



RESEARCH ARTICLE

Association between digital dermatoglyphics and handedness among Sinhalese in Sri Lanka [version 1; referees: 1 approved with reservations]

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Abstract

Background The relationship between handedness and digital dermatoglyphic patterns has never been investigated in the Sinhalese population. The goal of this study is to establish the above mentioned relationship, which would positively aid personal identification.

Findings One hundred Sinhalese students (50 right-handed and 50 left-handed) were studied for their digital dermatoglyphic pattern distribution. The results show that a statistically significant correlation exists for digit 3 (P=0.002, Fisher’s exact test) of the right hand and digit 1 (P=0.002, Fisher’s exact test) and digit 2 (P=0.021, Fisher’s exact test) of the left hand. Further, whorl patterns are more common in right-handed than left-handed Sinhalese students.

Conclusions Statistically significant differences in handedness and digital dermatoglyphic patterns were evident among Sinhalese people. Further study with a larger sample size is recommended.

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Referee Status:

	Invited Referees	
	1	2
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UPDATED		
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Introduction

Fingerprints (digital dermatoglyphics) are a unique form of evidence that greatly contribute towards personal identification in forensic science¹. Because they are unique for each individual and are strongly influenced by genetics, they also perform a significant role in anthropology, human genetics, ethnology and medicine. They are characterized by alternating strips of raised friction ridges and grooves present in a variety of patterns². These patterns start to develop between the 5th and 6th week of intrauterine life, and are fully formed by the 21st week³. These patterns do not change throughout postnatal life and their development is determined by several genes⁴.

Handedness (i.e. hand dominance) is defined as the uneven distribution of fine motor skills between the left and right hand⁵. Determination of the handedness of both the assailant and the victim are important in various aspects of forensic science, including personal identification⁶. Hence, establishing the relationship between handedness and digital dermatoglyphics will aid forensic identification.

To date, scarce amount of studies⁷⁻¹³ have investigated whether there is a correlation between handedness and digital dermatoglyphics. In 1940 Cummins discovered a slight association in the sex differences of asymmetrical occurrence of dermatoglyphic patterns⁸. Cromwell and Rife in 1942 found that left-handers are characterized by slightly less bimanual asymmetry than right-handers among on Caucasian school children in southwestern Ohio⁹. In 1943 Rife found associations characteristic of autosomal linkage between the whorl frequencies on the fingers and handedness among descended from northern European stock¹⁰. In 1994 Coren reported an increased number of arches, fewer whorls in left-handers as compared to the right-handers among Canadians¹¹. Cho in 2010 found significant difference of dermatoglyphics patterns on digit 3, 4 and 5 among Koreans¹². None have investigated this association in a Sinhalese population (an Indo-Aryan ethnic group who are native to the island of Sri Lanka¹⁴). The main goal of the current study is to determine the relationship between handedness and digital dermatoglyphics in a sample of Sinhalese population.

Methods

The study was conducted at the Department of Forensic Medicine, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka. Ethical clearance for this study was obtained from the Ethical Clearance Committee of the institute. A total of one hundred Sinhalese students (46 females, 54 males), who gave informed written consent, were included in the study. Their ages ranged between 22 and 28 years (mean \pm s.d. = 25 ± 2 years). Firstly, handedness was assessed using the Edinburgh Handedness Inventory¹⁵. This required participants to demonstrate 10 unimanual tasks (preferred hand for writing, drawing, throwing, striking a match, opening a box, holding scissors, holding a toothbrush, holding a spoon, holding a broom and holding a knife). These tasks are common to Sri Lankans and they were advised to state the degree of preference for the hand used in each case as either strong (two points) or weak (one point). The handedness measure was calculated by subtracting the score for the left hand from the score for the right hand, dividing by the sum of both, and multiplying it by 100, providing an absolute

range from -100 (completely left-handed) to +100 (completely right-handed). We recruited 50 predominant right-handers and 50 predominant left-handers after evaluating handedness.

