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ABSTRACT

Objective: **To establish the dermatoglyphic characteristics of indigenous Zimbabwean subjects.**
Design: **Cross-sectional study of randomly selected subjects.**
Setting: **Mufakose, a high-density township in cosmopolitan Harare and Gweru, a midland city in Zimbabwe.**
Main outcome: **Dankmeijer (DI) and pattern intensity (PII) indices and the variability of ridge patterns.**
Materials and methods: **Bilateral plantar and digital prints of the sole of selected subjects were recorded, studied and classified.**
Results: **Plantar pattern types, showed more loops than arches and more arches than whorls. The loops and arches were commoner on the distal than proximal zones of the sole; features also shown in Malawians. Whorls were absent in zone II and this appears to be peculiar to Zimbabweans. Digital pattern types showed the predominance of arches as was the case with Malawians but loops were the most prominent in the first digit and next in overall prominence to arches. The mean PII was higher in males than females while DI was higher in females than males, which were also the case with Malawian subjects previously studied. However, for both sexes the PII was significantly higher in Zimbabweans than Malawians while DI was significantly lower in Zimbabweans than Malawians (p<0.001).**
Conclusion: **This study has elucidated the normal dermatoglyphic characteristics of Zimbabweans, showing features that indicate affinities with Malawians. The digital features, however, could differentiate Zimbabweans better from Malawians, further emphasising the uniqueness of digital ridge patterns in differentiating population groups.**

INTRODUCTION

Human soles are covered with parallel ridges whose variations of pattern are of medical and genetic interest(1). Dermatoglyphics is the study of these ridges, which are also found on the toes as well as palms and fingers of the hand. Along with other morphological, molecular, and biochemical markers, dermatoglyphics has traditionally been used in biological anthropology to explore affinities and differences among population groups(2). Dermatoglyphics are polygenic traits, which are possibly under environmental influences restricted to the first few months of the embryonic life(3,4). Population studies have demonstrated the usefulness of the information provided by these traits in understanding the evolution and genetic structure of sub-divided human populations(5-7).

The plantar dermatoglyphics of Chinese, Japanese, Canadians and Chorote Indians have provided evidence for the anthropological characterisation of these groups(8). In 1925, Wilder(8) elucidated a striking difference between digital patterns of Japanese and Chinese on the one hand and those of other races. Plantar dermatoglyphic studies in sub-Saharan Africa, though few, have highlighted the role of digital patterns in the characterisation of ethnic groups(9,10). More recently, a plantar dermatoglyphic study of Malawians further highlighted that digital patterns are more specific in differentiating tribes and population groups(11). Despite these studies, there appears to be no published reports for Zimbabweans who together with Malawians, were in the Federation of Rhodesia and Nyasaland until 1963.

Zimbabwe, like Malawi, is landlocked and is bounded by Zambia in the north, Mozambique in the east, South Africa and Botswana in the south and west, respectively. Historically, there was a Bantu-speaking civilisation in the area of present day Zimbabwe before AD 300. In 1200, the Shona people who moved in from the north and created stone buildings occupied Mashonaland (now Eastern Zimbabwe). The name Zimbabwe meaning "stone house" in Bantu was thus derived from the Shona people. The Ndebele, another Bantu people, who were retreating from the Boers in the south, settled in present day western Zimbabwe. Both eastern and western Zimbabwe became Rhodesia in 1895. This area became Southern Rhodesia and 'self governing' in 1923 and was a member of the defunct Federation of Rhodesia and Nyasaland in 1953(12).

Nyasaland, the present day Malawi is a country traversed by the Great Rift Valley and Lake Malawi is situated in the trough formed by the valley. The early inhabitants were said to be the Boskopoid people who were the ancestors of the pygmies in central Africa. The Bantus were also said to have migrated into the area following the "great migrations", an important historical feature of Eastern and Southern Africa(13).

In the light of these historical and archaeological relationships, we carried out this study on Zimbabweans to establish their dermatoglyphic characteristics and compare them with those of Malawians we studied previously, in order to explore affinities and differences, if any, between them.

