International Journal of Anatomy and Research,
Int J Anat Res 2020, Vol 8(4.1):7753-60. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2020.167

Original Research Article

A PRELIMINARY ANTHROPOMETRIC STUDY OF THE RELATIONSHIP BETWEEN DERMATOGLYPHICS AND SICKLE CELL ANAEMIA

James Nketsiah [1], Chrissie Stansie Abaidoo *[2], Adjei-Antwi Collins [3].

[1] Department of Anatomy, School of Medicine and Dentistry- Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

*[2] Professor, Department of Anatomy, School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

[3] Department of Anatomy, School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

ABSTRACT

Dermatoglyphics have been utilized as models for the diagnosis of vast genetic conditions due to their relationship with the genetic make-up of an individual. However, little studies have been conducted worldwide trying to ascertain the relationship between dermatoglyphics and sickle cell anaemia. Therefore, the present study aimed at generating baseline data to elucidate the possible diagnostic value of dermatoglyphics for earlier detection and screening of Sickle Cell Anaemia (SCA) in Ghana. A total of 400 participants including 200 SCA patients from Komfo Anokye Teaching Hospital and 200 control group (CG) from KNUST were recruited for this study. The palmprints and fingerprints of the participants were taken and the sickling status of the control group was determined. Distribution of the three major fingerprint patterns, PIC patterns, ATD angle and total finger ridge count (TFRC) were determined. Loop dominated in both the SCA and control groups followed by whorl and arch. PIC 300 dominated in the SCA group while PIC 310 dominated in the control group, this was statistically significant. Also, the study recorded 5 unreported PIC's (PIC 400, PIC 410, PIC 430, PIC 500 and PIC 510) in the Ghanaian population. The SCA group recorded a mean ATD angle of 43.62° while the control group recorded 41.61°, this was statistically significant. The SCA group recorded a mean TFRC of 67.17 while the control group recorded 78.49. The results of the present study have shown that, there is a relationship between dermatoglyphics and SCA and this will serve as a reliable indicator for earlier detection and screening of sickle cell anaemia especially in neonates.

KEY WORDS: Dermatoglyphics, sickle cell anaemia, Ghana.

Corresponding Author: Prof. Chrissie Stansie Abaidoo, Department of Anatomy, School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, Tel: +233 208 126 817, **E-Mail:** knustsmsanat@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2020.167	**Article Information** Received: 21 May 2020 Accepted: 19 Jun 2020 Peer Review: 21 May 2020 Published (O): 10 Nov 2020 Revised: None Published (P): 10 Nov 2020

INTRODUCTION

The prevalence of genetically determined sickle cell anaemia in Ghana is very high (2%) and it is the cause of considerable morbidity and mortality [1,2]. Recent generally used post-natal diagnostic procedures consist of solubility tests and haemoglobin electrophoresis. These methods are problematic because there is interference from feotal haemoglobin (Hb F) when such methods are used in neonates less than six months old [3]. This is because, infants less than 6 months old

possess predominantly foetal haemoglobin (Hb F) [3-5]. Therefore, infants who are suffering from sickle cell anaemia or are carriers of the sickle cell trait do not produce sufficient amount of the haemoglobin S until several months later. Thus, the solubility test and the haemoglobin electrophoresis tests may give a false negative result when performed too early in infants who are usually less than six months old (if haemoglobin S < 10%)[3-5].

Shiono in 1986 reported a correlation between chromosomal aberrations and dermatoglyphics and since then, the use of dermatoglyphics in clinical medicine has been tried and tested [6,7]. According to Andani *et al*. (2012), dermatoglyphics serves as a useful clinical and research tool which could be used to a reasonable degree of certainty to diagnose certain genetic diseases particularly those associated with chromosomal aberrations [8]. It is a universal fact that, dermatoglyphics blue print or patterns are established before birth and is prenatally and genetically determined. Therefore, early or late post-natal dermatoglyphics analysis may aid the clinician in early diagnosis and detection of sickle cell [9].