All eligible students were asked to wash their hands thoroughly to remove dirt and dry them before obtaining fingerprints. Rolled prints were obtained by the ink and paper method as described by Cummins and Midlo². The subject was asked to roll their finger from the radial side to the ulnar side on an ink pad and then transfer their fingerprints in the same manner onto the allocated area of a double sheet of plain A4 paper (Figure 1). In this way, fingerprints for all the ten fingers were obtained for each individual. Digits are numbered as follows; digit 1 (thumb), digit 2 (index finger), digit 3 (middle finger), digit 4 (ring finger) and digit 5 (little finger).

Digital dermatoglyphic patterns (Figure 2) were classified as follows; ulnar loop, radial loop, whorl (double loop whorl, plain whorl, central pocket loop and accidental whorl were counted as whorl) and arch (plain arch and tented arch were counted as arch). In this way, fingerprints of all the ten fingers were obtained for each individual.

Analysis was carried out using SPSS 17. Descriptive statistics were used to express the data. Correlations between handedness and digital dermatoglyphics were evaluated by a two-sided Fisher's exact test. P values less than 0.05 were considered statistically significant.

Results

In this study we observed the handedness-wise digital dermatoglyphics pattern distribution of 100 individuals (50 left-handed [31 females, 19 males] and 50 right-handed [27 males, 23 females]).

Table 1 shows the digital dermatoglyphic pattern distribution of the right-handed Sinhalese students. Digit 3 of the right hand of right-handed students was found to have more ulnar loops (88%) compared to left-handers (60%), followed by 26% whorl on left-handed compared to 8% whorl in right-handed. Arches and radial loop patterns occurred less frequently. The rest of the digits on the right hand were not shown to be significantly different. Table 2 shows the digital dermatoglyphics pattern distribution of the left-handed Sinhalese students.

The right hand thumb (digit 1) of right-handed individuals had a higher ulnar loop frequency (54%) than whorl (46%) while the

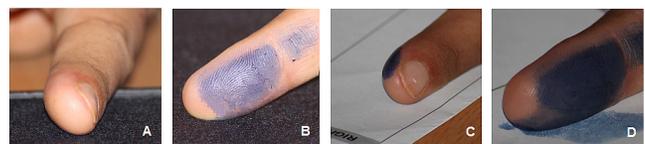


Figure 1. Method for obtaining fingerprints. A and B show the rolling of the finger from the radial side to ulnar side on an ink pad. C and D show the transference of fingerprints onto the allocated area of the paper.

