in India(46), Bologna Apennine(43), among medical students of Kasturba Medical College of India(41) and Port Harcourt Residents of Nigeria(45) revealed loop pattern was significantly higher in females. In this study being right hand had 14% less likely to have loop pattern than whorl pattern. Studies done in Basque population, Bologna Apennine and indigenous black Zimbabweans also showed that loop pattern was found more on left hand than right hand (39, 43, 49).

In the current study, whorl pattern was the 2nd prevalent digital ridge pattern. This is consistent with reports by other authors (8, 27, 45). This value 32.2% [95%CI: 30.8, 33.7] was comparatively similar to studies done among students of University of Gondar (30.4%)(27), Berber population of Marrakesh (32.5%) (39) and among Ijaw students of University of port Harcourt, Nigeria (32.6%)(42). However, it was lower than reports from India (37.6%)(46), and in Italian population (35.2%)(44). This difference might be explained by whorl pattern was higher among population-based studies and lower in African population than non-Africans.

The other digital ridge pattern observed in this study was arch pattern 7.6% [95%CI: 6.8, 8.4]. This value is in keeping with findings carried out in the Berber population of Marrakesh (7.7%)(39) and India (8.4%)(46).It was lower than studies conducted in Esan ethnic group of Nigeria (12.8%)(38), Ijaw ethnic group of Nigeria (14.3%)(42), Igbo ethnic group of Nigeria (17.7%)(47)

and among medical students of Kasturba Medical College of India (9.5%)(41). The current study showed that being female was nearly two times more likely to have arch pattern. Arch pattern was also more common among females as shown by studies conducted in Berber population of Marrakesh, Bologna Apennine and Italia population (39, 43, 44). On the other hand study conducted in Port Harcourt residents of Nigeria found arch pattern to be more common among males(45). Such variations in the pattern of dermatoglyphics may be related to difference in ethno-geographical factors.

5.2 Digital ridge count

In the present study, males have higher mean finger ridge count than females. Previous reports from students of University of Gondar(27), Bologna Apennine(43), Ireland(52) and Italia(44) also showed that males have higher mean finger ridge count than females. It, therefore, appears that finger ridge count is higher in males than females. Although it is a matter of further investigation, this could be related to the more physical nature of the fingers in the males than the females.

5.3 Palmar crease pattern

The present study revealed that the prevalence of normal palmar crease pattern was 87.9% [95% CI: 85.5, 90.0]. It was comparatively similar to a cross-sectional study conducted among Medical and Dental Students in Addis Ababa, Ethiopia (86.2%)(16) and Hausa ethnic group of Nigeria (89%)(28). On the other hand it was lower than a case-control study conducted in the Hausa ethnic group of Nigeria (93.1%) as reported by Taura et al.(50). However, it was higher than the studies conducted in Suwon Korea (84.4%)(13) and central India (79.6%)(14).The difference might be due to different study design, study population and the genetic differences between populations.

Among the aberrant palmar creases observed in this study, Simian crease was the most frequent. This is in keeping with reports by other authors (13, 16, 36). The prevalence of Simian crease in this study was 5.9% [95%CI: 4.5, 7.6]. This is in line with a study conducted in among Medical and Dental Students in Addis Ababa, Ethiopia(16) and students of University of Gondar, Ethiopia (5 %)(37). It is, however, more and less than several other studies in various populations with variable values ranging from Duchess 1.5% to 34.7% in the Pygmies (13, 14, 36, 59). In this study, Simian crease patterns were more common among males. This agrees with earlier studies conducted in Suwon Korea and among Zoroastrians ethnic group of Iran(13, 53). Studies conducted in the Hausa ethnic group of Nigeria(28), Nepal(26) and India(14) also showed that, Simian crease is found more among males. In this study unilateral occurrence of Simian crease

was more frequent than bilateral occurrence. This is in keeping with reports from Central India(14) where unilateral occurrence was greater than bilateral occurrence. On the other hand, it is different from a previous study report among Medical and Dental Students in Addis Ababa, Ethiopia(16). Studies showed that palmar creases are different among ethnicities independent of their association with a given disorder(60). This discrepancy might be explained by ethno-historic and geographic variations between different groups of people(54).