MATERIALS AND METHODS

The sample consisted of 315 Zimbabweans, 150 males and 165 females aged 11 - 47 years from Mufakose high-density township in the cosmopolitan city of Harare and in Zimbabwe's midlands city of Gweru. This gave a good mixture of social backgrounds to allow for the inclusion of quantitative plantar variables(14). The subjects were physically healthy and of Zimbabwean parent and grandparent heritage. Furthermore, the subjects were asked individually if there was any non-Zimbabwean contribution to their ancestry for as far back as they knew, and anyone who gave a positive answer was excluded.

Topographical zones of the sole: The sole was mapped topographically into ten zones based on Cummins and Midlo(15) nomenclature, where zones I to V represented the distal plantar sole and zones VI to X represented the proximal plantar sole. These zones were used to describe the characteristics reported in this study (Table 1 and Figure 1).

Table 1

Classification of zones of the sole of foot using Cummins and Midlo's nomenclature(15)

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

Plantar and digital pattern types: Bilateral plantar and digital prints of the sole were obtained by the inking procedure of Cummins and Midlo(15). The various plantar and digital patterns of arches, loops and whorls (Figure 2) were classified and counted with the aid of a hand lens, using Loesch and Skrinjaric's method(16). The frequencies of the ridge patterns of loops, arches and whorls were recorded, expressed as percentages of the total pattern types and analysed. Their respective ridge patterns were treated separately.

Figure 1

Schematic topographical representation of various zones of the sole of the foot

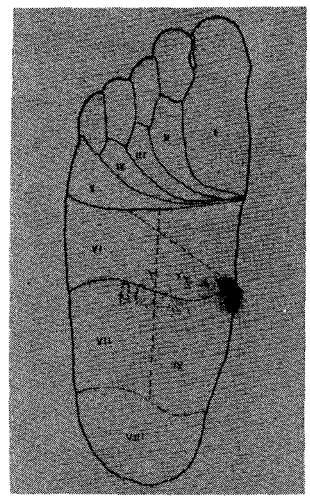
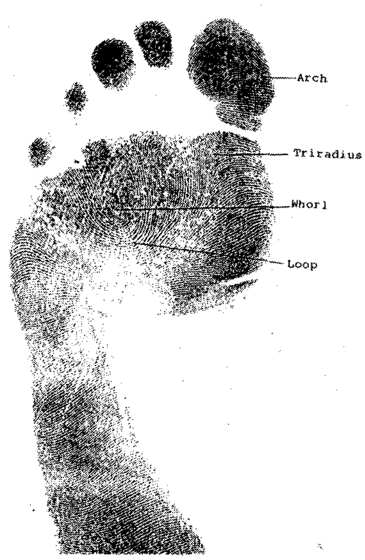


Figure 2

Foot print illustrating arches, loops, whorls and triradii



The digital variability of pattern was determined by the Dankmeijer's (DI) and pattern intensity indices (PII). The DI is the total frequency of arches divided by the total frequency of whorls x100 (17), while the PII is the mean number of triradii found on toes per individual. Using these indices, the frequencies of ridge patterns were compared with similar findings in Malawians (Table 4). The results are shown in Tables 2, 3 and 4.

Inter-observer variation in counting was eliminated as only one person examined all the prints. Chi-square tests were applied to discrete variables (arches, whorls and loops) and t-tests for quantitative variables (PII and DI).

RESULTS

Plantar pattern types: There were more loops than arches and more arches than whorls; the loops and arches

Table 2

The mean frequency of whorls on the distal part of the sole (zones I - VI) expressed as a percentage

Sex	Limb	N	Topographical zones					
			I	II	III	IV	V	VI
Male	Left	150	60.00	0.00	10.00	0.00	0.00	0.00
	Right	150	40.00	0.00	10.00	0.00	0.00	0.00
Female	Left	165	54.55	0.00	9.09	18.18	0.00	0.00
	Right	165	54.55	0.00	0.00	9.09	0.00	0.00
Male and	Left	315	57.14	0.00	9.52	9.52	0.00	0.00
Female	Right	315	47 62	0.00	4.76	4.76	0.00	0.00
Total		630	52.38	0.00	7.14	7.14	0.00	0.00

