

Variation Studies on Plantar Intertriradial Measurements

The c-d and direct a-d measurements in Panjabi Brahmans

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Introduction

Studies on the qualitative and quantitative traits of palmar and plantar areas have been undertaken by various investigators with a view to finding out the bilateral and male/female variability, as well as to associate it with the evolutionary and functional modifications. Cummins, Leche and McClure (1931) investigated the palmar intertriradial distances in 300 American young adults and discovered the distances to be comparatively larger in the left hands, with the exception of b-c distance which was slightly more in the right palms. However, only the excess in left hands of the a-b measurement was statistically significant. Another interesting revelation was that the gradation of the measurements was in the order $a-b > c-d > b-c$, which indicates that the measurement closer to the central axis of the hand was shorter than the one away from it. The proximity of triradii b and c, according to Cummins and Midlo (1961), shows a tendency towards the substitution of a single triradius for the two digital triradii. In their opinion this approximation may be associated with the feature of syndactyly due to disturbances in embryological processes.

The pattern intensity on the palmar and plantar interdigital areas has been correlated with the anatomical axis of the hand and foot. It has been pointed out that as the axis of hand and foot passes through digit III in non-human primates, the interdigital area III shows least pattern frequency. In man, however, where the axis has been shifted to digit II in foot, plantar area II shows corresponding reduction in pattern intensity.

The frequent occurrence of zygodactyly of toes II and III of the human foot has also been correlated with the shift in the central axis, in contrast to the webbing in digits III and IV of the hand. This feature, associated with "interdigital triradius", is also held responsible for the approximation of b and c triradii in palm and a and b triradii in the sole.

In a quantitative study of plantar interdigital areas in Panjabi Khatri, the author (Datta, 1964) found variations in the a-b, b-c and c-d measurements in both sexes. The distances were in the order $c-d > b-c > a-b$. Comparatively, the measurements were smaller in females than in males, and these differences were statistically highly

significant. The bilateral variation was non-significant in a-b and b-c measurements and significant in the c-d distance.

The study of plantar intertriradial measurement a-b in Panjabi Brahmans (Datta, 1964) reveals statistically significant bilateral and sex differences, whereas the investigation of b-c measurement (Datta, 1965) shows non-significant right/left variation and significant male/female difference.

In the present investigation, the c-d and direct a-d measurements of Panjabi Brahmans have been studied, in order to find out the variations, and also to correlate them with the digito-plantar arch and other associated features of the human foot.

Material and methods

The data for this investigation consists of the bilateral plantar prints of 100 males and 100 females from the Panjabi Brahman population, presently settled in Delhi. The sample includes young adults, between the ages of 20 and 40, selected at random, having no close relationship with each other.

Techniques recommended by Cummins and Midlo (1961) have been followed in recording the plantar prints and care has been taken to ensure uniformity of pressure in printing the subjects. For measuring the span of the distances on the prints, a metal divider with sharp ends has been used and the measurements checked on a precision scale. The 't' test has been applied for the test of significance and probability levels have been ascertained from Fisher and Yates (1953).

Results

The bilateral distribution of c-d measurement in males has been presented in Tab. 1. In right soles, the maximum frequency is in the 23 mm group, whereas the highest frequency of left soles belongs to the 24 mm group, indicating higher mean value in the left side (Fig. 1). This measurement falls in 13 groups on either side, showing less significant difference in the variability on two sides.

Tab. 2 gives the distribution of c-d measurement in females. Again, the difference in variability appears to be insignificant as the two sides fall in equal number of groups (Fig. 2).

The distribution of direct a-d measurement in Brahman males has been given in Tab. 3. The modal type of measurement for the right side is 58 mm, whereas the left side has the mode of 59 mm, showing tendency in the left soles to have higher value (Fig. 3).

Tab. 4 presents the frequency distribution of a-d measurement in Panjabi Brahman females. Once again, the notable feature is the smaller modal type in the right soles and comparatively higher mode in the left, showing higher value for the mean measurement in left soles (Fig. 4).