The other aberrant palmar creases observed in this study were Suwon 3.5% [95%CI: 2.4, 4.9] followed by Sydney 2.7% [95% CI: 1.6, 3.9].]. The more frequent occurrence of Suwon than Sydney crease observed in this study is in keeping with most of the previous reports from different populations, including Ethiopians (16, 34, 37), although the values show slight variations. The present value for Suwon is less than those found among Medical and Dental Students in Addis Ababa, Ethiopia (4.1%)(16), but more than those found among students of University of Gondar (2.3%)(37), in central India (2.4%)(14) and in Hausa ethnic group of Nigeria(2.8%)(34). Strikingly, Suwon crease was very less in a study conducted in Suwon Korea 0.5%(13). This might be due to which, the Suwon Korean report was the first report to identify Suwon crease pattern type and had limitations to clear it(13). The least occurrence of Sydney crease in this study was the same as most other previous reports (13, 16, 37). It was less than the values reported for Medical and Dental Students in Addis Ababa, Ethiopia (3.5%)(16), but more than those found in Hausa ethnic group of Nigeria (1.9%)(34).

In this study both Suwon and Sydney crease occurred more frequent among males than females. These are in line with previous study reports where Suwon crease was more common in males (13, 14, 16, 37). This study is also consistent with studies where Sydney crease was more common in males (13, 29, 37). In contrary, in Central India, Sydney crease pattern was more common among females(14).

This study showed that, variant palmar creases patterns were more prevalent on right hand even if it is not significant. This agrees with studies conducted in Nigeria where the prevalence of Simian, Sydney and Suwon creases were 2.8%, 2.8% and 3.7%, on right palm and 1.8%, 0.9%, and 1.8% on left palm respectively(34).Similarly, in central India the prevalence of Simian, Sydney and Suwon creases were 5.7%, 0.8% and 0.9%, on right hand and 3%, 0.9%, and 0.6% on left hand respectively(14). A study in Ijaws population of Nigeria showed that all variant creases were found

equally in both hands which are 2.16%(36). It, therefore, appears that variant palmar crease patterns are common on the right side of hand.

In general, the discrepancy in the prevalence of all types of palmar crease patterns can be explained by ethno-historic and geographic variations between different human populations(14), meanwhile dermatoglyphic polymorphism results from the cooperation of genetic, ethno-historic and environmental factors(54). Due to this, dermatoglyphics and palmar crease patterns could be utilized as valuable tools in explaining inter-ethnic variability in anthropological studies and diagnostic relevance(36, 54). Besides this, the study design, study population and age group of the population could have their own contribution in explaining the lack of homogeneity observed between various studies. Conclusively, these physical anthropological variations are normal occurrence among diverse human populations(36) and every person with variant types of palmar crease may not have something medically wrong with them(13). Analysis of dermatoglyphics and palmar crease patterns as diagnostic tools should be utilized with caution.

6. Strength of the study

The digital and palmar images were collected using high mega pixel camera which is modern and gives a clear image unlike most of the preceding studies which used ink to obtain palm and digit print. The study used independent t-test and multinomial logistic regression model in addition to chi-square test to assess the effect of explanatory variable to the types of digital ridge patterns and digital ridge counts. The use of independent t-test and multinomial logistic regression model were better than chi-square test which was used in preceding digital dermatoglyphic studies.

7. Limitations of the study

The current study was on high school students who were relatively the same age group and educational background. Consequently, populations from a different age groups and educational levels were not included. The study participants were from the same ethnic group due to this comparison with different ethnic group was not done.

8. Conclusions

The loop was the most prevalent followed by whorl and the least was arch pattern among digital ridge patterns on both sexes. The quantitative mean of digital ridge count of males was higher than females. The Normal type of palmar crease pattern was the most prevalent type among palmar crease pattern types. The common type among the variant palmar creases was Simian crease pattern followed by Suwon crease pattern and Sydney palmar crease pattern was the least.

9. Recommendations

Based on this study finding, the following recommendations were made:

- Researchers should conduct community-based study including all age groups and all ethnic groups of Ethiopia with a large sample size to generalize for Ethiopian population.
- A case-control study should be needed on subjects who have variant types of digital dermatoglyphics and palmar crease to assess all embryological, congenital and other diseases as well as gestational exposure status which may have an association with them.

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