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Original Article

Anatomy Section

The Prevalence and Pattern Types of Palmar Digital Dermatoglyphics and Ridge Counts among Students of University of Gondar, Northwest Ethiopia

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ABSTRACT

Introduction: Human palmar digital dermatoglyphic patterns are individually unique and permanent throughout life. Patterns of skin ridge lines of ink are used in forensic science and have diagnostic value in clinical and genetical abnormalities.

Aim: To determine the prevalence of the major dermatoglyphic pattern among students of University of Gondar, Ethiopia.

Materials and Methods: A total of 393 students were recruited from one college and 6 faculties of University of Gondar. A pre-tested questionnaire was used to collect socio-demographic characteristics and ink printed digital dermatoglyphic was taken on a square box of white paper. The printing ink was smeared on the glass plate and starting with the right hand digits the entire prints of the ten digits of each study participants was obtained.

Results: Ulnar loop was the most prevalent form (52.7%) followed by central pocket whorl (22%) and tenetd arch (13.53%). The total digital dermatoglyphic ridge count of males was slightly higher than that of females (8.59 versus 7.8 respectively). The frequency of the loop pattern among male was 55.33% (83/150) for Tigrie, 54.83% (159/290) for Oromo, 53.09% (791/1490) for Amhara students. In females, the prevalence of loop type dermatoglyphic pattern was 63.3% (57/90) for Guragie, 57.12% (217/380) for Tigrie, 53.86% (684/1270) for Amhara and 4.7% (75/1600) for Oromo students.

Conclusion: Ulnar loops were the dominant dermatoglyphic patterns and radial loop pattern was the least frequent among University of Gondar students. Understanding the Human population differences in dermatoglyphic patterns may have diagnostic significance for genetical and clinical purposes. Large scale study is required to determine the dermatoglyphic patterns of human population living around Gondar and the country Ethiopia.

Keywords: Arches, Loops, Whorls

INTRODUCTION

The superficial and deeper part of the human skin shows various patterns of epidermal creases, ridge configuration, flexur lines, tension lines, and pigmentations [1]. Papillary ridge lines of digits and palms have minute pores which are the opening of ducts of sweat glands [2]. These pores are permanent and vary in size, shape, position and number in a given length of the ridge of individuals [3].

The arrangements of palmar digital dermatoglyphic patterns are unique to an individual and permanent throughout life. Therefore, it has been used extensively for forensic and civil purposes [4,5]. Palmar digital prints are the results of minute raised papillary ridges and shallow furrows found on the superficial surface of palamr epidermis of digits [6]. The ridge pattern configuration in particular patterns make a difference between types. Each type further divides into arch, loop and whorls [7,8]. The arch type is sub-classified into tented and simple (plain) and arches have no ridge counts [9]. The loops are also sub-classified into ulnar and radial loops [10,11]. The whorls are sub-classified into central pocket, concentric circle, composite (plain), double loop and accidental whorls [12,13].

A single rolled inked digital impression (print) has many focal points, which are used in the detail classifications and identification. These specific points in a digit image termed as minutiae vary from digit to digit in a particular person. These minutiae include the ridge ending, ridge crossing, ridge islands (short ridges), ridge bridges and ridge spurs (hooks) [14]. Ridge count begins at the first ridge after delta and ended at the core for loop types and from left delta to right delta or from core to delta for the whorl types [8].

Although, palmar digital dermatoglyphic patterns and its characteristic variability among populations have been studied extensively in the developed world, to our knowledge there are no population based studies reported in the study area in particular and in Ethiopia in general. Hence, the aim of this study was to determine the frequency of palmar digital dermatoglyphic patterns, to identify and compare the major and subtypes of palmar digital dermatoglyphics and to investigate the total ridge count among University of Gondar students.

MATERIAL AND METHODS

Study Area

The study was conducted at University of Gondar located 739 km from the capital-city, Addis Ababa. The town lies on the average at 2,200 m above sea level.

Study Design and Period

A cross-sectional survey was conducted for the duration of 2 months from 1st of January to 28th of February 2010.

