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Review Article

Dermatoglyphic features of fingerprint patterns among African adults diagnosed with Type II diabetes

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Abstract

Dermatoglyphics is the study of epidermal ridges on volar aspect of hands and feet forming a variety of pattern configurations. It encompasses assessment and classification of fingerprint patterns for identification. Dermatoglyphic patterns in digital and palmar regions are associated with various diseases, especially of genetic origin, and have been reported by multiple researchers. Recently, type II diabetes cases has been on the rise in most African countries due to lifestyle changes. This review compared fingerprint patterns among patients diagnosed with type II Diabetes Mellitus residing in Africa. A systematic Comprehensive review using Whittemore and Knafl method involving a five-stage process of problem identification, literature search, data evaluation, data analysis, and presentation of findings was employed. Exploration was conducted across five databases (Medline, Pubmed, Scopus, Google Scholar and Science Direct) which aimed to detect related papers published between January 2019 to March 2025. PRISMA framework was used to identify and collate a total of 5/268 (1.87) related articles that were included in the study. They were summarized for similarities and different variables analyzed. This review concluded that, although no specific fingerprint pattern can be definitively recognized as a marker for diabetes, ulnar and radial loops displayed uncertain trends that warrant further investigation. It supports, that dermatoglyphics, together with genetic and clinical data, might aid as an additional non-invasive screening tool, thus reducing the morbidity and mortality related to diabetes. There is need for further studies to be done on larger sample size in different populations so as to validate this findings.

Keywords: Dermatoglyphics, Type II Diabetes, Finger print pattern

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1. Introduction

Dermatoglyphics is the study of epidermal ridges and their arrangements on the skin of fingers , palms and soles of foot (Amberbir et al., 2019).[1] It includes assessment and classification of fingerprint patterns for identification reasons (Tadesse, Gebremickael, Merid, Wondmagegn, et al., 2022).[2] From third month of intra-uterine life, all organs in the body have finalized their development including fingerprint patterns. These patterns are genetically determined and developed fully at birth remaining unchanged throughout life (Amberbir et al., 2019).[1] The patterns are categorized into loops (ulna and radial), whorls, and arches with each of them having a unique feature depending on shape and relationship of ridges. Loop patterns is divided into radial and ulna loops which curl back on themselves. (Tadesse et al.,2022).[2]
Fingerprint dermatoglyphics has been applied in mixed applications across different disciplines like criminology, personal identification, comparative anatomy, embryology, genetics and medicine because of their fixed arrangement throughout life and its uniqueness to every individual (Srivastava & Rajasekar, 2022).[3] Several studies indicate that there is a significant connection between dermatoglyphics and different genetic diseases like diabetes, mongolism, schizophrenia which have been well documented in literature (Fitriana, 2014).[4]

Complications associated to diabetes can exhibit before a diagnosis is made due to lack of early screening. This leads to increase in costs of care and treatment of complications for individuals and healthcare systems before a diagnosis is made (Kırbıyık, 2020).[5] This observation necessitate the need for developing and testing a predictive pre-assessment tool that can be used for early detection of diabetes. In addition, the tool need to be simple, affordable, painless and

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straightforward and this will guarantee prevention and reduction of healthcare costs (Clevin et al., 2024).[6]

