ORIGINAL ARTICLE

Anatomy Journal of Africa. 2023. Vol 12 (2): 2375-2383

FINGER PRINT PATTERNS DISTRIBUTION AMONG DIABETICS AND NON-DIABETICS IN WESTERN UGANDA POPULATION

Domnic Marera[1]

[1]Department of Human Anatomy, School of Medicine, Maseno University, Private Bag, Maseno, Kenya

Corresponding Author: Domnic Marera email: mareradomnic@gmail.com

ORCID ID: https://orcid.org/0000-0001-7052-4377

ABSTRACT

Background: Dactyloscopy is a branch of dermatoglyphics (the study of epidermal ridges) which involves assessment and classification of fingerprint patterns for identification. All fingerprint patterns are laid down permanently from the third month of the intra-uterine life and they remain unchanged throughout the life. This is also the time when all organs in the body are finalizing their development. Therefore, a positive association of the dermatoglyphic features with different diseases like diabetes, mongolism, schizophrenia and leprosy have been well documented in the literature. The aim of the present study was to evaluate the dermatoglyphic patterns and the specific variations which may be used as a valuable diagnostic tool for early detection of diabetes mellitus. **Methods:** This was a prospective cross-sectional study, a total of 150 diabetic subjects and 150 non- diabetics (control) were selected from the KIUTH Western Uganda and their fingerprints were taken by the Indian ink method. The print patterns including whorls, arches, ulnar and radial loops were analysed and the variations were cross-tabulated between sex, the side of the hand and pattern distribution indexes. Data was analysed using SPSS version 26 and Dankmeijer's index and Furuhata's index were used to assess variability of the fingerprint patterns. Chi square tests was used to test for significance in variations at a confidence interval of 95%. **Results and conclusion:** Ulnar loops were the most predominant patterns among diabetic subjects at 35.2% followed closely by whorls at 35.1%. The most common pattern were whorls found in both hands of females at 21% (315/1500), whilst the most common pattern for male group were whorls at 17.5% (262). However, some fingers such as the ring finger completely lacked an arch pattern in both groups. The increase in arches was strongly supported by a significant increase in Dankmeijer's index. The presence of high number of ulnar loops can therefore maybe used as an early indicator of type two diabetes.

Keywords: Dermatoglyphics, Fingerprint, Diabetes

DOI: https://dx.doi.org/10.4314/aja.v12i2.5

INTRODUCTION

The importance of dermatoglyphics goes back to ancient China in 1839 where it was common practice in the sale of the land (Thoma, 1974). The deed of the land carried the impression of the finger prints as an acknowledgement of the deed. In addition, there was the prevailing custom of the sale of children in China and the prints of the palm and soles were recorded as a safeguard against the impersonation (Thoma, 1974).

Dermatoglyphics deals with the study of the epidermal ridges and their configurations on the fingers, palms and soles. The word "dermatoglyphics" is derived from the Greek word derma "meaning skin and "glyphic" meaning carvings (Kiran et al., 2010). Dermal ridge differentiation takes place early in foetal development. The resulting ridge configurations are genetically determined and influenced or modified by environmental forces (Schaumann & Alter, 1976).

Dermatoglyphics are of interest in anthropology, criminology, and medicine, including dysmorphology (the study of congenital malformations) and the study of chromosome abnormalities such as trisomy 21 (Down syndrome) (Anitha et al., 2014). The study of fingerprints as a method of identification is also known as Dactylography or Dactyloscopy (Gutiérrez-Redomero et al., 2014), and currently it is also known as the Henry-Galton system of identification. Dactylography is the process of taking the impressions of papillary ridges of the fingertips for the purpose of identification of a person.

Epidermal ridges and their arrangement (dermatoglyphic patterns) exhibit a number of properties that reflect the biology of an individual (Crawford & Duggirala, 2014). Dermatoglyphic features statistically differ between the sexes, ethnic groups and age categories. Because dermatoglyphics and their components are genetically determined, and the arrangement of ridges remains constant throughout life, they have become of value as a supportive aid in the diagnosis of hereditary disorders (Crawford & Duggirala, 2014).