Sample Size

The total number of regular students registered at University of Gondar by the year 2010 was 10761. The sample size was determined using a single population proportion formula as follows:

$N = z^2 p (1-p)/ w^2$;

where N = the number of sampled students;

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

P = proportion of the study population estimated to have a particular characteristics of finger prints (since there was no other study conducted in the area, we used a 50% prevalence);

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

The calculated sample size was 384 but considering a 10% non-response rate, the required sample size was determined 422.

Sampling Methods

The University of Gondar had one college and 6 faculties which were used as a frame for selecting sampled students within each department. Six out of 32 departments were selected using the lottery method. From each department, first year to 4th year classes were selected by random sampling technique. Each student enrolled in the study was selected from each class following the roster/register of the student list and asked to participate in the study on voluntary bases. Among the 422 students, 29 were found insignificant in number to represent the respective ethnic group were they belong and were excluded from the study making the final sample size 393 students.

Demographic Data Collection

A structured and pre-tested questionnaire was prepared and used to collect socio-demographic characteristics of students such as age, sex and ethnicity.

Dermatoglyphic Data Collection and Processing

Using a six by six centimeter square box papers, impressions of palmar digital dermatoglyphics for the right and left digits were collected. After cleaning and drying individual's digit, the printing ink was smeared on the glass plate and individuals were asked to stand in front of it, at a forearm's length from the digital printing device, and instructed to stand on the right side, rear of the person taking the digital prints and asked to look at some distant objects. Starting with the right hand digits; right pollex (thumb), right digitus secoundus manus (index finger), right digitus medius/tertius (middle finger), right digitus annularis (ring finger), right digitus minimus manus (little finger) followed by left manus (hand) digits; left pollex (left thumb), left digitus secoundus manus (left index finger), left digitus medius/tertius (left middle finger), left digitus annularis (left ring finger), and left digitus minimus manus (left little finger) of the study subjects were grasped sequentially and separately applied on the ink smeared plate, rolled from nail to nail (from one side to the other side) and then the rolled inked digits were transferred and placed into a square box area of the questionnaire and rolled again from one side to the other to obtain impression of digits (finger prints). Finally, Plain prints were printed last at the bottom of the square box area.

Ethical Consideration

The study was commenced after ethically approved by the ethical review committee of the College of Medicine and Health Sciences, University of Gondar. Each College, faculty and department was communicated using a permission letter that had reference number CMHS/31/644/02 obtained from the Dean's office of the College of Medicine and Health Sciences, University of Gondar. Prior data collection, study subjects were properly explained about the purpose and the intended use of the study. Both verbal and written consent were obtained from each study participant.

RESULTS

Sociodemographic Characteristics and Ethnic Groups

Total three hundred-ninety three students were involved in this study. Two hundred-three (51.7%) were males and the other 190 (48.3%) were females. The age distribution ranges from 18-35 years. The study participants were from Amhara, Guragie, Oromo and Tigrie ethnic groups. Two hundred-seventy six (70.2%) were from Amhara, 53 (13.5%) Tigrie, 45 (11.5%) Oromo, and 19 (4.8%) Guragie.

Digital Dermatoglyphic Prevalence

The frequency of the loop types were 2119 (53.9%), followed by the whorl types 1193 (30.36%), and the arch types 618 (15.73%). Among male students, the frequency of the loop type pattern, whorl type and arch type were 1086 (53.5%), 664 (32.71%), and 280 (13.79%) respectively. On the other hand, the frequency of pattern types in females were 1033 (54.37%) for the loop type, 529 (27.84%) for the whorl type and 338 (17.79%) for the arch type [Table/Fig-1].

Pattern Types		Male (n=2030 digits)		Female (n=1900 digits)		Total	
		N	%	N	%	N	%
Archs	Tented arch	255	12.6	277	14.6	532	13.5
	Simple (plain) arch	25	1.2	61	3.2	86	2.2
Loops	Ulnar loop	1056	52	1017	53.5	2073	52.7
	Radial loop	30	1.5	16	0.84	46	1.2
Whorls	Central pocket whorl	457	22.5	408	21.5	865	22.0
	Composite whorl	104	5.1	46	2.42	150	3.8
	Concentric circle whorl	34	1.7	16	0.84	50	1.3
	Double loop whorl	69	3.4	59	3.10	128	3.3
Total		2030	100	1900	100	3930	100

[Table/Fig-1]: Frequency distribution of subtype patterns obtained from 3930 palmar digital dermatoglyphics among University of Gondar students.