Table 3

The frequency of whorls, loops and arches on toes expressed as a percentage

Sex	Limb	N	Digits				
			1	2	3	4	5
(a) Whorls:							
Male	Left	150	10.00	0.00	0.00	0.00	0.00
	Right	150	0.00	0.00	0.00	0.00	0.00
Female	Left	165	9.09	0.00	0.00	0.00	0.00
	Right	165	9.09	0.00	0.00	0.00	0.00
(b) Loops:							
Male	Left	150	80.00	20.00	30.00	0.00	0.00
	Right	150	90.00	10.00	30.00	0.00	0.00
Female	Left	165	63 64	27.27	18.18	9.09	9.09
	Right	165	63.64	9.09	9.09	18.18	9.09
(c) Arches							
Male	Left	150	20.00	80.00	70.00	90.00	90.00
	Right	150	10.00	90.00	70.00	90.00	90.00
Female	Left	165	18.18	90.91	90.91	100.00	100.00
	Right	165	18.18	100.00	100.00	90.91	100.00

Table 4

Comparison of digital patterns between Zimbabweans and Malawians

Variable	Malawians+		Zimbabweans++	
	Male	Female	Male	Female
PII	765	6.66	11.67	11.56
DI	9.76	10.13	6.08	6.13

Sources: Igbigbi and Msamati 1999 +; Present study 2000 ++.
Note: All studies used the same methods.

were commoner on the distal than proximal zones of the sole. Whorls were only present in zones I, III and IV of the distal sole. In both sexes, whorls were more frequently found in zone I than zones III and IV, both of which had equal frequency of distribution (Table 2). The frequency of loops was statistically greater in males than females and on the left sole than right sole (p<0 05). The most characteristic finding, however, was the absence of whorls in zone II in all the subjects studied (Table 2).

Digital pattern types: Arches were the most prominent patterns found on the digits (Table 3c). However, loops were the most prominent in the first digit and next in overall prominence to arches (Table 3b). Loops were absent in digits 4 and 5 in men. Whorls were very few and restricted to the first digit alone (Table 3c).

In Table 4, the mean PII was higher in males than females while DI was higher in females than males. However, for both sexes the PII was significantly higher in Zimbabweans than Malawians while DI was significantly lower in Zimbabweans than Malawians ($p<0.001$).

DISCUSSION

Most of the plantar ridge patterns exhibited in this study were consistent with what has been shown in other races and ethnic groups, an indication that these patterns may not differentiate races. This notwithstanding, there appears to be some plantar ridge patterns that may be peculiar to Zimbabweans. The absence of whorls in zone

II in all sampled subjects seems to be characteristic of Zimbabweans, although it must be pointed out that the frequency of whorls in zone II among Malawians was 3.5%(11). In the Urhobos of Nigeria, whorls were present in zones I-V and whorls in zone II was 15.9%(10). The absence of whorls in zone II could thus serve as a distinguishing feature between Zimbabweans, Malawians and Nigerians. This finding accords the observation that Negroes exhibit low frequency of whorls(8).

The prominence of digital arches and loops in the sample was consistent with observation in Malawians(11), an indication of their dermatoglyphic affinity. However, the prominence of loops in the first digit and their absence in digits 4 and 5 in Zimbabwean men are the opposite of what was found in Malawians where loops were absent in the small toe only(11). These features were not shown in Nigerian studies either(9,10).

The present study has also demonstrated that PII and DI did not differentiate dermatoglyphic ridge patterns by sex, as indeed was the case with Malawians. These parameters, however, differentiated Zimbabweans from Malawians in other respects. PII was higher in men than in women, a feature shown by Malawians(11) and Caucasians(8,18,19) and the reverse was the case with Nigerians(9,10). Despite the foregoing, Caucasians, Nigerians and Zimbabweans tended to have higher PII values than Malawians do. The DI values were nevertheless higher in females than males and this was consistent with most literature. In 1945, Holt(19) observed this when he showed that almost without exception women had higher frequency of arches and fewer whorls, thereby making the DI value to be higher in females.

