

# Palmar and digital dermatoglyphic traits of Kenyan and Tanzanian subjects

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## Summary

Dermatoglyphic traits, along with other morphological, molecular and biochemical markers have traditionally been used in biological anthropology to explore affinities and differences among human groups.

**Methodology:** We carried out a cross-sectional study of healthy able-bodied volunteers of indigenous Kenyan and Tanzanian subjects to establish their palmar and digital dermatoglyphic traits, by counting and classifying their ridge pattern configurations of arches, loops, whorls and ridges based on standard techniques.

**Results:** Ulnar loops were the most prevalent digital ridge patterns and arches were the least in our samples with significant sex differences exhibited in arches, ulnar loops and whorls ( $P < 0.05$ ). Similarly, men had significantly higher TFRC than women in Kenyans ( $P < 0.001$ ), while Tanzanians showed no sex difference ( $P < 0.5$ ). Women, however, had higher PII than men in Kenyans but the reverse was true in Tanzanians. In both groups, men showed significantly higher mean a-b ridge counts than women ( $P < 0.001$ , Kenyans;  $< 0.01$ , Tanzanians), and women showed greater mean atd angles than men ( $P > 0.5$ ). The TFRC, atd angle and a-b ridge count were significantly different between Kenyans and Tanzanians ( $P < 0.001$ ).

**Conclusion:** This study documents probably for the first time the normal and comparative dermatoglyphic traits of two East African populations, indicating that Tanzanians are dermatoglyphically closer to Malawians than Kenyans.

**Keywords:** Palmar dermatoglyphics, East Africans

## Résumé

Les traits dermatoglyphiques, avec d'autres marqueurs morphologiques, biochimiques et moléculaires ont été utilisés traditionnellement dans l'anthropologie biologique afin d'étudier les affinités et les écarts parmi les groupes humains.

**Méthodologie:** Nous avons effectué une étude coupe transversale des sujets volontaires forts et en bonne santé d'origine de Kenya et la Tanzanie afin d'établir leurs traits dermatoglyphiques digitaux et palmar, dénombrement et la classification de leur tendance de configuration de la crête de voûtes, boucles, verticille et voûtes fondés sur les techniques standards.

**Résultats:** Boucles cubitus étaient les tendances crêtes digitales les plus fréquentes et les voûtes étaient les moindres dans nos échantillons avec un écart sexe important montré dans les voûtes, boucles cubitus et verticillé ( $P < 0,05$ ), pareillement, les hommes avaient le TFRC remarquablement plus élevé plus que les femmes chez des Kenyans ( $P < 0,001$ ), tandis que les Tanzanians n'ont pas montré aucun écart en ce qui est du sexe ( $P < 0,05$ ). Toutefois, des femmes avaient PII plus élevée que des hommes chez des Kenyans mais c'est

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le contraire chez les Tanzanians. Chez les deux groupes, des hommes avaient montré compte a - b crête moyenne remarquablement plus élevée plus que chez des femmes ( $P < 0,001$ , Kenyans;  $< 0,01$ , Tanzanians), et des femmes avaient montré angles atd moyen plus que chez des hommes ( $P > 0,5$ ). Le TFRC, angle atd et compte a - b crête étaient remarquablement différents entre Kenyans et Tanzanians ( $P < 0,001$ ).

**Conclusion:** Il est probable que pour le premier fois, cette étude montre en détail les traits dermatoglyphiques moyens et comparés des deux populations de l'Afrique orientale, indiquant que des Tanzanians sont dermatoglyphiquement plus proche des Malawians plus que des Kenyans.

## Introduction

Analysis of fingerprints from the point of view of personal identification is well known. In principle it focuses on the ridges formed by the raised apertures of sweat glands that have unique detailed formations, are much less fortuitous in origin and have anatomical regularities<sup>1</sup>. The science of these ridges is known as dermatoglyphics. Dermatoglyphic traits, along with other morphological, molecular and biochemical markers have traditionally been used in biological anthropology to explore affinities and differences among human groups. In contrast to monogenic polymorphisms, dermatoglyphics are polygenic traits under possible environmental influences that are restricted to the first months of embryonic life<sup>2</sup>. There are also normal variations in these traits, which represent hereditary differences between members of separate populations and members of the same population or family<sup>1</sup>. Thus, dermatoglyphic traits are most useful in studying population dynamics<sup>3</sup>.