The Frequency Distribution of Dermatoglyphic Sub Type Patterns by Sex and Ethnicity

The prevalence of the loop type dermatoglyphic was 53.44% (147/276) for the Amhara students, 56.6% (30/53) for the Tigrie students, 51.1% (23/45) for the Oromo students and 57.89% (11/19) for the Guragie students. Among the Amhara students, the frequency of arch type dermatoglyphic pattern was 12.7% (189/1490 digits) among male students and 2.8% (35/1270 digits) among females. The prevalence of ulnar loop types were 51.7% (770/1490 digits) in males and 53.4% (678/1270 digits) in females [Table/Fig-2]. Among the Oromo students, the prevalence of tented arch types were 10% (29/290 digits) in male and 24.4% (39/160 digits) in females. A 53.45% (155/290 digits) ulnar loop type frequency was observed in male compared with a 46.9% (75/160 digits) prevalence in females. The frequency pattern among Guragie students revealed that tented arch types were 12% (12/100 digits) among males and 13.3% (12/90 digits) in females.

			TA	S/PA	UL	RL	CPW	CMW	CCW	DLW	Arch	Loop	Whorl
Amhara	Male	No=1490	189	8	770	21	330	92	31	49	197	791	502
		%	12.7	0.54	51.7	1.41	22.15	6.2	2.08	3.3	13.22	53.09	33.69
	Female	No=1270	164	35	678	6	287	40	15	45	199	684	387
		%	12.9	2.8	53.4	0.5	22.6	3.15	1.2	3.5	15.67	53.86	30.47
	Total	2760	353	43	1448	27	617	132	46	94	396	1475	889
Tigrie	Male	No=150	25	3	80	3	33	-	-	6	28	83	39
		%	16.7	2	53.3	2	22	-	-	4	18.67	55.33	26
	Female	No=380	62	21	210	7	67	-	-	13	83	217	80
		%	16.3	5.5	55.3	1.8	17.6	-	-	3.4	21.84	57.12	21.05
	Total	530	87	24	290	10	100	-	-	19	111	300	119
Oromo	Male	No=290	29	9	155	4	80	5	2	6	38	159	93
		%	10	3.1	53.45	1.4	27.6	1.7	0.7	2.1	13.10	54.83	32.07
	Female	No=160	39	4	75	-	37	3	1	1	43	75	42
		%	24.4	2.5	46.9	-	23.13	1.9	0.63	0.63	26.88	46.9	26.25
	Total	450	68	13	230	4	117	8	3	7	81	234	135
Guragie	Male	No=100	12	5	51	2	14	7	1	8	17	53	30
		%	12	5	51	2	14	7	1	8	17	53	30
	Female	No=90	12	1	54	3	17	3	-	-	13	57	20
		%	13.3	1.1	60	3.3	18.9	3.3	-	-	14.44	63.33	22.22
	Total	190	24	6	105	5	31	10	1	8	30	110	50

[Table/Fig-2]: Comparison of the pattern frequency variations and distribution of digital dermatoglyphic sub types by sex and ethnic groups (frequency patterns; n=3930 digits).

TA=Tented arch; S/PA=Simple (plain) arch; UL=Ulnar loop; RL=Radial loop; CPW=Central pocket whorl; CMW=Composite whorl; CCW=Concentric whorl; DLW=Double loop.

Simple (plain) arch types were 5% (5/100 digits) in male and 1.1% (1/90 digits) in females. The ulnar loop types were 51% (51/100 digits) in male and 60% (54/90 digits) in females. The Tigrie students demonstrated 16.7% (25/150 digits) tented arch types in male and 16.3% (62/380 digits) in females. The prevalence of simple (plain) arch types were 2% (3/150 digits) in males and 5.5% (21/380 digits) in females. The frequency of ulnar loop types were 53.3% (80/150 digits) in males and 55.3% (210/380 digits) in females [Table/Fig-3].