Table 1: Studies included in the review

No	Author, Year	Country	Study Title	Study Design	Aim of the Study	Study Setting	Characteristic of Sample size	Sample Size
1	Clevin et al., (2023).	Kenya	Fingerprint Dermatoglyphic Patterns among Adults with Type II Diabetes Mellitus in Western Kenya	comparative cross-sectional	To assess the variations in fingerprint patterns among adults with Type II diabetes mellitus which could be used as an early, easy, cheap and painless method of screening diabetes.	Western Kenya: Kakamega County Teaching and Referral Hospital	300 (150 T2DM & 150 Non DM) both Male and Female patients	300
2	Amanuel et al., (2022)	Southern Ethiopia	Evaluation of Dermatoglyphic Features of Type 2 Diabetic Patients as Compared to Non-Diabetics Attending Hospitals in Southern Ethiopia	Institution-based cross-sectional study	To compare the finger and palmar dermatoglyphics features in type 2 diabetic and non-diabetic patients and to evaluate the association with other variables.	Four Government Hospitals in Gedeo Zone; Dilla University Referral Hospital, Bule Primary Hospital, Yirgachefe primary, Gedeb primary Hospital.	T2DM and Non DM, both Male and Female Patients	390
3	Chuk et al., (2022)	Nigeria	Finger and palmar dermatoglyphics in diabetic subjects: a study in a Nigeria teaching hospital	A descriptive cross-sectional study	To evaluate digito-palmer print among diabetic patients visiting Irrua specialist Teaching Hospital	Nigerian Irrua specialist Teaching Hospital	T2DM Male and Female Patients	50
4	Howaida et al., (2020)	Egypt	Fingerprint pattern distribution between type II Diabetes mellitus and normal individuals among Egyptian population: a pilot study from Cairo, Egypt	Descriptive pilot study employing a purposeful convenience sample	To determine if fingerprint pattern distribution could be used as an early screening tool for predicting type II diabetes among at risk Egyptian populations	Kasr Al Ainy hospital, located in Cairo's metropolitan area	T2DM and Non DM, both Male and Female Patients	138

5	Domnic Marera, 2023	Uganda	Finger Print Patterns Distribution among Diabetics and Non-Diabetics In Western Uganda Population	prospective cross-sectional study	To evaluate the dermatoglyphic patterns and the specific variations which may be used as a valuable diagnostic tool for early detection of diabetes mellitus	KIUTH Western Uganda	300 (150 T2DM & 150 Non DM) both Male and Female patients	300
								1178

Table 1 results indicate that the cross-sectional study design was commonly used among four studies that were conducted in Uganda, Nigeria, western Kenya and Southern Ethiopia, while the descriptive design was only used in the study conducted in Egypt.

Table 2: Summary of Fingerprint distribution among type II diabetes patients

	Western Kenya		**Uganda**		**Egypt**		**Nigeria**		**Southern Ethiopia**	
	%	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Ulnar loop	61.33	920	35.20	528	42.61	588	56.94	289	63.39	824
Radial loop	2	30	23.67	355	10.65	147				
Arches	28	420	6	90	10.07	139	11.22	55	6.69	87
Whorl	8.67	130	35.13	527	36.67	506	31.84	156	29.92	389
Total	100	1500	100	1500	100	1380	100	500	100	1300

Table 2 results indicate that 6170 fingerprint digits of type II diabetic mellitus patients were sampled in the five studies reviewed**.** A majority of patients had ulnar loops as shown in the three studies that were conducted in Kenya, Uganda and Egypt. In Nigeria and Ethiopia, Ulnar and radial loops were combined and was also abundant. However, Archie's finger print pattern had the lowest values in Uganda, Egypt, Nigeria and Ethiopia, excluding western Kenya where radial loops had the lowest number.

Table 3: Summary of Fingerprint distribution according to gender among type II diabetes patients

	Western Kenya		**Uganda**		**Egypt**		**Nigeria**		**Southern Ethiopia**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Ulnar loop	39.09% (285)	54.09% (635)	33.69% (219)	36.35 % (309)	44.93% (310)	40.29% (278)	49.44% (89)	62.50 % (200)	65.1 % (566)	60% (258)
Radial loop	36.67% (11)	59.38% (19)	27.38% (178)	20.83% (177)	11.30% (78)	10 % (69)				
Arches	56.25% (45)	57.43% (85)	6.31% (41)	5.76% (49)	9.57% (66)	10.58% (73)	10.56% (19)	11.25 % (36)	7.8% (68)	4.4% (19)
Whorl	49.56% (169)	53.86% (251)	32.62% (212)	37.06% (315)	34.20% (236)	39.13% (270)	40% (72)	26.25 % (84)	27.1 % (236)	35.6% (153)
Total	510	990	650	850	690	690	180	320	870	430