The deviation of the different dermatoglyphic features in patients of thalassemia major according to Andani *et al*. (2012) provides a simple inexpensive method of clinical observation and adds another useful new diagnostic tool to the clinicians [9]. It has been documented in several studies that, dermatoglyphics have proven to be a useful means of identifying some specific syndromes with genetic origins and as such any alterations in the epidermal ridges of individuals will result in a distinguishing distinctive dermatoglyphic feature [10].

Thus, this study was aimed at elucidating the possible diagnostic worth and value of dermatoglyphics in people with sickle cell anaemia in Ghana.

MATERIALS AND METHODS

A total of 400 participants out of which 200 were pre-diagnosed with sickle cell anaemia (SS) from the Sickle Cell Units of Komfo Anokye Teaching Hospital, Ghana (100 males and 100 females) and 200 healthy individuals pre- diagnosed without the sickle cell gene (AA) (100 males and 100 females) were recruited for the present study. Ethics Committee approval was obtained from the Committee on Human Research and Publication Ethics at KNUST and Informed participants' consent were obtained. Participants with all ten fingers and palms intact were recruited for the present study. Healthy students who were used as control were individuals with the AA genotype for the sickle cell gene whilst sickle cell participants were individuals with SS genotypes. Participants who had permanent scared or burnt fingers and palms were excluded. Participants who had any of the fingers absent were also excluded. Individuals who had any deformity in the fingers being acquired or congenital such as leprosy were also excluded. Participants with extra, webbed or worn out fingers were excluded from the study. Participants who consented were categorize into the Sickle Cell Anaemic (SCA) group and the control group (CG).

Bilateral palm prints and fingerprints of both hands excluding the thumbs of all the participants were scanned using an automated CanoScan lide 120 scanner connected to a laptop with Corel Draw X7 Software installed. The thumb prints were then taken in a similar manner. The print of each of the participants was taken twice and given a code. The sickling status of the participants were then checked using sodium metabisulfite (manufactured by Zhuzhou Sante). The bilateral fingerprints and palm prints of participants who tested positive for the sickling gene were excluded from the control group. The fingerprints and palm prints of participant who tested negative for the sickle gene were further analyzed.

Assessment of the fingerprint and palm print variables: The scanned palm and fingerprints of each individual were given a code. The coded palm and fingerprints were magnified to reveal the necessary details using Picasa photo viewer software. Arches, loops and whorls were classified according to the standard classification criteria used by US Federal Bureau of Investigation [11,12] (Figure 1). The

total finger ridge counts (TFRC) were counted and recorded (Figure 2). Loops have a single delta (triradius), therefore, a straight line was drawn from the core of the loop print pattern to the triradius. The ridges crossing the straight line were then counted (Figure 2). Whorls have two deltas (triradii), thus, two straight lines were drawn from the core, one to each triradius and the number of ridges crossing the two straight lines were then counted (Fig 2).

The highest count of the two was noted. Arches have no delta or triradius, therefore arches have a zero (0) ridge count (Figure 2). In order to reduce the margin of error in the counting of the ridges, a two- person rule as well as both lower and higher magnifications were used in the process. For the ATD angle, a straight line was drawn from the axial triradius' (located proximal to the wrist crease) to the palmar triradii 'a' (located at the base of the index finger) and 'd' (located at the base of the little finger). A protractor was then used to measure the ATD (Figure 3).

The nature and pattern of the palmar flexion creases were also noted and recorded. The number of primary palmar flexion creases, their intersections if present and a complete transversal crease (PIC) if present were observed and recorded using Mensvoort (2009) classification method [13].

A: Whorl B: loop C: Arch

Fig. 1: A schematic diagram showing the three primary fingerprint patterns (Source: Verma *et al.*, 2015) [14].

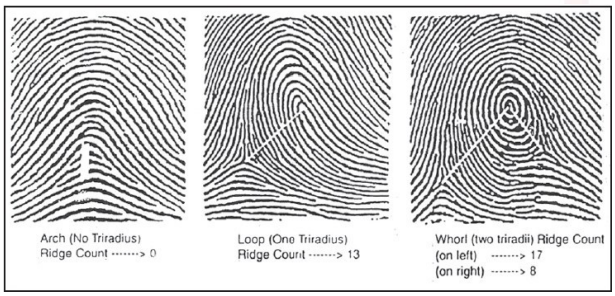

Fig. 2: An illustration showing finger ridges on fingertip of A-arch, B-loop and C-whorl (Source: Kahn *et al.*, 2001)[15]

Fig. 3: A photograph of the palm illustrating ATD angle (× 0.2).