Our study has exhibited normal plantar and digital ridge patterns of Zimbabweans that indicate affinities with Malawians. These features were characterised better in digital than plantar ridge patterns, further proof that digital patterns are better indices for differentiation of population groups as shown by previous studies(9,10,11). The affinities demonstrated in this study further indicate the close historical and anthropological relationship between Zimbabweans and Malawians, a point that becomes clearer if both groups are compared dermatoglyphically with Nigerians(9,10). In this study their digital pattern types could differentiate Zimbabweans better from Malawians, further emphasising the uniqueness of digital ridge patterns in differentiating population groups. When both plantar and digital features are considered, Zimbabweans are closer to Malawians than Nigerians are, hence dermatoglyphic traits could be used to explore affinities and differences between population groups.

REFERENCES

1. Penrose, L.S. On the geometry of loops and deltas. *Ann. Hum. Gen.* 1965; **29**:207 - 211.
2. Kandil, M., Luna F., Chafik A., Zaoni D. and Moral, P. Digital dermatoglyphic patterns of Moroccan Arabs: relationships with Mediterranean population. *Ann. Hum. Biol.* 1998; **25**:319-329.
3. Holt, S.B. Genetics of dermal ridges. *Amer. J. Phy. Anthrop.* 1945; 211-241.
4. Loesch, D. D. Topological classification and genetical studies of dermatoglyphic patterns. *J. Hum. Evol.* 1978; **7**:669-677.
5. Crawford, M. H. and Duggirala, R. Digital dermatoglyphic patterns of Eskimo and Amerindian populations: relationships between geographic, dermatoglyphic, genetic and linguistic distances. *Hum. Biol.* 1992; **64**:683 - 704.
6. Lin, P. M., Enciso, V. B. and Crawford, M.H. Dermatoglyphic inter and intra-population variation among indigenous New Guinea groups. *J. Hum. Evol.* 1983; **12**:103 -123.
7. Blangero, J. Population structure analysis using polygenic traits: Estimation of migration matrices. *Hum. Biol.* 1990; **62**:27-48.
8. Wilder, H.H. Racial differences in palm and sole configuration. *Amer. J. Phys. Anthrop.* 1925; **6**:244 - 248.
9. Igbigbi, P.S., Didia, B.C., and Emenike U.J.C. Plantar dermatoglyphic in the Ibos of Nigeria. *W. Afr. J. Anat.* 1996; **4**:43-49.
10. Igbigbi, P.S. and Didia, B.C. Plantar dermatoglyphic features of the Urhobos of Southern Nigeria. *East Afr. Med. J.* 1999; **76**: 672 - 675.
11. Igbigbi, P.S. and Msamati, B.C. Plantar and digital dermatoglyphics in Malawi. *Cent. Afr. Med. J.* 1999; **45**: 264 - 268.
12. Upshall, M. (Ed). Zimbabwe. In: Hutchinson encyclopaedia; edn. 10, Oxford. Helicon Publishing. 1992; p1144.
13. Else, D. Malawi In: Malawi, Mozambique and Zambia 1st Ed. 1992. Australia lonely plane: publications 1997: 9 - 29.
14. Reed, T. Review: Dermatoglyphic in Medicine - Problems and use in suspected chromosome abnormalities. *Amer. J. Hum. Gen.* 1981; **8**:411-429.
15. Cummins, H. and Midlo, C. Fingerprints, palms and soles. An introduction to dermatoglyphics. Edn 2, New York: Dover Publications Inc. 1961: 178 - 185.
16. Loesch, D. and Skrinjaric, I. Classification of dermal patterns on the proximal sole. *Ann. Hum. Biol.* 1979; **7**:529 - 553
17. Dankmeijer, J. Some anthropological data on finger prints. *Amer. J. Phys. Anthrop.* 1934; **23**:377-380.
18. Schwartz, H. and Rogers, C. Analysis of foot pattern. *J. Med. Gen.* 1928; **10**:15 - 23.