Fingerprint Dermatoglyphic Patterns among Adults with Type II Diabetes Mellitus in Western Kenya

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Abstract

BACKGROUND

Dermatoglyphics is the study of epidermal ridges and their configurations on the skin of the palms and soles of the foot. The patterns can be grouped into loops, whorls, and arches each of them having a unique characteristic that appears to be influenced by genetic factors. Diabetes Mellitus is a common metabolic disorder caused by reduced insulin secretion. Type 2 diabetes results from genetic disorders involving multiple genes that control insulin secretion and action. This study aimed 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.

MATERIALS AND METHODS

A comparative cross-sectional study design was used where 150 diabetic patients were compared with 150 non-diabetics as controls all selected from Kakamega County Teaching Referral Hospital, Western Kenya. Socio-demographic data and family history were recorded, thereafter fingerprints were taken using the Indian ink method. The chi-square test was used to check for a significant association between the pattern variations in diabetics and the control group.

RESULTS

The study involved 300 respondents where 33.33% were aged above 60 years with females being the majority at 60.67 % while among diabetics 68 % had a family history of diabetes. Whorl (p=0.0003) and ulna loops (p=0.002) patterns were decreased among male diabetics when compared to male non-diabetics while in female diabetics, whorl patterns were increased (p=0.02929) when compared to female non-diabetics. There was an association between whorl patterns and family history among diabetics (p=0.049). Ulna loops were significantly low (p=0.004) while whorls were significantly high (p=0.016) among diabetics when compared to non-diabetics.

CONCLUSIONS

This study showed that dermatoglyphic patterns could be used as a feature for early screening of type II diabetes.

Keywords: *Dermatoglyphics, Type II diabetes, Genetic*

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Introduction

Dermatoglyphics is a branch of Anatomy that studies epidermal ridges and their configurations on the skin of the palms and soles of the foot. The development of the epidermal ridge pattern is genetically determined and happens between the 10th to 16th week of intrauterine development. It is fully developed at birth and remains unaltered throughout life (1)

These patterns can be grouped into loops, whorls, and arches with each of them having a unique characteristic depending on the shape and relationship of the ridges. Loop patterns coil back on themselves making approximately 60% of pattern types and are divided into radial loops which point towards the thumb and ulnar loops which point towards the ulna bone. Whorl patterns form circular or spiral patterns making about 35% of pattern types and are divided into plain, central pocket loop, double loop and accidental loop. Arches pattern make a wave-like pattern making up about 5% of all pattern types and are divided into plain arches which are less sharp and tented arches which rise to a sharper point (2).

Fingerprints have been used in varied applications across disciplines like criminology, personal identification, comparative anatomy, embryology, genetics and medicine because their presentation is fixed throughout life and distinct in every individual (3).

Diabetes Mellitus is a common metabolic disorder caused by faulty insulin secretion by pancreatic β-cells and the incapability of insulin-sensitive tissues to respond properly to insulin leading to sustained hyperglycemia (4). Type II Diabetes mellitus results from several causes due to the relationship between genetic and environmental factors. It's a genetic disorder that is caused by the combined action of more than one gene involved in controlling insulin secretion and action, hence genetically influenced (5). Type II diabetes has a higher heredity chance than type 1 diabetes, accounting for 40–80 percent of overall disease susceptibility. Many patients have a family history of diabetes with a larger risk of type II diabetes in children conferred by a mother's history of diabetes than by a paternal history of diabetes probably due to the influence of maternal hyperglycemia in pregnancy. All of these factors are likely to play a role in the development of type II diabetes (6).

Management and diagnosis of diabetes are costly in low and middle-income countries. Moreover, being a chronic disease, complete eradication is not possible but with early diagnosis and access to proper management, a person may live a normal life.

Fingerprint patterns can be used to study genetic disorders like diabetes since they are genetically determined and cannot be influenced by advancement in age or other environmental changes (7). Since fingerprint patterns are genetically determined, they can be used to screen genetic predisposition to type II diabetes in future (8). Complications related to diabetes can arise before diagnosis, increasing costsfor individuals and healthcare systems (9). Adding a tool for early detection and management of diabetes by coming up with a simple,affordable, painless and straightforward screening tool for early detection of diabetes will ensure prevention and reduction of healthcare costs. The aim of this study was therefore to assess the variation in fingerprint patterns among patients with type II diabetics in comparison with those of non-diabetic individuals in Western Kenya.

