

# **A Comparative Study of Plantar and Digital Dermatoglyphic Features of Kenyan and Tanzanian Subjects**

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## **ABSTRACT**

The present report deals with plantar and digital dermatoglyphics of indigenous Kenyan and Tanzanian subjects, aged 12–25 years selected from the cosmopolitan cities of Nairobi and Dar-es-Salaam, giving a good mix of social backgrounds, that allowed for the inclusion of quantitative plantar variables. The results showed that plantar whorls were found only in zones III and I in Tanzanian women as against zones I to V in all other subjects. The percentage frequencies of the plantar ridge patterns, however, varied within and between the two groups. The most predominant digital ridge pattern found in all subjects was arches, which were absent in the first digit in Tanzanian women. Loops had the highest frequency in the first digit in all subjects. They were absent, however, on the fifth digit in Tanzanian women and on the left fifth digit in Kenyan women. Whorls were restricted to the first digit in Kenyan women but absent in Tanzanian women and this was characteristic of women in both groups. However, whorls were only found on the right side of Tanzanian men. Similarly, whorls were absent on the fourth and fifth digits in Tanzanian subjects. The pattern intensity (PII) and Dankmeijer's (DI) indices were higher in women than men, but the PII for Tanzanians was higher than for Kenyans. These digital dermatoglyphic features can therefore differentiate the two population groups. The normal plantar and digital dermatoglyphic features of subjects of from both countries are compared for the first time in East Africans, and they indicate affinities and anthropological relationship between them. Dermatoglyphically, the East Africans sampled were closer to Malawians and Zimbabweans of Southern African than Nigerians of West Africa.

Keywords: East Africans, Plantar dermatoglyphics.

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## **INTRODUCTION**

The fine lines that corrugate the toes and soles of the feet are called epidermal ridges. Dermatoglyphics is the science of these ridges which form well-defined patterns that characterize individuals [1,2]. Dermatoglyphic studies are useful in any local population because of their strong genetic determination, life long stability, absence of environmental influence, and lack of differential selective advantage [3]. These studies have also provided useful information in understanding of the

evolution of human population on one hand and in differentiating tribes and populations on the other [4,5].

Ridge patterns of the sole are less well documented than palmar patterns because good records are more difficult to obtain from soles. Besides, the sole patterns themselves are larger and often complex with the main lines so tortuous. Moreover, triradii on the ridges of the sole are difficult to find and frequently they are not printed [6]. However, previous plantar

dermatoglyphic studies on Caucasians have highlighted their usefulness in population structure and relationships [7,9], whereas studies of Chinese, Canadians and Chorote Indians have provided further useful information on the anthropological characterization of these peoples [7]. In sub-Saharan African populations, plantar dermatoglyphic studies have also demonstrated anthropological characterization of population groups, but more importantly these studies highlighted the role of digital patterns in the characterization of people [10-12]. Despite their importance, scanty reports have been published on plantar dermatoglyphics for Kenyans and Tanzanians of East Africa.

Kenya has an area of 582,600 sq km and is bounded to the north by Sudan and Ethiopia, east by Somalia and the Indian Ocean, south by Tanzania and west by Uganda. It has three largest ethnic groups, namely the Kikuyu (21%), Luhya (14%) and Luo (13%) and linguistically it belongs to the Niger-Congo language group [13]. On the other hand, Uganda and Kenya bound Tanzania to the north, east by the Indian Ocean, south by Mozambique, Malawi and Zambia, and west by the Democratic Republic of Congo, Burundi and Rwanda. It has an area of 945,000 sq km, with its inhabitants originating from the Bantu-speaking groups of Africa. The national language is Kiswahili, which has Bantu words as the main component but also an admixture of words from Arabic, Chinese and Portuguese. Linguistically, it also belongs mainly to the Niger-Congo language group like Kenya [13].

This study was carried out to establish the normal dermatoglyphic features of the sampled individuals from Kenya and Tanzania. This seeks to ascertain whether or not Kenyans and Tanzanians show plantar and digital dermatoglyphic closeness in the light of their linguistic similarity.

## MATERIALS AND METHODS

The sample was made up of 304 Kenyans, 164 males and 140 females aged 12–14 years from Nairobi Primary School and 300 Tanzanians, 180 males and 120 females aged 19–25 years from students of Muhimbili University College of Health Sciences. The subjects were able-bodied Kenyan and Tanzanian volunteers whose parents and grandparents were Kenyans and Tanzanians, respectively. They were all selected from the cosmopolitan cities of Nairobi and Dar-Es-Salaam, giving a good mixture of social backgrounds, which allows for inclusion of quantitative plantar variable [14]. Furthermore the subjects were asked individually if there was any non-Kenyan or non-Tanzanian contribution to their ancestry for as far back as they knew, and anyone who gave a positive answer was excluded. In the case of related individuals in the sample, only the print of one of them was included in the study to avoid analysis bias during the estimation of precision (eg. standard error) for the population sample [15].