Frequency Patterns in Right Hand vs Left Hand Digits

Amhara student's right hand digits showed an 11.09% of the arch types, 57.9% of loop types and 31.01% of the whorl type. In the left hand of the Amhara students, 17.61% arch type, 48.98% loop type and 33.41% whorl type digits were observed. The right hand digits of the Oromo students showed 15.11% arch types, 53.33% loop types, 31.16% whorl types and in the left hand digits 20.89% arch types, 50.67% loop types and 28.44% whorl type digits were observed. In Guragie student's right hand, the prevalence of the arch types, loop types, and whorl type's digits were 13.68%, 57.89%, and 28.42% respectively. In the left hand of the Guragie students the arch type accounted for 17.89%, loop types for 28.42% and the whorl types for 24.21%. The Tigrie students right hand digits depicts an arch type digits of 15.47%, loop type 60%, whorl types 24.53% and in the left hand the arch types were 26.42%, loop types 53.21% and the whorl types 20.38%.

Digit by Digit Specific Distribution of Dermatoglyphic Patterns

Dermatoglyphic prevalence and subtype proportion among male students showed that the tented arch types were with high frequency on digitus secundus (29%; 74/255) and least frequent on pollex (5.1%; 13/255). The prevalence of simple (plain) arch type digits was 48% (12/25), high on digitus minimus manus. Ulnar loop types were 25.7% (271/1056) with high prevalence on digitus minimus manus. The radial loop types were 70% (21/30) with high proportion on digitus secundus and least prevalent on digitus medius 3.3% (1/30).

The dermatoglyphic intra-digital frequency among male students showed that the subtype tented arch was 100% limited to digitus minimus (little fingers). The occurrence of the ulnar loop type was high on digitus secundus (99.6%). Among the whorl type digits, the central pocket whorl type (87.85%) was frequent on digitus minimus and that of the composite whorl types (28.35%) was prevalent on pollex. In females, the subtype tented arch (93.05%) was highly prevalent on digitus minimus [Table/Fig-4].

Association of Digital Dermatoglyphic Pattern Characteristics with Gender

In this study, the frequency distribution of the arch type dermatoglyphic pattern was high (17.8%) in female students compared with males (13.8%) and the loop type pattern prevalence was relatively similar in both male and female students (53.5% versus 54.4% respectively). The prevalence of the whorl type dermatoglyphic patterns was 32.7% in male and 27.8% in female students. Moreover, digital dermatoglyphic pattern was significantly associated with gender ($p<0.001$).

Digits		Archs (n=280)		Loops (n=1086)		Whorls (n=664)				Archs (n=338)		Loops (n=1033)		Whorls (n=529)			
		Ta	S/Pa	UL	RL	CPW	CMW	CCW	DLW	Ta	S/Pa	UL	RL	CPW	CMW	CCW	DLW
PO	NO	13	4	191	3	100	55	9	30	19	18	189	1	86	36	3	26
	%	5.1	16	18.09	10	21.88	52.88	26.47	43.48	6.86	29.51	18.58	6.25	21.08	78.26	18.75	44.07
DSM	NO	74	12	163	21	97	17	9	15	60	16	173	12	96	5	3	16
	%	29.02	48	15.44	70	21.22	16.35	26.47	21.74	21.66	26.23	17.01	75	23.53	10.87	18.75	27.12
DM	NO	72	5	251	1	55	12	4	6	72	17	227	1	51	3	1	6
	%	28.24	20	23.77	3.33	12.04	11.54	11.76	8.89	25.99	27.87	22.32	6.25	12.5	6.52	6.25	10.17
DA	NO	44	4	180	3	134	17	9	14	59	6	170	1	126	2	9	10
	%	17.25	16	17.05	10	29.32	16.35	26.47	20.29	21.29	9.84	16.72	6.25	30.88	4.35	56.25	16.95
DMM	NO	52	-	271	2	71	3	3	4	67	4	258	1	49	-	-	1
	%	20.39	-	25.66	6.67	15.54	2.88	8.82	5.79	24.18	6.67	25.37	6.25	12.01	-	-	1.69
Total	NO	255	25	1056	30	457	104	34	69	277	61	1017	16	408	46	16	59
	%	91.07	8.93	97.24	2.76	68.83	15.66	5.12	10.39	81.95	18.05	98.45	1.55	77.13	8.69	3.02	11.15