Table 3 results show ulnar loops are the most common pattern overall, especially among females as seen in Nigeria, Uganda and Western Kenya. Whorls are also prominent with females showing higher frequencies than males apart from Nigeria. Arches are relatively rare in most populations except in Western Kenya, where both sexes have unusually high proportions .Radial loops are least represented overall and inconsistently reported across countries.

Table 4: Summary of Fingerprint distribution among type II diabetes and non-diabetic patients

	Western Kenya		**Uganda**		**Egypt**		**Southern Ethiopia**	
	D.M	**Non-DM**	**D.M**	**Non-DM**	**D.M**	**Non-DM**	**D.M**	**Non-DM**
Ulnar loops	920 (61.33%)	983 (65.55%)	528 (35.2%)	561 (37.4%)	588 (42.60%)	568 (41.16%)	824 (63.38%)	1787 (68.73%)
Radial loops	30 (2%)	32 (2.13%)	355 (23.67%)	323 (21.53%)	147 (10.65%)	104 (7.54%)		

Arches	130 (8.7%)	98 (6.53%)	90 (6%)	48 (3.2%)	139 (10.07%)	168 (12.17%)	87 (6.69%)	142 (5.46%)
Whorl	420 (28%)	387 (25.8%)	527 (35.13%)	568 (37.89%)	506 (36.67%)	540 (39.13%)	389 (29.92%)	671 (25.81%)
Total	1500	1500	1500	1500	1380	1380	1300	2600

Table 4 results indicate that a majority of type II diabetes mellitus patients from western Kenya had ulnar loops 920(61.33%) while a small group of non-diabetes from Uganda had 561(37.4%) had ulnar. A majority of DM patients from Uganda had radial loop 355(23.67%) while a minority 30(2%) of DM patients were from western Kenya. 139 (10.07%) of DM patients from Egypt had arches while 48 (3.2%) Non-DM patients from Uganda 568(37.89%), and Kenya 387(25.8%) had abundant whorl patterns respectively.