Considerable progress has been made in the understanding of the associations between dermatoglyphics and various medical disorders, and nearly all chromosomal disorders have been known to show dermatoglyphic patterns which can be used as part of preliminary diagnostic tools for such disorders (Yunis, 2012). Therefore, dermatoglyphic analysis has been established as a useful diagnostic and research tool in clinical disorders such as type two diabetic melitus (Anitha et al., 2014).

Currently, dermatoglyphics is involved in the forensic and medical field of research, such as Down’s syndrome, psychosis, bipolar disorders and Diabetes mellitus (Anitha et al., 2014). However, some practitioners misuse dermatoglyphics and conduct fortune-telling instead of proper scientific analysis. This practice is considered a *faux pas* as dermatoglyphics is based on genetic research instead of baseless predictions (Valdez & Pathak, 2014).

The American Diabetes Association (2010), defines Diabetes Mellitus as a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels (Funnell et al., 2011). The prevalence of diabetes mellitus is increasing, particularly in developing countries. It is one of the leading causes of morbidity and mortality and 90% of its etiology is genetically influenced (Whiting et al., 2011). The disease has a strong hereditary background. Offspring of two diabetic parents have an 80% lifetime risk of diabetes (Kenny et al., 1995)

Treatment of diabetes is expensive especially in third world countries, therefore early identification and management may reduce complications associated with it. Several significant population specific studies have been carried out to determine the association between dermatoglyphics and incidence of diabetes mellitus (Table 5). However, none so far have been undertaken in Western Uganda. Therefore, the present study intends to evaluate the relationship between the fingerprint patterns and the incidence of diabetes mellitus in the Western Uganda population. Widespread variation between the ethnic groups occurs, thus there is need to determine the parameter values for use in making a diagnosis in each ethnic group. There are 4 main finger print patterns although current techniques have divided some patterns into smaller sub groups (Figure 1).

Figure 1: Digital finger print patterns

Frequency distribution indices of finger print patterns

The frequency distribution indices are unique fingerprint calculations that can be used to determine an individual's or a specific population distribution of patterns. These indices cannot be the same within individuals; thus, federal bureaus of investigation have frequently used it to identify persons of interest. However, these patterns can be used to determine the fingerprint distribution of one population to another (Issrani & Sinha, 2013). These indices include: Pattern intensity index (PII): ($2 \times$% whorl $+$% loop) $\div 10$); arch/whorl index of Dankmeijer's; (% arches $\div$% whorl) $\times 100$; and whorl/loop index of Furuhata's; (% whorl $\div$% of loop) $\times 100$ (Mavalwala & Hunt, 1964).
The highest 'pattern intensity index' in the world is found in populations located in Australia and the Eskimos in Northern America - in these populations are whorls are predominant, resulting in an average 'pattern index' above 15.5 (while in most other populations loops are most common). And the lowest 'pattern intensity index' in the world is found in populations located in central Africa, such as the Bushmen and Pygmies - in these population groups arches and whorls are relatively common, resulting in an average 'pattern index' below 10 (while in other populations whorls are usually much more common than arches), (Mensvoort, 2013).

Value of dermatoglyphics in medicine

Considerable progress has been made in the understanding of the associations between dermatoglyphics and various medical disorders (Table 5). As a result of these advancements dermatoglyphic analysis has been established as a useful diagnostic and research tool in medicine, providing important insights into the inheritance and embryologic development of many studied clinical disorders (Anitha et al., 2014). Congenital anomalies like trisomy 21 and 46 XY female (Bosco et al., 2001) can have multiple effects on the phenotype, including the pattern of dermatoglyphics (Anitha et al., 2014).
Studies have also shown that dermatoglyphics may be an important feature in psychiatric illness. Schizophrenic cases showed reductions in palmar a-bridge counts (Stosljevic et al., 2013), whereas radial loops are increased in bipolar mood disorder (Chakraborty, 2001). Recent studies observed dermatoglyphics as diagnostic clues to various clinical conditions like acute lymphoblastic leukemia, occupational allergic bronchitis, locomotor disorder, coeliac disease, beta-thalassemia and many others (Mollik & Habib, 2012).

Currently, there are several ongoing studies on the relative frequencies of various dermatoglyphic features for chromosomal disorders. When combined with other clinical features of a particular disease, dermatoglyphics can serve to strengthen a diagnostic impression and may be useful in screening select individuals for additional diagnostic studies (Anitha et al., 2014).