[Table/Fig-3]: proportion and distribution of dermatoglyphic subtypes on each specific digit of the students.
PO= Pollex; DSM=Digitus secundus manus; DM=Digitus medius; DA= Digitus annularis; DMM=Digitus minimus manus; TA=Tented arch; S/PA=Simple (plain) arch; UL=Ulnar loop; RL=Radial loop; CPW=Central pocket whorl; CMW=Composite whorl; CCW=Concentric whorl; DLW=Double loop

Digits		Archs (n=280)		Loops (n=1086)		Whorls (n=664)				Archs (n=338)		Loops (n=1033)		Whorls (n=529)			
		TA	S/Pa	UL	RL	CPW	CMW	CCW	DLW	Ta	S/Pa	UL	RL	CPW	CMW	CCW	DLW
PO	NO	13	4	191	3	100	55	9	30	19	18	189	1	86	36	3	26
	%	76.47	23.53	98.45	1.55	51.55	28.35	4.64	15.46	51.35	48.65	99.47	0.53	56.95	23.84	1.99	17.23
DSM	NO	74	12	163	21	97	17	9	14	60	16	173	12	96	5	3	16
	%	86.05	13.95	88.59	11.41	70.81	12.41	6.57	10.23	78.95	21.05	93.51	6.49	80	4.17	2.5	13.33
DM	NO	72	5	251	1	55	12	4	6	72	16	227	1	51	3	1	6
	%	93.51	6.49	99.60	0.4	71.43	15.58	5.19	7.79	81.82	18.18	99.56	0.44	83.61	4.92	1.64	9.84
DA	NO	44	4	180	3	134	17	9	15	59	6	170	1	126	2	9	10
	%	91.67	8.33	98.36	1.64	76.57	9.71	5.14	8.57	90.77	9.23	99.42	0.58	85.71	1.36	6.12	6.80
DMM	NO	52	-	271	2	71	3	3	4	67	5	258	1	49	-	-	1
	%	100	-	99.27	0.73	86.65	3.70	3.70	4.94	93.05	6.94	99.61	0.39	98	-	-	2
	NO	255	25	1056	30	457	104	34	69	277	61	1017	16	408	46	16	59
Total	%	91.07	8.93	97.24	2.76	68.83	15.66	5.12	10.39	81.95	18.05	98.45	1.55	77.13	8.69	3.02	11.15

[Table/Fig-4]: Proportion and distribution of intra digital dermatoglyphic subtypes on each digit among male and female students.
PO= Pollex; DSM=Digitus secundus manus; DM=Digitus medius; DA= Digitus annularis; DMMP=Digitus minimus manus; TA=Tented arch; S/PA=Simple (plain) arch; UL=Ulnar loop; RL=Radial loop; CPW=Central pocket whorl; CMW=Composite whorl; CCW=Concentric whorl; DLW=Double loop.

Distribution of Dermatoglyphic Patterns Among Specific Digits of Right and Left Hand of Male and Female Students

The frequency of ulnar loop types on the right digitus minimus manus was relatively high in male (25.7%) compared with female students (23.7%). On the other hand, the prevalence of ulnar loop types was relatively low on right digitus secundus of male students (16.07%) and right digitus annularis of female students (17.32%). The prevalence of radial loop types was high on right digitus secundus manus of both male and female students (87.5% versus 100% respectively). The frequency of the whorl types on the right pollex was relatively high in male students compared with females (30.47% versus 28.46% respectively). On the left hand digits, the prevalence of ulnar loop types was relatively high on digitus minimus (25.6%) in male and female students (27.8%). The radial loop types occurrence was also high on the left digitus secundus of male students (63.64%) and female students too (63.64%). The prevalence of the whorl type was similar on the left pollex of male (27.9%) and female students (28.26%) but low on the left digitus medius of male (13.5%) and left digitus minimus of female students (8.7%).

Quantitative Analysis of Total Digital Dermatoglyphic Ridge Counts

The total digital ridge count of male students (17443) was higher than the total ridge count of female students (14788). The loop type pattern ridge count (18095) was higher among male students in any of the ethnic groups than the whorl pattern ridge count (14136). The mean total digital ridge count of male students was 8.59 and that of female students was 7.78. The mean prevalence of the pollex digits ridge count was 11.18 on the left hand of male students and 11.88 on the right hand. The prevalence of the pollex digits ridge count was 10.33 for the left hand and 10.67 for the right hand of female students.