### Topographical zones of the sole

The sole was mapped into 10 topographical zones based on Cummins and Midlo nomenclature [16], where zones I–V represented the distal plantar sole and zones VI–X represented the proximal plantar sole. These zones were used to describe the characteristics reported in this study (Table 1, Fig. 1).

### Plantar and digital pattern types

Bilateral plantar and digital prints of the sole were obtained by the inking procedure described by Cummins and Midlo [16]. The plantar and digital patterns of arches, loops and whorls (Fig. 2) were classified and counted with the aid of a magnifying hand lens, using Loesch and Skrinjaric's method [17]. The frequencies of these ridge patterns were recorded, expressed

as percentages of the total pattern types and analysed, each pattern being treated separately. The Dankmeijer's (DI) and pattern intensity indices (PII) were used to determine the digital variability of patterns. The DI is the total frequency of whorls x 100 [18], while the PII is the mean number of triradii found per individual. Using these indices, the frequencies of ridge patterns were compared between Kenyan and Tanzanian subjects. Inter-observer variation in counting was eliminated as only one 'blinded' person who did not collect the prints examined all the prints. Chi-square tests were applied to discrete variables of arches, whorls and loops and t-tests for quantitative variables of PII and DI.

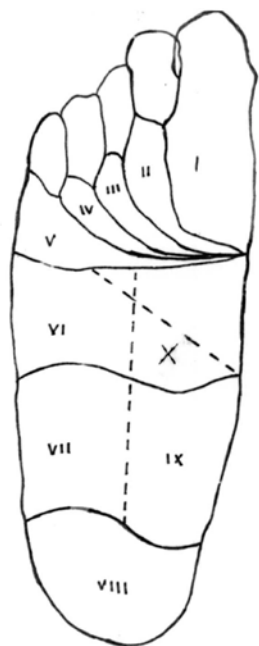


Fig. 1: Schematic topographical representation of the various zones of the sole of the foot.

## RESULTS

### Plantar pattern types

There were more loops than arches and more arches than whorls. The loops and arches were commoner on distal than proximal parts of soles. The frequency of loops was statistically greater in males than females and on the left than right sole ( $P < 0.05$ ).

Whorls were present in zones I to V in all Kenyan subjects but in Tanzanians, they were

only present in zone III in the men and zone I in the women. Differences occurred in percentage frequencies between Kenyan and Tanzanian subjects but the highest frequency of whorls was in zone I for all the subjects studied (Table 2).

### Digital pattern types

Arches were the most predominant patterns found on the digits in all subjects. The percentage frequency of arches increased from the first to the fourth digit in all the subjects but they were absent in Tanzanian women in the first digit (Table 3). Loops were, however, most predominant in the first digit of the sampled subjects. The percentage frequency of loops on the first digit was higher in Tanzanians than Kenyans. Loops were absent on the fifth digit bilaterally in Tanzanian women, but only on the left fifth digit in Kenyan women (Table 3). In the first digit, whorls were present in Kenyan women and on the right side of Tanzanian men, but were absent in Tanzanian women and also on the fourth and fifth digits in Tanzanians (Table 3).

Table 4 compares the PII and DI in male and female Kenyan and Tanzanian subjects. Although both indices were higher in women than men, PII were higher among Tanzanians than Kenyans. These differences were, however, not statistically significant ( $P > 0.05$ ).



Fig. 2: Foot print illustrating arches, loops, whorls and triradii.

## DISCUSSION

In common with other sub-Saharan population, the plantar ridge patterns exhibited by subjects in this study were consistent with those previously reported, an indication that plantar patterns may not differentiate population groups. The present study employed both qualitative traits (finger print pattern frequencies) and quantitative methods (DI and PII) and the results obtained are therefore comparable with previous work in African populations [19].

The plantar patterns shown in this study, demonstrated some similarities between Kenyan and Tanzanian subjects as indeed with Malawians [12], Zimbabweans [20] and Nigerians [10,11]. In this notwithstanding, there appears to be some plantar patterns peculiar to

Kenyan and Tanzanian subjects. For instance, whereas whorls were absent in zones II, IV and V in Tanzanian women, this was not the case in Kenyan women. Digital whorls were absent in digits 4 and 5 in Tanzanian subjects as against the absence in digit 5 only in Kenyan subjects. Among Kenyans whorls were absent in all digits except the first in women as against only the fifth digit in Kenyan men. Although the prominence of digital arches and loops in the present study were also observed in Malawian and Zimbabwean subjects [12,20], the digital features exhibited in the present study showed that digital whorls, arches and loops differed sufficiently to differentiate population groups in our sample. They also showed greater affinity between Kenyans and Tanzanians than Malawians and Zimbabweans.