Statistical analysis: The data was tabulated using Microsoft Excel (Version 13. Microsoft Corporation, Redmond, WA, USA) and statistical analysis was done using chi-square test and 'Z test' to compare the digital and palmar dermatoglyphics between the SS and the AA groups separately. Comparisons between the right and left hands as well as between male and female participants and controls were made. A p-value less than 0.05 ($p<0.05$) was considered as being statistically significant. Data analysis was done using IBM Statistical Package for Social Sciences (SPSS) for Windows (Version 22.0. Armonk, NY: IBM Corporation). The data were analyzed according to the statistical methods described by Shetty and Sarda (2017) and Oladipo *et al.* (2007) [16,17].

RESULTS

Table 1 summarises the percentage distribution of the three major fingerprint patterns between the sickle cell anaemic and control groups. The highest fingerprint pattern recorded in all the hand digits of the participants with the SCA was loops (694) followed by whorls (200) and then arches (106) representing 69.4%, 20% and 10.6% respectively (Table 1). In the control group, a similar trend was observed with the loops recording the highest (64.85%), followed by the whorls (23.4%) and then the arches (11.75%) (Table1). Out of the total number of 1388 loop pattern identified in the SCA participants, the highest frequency was observed in males (69.9%) and the lowest in females (68.9%). A similar trend was observed in the control group with males recording the highest frequency of (65.3%) and 64.4% for females (Table 1). In both the SCA

and control groups, males recorded more whorls than the females. In the arch pattern, the highest frequency in both the SCA group and control group was observed in the females. (Table 1). A chi square (X^2) analysis showed no statistically significant differences ($p > 0.05$) between the distribution of the primary fingerprint patterns in both the SCA group and the control group.

Table 2 shows an independent sample t-test comparing the ATD angle between the SCA and control groups. For both hands of the total population of the SCA and control groups, there was a statistically significant difference between the SCA group (M = 43.62, SD = 5.92) and control group (M = 41.61, SD = 5.26); t = 2.542, p = 0.015. There was a significant difference between both hands of the male SCA group (M=42.85, SD=5.29) and male control group (M = 42.19, SD = 5.56); t = 2.448, p = 0.015. Similarly, there was a significant difference between both hands of the female SCA group (M = 44.39, SD = 6.55) and female control group (M = 42.14, SD = 5.24); t = 2.700, p = 0.008. The right and left hands of both SCA and control groups for both male population and female population showed statistically significant difference (Table 2).

Table 3 shows an independent t-test conducted to compare the significant difference of the total finger ridge count (TFRC) between the SCA and control groups. There was no statistically significant difference between both hands of the SCA group (M = 67.17, SD = 94.52) and the control group (M = 78.49, SD = 97.64); t = -1.177, p = 0.240. Neither the right hand nor the left hand of the SCA group showed a significant statistical correlation when compared with the corresponding control group.

Table 4 shows the distribution of palm print patterns among the SCA and control groups. The palm print patterns were classified as PIC 200, PIC 201, PIC 211, PIC 300, PIC 301, PIC 310, PIC 311, PIC 321, PIC 400, PIC 410, PIC 430, PIC 500 and PIC 510. Out of the 800 palm prints analyzed (400 each for the SCA group and control group), the highest PIC pattern in the SCA group was the PIC 310 with a percentage of 61.25%, and this was followed by PIC 300, PIC 410, PIC 400, PIC 301, PIC 211 and PIC 201 with percentages of 28%, 1.25%, 1%, 0.75%, 0.5% and 0.25%, respectively. These PICs; PIC 311, PIC 430, PIC 500 and PIC 510 all recorded 0% each in the SCA group. The highest PIC recorded in the control group was the PIC 300 with a percentage of 54.75%, this was followed by PIC 310, PIC 200, PIC 201, PIC 410, PIC 500, PIC 510, PIC 311, PIC 321 and PIC 430 with percentages of 39.5%, 2.5%, 0.75%, 0.75%, 0.5%, 0.5%, 0.25%, 0.25% and 0.25%, These PICs PIC 301, PIC 211 and PIC 400 all recorded 0% each in the control group (Table 4). Chi square analysis revealed statistically significant difference in the distributions of the various palm print patterns both in the right and left hands of the SCA and control groups ($X^2 = 162.452$; degrees of freedom = 12; p = 0.000).