MATERIALS AND METHODS

This was a cross sectional prospective study that included 300 residents (150 patients with diabetic mellitus and 150 control group) in Bushenyi District, Western Uganda. Diabetic patients were selected from outpatient department of Kampala International University Teaching Hospital (KIUTH) while the control groups with no family history of diabetes were randomly sampled from the surrounding community.

Only subjects who consented were included in the study. Any subjects with congenital conditions were excluded in the study. After obtaining consent from the respondents, all the subjects were asked to wash and dry their hands to remove dirt and grease.
For the collection of fingerprints, a plain glass plate of 12x12 inches was uniformly smeared with a thin layer of black printers' ink by using the inking roller, then the rolled impressions of each finger were stamped in the allotted space for that given finger on the data sheet. In this way for each and every individual the entire prints of ten fingers were prepared. The prints were then studied with the aid of a magnifying glass

In the present study, the arches, whorls, ulnar and radial loops were analyzed. All the types of whorls such as concentric, single spiral, double spiral, accidental, and also all the types of composite whorls such as twin loops, central pocket loops, lateral pocket loops, crested and knot-crested loops were grouped under the broad category of 'whorls'. On the other hand, radial and ulnar loops (RL and UL) were classified separately. The dermatoglyphic features for both hand and sexes were then evaluated and presented for the control group and diabetic patients separately.

Three indices were also calculated on the basis of the frequency distribution of different finger patterns. These included: (a) The pattern intensity index (PII) $(2 \times \%$ whorl $+\%$ loop$) \div 10)$; (b) Dankmeijer's index $(\%$ arches $\div\%$ whorl$) \times 100$; and Furuhata's index $(\%$ whorl $\div\%$ of loop$) \times 100$. Variations were subjected to chi-square tests and a '*p*' value of <0.05 was recorded as significant (with the corresponding degree of freedom).

Ethical clearance was obtained from KIUTH ethics committee and gate keepers authorization obtained from the Hospital management. Patients were informed of the process, assured of confidentiality and anonymity throughout the process. All collected finger prints were disposed of after study as was agreed in the consent forms.

RESULTS

Demographics characteristics

Table 1: Comparison of frequency (%) distribution of fingerprint patterns between sexes of control and diabetic groups

	Pattern type (%)				
	Sex	**Arches (%)**	**U Loops (%)**	**R Loops (%)**	**Whorls (%)**
Control (N=1500 fingerprints)	**Male**	0.93 (14)	14.7 (221)	8.2 (123)	17.5(262)
	Female	2.27 (34)	22.67 (340)	13.33(200)	20.4 (306)
	Total	3.2 (48)	37.37 (561)	21.53 (323)	37.9 (568)
Diabetic (N=1500 fingerprints)	**Males**	2.73 (41)	14.6 (219)	11.87 (178)	14.13 (212)
	Female	3.27 (49)	20.6 (309)	11.8 (177)	21 (315)
	Total	**6 (90)**	**35.2 (528)**	**23.67 (355)**	**35.13 (527)**

A total of 3000 fingerprints (1500 diabetic and 1500 control groups) were analyzed from 300 subjects (150 Diabetic and 150 control groups) for different digital patterns. The mean age of the two groups was 32.7±4.2 and 29.7±5.1 for diabetic and control group respectively. The total number of males and females were 42.3% ($^{127}/_{300}$) and 57.7% ($^{173}/_{300}$) respectively (Table 1).

General fingerprint patterns

The general frequency (%) distribution of the 300 (3000 fingerprints) participants were as follows; 58.9% ($^{1767}/_{3000}$) loops (Ulnar loops 36.3% + Radial loops 22.6%): 4.6% ($^{138}/_{3000}$) arches, while 36.5% ($^{1095}/_{3000}$) were whorls. Of the total 138 arches, the left hand had 46.6% ($^{63}/_{138}$) and right was 54.4% (75/138). Total loops (U loops + R loops) on the left hand was 48.6% ($^{858}/_{1767}$) and right had 51.5% ($^{909}/_{1767}$), while the total whorls were 52.9% ($^{579}/_{1095}$) for the left and 47.1% ($^{516}/_{1095}$) for the right hand (Figure 3).