Mean, standard deviation, coefficient of variation and range of c-d measurement

Tab. 1. Distribution of c-d measurement in Panjabi Brahman males (100)

No.	Range (mm)	Right		Left	
		no.	%	no.	%
1	19.0-19.9	3	3.19	1	1.06
2	20.0-20.9	5	5.32	3	3.19
3	21.0-21.9	8	8.52	4	4.26
4	22.0-22.9	13	13.84	7	7.46
5	23.0-23.9	19	20.22	13	13.83
6	24.0-24.9	11	11.69	20	21.27
7	25.0-25.9	10	10.63	15	15.95
8	26.0-26.9	9	9.57	11	11.69
9	27.0-27.9	6	6.38	7	7.46
10	28.0-28.9	4	4.26	5	5.32
11	29.0-29.9	3	3.19	4	4.26
12	30.0-30.9	1	1.06	3	3.19
13	31.0 and above	2	2.13	1	1.06
Total		94*	100.00	94*	100.00

* Measurements could not be taken on remaining soles due to absence of triradii.

Tab. 2. Distribution of c-d measurement in Panjabi Brahman females (100)

No.	Range (mm)	Right		Left	
		no.	%	no.	%
1	16.0-16.9	3	3.00	2	2.04
2	17.0-17.9	5	5.00	3	3.06
3	18.0-18.9	4	4.00	4	4.08
4	19.0-19.9	9	9.00	7	7.14
5	20.0-20.9	13	13.00	10	10.21
6	21.0-21.9	16	16.00	22	22.45
7	22.0-22.9	18	18.00	15	15.31
8	23.0-23.9	20	20.00	11	11.23
9	24.0-24.9	5	5.00	7	7.14
10	25.0-25.9	3	3.00	5	5.10
11	26.0-26.9	2	2.00	9	9.18
12	27.0-27.9	1	1.00	2	2.04
13	28.0 and above	1	1.00	1	1.02
Total		100	100.00	98*	100.00

* Measurements could not be taken on remaining soles due to absence of triradii.

Tab. 3. Distribution of direct a-d measurement in Panjabi Brahman males (100)

No.	Range (mm)	Right		Left	
		no.	%	no.	%
1	52.0-52.9	2	2.13	1	1.06
2	53.0-53.9	5	5.32	3	3.19
3	54.0-54.9	7	7.47	6	6.38
4	55.0-55.9	9	9.57	5	5.32
5	56.0-56.9	9	9.57	7	7.47
6	57.0-57.9	10	10.63	9	9.57
7	58.0-58.9	16	17.02	11	11.69
8	59.0-59.9	9	9.57	14	14.88
9	60.0-60.9	6	6.38	10	10.62
10	61.0-61.9	5	5.32	8	8.52
11	62.0-62.9	5	5.32	7	7.47
12	63.0-63.9	5	5.32	5	5.32
13	64.0-64.9	4	4.26	5	5.32
14	65.0-65.9	1	1.06	2	2.13
15	66.0 and above	1	1.06	1	1.06
Total		94*	100.00	94*	100.00

* Measurements could not be taken on remaining soles due to absence of triradii.

Tab. 4. Distribution of direct a-d measurement in Panjabi Brahman females (100)

No.	Range (mm)	Right		Left	
		no.	%	no.	%
1	44.0-44.9	1	1.09	1	1.06
2	45.0-45.9	1	1.09	1	1.06
3	46.0-46.9	2	2.17	3	3.19
4	47.0-47.9	4	4.35	3	3.19
5	48.0-48.9	6	6.52	4	4.26
6	49.0-49.9	9	9.78	5	5.32
7	50.0-50.9	13	14.13	7	7.46
8	51.0-51.9	16	17.38	8	8.52
9	52.0-52.9	11	11.96	11	11.70
10	53.0-53.9	8	8.69	17	18.08
11	54.0-54.9	7	7.61	10	10.63
12	55.0-55.9	5	5.44	9	9.56
13	56.0-56.9	4	4.35	7	7.46
14	57.0-57.9	4	4.35	6	6.38
15	58.0 and above	1	1.09	2	2.13
Total		92*	100.00	94*	100.00

* Measurements could not be taken on remaining soles due to absence of triradii.