Materials and Methods

This was a comparative cross-sectional study design where a total of 300 participants (150 diabetics as cases and 150 non-diabetics as controls) were selected from Kakamega County, Western Kenya. Diabetic patients were purposively selected from the diabetic clinic of Kakamega County Teaching and Referral Hospital while the control group was randomly selected from non-diabetic patients within the same hospital. Participants who met the inclusion criteria were informed of the procedure and gave consent. To acquire fingerprints, consenting subjects first washed their hands with Soap and water and then dried them with non-fiber/paper towels. Each digit was then rolled on an ink pad one by one so that the entire fingerprint pattern area was evenly covered with ink after which it was rolled on the data entry form (Figure 1). A magnifying glass was used to identify fingerprint patterns as either whorls, arches, ulna or radial loops (figure 2).

Descriptive statistics was used to analyze common types of fingerprint patterns and socio-demographic factors associated with different fingerprint patterns. The chi-square test was used to assess the association between the fingerprint patterns of diabetics from those of controls. A p-value of less than 0.05 ($p<0.05$) was considered significant in this study at 95% degree of confidence. Ethical clearance was acquired from Maseno University Scientific and Ethics Review Committee (MUSERC) under Reference number: MSU/DRP/MUSERC/01138/22 and the research permit was obtained from the National Commission for Science, Technology & Innovation (NACOSTI) under License No: NACOSTI/P/23/23810. Patients were ensured of their confidentiality and no names or patient records were linked with the collected fingerprints.

Results

Socio-demographic characteristics of respondents

In this study, of the total 300 respondents enrolled;150 were diabetic(cases) while 150 were non-diabetics(controls), out of which 33.33% (100) were aged 60 years and above while the lowest age set was 20-30 years at 6.0 % (9). 96.67% (290) of the total respondents were Christians while 3.33% (10) were Muslims.49.67 % (149) had a family history of diabetes while 50.33% (151) had no family history. In terms of sex, females were the majority at 60.67 % (182) as compared to males at 39.33% (118).

Figure 1:
Fingerprints being obtained using Indian ink staining method

Figure 2:
Different types of fingerprint patterns

Frequency distribution of the total digital dermatoglyphic patterns

Of the total 300 respondents each having 10 digits (3000 digits), the most common type of digital pattern was the ulna loops at 63.43% (1903), followed by whorls at 26.9% (807), then arches at 7.60% (228) and the lowest being radial loops at 2.07% (62) (Figure 3).

Comparison of the distribution of fingertip patterns among different sexes between diabetics and controls.

The male diabetics had a high number of arches (56.25%) compared to male non-diabetics (43.75%) while the whorls, ulna and radial loops had low numbers (49.56%,39.09% and 36.67% respectively) in male diabetics compared to non-diabetics. Among the females, all the patterns were present at a high percentage in female diabetics at Arches (57.43%), Whorls (53.86%), Radial loops (59.38%), and Ulna loops (54.09%) when compared to the female non-diabetics-. (Table 1)

There was a significant statistical difference where there was a decrease in whorl and ulna loop patterns among male diabetics at p=0.0003 and p=0.002 respectively when compared to male non-diabetics. Among the females, there was a statistically significant increase in whorl patterns at p=0.02929 when compared to female non-diabetics. (Table 2)