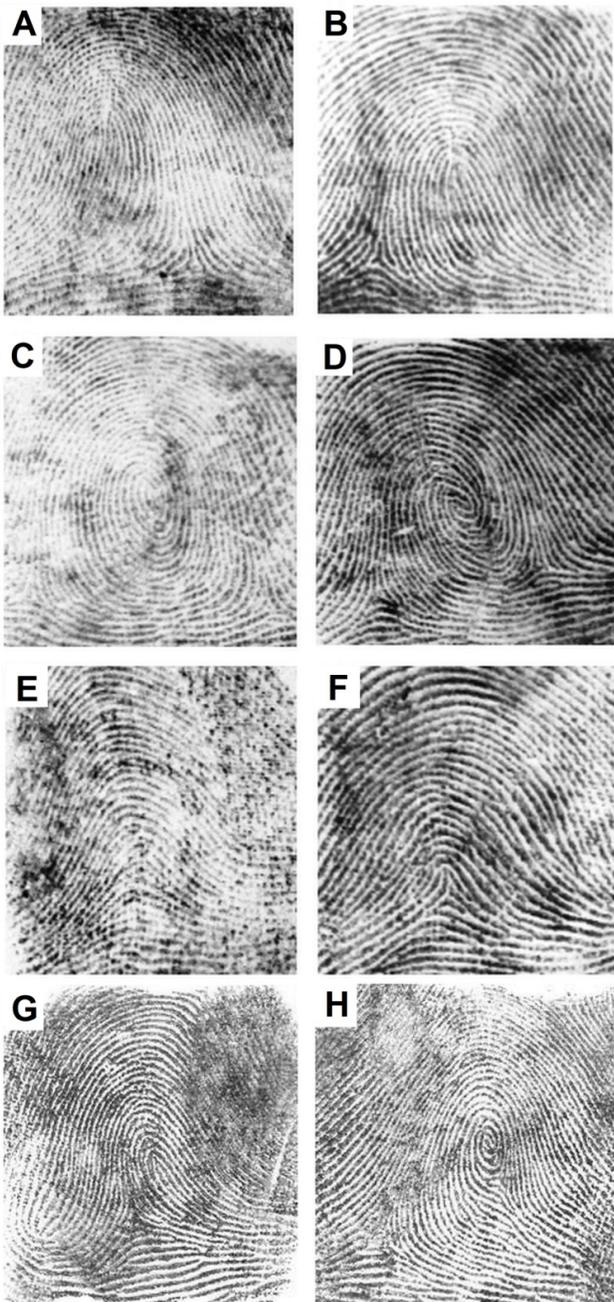


Figure 2. Different types of fingerprints. A: Ulnar loop, B: Radial loop, C: Plain Whorl, D: Double loop whorl, E: Plain arch, F: Tented arch, G: Accidental whorl, H: Central pocket loop.

reverse was true for the left hands of right-handed persons (ulnar loop 40%, whorl 56%). The right hand index finger (digit 2) of right-handed persons had a higher ulnar loop frequency (52%) than whorl (36%), although whorls were more frequent (38%) than ulnar loops (30%) on the left hand of right-handed people for this digit. Radial loops were more common on the left hand compared to the right hand in both handedness groups.

The percentage of digital dermatoglyphics pattern distributions for both hands in both right- and left-handed Sinhalese individuals are shown in **Figure 3**.

In both hands of the total population 35.6 percent of whorls were found on right-handed people while 31.2 percent on left-handed. Radial loops were more commonly found on both hands of left-handed (6.2%) than right-handed (1.6%) people.

A statistically significant correlation was observed in digital dermatoglyphic patterns between right- and left-handed people for digit 3 of the right hand ($P=0.002$, Fisher’s exact test), as well as for digits 1 ($P=0.002$, Fisher’s exact test) and 2 ($P=0.021$, Fisher’s exact test) of the left hand.

Discussion

It has been affirmed that the digital dermatoglyphic pattern of the skin is unique and unchallengeable for an individual¹. This is valuable as a means of identification. In this study, effort has been made to study the relationship between dermatoglyphic and handedness in 100 Sinhalese students.

The statistically significant difference between handedness and the dermatoglyphic pattern in digit 3 on the right hand and digit 1 and digit 2 on the left hand were the most important finding of our study.

In the past, few studies have been conducted on different ethnic groups with the idea of establishing a relationship between handedness and dermatoglyphic pattern. Results of some studies are in line with the present study.

In their study on Caucasian school children in southwestern Ohio, Cromwell and Rife (1942)⁹ observed a slightly higher frequency of whorls (1.3%) on left ring fingers (digit 4) of left-handers than of right-handers. Whorls were absent on the right ring finger of both

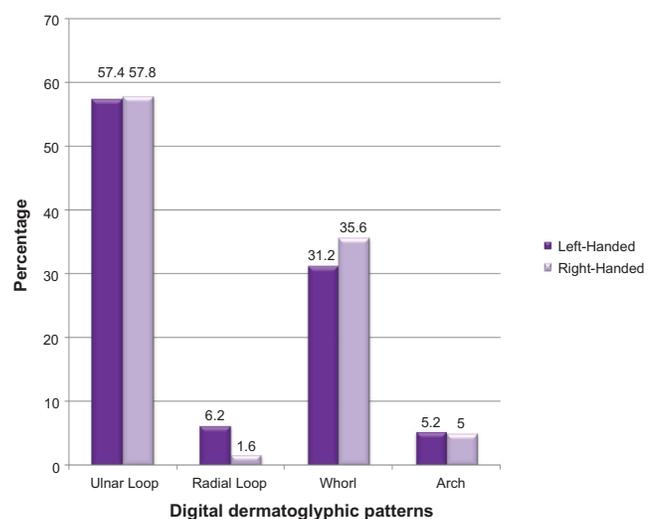


Figure 3. Percentage of different digital dermatoglyphics patterns for both hands of right and left handed Sinhalese individuals.

Table 1. Digital dermatoglyphic pattern distribution of 50 right-handed Sinhalese individuals.