For the male SCA group, the highest PIC was recorded in the PIC 310 with a percentage of 68%, this was followed by PIC 300, PIC 200, PIC 211, and PIC 301 with percentages of 28%, 1%, 0.5% and 0.5% respectively. These PICs; PIC 201, PIC 311, PIC 321, PIC 430, PIC 500 and PIC 510 all recorded 0% each in the male SCA group. For the male control group, the highest PIC was recorded in the PIC 300 with a percentage of 54.5%, this was followed by PIC 310, PIC 200, PIC 201 and PIC 321 with percentages of 39.5%, 4%, 1.5% and 0.5% respectively. PIC 211, PIC 301, PIC 311, PIC 400, PIC 410, PIC 430, PIC 500 and PIC 510 all recorded 0% each in the male control group (Table 4).

For the female SCA group, the highest PIC recorded was PIC 310 with a percentage of 54.5%, this was followed by PIC 300, PIC 410 PIC 200, PIC 301 and PIC 400 with percentages of 42%, 1.5%, 1%, 0.5%, 0.5% respectively. These PICs; PIC 201, PIC 211, PIC 311, PIC 321, PIC 430, PIC 500 and PIC 510 all recorded 0% each in the female SCA group. For the female control group, the highest PIC was recorded in the PIC 300 with a percentage of 55%, this was followed by PIC 310, PIC 410, PIC 200, PIC 500 and PIC 510 with percentages of 39.5%, 1.5%, 1.5%, 1% and 1% respectively. PIC 201, PIC 211, PIC 301, PIC 321 and PIC 400 all recorded 0% each in the male control group (Table 4).

Table 1: Comparison of the Three Major Types of Fingerprint Patterns between the SCA and Control Groups.

Fingerprint pattern	F-SCA n (%)	M-SCA n (%)	Total SCA	A-SCA n (%)	F-CG n (%)	M-CG n (%)	Total CG	A-CG n (%)
Whorl	184 (18.4)	216 (21.6)	400	200 (20.0)	214 (21.4)	254 (25.4)	468	234 (23.4)
Loop	689 (68.9)	699 (69.9)	1388	694 (69.4)	644 (64.4)	653 (65.3)	1297	648.5 (64.85)
Arch	127 (12.7)	85 (8.5)	212	106 (10.6)	142 (14.2)	93 (9.3)	235	117.5 (11.75)
Total	1000 (100)	1000 (100)	2000	1000 (100)	1000 (100)	1000 (100)	2000	1000 (100)

F-SCA-female sickle cell anaemia; **M-SCA**-male sickle cell anaemia; **A-SCA**-average sickle cell anaemia; **F-CG**-female control group; **M-CG**-male control group; **A-CG**-average control group; Figures represent number of participants with percentages in brackets.

Table 2: Comparison of Palmar 'ATD' Angle among the SCA Group and Control Group.

Sex	Side	Sickle cell anaemia		Control group		95% CI		t	p
		Mean	SD	Mean	SD	Lower	Upper		
M	Right	42.98	5.84	41.9	4.94	0.225	3.32	2.259	**0.025***
	Left	42.71	4.74	42.48	6.18	0.342	3.18	2.448	**0.015***
	(R+L)	42.85	5.29	42.19	5.56	0.284	3.25	2.354	**0.020***
F	Right	44.04	5.93	41.92	4.61	0.64	3.3	2.824	**0.005***
	Left	44.74	7.18	42.35	5.88	0.56	4.22	2.576	**0.011***
	(R+L)	44.39	6.55	42.14	5.24	0.6	3.76	2.824	**0.005***
(M+F)	Right	43.51	5.88	41.57	4.9	0.433	3.31	2.542	**0.015***
	Left	43.73	5.96	41.65	5.6	0.451	4	2.512	**0.013***
	(R+L)	43.62	5.92	41.61	5.26	0.442	3.65	2.542	**0.015***

Data are expressed in Mean ± standard deviation (**SD**), Range with lower and upper limits, **t** = t-statistic and **p**-value- statistically significant at 0.05.