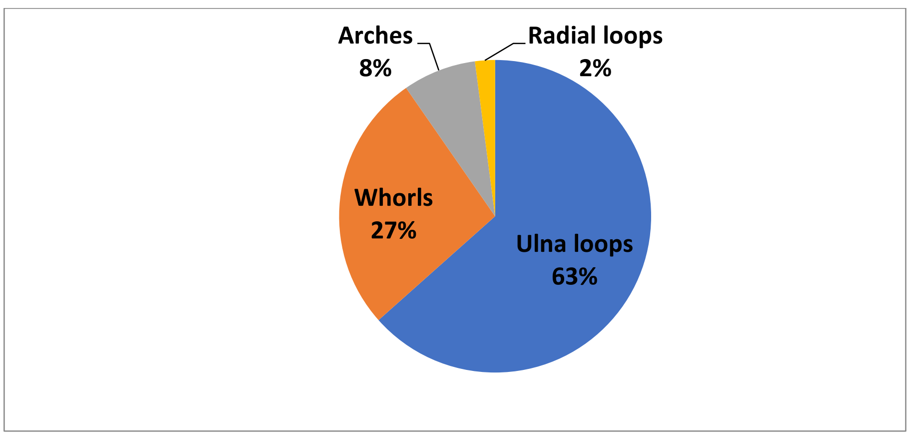

Figure 3:
Frequency of distribution of the total digital dermatoglyphic patterns

Table 1:
Frequency distribution of digital dermatoglyphic patterns among the different sexes in diabetic and non-diabetics.

	Male			Female		
	Diabetic	**Non-Diabetic**	**Total**	**Diabetic**	**Non-Diabetic**	**Total**
Arches	45 56.25%	35 43.75%	80	85 57.43%	63 42.57%	148
Whorls	169 49.56%	172 50.44%	341	251 53.86%	215 46.14%	466
Radial loops	11 36.67%	19 63.33%	30	19 59.38%	13 40.63%	32
Ulna loops	285 39.09%	444 60,91%	729	635 54.09%	539 45.91%	1174
Total	510	670	1180	990	830	1820

Association between diabetics and positive family history

Among the diabetics, there was a statistically significant association between the whorl patterns and positive family history at a p=0.049. Other patterns had no significant association with positive family history. (Table 3)

Variation between finger digital dermatoglyphic patterns among the diabetic and non-diabetic groups

The ulna loops were significantly lower among the diabetics (48.34%) than non-diabetics (51.66%) at a p=0.004 while the whorls were significantly higher among the diabetics (52.04%) than non-diabetics (47.96%) at a p=0.016. The radial loop and arches were not statistically significant. (Table 4)

Discussion

In the present study, of the total 300 respondents (3000 digits), ulna loops were the highest finger patterns, followed by whorls, arches and radial loops being the lowest (Figure 3). Several authors have also observed that the ulna loop fingerprint pattern was the most common in several population groups (10-13). However, one study by Swargiary and Das (14) on the fingerprints of 40 individuals aged 40-70 years from India contradicted the current findings and found that radial loops had the highest percentage of fingerprint patterns while whorls had the lowest.

Table 2:
Comparison of distribution of fingertip patterns between male and female diabetics and non-diabetics

Pattern	Male			Female		
	Chi	Df	P value	Chi	df	P Value
Arch	7	3	0.0718	5	3	0.17179
Whorl	16	3	0.0003	9	3	0.02929
Radial loop	3	3	0.223	6	3	0.11
Ulnar loop	12	3	0.002	4	3	0.26146

Table 3:
Association between diabetics and positive family history

	Mode	Mean	Variance	95% C Interval Lower Bound	95% C Interval Upper Bound	t	df	Sig.(2-tailed)
Arch	.14	.14	.033	.21	.50	.812	298	.417
Whorl	.36	.36	.029	.02	.69	1.973	298	.049
Radial loop	.06	.06	.032	.41	.29	.357	298	.721
Ulnar loop	.16	.16	.026	.16	.48	.941	298	.347

Table 4:
Variation between Individual finger digital dermatoglyphic patterns among the diabetic and non-diabetic groups.

Sr. No.	Parameters	Diabetics (n=1500)		Non-diabetics (n= 1500)		Value	df	'p' value	Significance
		Mean	SD	Mean	SD				
1.	Ulnar Loop	3.10	1.10	4.11	2.64	13.249	3	.004	Significant
2.	Radial Loop	2.11	0.27	1.31	0.44	58.56	3	.278	Not Significant
3.	Whorl	3.21	1.98	3.41	2.86	10.333	3	.016	Significant
4.	Arch	0.71	2.16	2.01	46.376		3	.77	Not Significant

This difference in observation may have been due to the small sample size of 40 participants as compared to the current and other studies which assessed more than 100 participants.