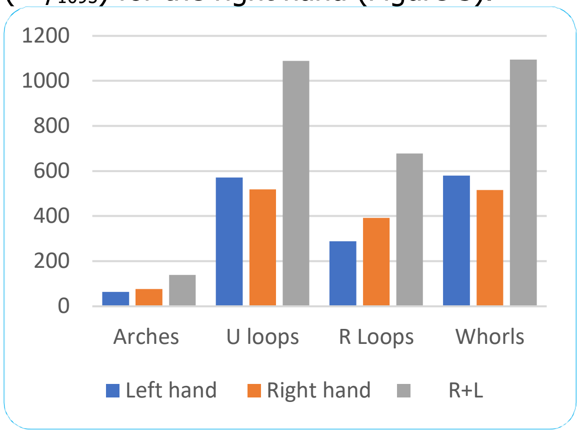

Figure 2: General frequency distribution of fingerprint patterns on the right and left hands

Frequency distribution of fingerprints between control and diabetic group

Ulnar loops were the most predominant patterns in both hands of diabetic subjects with a frequency of 35.2% ($^{528}/_{1500}$) followed closely by whorls at 35.1% ($^{527}/_{1500}$), however, whorls were most predominant in the control group at 37.9% ($^{568}/_{1500}$) (Table 2). The least pattern observed were arches in both groups; the Control group had the lowest at 3.2% (48) and diabetic with 6% (90) of the total 1500 fingerprints (Table 2).

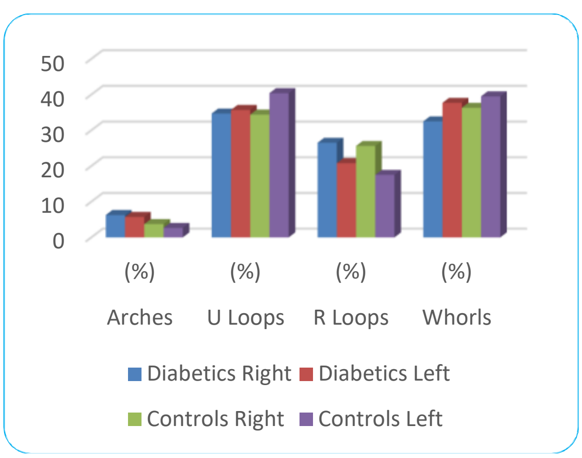

Figure 3: Frequency distribution of the right and left fingerprint patterns, between diabetic and control groups.

Table 2: Frequency distribution of fingerprint patterns between the control and diabetic groups

Pattern distribution	Subjects		
	Diabetic N=1500	**Control N=1500**	**Total (N=3000)**
Arches	6 (90)	3.2 (48)	4.6 (138)
Ulnar Loops	35.2 (528)	37.4 (561)	36.3 (1089)
Radial Loop	23.67 (355)	21.53 (323)	22.6 (678)
Whorls	35.1 (527)	37.9 (568)	36.5 (1095)
Total	100 (1500)	100 (1500)	100 (3000)

Comparison of distribution of fingerprint patterns between control and diabetic groups in relation to gender.

On the control group, (Table 1) ulnar loops were more common on the female side for both hands at 22.67% ($^{340}/_{1500}$), followed by whorls at 21% ($^{315}/_{1500}$). The most common pattern for male control group were whorls at 17.5% (262) followed by ulnar loops at 14.6% (219). Arches were the least common pattern in control group at 0.93% (14/1500) followed by arches in females at 2.27% ($^{34}/_{1500}$).

On the diabetic group (Table 1) the most common pattern were whorls found in both hands of females at 21% ($^{315}/_{1500}$), followed by ulnar loops at 20.6% ($^{309}/_{1500}$). The predominant pattern in male diabetic group were radial loops at 11.87% ($^{178}/_{1500}$). Arches were the least common pattern in diabetic subjects at 2.73% ($^{41}/_{1500}$) followed by arches in females at 3.27% ($^{49}/_{1500}$).

Frequency distribution indices of fingerprint patterns

The diabetic group had a total of 17.4% Dankmeijer's whilst the control group had less than half (8.22%) of the same for both male and female subjects (Table 3). Both hands (right and left for control and diabetic) were calculated together to ensure consistency. Descriptive statistics for fingerprint patterns including mean, Standard deviation and Standard of error among diabetic and control subjects are presented in Table 4 respectively.