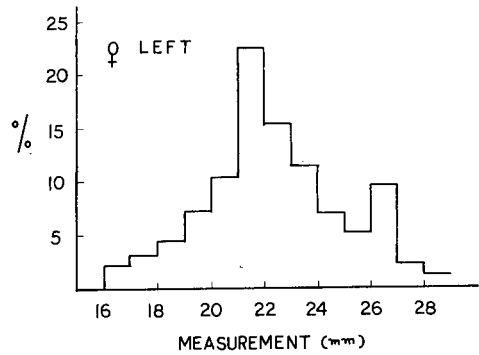
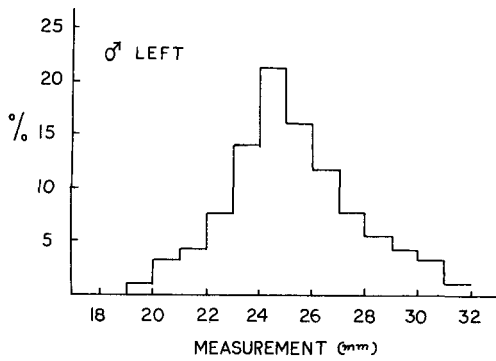
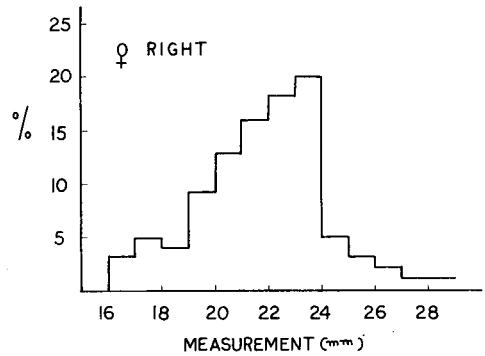
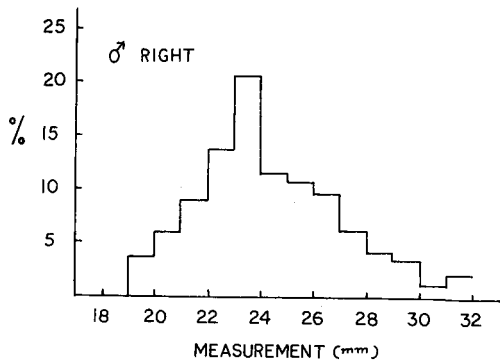


Fig. 1. Distribution of c-d measurement in males

Fig. 2. Distribution of c-d measurement in females

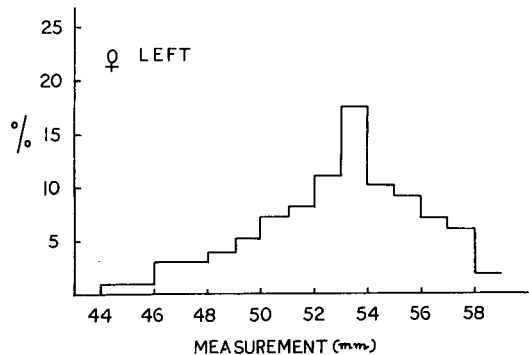
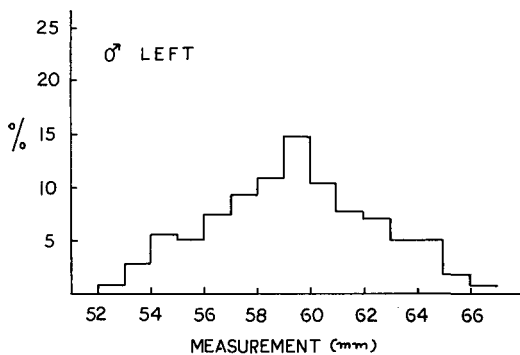
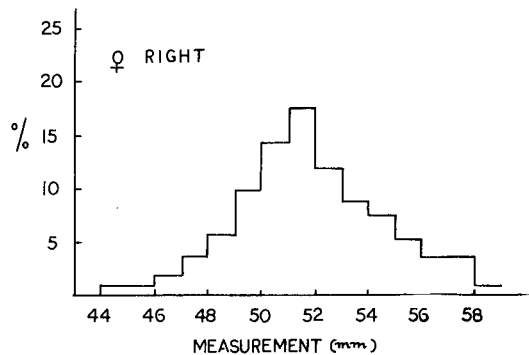
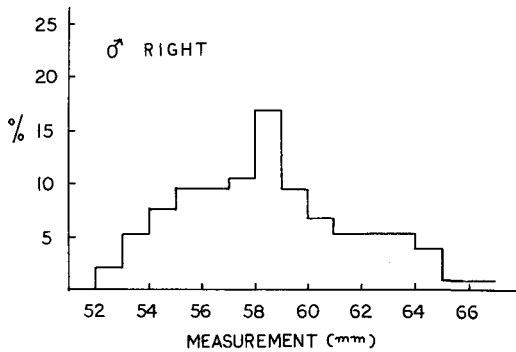