Table 3: Comparison of TFRC between the SCA and Control Groups.

TFRC RIGHT AND LEFT HANDS								
Side	SCA		CG		95%		t	p
	Mean	SD	Mean	SD	Lower	Upper		
Right hand	38.12	52.34	42.31	51.74	-14.417	6.047	-0.804	0.422
Left hand	29.05	47.26	36.18	50.98	-16.793	2.533	-1.451	0.148
Both hands	67.17	94.52	78.49	97.64	-15.605	4.29	-1.177	0.24

Data are expressed in Mean ± standard deviation (**SD**) Range with lower and upper limits, **t** = t-statistic and **p**-value- statistically significant at 0.05.

Table 4: Distribution of 'PIC' Patterns Among the Study Population.

PIC pattern	M-SCA (%)	F-SCA (%)	A-SCA (%)	M-CG (%)	F-CG (%)	A-CG (%)
200	1	1	1	4	1	2.5
201	0	0	0	1.5	0	0.75
211	0.5	0	0.25	0	0	0
300	28	42	35	54.5	55	54.75
301	0.5	0.5	0.5	0	0	0
310	68	54.5	61.25	39.5	39.5	39.5
311	0	0	0	0	0.5	0.25
321	0	0	0	0.5	0	0.25
400	1	0.5	0.75	0	0	0
410	1	1.5	1.25	0	1.5	0.75
430	0	0	0	0	0.5	0.25
500	0	0	0	0	1	0.5
510	0	0	0	0	1	0.5
TOTAL	100	100	100	100	100	100

F-SCA-female sickle cell anaemia; **M-SCA**-male sickle cell anaemia; **A-SCA**-average sickle cell anaemia; **F-CG**-female control group; **M-CG**-male control group; **A-CG**-average control group.

DISCUSSION

In the present study, the highest fingerprint pattern recorded was loops (69.44% in SCA group: 64.85% in control group), followed by whorls (20.0% in SCA group: 23.4% in control group) and then arches (10.6% in SCA group: 11.75% in control group) in both hands of all the participants. This trend of primary fingerprint pattern distribution is in accordance with reports from published literature in different populations across the globe [8,10,17-25]. A study by Shetty and Sarda (2017) in an Indian population of 75 sickle cell anaemic children indicated that, the predominant pattern was loops (63.43% in SCA group: 33.47% in control group) followed by whorls (28.57% in SCA group: 53.07% in control group) and then arches (8.0% in SCA group: 13.46% in control group) [16]. Shetty and Sarda (2017) found no statistical significant difference between the SCA and control groups when subjected to statistical analysis [16].

In addition, among 59 SCA participants of the residents of Andhra Pradesh-India, Ramesh *et al*. (2011) reported that 51.16% of the patterns observed in the SCA group were loops followed by whorls (37.50%) and then arches (11.34%) [26]. In the control group, Ramesh *et al*. (2011) observed a similar trend where the loops recorded 56.33%, whorls (34.17%) and arches (9.50%) [26]. They indicated that, there was no statistical significant difference between the SCA and control groups ($p > 0.05$). The present study was also consistent with studies by Oladipo *et al*. (2007) among 90 SCA patients from the Sickle cell units of Lagos University Teaching Hospital (LUTH) and General Hospital, Ikeja-Nigeria and 90 students (normal) from the Department of Anatomy, College of Medicine of the University of Lagos, Idi-Araba [10]. They reported that, loops dominated (61.42% in the SCA: 62.12% in the control group), followed by whorls (29.79% in the SCA: 27.47% in the control group) and then arches (8.23% in the SCA: 10.43% in the control group). They documented that, although little differences in values occurred for the three major fingerprint patterns, they were statistically not significant.