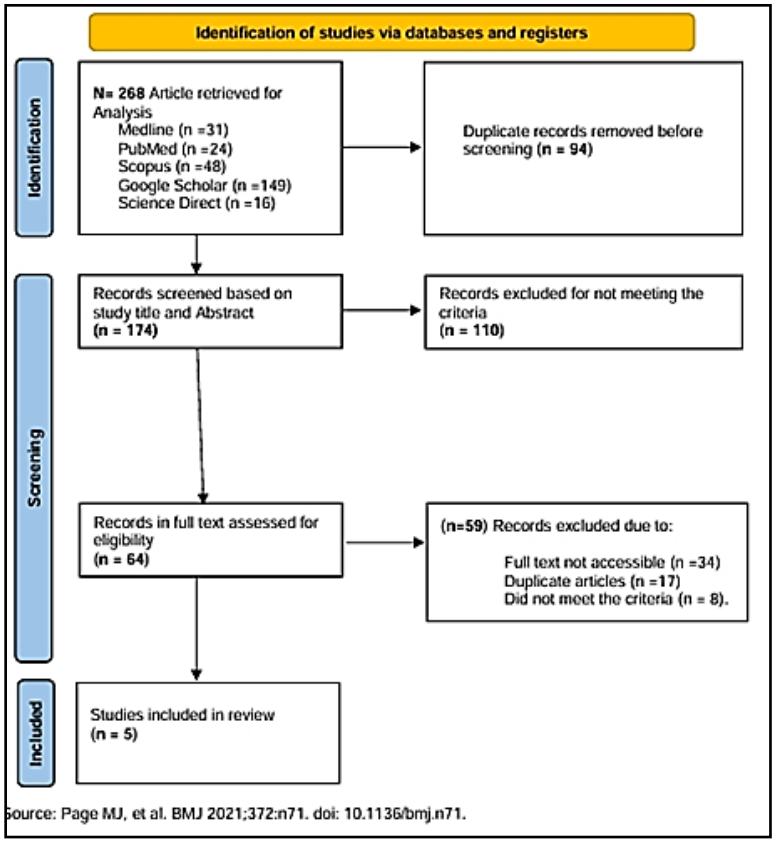

Figure 1: PRISMA flow chat for identification of articles

2. Materials and Methods

This study was conducted as a systematic review (Aamodt et al., 2019)[7] that was intended to fuse evidence from existing published literature regarding comparing the relationship in fingerprint dermatoglyphic patterns among type II diabetes mellitus patients in comparison to non-diabetic persons residing in Africa. This approach helped the incorporation of study findings from diverse settings, populations, and methodologies, contributing to meaningful insights between the relationship "Dermatoglyphics and type II Diabetes Mellitus from the general population (Shea et al., 2007).[9]

2.1. Identifying the research questions

To achieve the study objective, a research question was developed that directed the current review which was: "Is there a relationship between fingerprint dermatoglyphic pattern and patients with type II Diabetes Mellitus residing in Africa?"

2.2. Search strategy and selection criteria

A systematic integrative review using the Whittemore and Knafl method was employed that involved a five-stage process of problem identification, search for literature, evaluation and analysis data, and final presentation of findings (Whittemore & Knafl, 2019).[10] Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was performed (**Figure 1**) as suggested by (Amberbir et al., 2019)**..** In particular, database search encompassed PubMed, Medline, Scopus, Google scholar and Science Direct was used. Hand searches were conducted using Medical Subject Headings and free Key text terms to identify eligible studies. The Search term combinations used to identify the assumed studies was "Fingerprint Dermatoglyphic Patterns and type II

Diabetes". Similarly, time restrictions between January 2019 to March 2025 were included.

The search approach was personalized to each database to allow for variations in structure and terminology. In addition, a 'framework for understanding Dermatoglyphic fingerprint patterns with specific variations which may be used during diagnostic protocol among adults with Type II diabetes mellitus and non-diabetes patients was used to identify, analyze, and synthesize the review findings narratively (Aamodt et al., 2019).[7]

Two experienced authors (R.O and P.N.) were independently engaged to review each title and abstract for inclusion, followed by complete full-text screening as suggested by (Abdelkader et al., 2021). any disagreement that arose was resolved by a joint review of the article with a third reviewer (S.A.) to moderate the indifference of opinion as supported by (Bai et al., 2007).

All 268 studies done in Africa that reported on fingerprint dermatoglyphic patterns among Adults with type II Diabetes Mellitus were included. No boundaries were placed on population, age, or language. Owing to paucity of research in this setting as argued by (Bakker et al., 2023), hence all study designs were made eligible for inclusion, except commentaries and editorials as recommended by (Atkinson et al., 2015) as illustrated in **Figure 1**.

2.3. Data extraction procedure

Systematic review to plan and synthesize studies on fingerprint Dermatoglyphics and type II Diabetes Mellitus in order to establish the relationship between Dermatoglyphic studies undertaken in Africa within the last five years (2019-2025). The review followed five-step methodology proposed by Arksey and O'Malley (2005) that included:(1) identify the research questions;(2) identify relevant information;(3) select the studies;(4) chart the data; and (5) collate, summarize, and report the results. The final step employed PAGER framework (Bennett & Hauser, 2013) and the review was reported in line with PRISMA-ScR checklist, as shown by Bai et al. (2007).