In the present study, there was a statistically significant variation of whorls in both males and females (p=0.0003 and p=0.02929 respectively) while ulna loops presented a statistically significant variation in only males (p=0.002) (Table 2). There was a statistically significant low number of whorls and ulna loop pattern among male diabetics which represent similar findings in studies done by Srivatsava and Burli (15), Kakkeri, and Attar (16) who also reported a lower incidence of loop patterns in male diabetics while Shekar (17) found a decrease in the frequency of whorls among male diabetics. Whorl patterns were significantly high among female diabetics (p=0.02929) as compared to non-diabetics. Sudharson, Karthikean (12), Shekar (17), Tarigoppula, Syamala (18), Bhat, Mukhdoomi (19), Srivastava and Rajasekar (20) also observed a statistically significant increase in incidences of whorls in female diabetics. However, Tarigoppula, and Syamala (18) in their study on evaluation of the role of dermatoglyphics, oral micronuclei and ABO blood grouping in determining Type 2 diabetes found the occurrence of loop type higher in diabetic males and reduced number of whorls in female diabetics. This difference could be due to the inclusion of other factors like oral micronuclei and ABO blood grouping, unlike the current and other studies that only focused on dermatoglyphic.

Unlike the current study, Tadesse, and Gebremickael (10) in their study done across Hospitals in Southern Ethiopia also found the occurrence of loop patterns higher in both sexes among diabetics. This may indicate that fingerprint patterns have inconsistent variations within different population groups and even within ethnic or racial cohorts.

The study tested for any significant association between fingerprint patterns and any close family member having a previous or current history of diabetes. Whorl patterns had a statistically significant association with family history (p=0.049) among the diabetics while the other patterns had no significant association (Table 3). Srivatsava and Burli (15) had similar findings in their study when they included a positive family history of diabetes in the selection of cases and no family history of diabetes among the controls; the team found a significantly higher frequency of whorls in both male and female diabetics and higher frequency of loops in male and female controls. The current study also noted that the whorls pattern was the most common variation between the diabetics and controls and therefore may be the most appropriate pattern for predicting the population predisposed to type II diabetes in both sexes.

Of the total 10 digits per study participant, ulna loops were significantly low (p=0.004) while whorls were significantly high (p= 0.016) in diabetics as compared to the non-diabetics (Table 4). Srivatsava and Burli (15), Kakkeri, Attar (16), Srivastava and Rajasekar (20), and Lekshmi, Srimathi (21) in their studies support the current findings where there was a high occurrence of whorls and low occurrence of ulnar loops in diabetics when compared to the control groups. However, other studies done in different ethnic and geographical locations found contrary results to the current study where Tadesse, Gebremickael (10), Tarigoppula, and Syamala (18) found that loop patterns were significantly higher while whorl patterns were significantly lower in diabetics when compared to the non-diabetic. These differences could be a result of a variation in geographic location or ethnicity. In addition, these previous studies used a small sample size of less than 50 participants. Bhat, Mukhdoomi (19) also reported an increase in arches and a decrease in whorls while Nayak, Shrivastava (22) showed that the average number of arches, loops and whorls in diabetics were not statistically significant as compared to non-diabetics.

The current study shows an association between type of fingerprint patterns and predisposition to type II diabetes where whorl patterns were significantly high in diabetics as compared to non-diabetics and also showed a significant association with positive family history to diabetes among the diabetic group. This shows that a person presenting with a whorl fingerprint pattern with a positive family history of diabetes may be predisposed to type II diabetes mellitus in future hence this can be used as a screening fingerprint pattern among the Western Kenya population.

Conclusion

In summary, the study revealed that ulna loop patterns were the most common fingerprint pattern among individuals with diabetes, followed by whorls; furthermore, it suggested that females with a high number of whorl patterns may be predisposed to type II diabetes mellitus, while males with a low number of ulna loop and whorl patterns may share this predisposition; finally, the findings indicated the potential use of fingerprint patterns, particularly whorls, in screening for type II diabetes, with individuals presenting a whorl pattern and a positive family history being more likely predisposed to type II diabetes mellitus.

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Availability of data statement: The authors confirm that important data on the findings of this study is available within the article and its supplementary material. Important raw data findings are available from the corresponding author upon request.

Conflict of interest statement: None to declare

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