The differences in values observed between the present study and that of Oladipo *et al*. (2007), Ramesh *et al*. (2011) and Shetty and Sarda (2017) might be attributed to differences in sample size as well as ethnic and racial variations [27-30]. Additionally, in this study, both the SCA and control groups were selected at random from a teaching hospital and a University respectively in Kumasi-Ghana (a cosmopolitan area with diverse tribal and ethnic composition). Dermatoglyphics have been shown to have ethnic specificity [30], it is therefore possible that, an ethnic sensitive sample would yield a different result.

In the present study, the 'ATD' angle for the SCA group ($43.62^0 \pm 5.92$) was significantly ($p = 0.015$) larger than the control group ($41.61^0 \pm 5.26$). This was consistent with studies conducted by Ramesh *et al*. (2011) and Shetty and Sarda (2017) [16,26]. Ramesh *et al*. (2011) reported a mean 'ATD' angle of $43.74^0 \pm 0.53$ in the SCA group and $41.58^0 \pm 0.52$ in the control group while Shetty and Sarda (2017) reported a mean 'ATD' angle of $57.14^0 \pm 1.46$ in the SCA group and $46.7^0 \pm 4.4$ in the control group [16,26]. Both studies conducted by Ramesh *et al*. (2011) and Shetty and Sarda (2017) were statistically significant when subjected to statistical analysis [16,26]. On the contrary, Oladipo *et al*. (2007) observed a slightly higher 'ATD' angle in the control group (41.0 ± 0.61) than the SCA group (40.0 ± 0.60) [10]. This was statistically not significant when it was subjected to statistical analysis.

There was no statistically significant difference ($p > 0.240$) in the mean TFRC between the SCA and control groups. However, the control group recorded a higher mean TFRC value (78.49 ± 97.64) as compared to the SCA group (67.17 ± 94.52). This study is consistent with the study by Ramesh *et al*. (2011) who observed a lower mean TFRC in the SCA (61.18 ± 2.23) and control groups (64.88 ± 2.23) when compared with the present study which were all not significant [26]. There is inadequate literature on the TFRC between the sickle cell anaemic and control groups. Finger ridge count is a polygenic trait which is under the influence of a series of additive

genes of independent effect without dominance and maternal intrauterine influence [20,31]. Medland *et al*. (2007) observed a polygenic mode of inheritance for finger ridge count in which they reported a significant genomic linkage on chromosomes 5 and 1 (5q14.1) [32]. Sickle cell anaemia is a group of inherited red blood cell disorders caused by a mutation in the haemoglobin beta gene found on chromosome 11 that affects the blood and various organs of the body [5]. Haemoglobin is the protein in red blood cells that carries oxygen throughout the body. Each person inherits two haemoglobin genes, one from each parent according to Mendelian genetics: Mendel law of independent assortment [10,16,26]. Therefore, the non-significant association occurring between the SCA and control groups for the TFRC is probably because, finger ridge count is inherited as a polygenic trait with additive effect by several genes whilst SCA is inherited as a monogenic trait through Mendel's law of independent assortment.

The predominant palm print pattern in the present study in the SCA group was PIC 310 followed by PIC 300, PIC 410, PIC 200, PIC 400 and PIC 301 whereas that of the control group was PIC 300, PIC 310, PIC 200, PIC 201 and PIC 410, PIC 500 and PIC 510, PIC 311, PIC 321 and PIC 430. A chi-square test analysis revealed statistically significant difference in the distribution of the PIC patterns between the SCA and control groups (p = 0.000). The present study recorded some PIC's which have not been reported in earlier published works; these were PIC 400, PIC 410, PIC 430, PIC 500 and PIC 510.

ACKNOWLEDGEMENTS

We are grateful to the staff at the Sickle Cell Unit of Komfo Anokye Teaching Hospital, Ghana.

Conflicts of Interests: None

REFERENCES

[1]. World Health Organization. Sickle cell disease in the African region: Current situation and the way forward. Regional office for Africa, 2006;56:1-2.

[2]. Driss, A., Asare, K. O. and Hibbert, J. M. Sickle Cell Disease in the Post Genomic Era: A monogenic Disease with Polygenic Phenotype. Genomics Insights, 209;23-24.