DISCUSSION

The result of the current study showed that the distribution of dermatoglyphic pattern types and total digital ridge count variation among University of Gondar students. Human fingerprints are characterized by various types of ridge patterns classified as an arch, a loop, or a whorl—each has a unique characteristic with respect to a reference point called a triradius [15]. Arches are the simplest patterns and also found rarely. Loops are formed by ridge lines that flow in from one side of the print designated as being either radial or ulnar [16]. According to Holt [17], a ridge count is the number of ridges intervening between the triradius and the core or center which cuts or touches a straight line joining these two points in a finger. Arch patterns have zero ridge count, loop pattern ridge count is obtained by counting the number of ridges between the triradius and the center or core of the pattern and whorl pattern ridge count is made from each triradius to the center of the fingerprint.

In the present study, the prevalence of loop type, whorl type and arch type patterns were 53.9%, 30.36% and 15.73% respectively. Previous report from Malawian subjects [18] reported a 54.4% prevalence of the loop type, 27.8% whorl type and 17.8% arch type for females and the loop type, the whorl type, arch type 53.5%, 32.7% and 13.7% for males respectively. The subtype patterns among University students

in Gondar showed a 52%, 22% and 0.12% prevalence for the ulnar loop, central pocket whorl and radial loop types respectively. Previous reports showed that the average frequency of the whorl, ulnar loop, radial loop and arch among different population was reported 25%, 70%, < 1% and 55% respectively [10]. Genetic inheritance and environmental factors determined during the 6th to 11th week of development of embryo in the intrauterine life are reported as the main reasons for dermatoglyphic pattern variations [19].

In the current study, the prevalence of tented arch types and ulnar loop types were slightly higher among female than in male students but the frequency of the composite whorl type was higher in males than females. In a study conducted in India on 200 medical students, the frequency of the loop type was found higher in females (52.42%) than males (47.58%) whereas the whorls were frequent in males (55.78%) as compared to females (44.22) [19]. There are some reports that associate fingerprint patterns with the living opportunity of an individual. For example, Richard Unger's associated the presences of tented arch with wisdom were the individual develop risk and fully experience life with joy. Vernon Mahabal declares two or more tented arches dwell on the finger tips of the 'enthusiasts' [20].

The tented arch types were nearly equal by prevalence in male and female students within the different ethnic groups of University of Gondar students. The simple arch type patterns were more prevalent in female Amhara, Oromo, and Tigrie students than males. Contrarily, the simple arch type prevalence was relatively higher in male than female Guragie students. There are reports that documented that certain fingerprint patterns appear with great frequency among certain ethnic heritages. European and African have shown a predominance of loop pattern, Pacific Island races linked with whorl, while arch pattern is associated with Eskimos, persons from Scandinavia, and the Bushmen of Central Africa [20].

The quantitative digital ridge count indicates a higher amount of ridge count among Amhara male than that of females. Greater amount of ridge count was also observed among Oromo males than females and among Guragie males compared with females. Among Tigrie students, increased amount of ridge count was seen in females than that of males. The total ridge count data showed that males had higher ridge count compared to females. One possible reason could be the fast and slow regression of the palmar volar pad at the 10th and 11th week of gestation period [21]. Acree's demonstrated the significant differences in the loop ridge count of male subjects compared to that of female subjects. However, Angela Bell reported that no significant mean difference in the loop ridge counts across gender. Another report found that males tend to have more ridge counts than females [22,23].

CONCLUSION

The prevalence of the loop type dermatoglyphic patterns was the dominant patterns among University of Gondar students. The quantitative total digital dermatoglyphic ridge count of males was higher than females. Further study with emphasis on papillary (epidermal) ridge line configuration and their relationship with genetics and acquired diseases relations are recommended.

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AUTHOR'S CONTRIBUTION

This work was carried out in collaboration between all authors. MT conceived the study, undertook all laboratory works. Author BG prepared the final manuscript for publication. Authors KD and AB managed the literature search. Author MA involved in the study design. All authors read and approved the final manuscript.