2.4. Inclusion criteria

1. Setting: Africa
2. Focus: studies addressing Dermatoglyphic and type II Diabetes Mellitus
3. Population: Adult patient Diagnosed with type II Diabetes Mellitus
4. Time frame: studies published between January 2019 to March 2025

2.5. Exclusion criteria

1. Publication design: articles, conference abstracts, opinion pieces, editorials, and gray literature
2. Focus: studies on Dermatoglyphic without type II Diabetes Mellitus
3. Population: studies focusing solely on Dermatogpraphics only or with other variable
4. Language: publications in other languages rather than English.

Based on these criteria, only articles of high quality and relevance to relationship between dermatoglyphics and type II diabetes mellitus were included.

3. Results

The review followed PRISMA guidelines to guarantee a transparent and systematic selection process. Initially, 268 records were obtained from database searches, and after eliminating n=94 (35%) of records as duplicates, n=174 (56.6%) of the records were unique and went through title and abstract screening by two independent reviewers as indicated earlier.

This screening phase lead to exclusion of (59/62) (95.16 %) of records due to inappropriateness, especially those not addressing Dermatoglyphic with other variables e.g. age sex and race. Ultimately, 5/268 (1.87%) of the study articles met all inclusion criteria and were included into the final analysis (**Figure 1**).

3.1. Fingerprint configuration

The five studies were found to have configured fingerprints based on Galton's classification which divided ridge patterns on distal phalanges of fingertips into three groups of arches, loops, and whorls as suggested (Gray, 2003). Arch (A) is simplest pattern consisting of more or less parallel ridges that traverse the pattern area and form a curve which is concave proximally. Loops (L) is the most common pattern where the ridges start from one side, run in parallel lines and then, curve backwards to terminate on the same side of their origin. It is further divided in to ulna or radial loop depending with which side they terminate. Whorls (W) are multiple circular or oval ridges, one around the other, or a single ridge runs spirally in multiple rounds.

4. Comparison of data collection Procedure for Screening Fingerprint Pattern

All five studies observed ethical consideration protocol. The participants were first briefed of the study, procedure, and need for the handprint. After obtaining an informed consent form, study participants were advised to wash their hands and air dry them or dry them with tissues. All five studies Reported, indicate that a similar procedure using Indian ink method was undertaken while collecting fingerprints.

4.1. Comparison of methodology used

There are some notable implanted strategies for human identification, and among them, one of the easiest approaches to distinguishing humans is through analysing the differences in fingerprints and fingerprints as noted by (Tadesse, Gebremickael, Merid, Wondmagegn, et al., 2022)

All five studies were eligible for the current review since they had a similar aim of developing a tool that can be used for early prediction of type II diabetes. They compared the variation on fingerprint patterns among patients diagnosed with type II Diabetics Mellitus as cases to non-diabetic individuals as controls, residing in Africa apart from the Nigerian study, which only focused on type II DM patients without controls.

These studies were conducted in various hospitals that are situated in different locations of Kenya, Uganda, Egypt, Southern Ethiopia and Nigeria emphasizing a broad geographical representation. In particular, in Western Kenya Kakamega County Teaching and Referral Hospital, four Government Hospitals in Gedeo Zone; Dilla University Referral Hospital, Bule Primary Hospital, Yirgachefe primary, Gedeb Primary Hospital from southern Ethiopia, Nigerian Irrua specialist Teaching Hospital and Kasr Al Ainy hospital, located in Cairo's metropolitan area, KIUTH, Western Uganda. This wide distribution of study sites across different healthcare settings and regions enriches the generalizability of findings and allows for a more indepth understanding of the research question within diverse contexts.

Regarding the research design, a cross-sectional study design was employed in studies conducted in Uganda, Nigeria, Western Kenya, and Southern Ethiopia which allowed researchers to assess variables of interest at a specific point in time, enabling identification of patterns and potential associations within each setting. In contrast, Egypt study utilized a descriptive design, focusing primarily on summarizing and outlining the characteristics of the population without exploring associations. Despite the variations, both designs are observational in nature sharing several methodological similarities which allows meaningful comparison across the studies ensuring that overall aim of the research was constantly addressed (Saraswati & others, 2023).