Table 3: Comparison of frequency (%) distribution indices between diabetic and control.

	Gender	Furuhata's index % Whorls/% Loops x 100	Dankmeijer's index % Arches/% Whorls x 100	PII (2 ×% whorls +% loops) ÷10
Diabetic	Male	53.38	19.32	8.12
	Female	64.81	15.57	10.68
	Total	**59.0**	**17.4**	**9.4**
Control	Male	76.42	5.31	8.08
	Female	56.67	11.13	11.28
	Total	**66.5**	**8.22**	**9.68**

Table 4: Descriptive statistics and a test of significance for control and diabetic subject

Parameters	**Diabetic (n=150)**		**Control (n= 150)**		**S. E**	**'*p*' value**	**Significance**
	Mean	SD	Mean	SD			
Arch	5.25	0.96	5.28	1.374	0.029	< 0.05	Significant
Ulnar Loop	5.0	1.44	5.0	1.49	0.485	> 0.05	Not Significant
Radial Loop	5.53	1.25	5.64	1.41	0.313	>0.05	Not Significant
Whorl	5.99	1.33	5.375	1.32	0.434	> 0.05	Not Significant

DISCUSSION

All the 300 (150 Diabetic and 150 control group) participants were adults of consenting age and with a mean 32.7±4.2 years and 29.7±5.1 years of age for diabetic and control groups respectively. However, most diabetic patients were much older than the control groups, this might be because most symptoms of diabetes begins to show in late adulthood except in the case of juvenile diabetes (Funnell et al., 2011). Although the onset and symptoms of diabetes commonly begins at late adulthood, age has no correlation with the fingerprint patterns as they form during intrauterine life and never change. There was a high number female participants for both control and diabetic groups although this was insignificant in the final results as the deference was very small.

In the current study, the most predominant fingerprint pattern were loops (Ulnar + Radial loops) for both diabetic and control groups at 58%. This conforms to findings of other authors who noted that loops were the most frequent patterns (Dhumal et al., 2021; Okeke et al., 2018; Sudharson et al., 2020; Tadesse et al., 2022). The general international distribution of fingerprint patterns as recorded in the literature (Mensvoort, 2013) also notes that loops are the most predominant. Arch patterns were rare in the general population and were completely absent on the thumbs of all diabetic patients and on the ring fingers of all the 300 participants, However, there was a general significant increase ($p<0.05$) of arch patterns in diabetic subjects as compared to the control group. After meta-analysis on

similar studies, several studies (Table 5) have reported a significant increase of arch pattern among diabetics than the control groups This findings however, were not in line with the results results of Tadesse et al. (2022); Tarigoppula et al. (2018) who noted that loop patterns were significantly higher in diabetic patients.
Most arch and Loop (U loops + R loops) patterns were predominant on the right hand of all subjects at 54.4% and 51.5% respectively, while the whorl pattern was more predominant on the left hand at 52.9% for both subjects and sexes (Figure 3). {Umana, 2014 #5073@@author-year} on the other hand reported consistent presence of high number of ulnar loop patterns in both right and left hands of diabetic patients, the authors did not correlate their findings to a control group thus no significant association was established.

The rarest pattern observed were arches (only 4.6% for the 300 respondents) in both groups although the control group had almost half the number of arches at only 3.2% as compared to the diabetic cases at 6% of the total 1500 fingerprints. This was statistically significant at a *p* value of 0.0932 (<0.05). Several Authors (Table 5) have also noted significant increase in Arch patterns among diabetic groups from different populations and therefore, diabetes mellitus seems to affect the distribution of fingerprint arch patterns.

On a more specific note, ulnar loops were more predominant finger print pattern and were found in the female control groups at 22.67%, followed by whorls at 21%, while the most predominant pattern in the diabetic group were whorls in females at 21%, followed by ulnar loops at 20.6%, The predominant pattern for the male control group were whorls at 17.5% (262) while for male diabetic group were radial loops at 11.87%. This indicates that the females on both diabetic and control groups had the most predominant ulnar and loop patters as compared to their male counterparts.