[3]. Wethers, D. L. Sickle cell disease in childhood: Laboratory diagnosis, Pathophysiology and health maintenance. American Family Physician Journal,2000;62(5):1013-1027.

[4]. Pagrut, K. and Chide, P. Screening for the sickle cell gene in Yavatmal District, Maharashtra, India: An approach to a major public health problem. International Journal of Biomedical and Advance Research, 2017;8(2):50-53.

[5]. Piel, F. B., Steinberg, M. H., and Rees, D. C. Sickle Cell Disease. The new England Journal of Medicine, 2017;1561-1573. https://doi.org/10.1056/NEJMra1510865 PMid:28423290

[6]. Shetty, R. M. and Sarda, R. Dermatoglyphic Patterns in Sickle Cell Anaemia Patients of Chhattisgarh. Indian Journal of Dental Science, 2017;2(4):2-6. https://doi.org/10.23880/OAJDS-16000141

[7]. Than, M., Myat, K. A., Khadijah, S., Jamaludin, N., Isa, M. N. Dermatoglyphics of Down's syndrome patients in Malaysia, a comparative study. Journal of Biological and Clinical Anthropology, 1998;56(4):351-365. https://doi.org/10.1127/anthranz/56/1998/351

[8]. Andani, R. H., Dharati, K., Ojaswini, M., Nagar, S. K., Kanan, U. and Bhaskar, P. Palmar dermatoglyphics in patients of thalassemia major. National Journal of Medical Research, 2012;2(3):287-290.

[9]. Gualdo, E. A topographical study of the differentiation of the dermatoglyphics in the human fetus. Tulane University, 1948. Thesis.

[10]. Oladipo, G. S., Olabiyi, O., Oremosu, A. A., Noronha, C. C., Okanlawon, A. O. and Paul, C. U. Sickle cell anemia in Nigeria: dermatoglyphic analysis of 90 cases. African Journal of Biochemistry Research, 2007;1(4):54-59.

[11]. Offei, E. B., Abledu, J. K., Osabutey, C. K. and Kesse, D. K. Relationship between palmar dermatoglyphics and academic performance. Journal for Medical and Biomedical Science, 2014;3(2):24-31. https://doi.org/10.4314/jmbs.v3i2.5

[12]. Parker, C. Fingerprint and intelligence. Fingerprint and Identification Magazine, 1971;3(4):16-18.

[13]. Mensvoort, V. M. Fingerprints-the history of fingerprinting and the study of dermatoglyphics, 2015 http://www.handresearch.com/diagnostics/fingerprints history.htm (accessed 2018 February 14 at 14:07GMT).

[14]. Verma, U., Singroha, R. and Malik, P. A Study to Find Correlation Between Dermatoglyphic Patterns and ABO Blood Groups. International Journal of Anatomy and Research, 2015;3(3): 1293-1297. https://doi.org/10.16965/ijar.2015.214

[15]. Kahn, H. S., Ravindranath, R., Valdez, R. and Narayan, K. V. Fingerprint ridge-Count difference between adjacent fingertips (dR45) predicts upper-Body tissue distribution: evidence for early gestational programming. Journal of Epidemiology, 2001;153: 338-344. https://doi.org/10.1093/aje/153.4.338 PMid:11207151

[16]. Shetty, R. M. and Sarda, R. Dermatoglyphic Patterns in Sickle Cell Anaemia Patients of Chhattisgarh. Indian Journal of Dental Science, 2017;2(4):2-6. https://doi.org/10.23880/OAJDS-16000141

[17]. Bharadwaja, A., Saraswat, P.K., Aggarwal, V., Banerji, P. and Bharadwaja, S. Pattern of Finger-Prints in Different ABO Blood Groups. Journal of Indian Academy of Forensic Medicine, 2004;26(1):6-9.

[18]. Ramani, P., Abhilash, P. R., Sherlin, H. J., Anuja, N., Premkumar, P. and Chandrasekar, T. Conventional dermatoglyphics- Revived concept: A review. International Journal of Pharmacology and Biological Science, 2011;2:446-458.

[19]. Karthikeyan, G. A study on dermatoglyphic pattern in women with breast cancer. PHD Thesis-Madras Medical College and Research Institute, 2013;9:315-317.