Studies on Caucasians<sup>4-6</sup> have demonstrated that dermatoglyphic traits could be used in tracing the history and relationships of population. In this connection, Wilder<sup>7</sup> showed that racial differences existed in the palm and finger configuration of Germans, European-Americans, Chinese and Japanese. The distribution of finger print characteristics in Whites and Negroes living in Brazil have also been documented and the most marked difference observed between Whites and the total Negroid group was in the prevalence of radial loops<sup>8</sup>. These results are further testimony of the usefulness of dermatoglyphic traits in population study.

Several studies in sub-Saharan African populations have further demonstrated the existence of dermatoglyphic differences between various ethnic and population groups<sup>9-16</sup>. Yet despite their usefulness, there are only two published reports on East Africans - one for the Hehe Bantu-speaking tribe of southern highlands of Tanzania<sup>17</sup>, and the other examined the associations between dermatoglyphic variation, topography, and climate in Kenya<sup>18</sup>. However, apart from these reports no dermatoglyphic study has compared the

two neighbouring East African countries whose common language is Kiswahili.

Kenya with an area of 582,600sq km is bounded by Sudan and Ethiopia to the north, Somalia and the Indian Ocean to the east, Tanzania to the south and Uganda to the west. Linguistically it belongs to the Niger-Congo language group<sup>19</sup>. Uganda and Kenyan on the other hand bound Tanzania to the north, the Indian Ocean is to the east, Mozambique, Malawi and Zambia to the south, and the Democratic Republic of Congo, Burundi, Rwanda and Lake Tanganyika to the west. It has an area of 945,000 sq km and linguistically belongs mainly to the Niger-Congo language group. The objective of this study is to establish the normal finger and palmar dermatoglyphic features of Kenyan and Tanzanian subjects, in order to explore their affinities and differences, if any, since they belong to the same linguistic group.

**Materials and methods**

Altogether 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 students of Muhimbili University College of Health Sciences were studied. The subjects were healthy able-bodied volunteers whose parents and grandparents were indigenous Kenyans or Tanzanians, respectively, selected from the cosmopolitan cities of Nairobi and Dar-es-Salaam. This provided a good mixture of social backgrounds to allow for the inclusion of quantitative palmar variables<sup>20</sup>. All subjects were asked individually if there was any non-Kenyan or 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 to avoid statistical distortion of occurrences of particular features in a relatively small sample<sup>21</sup>.

Bilateral finger and palmar prints were obtained and the pattern configurations were classified according to Cummins and Midlo's<sup>22</sup> standard technique. Only clear prints were classified into arches, loops and whorls (Fig. 1). Ridge counts were made according to the method described by Holt<sup>2</sup>. Inter-observer variations in counting were eliminated as one 'blinded' person who did not collect the prints examined them all with the aid of a magnifying lens. The following features were examined:

The total finger ridge counts (TFRC) are the sum of the ridge-counts (largest count only when there is more than one) on all ten fingers for each sex.

Pattern intensity index (PII) is the mean number of triradii formed on digits per individual subject, and it was calcu-

lated from the totals of the pattern type frequency. This reflects the complexity of the finger patterns in an individual or population. In this system, arches having no triradius are scored 0; loops representing pattern formation with one triradii are scored 1; and whorls or composite patterns with two (or more) triradii are scored 2. The pattern frequency of a population is therefore summarised by the finger pattern intensity representing the mean number of digital triradii per person.

The atd angle is the angle between two straight lines joining the radial (a) and ulnar (d) triradii to the hypothenar triradius (t), (Fig. 1).

The a-b ridge count represents the number of ridges between triradii (a) and (b) (Fig. 1)

The ridge patterns, TFRC, PII, atd angle and a-b ridge counts were analysed statistically using Chi-square tests with 2 degree of freedom for ridge patterns and student's t-tests for matched or unmatched pairs as appropriate for the other parameters. The data obtained for Kenyan and Tanzanian subjects were then compared with findings for Malawians obtained previously using similar methods.