Fig. 3. Distribution of a-d measurement in males

Fig. 4. Distribution of a-d measurement in females

in males and females have been shown in Tab. 5. It is evident from the table that there is a distinct bilateral variation in the two sexes, left soles having relatively higher values. The means in males are comparatively greater than those in females. The standard deviation and the coefficient of variation do not display significant differ-

Tab. 5. Mean, standard deviation, coefficient of variation, and range of variation of c-d measurement in Panjabi Brahmins

	♂		♀	
	Right	Left	Right	Left
Mean \pm SE (mm)	24.49 \pm 0.27	25.47 \pm 0.25	21.39 \pm 0.23	22.11 \pm 0.26
S.D. \pm SE (mm)	2.64 \pm 0.19	2.44 \pm 0.17	2.36 \pm 0.16	2.57 \pm 0.18
C.V. \pm SE	10.78 \pm 0.50	9.58 \pm 0.43	11.03 \pm 0.39	11.62 \pm 0.47
Range (mm)	19.0 — 35.8	19.8 — 35.9	16.2 — 28.0	16.0 — 28.3

ential trends between the two sides or between the two sexes. However, the highest S.D. and C.V. are shown by the male rights and female lefts, respectively. The difference in the range of variation is negligible.

Tab. 6 gives these statistical constants for the a-d measurement in Panjabi Brahman males and females. As seen before, the mean distances in males are appreciably higher than in females and that in both sexes the left side presents higher mean value

Tab. 6. Mean, standard deviation, coefficient of variation and range of variation of direct a-d measurement in Panjabi Brahmins

	♂		♀	
	Right	Left	Right	Left
Mean \pm SE (mm)	58.40 \pm 0.33	59.47 \pm 0.32	52.06 \pm 0.30	53.04 \pm 0.32
S.D. \pm SE (mm)	3.22 \pm 0.23	3.13 \pm 0.22	2.91 \pm 0.21	3.11 \pm 0.22
C.V. \pm SE	5.51 \pm 0.75	5.26 \pm 0.71	5.59 \pm 0.62	5.86 \pm 0.70
Range (mm)	52.7 — 66.3	52.0 — 68.0	44.0 — 58.1	44.5 — 61.2

than the right side. The standard deviation and coefficient of variation do not display significant variations. They are, however, greater in the left sides, both in males and females. The range of variation has a relatively higher absolute range in both sexes.

The distribution of right/left differences in the c-d and a-d measurements, separately for males and females, have been given in Tab. 7. It is to be noted that the highest frequency is shown by $R < L$ in both measurements by both sexes and, like-

wise, $R = L$ shows the least frequency in a similar way. This feature tends to show that differences between right and left sides may be highly significant.