Table 5: Predominant fingerprint patterns as noted by various authors from different regions

Author	Sample size (n)	Region	Prevalent fingerprint pattern
Ravindranath and Thomas (1995)	150	India	Loops
Verbov (1973)	80	UK	Arches
Padmini et al. (2011)	200	India	Arches
Umana (2013)	101	Nigeria	Arches
Nezhad and Shah (2010)	30		Ulnar loop
Igbigbi et al. (2001)	99	Malawi	Arches
Marera et al. (2015)	150	Uganda	Arches

Arch patterns were the least common under the control and were found in the male side at only 0.93%. The same pattern (Arches) was still the least predominant pattern under diabetic group and found in males too at only 2.73%. The female control group had three times the number of arches as compared to their male counterparts at 2.27% of the total 1500 fingerprint studied.
On analysis of unique finger print frequency distribution indexes, Furuhata's index was lower in diabetic than the control groups; however, the Dankmeijer's index was twice as high (17.4%) in diabetic group than control group (8.22%), this was probably because of the significantly high number of arches in diabetic subjects. The pattern intensity index and Furuhata's index were high in the control group but with an insignificant percentile difference (Table 3), this was likely because the number of whorls and arches were almost near equal in both diabetic and control groups. The lowest pattern intensity indices are below 10% as stated in the above literature (Mensvoort, 2013), therefore the PPI in this study were well below the limit as commonly noted in African countries (Mensvoort, 2013).

CONCLUSION

Several studies done in different regions have significantly identified correlation between different fingerprint patterns and diabetes, however the type of pattern

identified varies from one region to another. This may be because of racial dermatoglyphic differences from one region to another. There are also different types of diabetes mellitus and each may present genetically with a different pattern.
Therefore, a more population and disease specific study may be required to confirm the value of dermatoglyphics in early diagnosis of diabetes mellitus. It would also be appropriate to subject results through calculations of frequency distribution indices such as PPI to confirm the significance of the predominant pattern. In the case of this study, statistically significant differences are evident in Arch pattern and Dankmeijer's finger print distribution index.

REFERENCES

1. Anitha, C., Konde, S., Raj, N., Kumar, N., & Peethamber, P. (2014). Dermatoglyphics: A genetic marker of early childhood caries. *Journal of Indian Society of Pedodontics and Preventive Dentistry*, *32*(3), 220.
2. Association, A. D. (2010). Diagnosis and classification of diabetes mellitus. *Diabetes care*, *33*(Supplement 1), S62-S69.
3. Bosco, J., Rajangam, S., Shankar, J., & Thomas, I. (2001). Dermatoglyphics in 46, XY females. *J Indian Med Assoc*, *99*(8), 418-420.
4. Crawford, M., & Duggirala, R. (2014). Digital Dermatoglyphic Patterns of Eskimo and Amerindian Populations: Relationships between Geographic, Dermatoglyphic, Genetic, and Linguistic Distances. *Human biology*, *64*(5), 4.
5. Dhumal, S., Choudhari, S. K., Masne, S., Khetan, P., & Patankar, S. (2021). Dermatoglyphics and saliva blood grouping can be used for sex identification. *Journal of Indian Academy of Forensic Medicine*, *43*(1), 34-36.
6. Funnell, M. M., Brown, T. L., Childs, B. P., Haas, L. B., Hosey, G. M., Jensen, B., Maryniuk, M., Peyrot, M., Piette, J. D., & Reader, D. (2011). National standards for diabetes self-management education. *Diabetes care*, *34*(Supplement 1), S89-S96.
7. Gutiérrez-Redomero, E., Rivaldería, N., Alonso-Rodríguez, C., & Sánchez-Andrés, Á. (2014). Assessment of the methodology for estimating ridge density in fingerprints and its forensic application. *Science & Justice*, *54*(3), 199-207.
8. Igbigbi, P., Msamati, B., & Ng'ambi, T. (2001). Plantar and digital dermatoglyphic patterns in Malawian patients with diabetes, hypertension and diabetes with hypertension. *Dubai Diabetes and Endocrinology Journal*, *9*(1-2), 24-31.
9. Issrani, N. P. R., & Sinha, S. M. G. M. S. (2013). Dermatoglyphics in Health and Diseases-A Review.
10. Kenny, S. J., Aubert, R. E., & Geiss, L. S. (1995). Prevalence and incidence of non-insulin-dependent diabetes. *Diabetes in America*, *2*, 47-67.
11. Kiran, K., Rai, K., & Hegde, A. M. (2010). Dermatoglyphics as a noninvasive diagnostic tool in predicting mental retardation. *Journal of International Oral Health*, *2*(1).
12. Marera, D., Oyieko, W., & Agumba, G. (2015). Variation in Dermatoglyphic patterns among diabetics in Western Uganda population. *African Journal of Science & Research*, *7*(3), 20-25.
13. Mavalwala, J., & Hunt, E. E. (1964). Finger and palm prints of the Micronesians of Yap. *Zeitschrift für Morphologie und Anthropologie*, 11-23.
14. Mensvoort, M. (2013). Hand Research: Global News & Science about Hands. In.
15. Mollik, M., & Habib, M. (2012). Dermatoglyphics A Good Tool In Preventive Medicine. *Journal of Armed Forces Medical College, Bangladesh*, *7*(2), 1-2.