**Results**

**Palmar ridge patterns:** The overall distribution of the palmar patterns on both hands of each sex was not significantly different ( $p > 0.5$ ).

**Digital ridge patterns:** Ulnar loops were the most prevalent finger ridge patterns and arches were the least type in the sampled populations. Significant sex differences were exhibited in arches, ulnar loops and whorls in the sampled populations ( $p < 0.05$ , Table 1).

Table 2 shows the mean total finger ridge count (TFRC), mean atd angles, mean a-b ridge counts and pattern intensity index (PII) by sex. There was significant sex difference in TFRC in Kenyans ( $P < 0.01$ ) but none in Tanzanian subjects ( $p > 0.5$ ). In both groups men showed significantly higher mean a-b ridge counts than women ( $p > 0.001$ , Kenyans;  $p < 0.01$ , Tanzanians). Women had higher mean atd angles than men in both groups but the differences were not statistically significant ( $p < 0.5$ ). Women had also higher PII than Kenyan men and the reverse was the case in Tanzanians.

Table 3 compares the dermatoglyphic traits of Kenyans, Tanzanians and of Malawians previously reported<sup>23</sup>. There were significant differences between Kenyans and Tanzanians with respect to TFRC, atd angle and a-b ridge counts ( $p < 0.001$ ). Similar significant differences also existed in all the above parameters between Malawians and both Kenyans and Tanzanians ( $p < 0.001$ ).

**Table 1 The percentage frequency of digital ridge patterns of Kenyan and Tanzanian subjects**

| Ridge Pattern | Kenyan |       |       |        |       |       | Tanzanian |       |        |       |       |       |
|---------------|--------|-------|-------|--------|-------|-------|-----------|-------|--------|-------|-------|-------|
|               | Male   |       | Mean  | Female |       | Mean  | Male      |       | Female |       | Mean  |       |
| Types         | Left   | Right |       | Left   | Right |       | Left      | Right | Left   | Right |       |       |
| Arch          | 5.71   | 4.28  | 4.99  | 3.16   | 2.63  | 2.89  | 5.11      | 4.67  | 4.89   | 3.33  | 3.33  | 3.33  |
| Radial loop   | 6.25   | 6.42  | 6.34  | 6.32   | 7.11  | 6.71  | 6.67      | 7.04  | 6.86   | 7.50  | 7.50  | 7.50  |
| Ulnar loop    | 69.05  | 76.19 | 72.62 | 69.12  | 70.18 | 69.65 | 65.56     | 68.89 | 67.22  | 79.17 | 70.83 | 75.00 |
| Whorl         | 18.99  | 13.11 | 16.05 | 21.40  | 20.08 | 20.75 | 22.66     | 19.40 | 21.03  | 10.00 | 18.34 | 14.17 |

**Table 2** The total finger ridge count (TFRC), atd angle, a-b ridge counts and pattern intensity indices of Kenyan and Tanzanian subjects

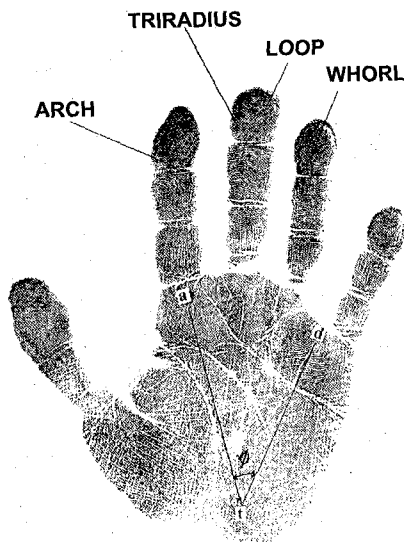
| Variables       | Kenyan |        |        | Tanzanian |        |       |
|-----------------|--------|--------|--------|-----------|--------|-------|
|                 | Male   | Female | P      | Male      | Female | P     |
| <b>TFRC</b>     |        |        |        |           |        |       |
| Mean            | 125.60 | 116.26 | <0.01  | 115.05    | 114.9  | >0.5  |
| SD              | 39.0   | 32.16  |        | 32.14     | 32.50  |       |
| atd angle       |        |        |        |           |        |       |
| Mean            | 85.20  | 86.78  | <0.1   | 77.98     | 78.00  | <0.05 |
| SD              | 10.24  | 11.50  |        | 8.86      | 7.22   |       |
| a-b ridge count |        |        |        |           |        |       |
| Mean            | 89.60  | 87.00  | <0.001 | 85.42     | 83.42  | <0.01 |
| SD              | 15.36  | 17.34  |        | 19.80     | 18.90  |       |
| PII*            |        |        |        |           |        |       |
| Mean            | 7.94   | 8.91   |        | 8.23      | 7.09   |       |