**Table 1: Classification of zones of the sole of foot using Cummins and Midlo's (1961) nomenclature.**

Topographical nomenclature zones		Topographical nomenclature zones	
I	Hallucal	VI	Hypothenar distal
II	Second interdigital	VII	Hypothenar proximal
III	Third interdigital	VIII	Calcar (heel)
IV	Fourth interdigital	IX	Thenar proximal
V	Hypothenar distal	X	Thenar distal

**Table 2: The mean frequency of whorls on the distal part of the sole (zones I-V) expressed as a percentage.**

Sex	Limb	Topographical zones-Kenyan subjects						Topographical zones-Tanzanian subjects					
		n	I	II	III	IV	V	n	I	II	III	IV	V
Male	Left	164	56.10	1.22	4.88	6.10	2.44	180	80.00	11.11	13.33	4.44	4.44
	Right	164	59.76	3.66	4.88	7.32	2.44	180	80.00	8.89	13.33	8.89	2.22
Female	Left	140	64.29	1.43	10.00	7.14	4.29	120	83.33	0.00	8.33	0.00	0.00
	Right	140	68.57	2.86	2.86	11.43	4.29	120	83.33	0.00	0.00	0.00	0.00
Male and female	Left	304	59.87	1.32	7.24	3.29	3.29	300	80.70	8.77	12.28	3.51	3.51
	Right	304	63.82	3.29	3.95	9.21	3.29	300	82.46	7.02	10.53	7.02	1.75
<b>Total</b>		608	61.84	2.31	5.59	6.25	3.29	600	81.58	7.90	11.41	5.27	2.63

However, if these features were compared with those of Nigerians [10, 11], it could be seen that the East African subjects had greater dermatoglyphic affinity and were thus closer to Malawians and Zimbabweans than Nigerians.

The present study has also demonstrated the lack of sexual dimorphism in PII and DI, as was the case with Malawians and Zimbabweans; but both PII and DI were higher in men than women in Kenyan and Tanzanian subjects (Table 3). Previous studies in Malawians and Zimbabweans showed that PII was higher in men than women, whereas DI was higher in women than men [12, 20]. The DI values for

Kenyans and Tanzanians, however, were the lowest so far recorded for sub-Saharan Africans. Despite the foregoing, we found that the PII indices for Kenyans were similar to those of Malawians [12], while those of Tanzanians were midway between Kenyans, Malawians [12] and Zimbabweans [20] on the lower side and those of Nigerians [10, 11], Zimbabweans [20] and Caucasians [7,9] on the higher side.

The present study has demonstrated the normal plantar and digital dermatoglyphic features of Kenyan and Tanzanian subjects indicating affinities and anthropological relationship between them.

**Table 3: The digital frequency of whorls, loops and arches on toes expressed as percentage.**

Sex	Limb	Digital pattern types—Kenyans						Digital pattern type—Tanzanians					
		n	1	2	3	4	5	n	1	2	3	4	5
a. Whorls													
Male	Left	164	3.66	2.44	2.44	1.22	0.00	180	6.67	2.22	2.22	0.00	0.00
	Right	164	2.44	1.22	1.22	0.00	0.00		0.00	2.22	2.22	0.00	0.00
Female	Left	140	4.29	0.00	0.00	0.00	0.00	120	0.00	8.33	8.33	0.00	0.00
	Right	140	1.43	0.00	0.00	0.00	0.00		0.00	8.33	0.00	0.00	0.00
b. Loops													
Male	Left	164	53.66	14.63	10.98	7.32	2.44	180	91.11	26.67	6.67	6.67	6.67
	Right	164	48.78	19.51	13.42	8.54	2.44		97.78	26.67	11.11	6.67	6.67
Female	Left	140	58.57	14.29	10.71	75.71	0.00	120	100.00	25.00	8.33	16.67	0.00
	Right	140	45.71	21.43	21.43	10.00	1.43		100.00	25.00	25.00	16.67	0.00
c. Arches													
Male	Left	164	20.00	36.36	47.27	45.45	52.73	180	2.22	68.89	88.89	91.11	84.44
	Right	164	12.73	34.55	41.82	47.27	45.45		2.22	62.22	86.67	91.11	84.44
Female	Left	140	14.00	54.00	62.00	62.00	52.00	120	0.00	58.33	75.00	83.33	91.67
	Right	140	14.00	38.00	48.00	60.00	50.00		0.00	66.67	75.00	83.33	91.67

**Table 4: Comparison of digital patterns between Kenyans and Tanzanians using the pattern intensity and Dankmeijer's indices.**

Variables	Kenyans		Tanzanians	
	Male	Female	Male	Female
PII	6.47	6.50	8.44	8.72
DI	3.00	3.62	2.39	3.34

Note: PII and DI were calculated from pattern type frequencies; hence, standard deviations were not obtained.