16. Nezhad, H. R., & Shah, N. M. (2010). Application of dermatoglyphic traits for diagnosis of diabetic type 1 patients. *International Journal of Environmental Science and Development*, *1*(1), 36.
17. Okeke, C., Etoniru, I., & Oforbuikem, V. (2018). Comparative study of digital dermatoglyphics among congenital deaf and control subjects in South East Nigeria.
18. Padmini, M. P., Rao, B. N., & Malleswari, B. (2011). The study of dermatoglyphics in diabetics of north coastal Andhra Pradesh population. *Indian Journal of Fundamental and Applied Life Sciences*, *1*(2), 75-80.
19. Ravindranath, R., & Thomas, I. (1995). Finger ridge count and finger print pattern in maturity onset diabetes mellitus. *Indian J Med Sci*, *49*(7), 153-156.
20. Schaumann, B., & Alter, M. (1976). *Dermatoglyphics in medical disorders*. Springer.
21. Stosljevic, M., Adamovic, M., Eminovic, F., Damjanovic, A., & Ahmo, G. (2013). Quantitative characteristics of digito-palmar dermatogliphic complex among men with schizophrenia in Serbia. *HealthMED*, 104.
22. Sudharson, T., Karthikean, S., Singh, M., Rajkamal, R., & Brethis, C. (2020). A cross sectional study of dermatoglyphic patterns among type 2 diabetic patients and non-diabetics in Chennai. *International Journal of Medical Toxicology & Legal Medicine*, *23*(3and4), 205-209.
23. Tadesse, A., Gebremickael, A., Merid, M., Wondmagegn, H., Melaku, T., Ayele, T., Meskele, S., Esubalew, H., & Birhanu, A. (2022). Evaluation of Dermatoglyphic Features of Type 2 Diabetic Patients as Compared to Non-Diabetics Attending Hospitals in Southern Ethiopia. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 1269-1280.
24. Tarigoppula, R. K. V., Syamala, M., Raheem, A. M. B., & Patil, S. K. (2018). Evaluation of the Role of Dermatoglyphics, Oral Micronuclei and ABO Blood Grouping in Determining Type 2 Diabetes-A Multi-Parameter Approach. *Journal of Clinical & Diagnostic Research*, *12*(10).
25. Thoma, A. (1974). Dermatoglyphics and the origin of races. *Journal of Human Evolution*, *3*(3), 241-245.
26. Umana, U. E. (2013). Dermatoglyphic and cheiloscopic patterns among diabetic patients: a study in Ahmadu Bello University Teaching Hospital Zaria, Nigeria. *J Biol Life Sci*, *4*(2), 206-214.
27. Valdez, D. M. L. A., & Pathak, T. (2014). Assessment of Dermatoglyphics Multiple Intelligence Test (DMIT) Reports: Implication to Career Guidance Program Enhancement of Academic Institutions. *Asia Pacific Journal of Multidisciplinary Research*, *2*(2).
28. Verbov, J. L. (1973). Dermatoglyphics in early-onset diabetes mellitus. *Human heredity*, *23*(6), 535-542.
29. Whiting, D. R., Guariguata, L., Weil, C., & Shaw, J. (2011). IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes research and clinical practice*, *94* (3), 311-321.
30. Yunis, J. J. (2012). *Human chromosome methodology*. Academic Press.