PII\* were calculated from pattern type frequency totals, hence standard deviations were not obtained.

**Table 3** A comparison of dermatoglyphic variables between Kenyan, Tanzanian and Malawian subjects

| Variables       | Kenyan (2001)+ |        | Tanzanian (2001)+ |        | Malawians (1999)++ |        |
|-----------------|----------------|--------|-------------------|--------|--------------------|--------|
|                 | Male           | Female | Male              | Female | Male               | Female |
| <b>TFRC</b>     |                |        |                   |        |                    |        |
| Mean            | 125.60         | 116.26 | 115.05            | 114.9  | 123.72             | 140.15 |
| SD              | 39.0           | 32.16  | 32.14             | 32.50  | 39.82              | 48.70  |
| n               | 164            | 140    | 180               | 120    | 89                 | 142    |
| atd angle       |                |        |                   |        |                    |        |
| Mean            | 85.20          | 86.78  | 77.98             | 78.00  | 72.06              | 80.66  |
| SD              | 10.24          | 11.50  | 8.86              | 7.22   | 8.30               | 8.50   |
| a-b ridge count |                |        |                   |        |                    |        |
| Mean            | 89.60          | 87.00  | 85.42             | 83.42  | 79.74              | 64.66  |
| SD              | 15.36          | 17.34  | 18.90             | 6.30   | 16.88              | 13.22  |
| PII*            |                |        |                   |        |                    |        |
| Mean            | 7.94           | 8.91   | 8.23              | 7.09   | 7.65               | 6.66   |

PII\* were calculated from pattern type frequency totals, hence standard deviations were not obtained. (Sources: ++Present study; +Igbigbi and Msamati 1999. Note the same methods were employed in both studies.)



**Fig. 1** Palmar and digital prints illustrating arches, loops, whorls, triradii and atd angle

However, the level of significance between Malawian and Tanzanian men in TFRC, and between Tanzanian and

Malawian women in atd angle differed ( $p < 0.01$ ). The TFRC in females was higher in Malawians, high in Kenyans and least in Tanzanians; for men it was higher in Kenyans, high in Malawians and least in Tanzanians. The atd angle was higher in Kenyans, high in Tanzanians and least in Malawians; a similar trend emerged with the a-b ridge counts. The PII of Kenyans was closer to the indices of Tanzanians than those of Malawians (Table 3).

**Discussion**

Our study has demonstrated that palmar patterns do not exhibit sexual dimorphism and may therefore not differentiate population groups. Previous studies in Africans<sup>12, 15-16</sup> and Caucasians<sup>24-25</sup> do support this view. The Chorote Indians have also demonstrated the lack of sexual dimorphism in palmar pattern types<sup>26</sup>. The present study has also shown the prevalence of digital ulnar loops followed by whorls as, indeed, was the case with other African populations studied<sup>12, 15, 16, 28, 29</sup>. However, Kenyan men had more ulnar loops than women, as is the case with the Zulus of South Africa<sup>29</sup>. This is an interesting finding for a number of reasons. It emphasises that prints of the finger and palmar surface provide a distinct technical record in physical anthropology<sup>30</sup> because they have greater phylogenetic stability<sup>31</sup>. However, in Caucasians, high frequencies of digital arches and radial loops in both sexes have been reported<sup>24</sup>. These findings underline the usefulness of digital patterns in differentiating population groups. In this connection, De Sa Benevides and Salzano<sup>8</sup> had also shown that the most marked difference between Whites and the total Negroid group was the prevalence of radial loops in the latter than the former. In another study on the Hehe tribe of Tanzania it was shown that the finger pattern types of women showed rather greater than usual elevation in the total frequency of loops and a diminution in whorls<sup>17</sup>, which was also shown in this study. As far as we know the only other female sample with high loop frequency was in Mozambique<sup>17</sup>. The present study has also demonstrated a higher frequency of loops in both sexes of both groups, suggesting dermatoglyphic similarity between Kenyans and Tanzanians.