[20]. Bhat, G. M., Mukhdoomi, M. A., Shah, B. A. and Ittoo, M. S. Molecular dermatoglyphics: in health and disease - a review. International Journal of Research in Medical Sciences, 2014;2:31- 37. https://doi.org/10.5455/2320-6012.ijrms20140207

[21]. Ekanem, A. U., Abubakar, H. and Dibal, N. I. A Study of Fingerprints in Relation to Gender and Blood Group among Residents of Maiduguri, Nigeria. Journal of Dental and Medical Sciences, 2014;13(8): 18-20. https://doi.org/10.9790/0853-13831820

[22]. Nagaraj, G., Tangpu, V., Lakshmi, K. S. and Geetha, R. Study on distribution of fingerprint patterns - A novel experiment for school students. International Journal for Life Sciences and Educational Research, 2015;3(2): 25-30.

[23]. Maled, V., Khode, V., Maled, D., Jain, A., Male, S. and Ruikar, K. Pattern of Fingerprints in Different ABO and Rh Blood Groups. Journal of Indian Academy of Forensic Medicine, 2015;37(2):124-126. https://doi.org/10.5958/0974-0848.2015.00030.5

[24]. Margi, V. D., Tripathi, S. R., Sharma, S., Nirali, J. K., Patel, A. and Roz, H. Co - Relational Scrutiny between Dermatoglyphics and Blood Group Patterns Revisited. International Journal of Trend in Research and Development, 2016;3(1): 2394-9333.

[25]. Lakshmana N, Nayyar AS, Pavani BV, Ratnam M, Upendra G. Revival of dermatoglyphics: Syndromes and disorders, a review. Advanced Human Biology, 2017;7: 2-7. https://doi.org/10.4103/2321-8568.199528

[26]. Ramesh, M., Geetha, K. K., Sudhakar, G. and Lakshmi, K. V. A dermatoglyphic study on sickle cell anemia patients of north coastal Andhra Pradesh, south India. International Journal of Current Research,2011;3(8): 62-67.

[27]. Igbigbi, P. S. and Msamati, B. C. B. Palmar and digital dermatoglyphics of indigenous black Zimbabweans. Medical Science Monitor. International Medical Journal of Experimental and Clinical Research, 2002;8(11):757-761.

[28]. Harich, N., Esteban, E., Chafik, A. and Moral, P. Dermatologic characterization of berbers from morocco: Qualitative and quantitative digital and palm data. Annals of Human Biology, 2002;29(4):442-456. https://doi.org/10.1080/03014460110102205 PMid:12160477

[29]. Kusuma, Y. S., Babu, B. V. and Naidu, J. M. Finger ridge correlations among four tribes of Andra Pradesh. Indian College of Anthropology, 2002;26(1): 319-323.

[30]. Oladipo, G. S. and Akanigha, B. E. Dermatoglyphic patterns in andro- genetic alopecia in a South Eastern Nigeria Population. Journal of Experimented and Clinical Anatomy, 2005;4(2):44 - 47. https://doi.org/10.4314/jeca.v4i2.30931

[31]. Weninger, M., Aue-Hauser, G. and Scheiber, V. Total Finger Ridge-Count and the Polygenic Hypothesis: A Critique. Human Biology. 1976;48(4):713-725.

[32]. Medland, S. E., Loesch, D. Z., Mdzewski, B., Zhu, G., Monrgomery, G. W. and Martin, N. G. Linkage analysis of a model quantitative trait in humans: finger ridge count shows significant multivariate linkage to 5q14.1 PLoS. Genetics, 2007;3:1736-1744. https://doi.org/10.1371/journal.pgen.0030165 PMid:17907812 PMCid:PMC1994711

How to cite this article:

James Nketsiah, Chrissie Stansie Abaidoo, Adjei-Antwi Collins. A PRELIMINARY ANTHROPOMETRIC STUDY OF THE RELATIONSHIP BETWEEN DERMATOGLYPHICS AND SICKLE CELL ANAEMIA. Int J Anat Res 2020;8(4.1):7753-7760. **DOI:** 10.16965/ijar.2020.167