REFERENCES

[1] Hassanzadeh M, Raoofian R, Abutorabi R, Hosseini H. Dermatoglyphic assessement in Down and Klinefelter syndromes. *Iranian Journal of Medical Sciences*. 2007;32(2):105.

[2] Crawford M, Duggirala R. Digital dermatoglyphic patterns of Eskimo and Amerindian populations: relationships between geographic, dermatoglyphic, genetic, and linguistic distances. *Human Biology*. 1992;64(5):683-704.

[3] Samia A, Temtamy. Diagnostic significance of dermatoglyphics on certain dirt defects. Progress in dermatoglyphic research, New York, 1982.

[4] Demon A. Finger print classification in forensic science. www.acdemon.com/essay-fingerprint-classifications-in--/61802. 2005.

[5] Ekanem E, Eluwa M, Udoaffah G, Ekanem T, Akpantah A. Digital dermatoglyphic patterns of Annang Ethnic group in Akwa Ibom state of Nigeria. *The international journal of Biological Anthropology*. 2009;3(1):8.

[6] Sanna E, Usai E, Soro M, Floris G. Quantitative digital dermatoglyphics in males and females of four Sardinian linguistic groups. *The international journal of Biological Anthropology*. 2005;20(1):1-11.

[7] Jantz R, Brehme H. Finger and palmar dermatoglyphics of a Yoruba (Nigeria) sample. *Annales of Human Biology.* 1978;5(6):539-46.

[8] Henery E. Classification and uses of finger prints. Digital edition. London, 2004. http://galton.orgbyGavantredoux.

[9] Arrieta M, Ibarrondo M, Lostao C. Digital dermatoglyphics in the Basque population: Univariate and multivariate comparison with other Spanish populations. *Am J Phys Anthropol.* 1987;73:89-98.

[10] Narahari S, Padmaja JS. Finger and palmar dermatoglyphic study among the Bondos of Orissa. *Anthropologist*. 2006;8(4):237-40.

[11] Kawagoe M, Tojo A. Finger print pattern classification and pattern recognition. Pergamon Press, Oxford. 1984;17(3):295-303.

[12] Hajn V. Less common dermatoglyphic patterns on the palm in Moravian population. *Tr Svobody, Olomouc, Czech Republic*. 2002;26:46-71.
[13] Osunwoke E, Ordu K, Hart J, Esomonu C, Tamunokuro F. A study on the dermatological patterns of Okrika and Ikwerre ethnic groups of Nigeria. *Scientia Africana*. 2008;7(2):143-47.
[14] Rosa P. A dermatoglyphic survey of Kenyan school children. *Annals of Human Biology, University of Stirling, Scotland*. 1983;10(6):579-83.
[15] Gutierez S, Lucenario J, Yebes M. Dermatoglyphic studies among the Dumagat Remontado tribal population of the Philippines. *Journal of Anthropology*. 2012; http://dx.doi.org/10.1155/2012/812128.
[16] Rastogi P and Pillai K. A study of finger prints in relation to gender and blood group. *Journal of Indian Acad forensic Med*. 2010;32(1):11-14.
[17] Holt SB. Epidermal ridge-counts. *Collegium Anthropologicum*. 1979;1(3):97–106.
[18] Igbigbi P, Masamatic B. Palamr and digital dermatoglyphic patterns in Malawian subjects. *East African Medical Journal*. 2000;76(12):668-71.
[19] Ahmed I, Yasin I. Dermatoglyphic study. *APMC*. 2010;4(2):107-1010.
[20] Kandil M, Luna F, Chafik A, Zaoui D, Moral P. Digital dermatoglyphic patterns of Morroccan Arabs: relationships with Meditrranean populations. *Ann Hum Biol.* 1998;25 (4):319-29.
[21] Babler WJ. Prenatal development of dermetoplyphic digital patterns association with epidermal ridges, vollar pad and bone morphology. *Antropol*. 1987;11(2):297-304.
[22] Udoaka A, Alaba I, Udoaka EG. Digital dermatoglyphics in Ijaw students of university of port Harcourt, Nigeria. *Continental J Biomedical Sciences*. 2009;3:1-5.
[23] Balbber W. Embryologic development of epidermal ridge and their configuration. Birth defects. Original Article Series. 1991;27(2):95-112.

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