Regarding the study population characteristics and sample size, studies conducted in Uganda, Egypt, Western Kenya, and Southern Ethiopia used a population size of more than 100 participants for both cases and controls therefore enhancing reliability of their study findings since bigger sample sizes tend to reduce sampling error and rise the statistical power. However, the Nigerian study stands out as an exception with a limited sample size of only 50 diabetic patients with no control group hence limiting the validity of the study as noted by the researcher. Lack of controls makes it difficult to attribute the observed characteristics specifically to diabetes since there is no standard for comparison. The smaller sample size may not adequately represent the broader diabetic population hence increasing risk of bias and limiting the study's ability to detect meaningful associations or differences.

4.2. Comparison of inclusive Malti-variables assessed

Table 2 findings revealed that distribution of fingerprint patterns among type II DM patients drawn from the five selected countries was uneven which was similar to studies that were conducted in different regions of India by (Burute, 2013)[8] suggesting a possible regional, genetic or environmental influence. Ulnar loops are common in Western Kenya and Southern Ethiopia while Whorl patterns are more common in Egypt and Uganda, which is different with Western Kenya, where whorls are less common. Radial loops and arches show significant variations, with arches showing a high prevalence in Western Kenya. These differences could be due to genetic diversity among populations, sample size variations, or methodological discrepancies hence the need to consider population-specific norms when using fingerprint dermatoglyphics in medical or forensic applications.

Table 3 revealed that distribution of fingerprint patterns among type II DM patients across the gender both males and females had a significant variation in the distribution of fingerprints based on their respective country of origin. Females consistently show higher frequencies of ulnar loops than males across all regions suggesting a potential gender-linked pattern which contradicts the findings of (Pathan & Hashmi, 2013), who noted a rise in the frequency of ulnar loops among both males and females. Regarding the arches distribution, the study noted that a majority of females from western Kenya had higher frequencies of arches pattern as compared to their parts from the other four countries which possibly could be due to genetic or demographic factors. Whorl patterns seemed more evenly distributed aligning with a similar study conducted by (Bala et al., 2016) whereby it is reported that both male and females had higher frequency as compared the non-diabetic patients.

In this study we also, compared the finger print distribution among type II diabetics and non-diabetic patients. Findings in table 4 indicate that ulnar loops are consistently more dominant in non-diabetic individuals, especially in Southern Ethiopia, western Kenya and Uganda which may show an opposite association with diabetes and a potential protective trait. These findings are similar to a study conducted by (Bag, 2023),[12] and other similar studies that were conducted in Northan and southan India which had similar outcomes as noted by (Bala et al., 2016; Khan et al., 2013; Pathan & Hashmi, 2013; Saeed et al., 2021).[14-17] Radial loops show a slightly higher frequency in diabetics, especially in Egypt and Uganda suggesting a potentially weak positive association. Arches and whorls do not show consistent in patterns across the regions, indicating they may not be of predictive value for diabetes. A study by (Srivastava & Rajasekar, 2022)[3] also noted a significant difference. This shows that Regional and genetic differences influence fingerprint dermatoglyphic distributions, and its associations

with diabetes should be taken within local population contexts.

5. Conclusion

While no specific fingerprint pattern can be considered an ultimate marker for diabetes, ulnar and radial loops show uncertain trends worth further exploration. This analysis supports, that dermatoglyphics, when joined with genetic and clinical data, might aid as a non-invasive additional screening tool in some populations, thus reducing the morbidity and mortality.

Systematic review on fingerprint Dermatoglyphic studies related to diabetes has to be done in larger populations and in different ethnicities, geographical region to clearly pronounce the current features of dermatoglyphic findings of diabetes mellitus type II and finger print patterns.

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8. Conflict of Interest

None.

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