The values of 't' for various comparisons between right/left sides and between males/females in the c-d and a-d measurements have been given in Tab. 8. It is evident

Tab. 7. Distribution of right/left differences

Comparison	♂		♀	
	No.	%	No.	%
<i>c-d measurement</i>				
$R > L$	19	20.21	27	27.55
$R = L$	6	6.38	8	8.16
$R < L$	69	73.41	63	64.29
Total	94	100.00	98	100.00
<i>a-d measurement</i>				
$R > L$	23	24.47	19	20.65
$R = L$	6	6.38	5	5.44
$R < L$	65	69.15	68	73.91
Total	94	100.00	92	100.00

Tab. 8. Value of 't' for various comparisons of intertriradial measurements c-d and a-d in Panjabi Brahmans

No.	Comparison	c-d		a-d	
		't'	Result	't'	Result
1	Rights (200) and lefts (200) of entire series (both sexes combined)	2.36	Significant	2.29	Significant
2	Rights (100) and lefts (100) of males	2.66	Significant	2.33	Significant
3	Rights (100) and lefts (100) of females	2.07	Significant	2.23	Significant
4	Males (200) and females (200) of entire series (both sides combined)	8.97	Significant	14.33	Significant
5	Male rights (100) and female rights (100)	8.75	Significant	14.21	Significant
6	Male lefts (100) and female lefts (100)	9.33	Significant	14.22	Significant

from this table that the bilateral and the sex variations are statistically significant, both when the sexes or sides are taken jointly or separately. The male/female differences are, however, more significant than the bipedal differences.

Summary

The distribution of c-d and direct a-d intertriradial measurements has been investigated in the plantar dermatoglyphic surface of 100 males and 100 females from the Panjabi Brahman population.

The mean values of both c-d and measurements appear to be smaller in females and on the right sides.

The 't' test reveals that bilateral variation is statistically significant in the c-d measurements, both when the sides are combined or separate.

Sex differences too are statistically highly significant in the c-d and a-d measurements, both when the rights and lefts are studied individually or jointly.

References

- CUMMINS H., LECHE S. & McCLURE K.: Bimanual variations in palmar dermatoglyphics. *Am. J. Anat.*, 1931, 48, 199-230.
- & MIDLO C.: *Finger prints, palms and soles: An introduction to dermatoglyphics.* Dover Publication, New York, 207, 1961.
- DATTA P. K.: The variations in plantar intertriradial measurements and their significance as related to the shift in the axis of human foot (Unpub.), 1964.
- Variation studies on plantar intertriradial measurements: The a-b measurement in Panjabi Brahmans (unpub.), 1964.
- Variation studies on plantar intertriradial measurements: The b-c measurement in Panjabi Brahmans. *Anthropologist*, Univ. Delhi, 1963, X, 1-6.
- FISHER R. A. & YATES F.: *Statistical tables for biological, agricultural and medical research.* New York 1953.

RIASSUNTO

E stata osservata la distribuzione delle misurazioni c-d ed a-d diretta sulla superficie plantare di 200 individui (100 ♂ e 100 ♀) della popolazione Bramana Panjab. I valori medi per ambedue le misurazioni sono risultati essere più bassi nelle donne e nelle destre. Il test del « t » ha rivelato che la variabilità bilaterale è statisticamente significativa. Molto significative sono anche le differenze di sesso nelle misurazioni. La significatività sussiste sia che destre e sinistre vengano studiate separatamente, sia che vengano studiate insieme.

RÉSUMÉ

La distribution des mensurations c-d et a-d directe a été observée sur la surface plantaire de 100 ♂ et 100 ♀ de la population Brahmane Panjab. Les valeurs moyennes pour l'une et l'autre mensuration résultent être plus bas chez les femmes et sur les droites. Le test du « t » indique que la variabilité bilatérale et les différences de sexe sont statistiquement significatives, soit qu'on considère droites et gauches séparément, soit qu'on les considère ensemble.

ZUSAMMENFASSUNG

An 200 Exploranden (100 ♂ und 100 ♀) der Panjab Brahminen-Bevölkerung wurde die Distribution der c-d und a-d Messungen an der Fußsohlenfläche beobachtet. Es zeigte sich, daß bei beiden Messungen die Durchschnittswerte bei Frauen und auf der rechten Seite niedriger sind. Der « t »-Test bewies, daß die bilaterale Variabilität statistisch bedeutungsvoll ist. Bedeutungsvoll sind auch die Geschlechtsunterschiede bei den Messungen, und zwar sowohl wenn man rechts und links gemeinsam als auch, wenn man sie einzeln untersucht.