Our study has demonstrated sexual dimorphism in TFRC in Kenyans but none in Tanzanians. However, in both groups the

mean TFRC was higher in men than women. This is the opposite of what was reported in Malawians<sup>23</sup> but it was in agreement with what was reported among valley Basques when compared with other Spaniards<sup>24</sup>. A previous study had indeed shown that racial differences do exist between Africans and Caucasians in mean TFRC<sup>24</sup>. Other authors have also demonstrated that the mean TFRC was lower in African than in British samples but the difference was most marked in men<sup>28</sup>. Our findings tend to suggest that mean TFRC can also differentiate African population groups. Differences in total ridge count frequencies between different populations may also be expected, since the frequencies of arches, loops and whorls vary between races<sup>28</sup>.

Moreover, we have shown that the PII was higher in Kenyan women than men but the reverse was the case in Tanzanian and Malawian subjects (Table 3). This may indicate a closer dermatoglyphic link between Malawians and Tanzanians. The mean atd angle was also found to be higher in women than men in our study but the differences were not statistically significant, thus confirming the reports in other populations<sup>15, 16, 23, 28</sup>. The mean a-b ridge count was significantly higher in men than women ( $p < 0.001$  Kenyans;  $p < 0.01$  Tanzanians) as was the case with Malawians, contrary to what was shown in Caucasians, suggesting racial differences<sup>32</sup>. Pons<sup>32</sup> demonstrated that racial differences existed in human palms with those of white populations varying between 80 and 86 ridges, black populations, between 74 and 80, the Indian subcontinent between 68 and 80 and American Indians between 80 and 90. In our study, we found ridge counts of between 87 and 90 for Kenyans and between 83 and 86 for Tanzanians. These values are, however, higher than those of Southern African populations previously studied by Blecher<sup>28</sup> Pons<sup>32</sup>, and Malawians<sup>23</sup> (64 and 80) we reported previously. Notwithstanding this, it is worth noting that the values quoted for Africans by Pons may be more accurate for West Africans as Igbigbi et al<sup>15, 16</sup> had shown in the Yorubas, Ibos, Hausas and Urhobos of Nigeria. The significant differences ( $p < 0.001$ ) in dermatoglyphic parameters between Kenyan and Tanzanian subjects as well as between Malawians, Kenyans and Tanzanians (Table 3) further indicate the usefulness of dermatoglyphic traits in studying population dynamics as Chai<sup>3</sup> had also demonstrated.

Finally, we have presented the normal dermatoglyphic palmar and digital traits of Kenyan and Tanzanian subjects. In our comparison, we have shown that both groups have some digital dermatoglyphic traits that are similar while also demonstrating traits that are different as shown in other African studies<sup>15, 16, 23, 28, 29</sup>. When both groups were compared with Malawians, our findings suggest that dermatoglyphically, Tanzanians appear to be closer to Malawians than to Kenyans. This finding could be explained on dermatoglyphic distance between Kenyans and Malawians despite their linguistic similarity, the Niger-Congo language grouping. However, it must be pointed out that Kenyans and Tanzanians have adopted Kiswahili as a common language in addition to their many dialects. The admixture of some Kiswahili words from Arabic, Chinese and Portuguese<sup>19</sup> and the fact that dermatoglyphic finger and palmar taxonomic traits show relationships with climate and

altitude<sup>18</sup>, could also explain some of the dermatoglyphic differences highlighted in our study.

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