However, their digital dermatoglyphic features can better differentiate both groups.

Although East Africans were different from Malawians and Zimbabweans of southern African, their dermatoglyphic features were closer to Malawians and Zimbabweans than Nigerians. These findings seem to correspond with the linguistic disparity between West and East Africa, confirming that dermatoglyphic features express affinities and differences between sub-Saharan African peoples.

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#### REFERENCES

1. Roberts DF, Coope E (1975). Components of variation in a multifactorial character: a dermatoglyphic analysis. *Human Biology*. 47: 169-188.
2. Meier RJ (1980). Anthropological dermatoglyphics: A review *Yearbook Physical Anthropology*. 23: 147- 178.
3. Hauser G (1986). Significance of dermatoglyphics in studies of population genetic variation in man. In: Genetic variation and its maintenance. Roberts DF de Stefano (Ed) pp. 237 – 243. Cambridge: Cambridge University Press.
4. Crawford MH, Duggirala R (1992). Digital dermatoglyphic patterns of Eskimo and Amerindian populations: Relationships between geographic, dermatoglyphic, genetic and linguistic distances. *Human Biology*. 64: 683 -704.
5. Kandil M, Luna F, Chafik A, Zaoni D, Moral P (1998). Digital dermatoglyphic patterns of Moroccan Arabs: relationships with Mediterranean population. *Annals of Human Biology*. 25: 319-329.
6. Penrose LS, Loesch D (1969). Dermatoglyphic sole patterns: a new attempt at classification. *Human Biology*. 41: 427 – 448.
7. Wilder HH (1925). Racial differences in palm and sole configuration. *American Journal of Physical Anthropology*. 6:244-248.
8. Wichman D (1980). Genetic inheritance patterns on the sole. *Journal of Morphology and Anthropology*. 47: 331 – 335.
9. Lenza SU, Galactionou OK (1982). Dermatoglyphics in the forest Nentsy, Nganasans and Chukchi: dermatoglyphic distances. *American Journal of Physical Anthropology*. 57: 245 – 252.
10. Igbigbi PS, Didia BC, Emenike UJC (1996). Plantar dermatoglyphic in the Ibos of Nigeria *West African Journal of Anatomy*. 4: 43 – 49.
11. Igbigbi PS, Didia BC (1999). Plantar dermatoglyphic features of the Urhobos of southern Nigeria. *East African Medical Journal*. 76: 672 – 675.
12. Igbigbi PS, Msamati BC (1999). Plantar and Digital dermatoglyphics in Malawi. *Central African Journal of Medicine*. 45: 264–268.
13. Upshall M. (Ed) Kenya, Tanzania (1992). In: Hutchinson encyclopaedia Ed. 10. pp. 579–

- 580; 1012–1013. Oxford: Helicon Publishing.
14. Reed J (1981). Review: Dermatoglyphic in Medicine – problems and use in suspected chromosome abnormalities. *American Journal of Human Genetics*. 8: 411 – 429.
  15. Cotterman CW (1954). Estimation of gene frequencies in non-experimental populations. In: Kempthorne, Bankfort, Gowen and Lush *Statistics and Mathematics in Biology* (Jowa College Press, Ames).
  16. Cummins H, Midlo C (1961). Fingerprints, palms and soles. An introduction to dermatoglyphics Ed 2, 178 – 185. New York: Dover Publications Inc.
  17. Loesch D, Skrinjaric I (1979). Classification of dermal patterns on the proximal sole. *Annals of Human Biology*. 7: 529 – 553.
  18. Dankmeijer J (1934). Some anthropological data on finger prints. *American Journal of Physical Anthropology*. 23: 377 – 380.
  19. Blecher SR (1972). Dermatoglyphics of the Pandanatenga Bush-Bantu Hybrids. *Human Heredity*; 22: 149 – 172.
  20. Igbigbi PS, Msamati BC (2001). Plantar and digital dermatoglyphic characteristics of Zimbabwean subjects. *East African Medical Journal*. 78: 536 – 539.