Digit	Handedness	Ulnar loop		Radial loop		Whorl		Arch	
		n	%	n	%	n	%	n	%
Digit 1	Right	27	54	0	0	23	46	0	0
	Left	27	54	0	0	22	44	1	2
Digit 2	Right	26	52	0	0	18	36	6	12
	Left	29	54	4	8	12	24	5	10
Digit 3	Right	44	88	0	0	4	8	2	4
	Left	30	60	5	10	13	26	2	4
Digit 4	Right	21	42	0	0	29	0	0	0
	Left	18	36	1	2	30	60	1	2
Digit 5	Right	41	82	0	0	9	18	0	0
	Left	38	76	2	4	9	18	1	2

Table 2. Digital dermatoglyphic pattern distribution of 50 left-handed Sinhalese individuals.

Digit	Handedness	Ulnar loop		Radial loop		Whorl		Arch	
		n	%	n	%	n	%	n	%
Digit 1	Right	20	40	0	0	28	56	2	4
	Left	32	64	4	8	13	26	1	2
Digit 2	Right	15	30	7	14	19	38	9	18
	Left	28	56	7	14	7	14	8	16
Digit 3	Right	34	68	0	0	11	22	5	10
	Left	28	56	4	8	13	26	5	10
Digit 4	Right	24	48	1	2	25	50	0	0
	Left	20	40	2	4	27	54	1	2
Digit 5	Right	37	74	0	0	12	24	1	2
	Left	37	74	2	4	10	20	1	2

right- and left-handers. They further observed that the incidence of arches only on digit 3 of right hands shows highly significant differences between left-handers and right-handers ($P < 0.001$).

Coren (1994)¹¹ in his study on Canadians found that left-handers were more likely to have arches and radial loops, while fewer whorls than right-handers. The correlation of handedness and digital dermatoglyphics was most marked on the left hand, which showed significant differences on four digits except digit 1. On the right hand, handedness was associated with a digital dermatoglyphics patterns only on digit 4.

Cho (2010)¹², in their study on Koreans, found that both hands of left handers exhibited more arch and ulnar loop types than the right-handers and less whorl and radial loop types than the right-handers.

The digital dermatoglyphic pattern of digit 3, digit 4 and digit 5 of the left hand showed a statistically significant relationship between left- and right-handed people.

In Karev's study on Bulgarian individuals¹³, he found that whorls were significantly less frequent, and ulnar loops significantly more frequent in all digits for right-handed people when compared to left-handed people. The ulnar fluctuating asymmetries of digits 1 and 4 showed a highly significant relationship with handedness.

Rife (1955)¹⁶, in his study on students at Ohio State University, USA, observed that arches were more common on the left middle finger of right-handed students than left-handed students.

The major limitation of our study is the small sample size, even though it was obvious that there is a significant handedness-wise difference of dermatoglyphics. The results can be used as supporting evidence for individual identification. Additional research involving larger samples are needed to further confirm current findings.

Conclusion

The present study supports the hypothesis that handedness and digital dermatoglyphics are correlated in members of the Sinhalese population. Our results show that there is a statistically significant difference in fingerprint patterns between right- and left-handed people for digit 3 on the right hand and for digits 1 and 2 on the left hand. The results of this study support the relationship between handedness and digital dermatoglyphics in the Sinhalese population.

Author contributions

BTBW was involved in study conception and design. BTBW and RMGK assisted with data collection, study coordination and data analysis. Both authors were involved with drafting the manuscript. Both authors read and approved the final manuscript.

Competing interests

No competing interests were disclosed.

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The study was based on data from 100 individuals (50 left-handed [31 females, 19 males] and 50 right-handed [27 males, 23 females]). The greatest limitation of this study is the small sample size, as authors indicate; this size would be even smaller if the sample was analyzed by sex, as should have been done. The distribution of digital patterns presents sex differences in most of the samples analyzed, and so, the results cannot be accepted because they are affected by the effect of sex differences.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 08 Jul 2013

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We would like to thank Professor Esperanza Gutierrez Redomero for the valuable time spent reviewing our manuscript and the important comments she has made. We have attempted to address and incorporate most of the concerns that were raised in version 2 of our article.

Competing Interests: No competing interests were disclosed.