

## VARIATION IN FINGER RIDGE COUNTS AMONG 5 ENDOGENOUS GROUPS OF RAJASTHAN

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### INTRODUCTION

Holt's extensive genetic investigations of total finger ridge count (TFRC) have established beyond doubt that the trait is determined by additive polygenes with independent effects, without dominance and without environmental influence (Holt, 1968, Loesch, 1983). The trait TFRC with high heritability, genetic variance being over 70 percent, has been during the last 15 years subjected to extensive biological investigations. The trait has been employed, by a number of investigators, to study its distribution between and within major ethnic groups (for references see Malwalwala, 1977), to study microevolutionary variation (Roberts and Coope, 1972, Chai, 1972; White and Persons, 1973; Rothhammer *et al.*, 1973; Friedlaender, 1975; Malhotra, 1978), to study variation within populations (Persons, 1964; Jantz, 1977), to study variation within individuals (Holt, 1951, 1958; Jantz, 1974, 1975, 1976, 1977, 1979; Harvey and Siogh, 1980; Chakraborty and Malhotra, 1981; Chakraborty *et al.*, 1981; Loesch and Martin, 1982; Malhotra and Sen Gupta, 1984) and to study association between the trait and various congenital malformations (for a review see Holt, 1968; Schauman and Alter, 1976; Loesch, 1983).

Despite the fact that India continues to have a strong tradition of research in dermatoglyphics, not many populations have been investigated for the trait TFRC, and therefore our knowledge of the ethnic and geographical variation of the trait in the country in general and western India (except Maharashtra) in particular is limited.

The purpose of this paper, therefore, is to report for the first time distribution of TFRC and absolute finger ridge counts (AFRC) among five endogenous groups from the western Indian state of Rajasthan.

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## MATERIAL AND METHOD

The materials analysed here were collected as part of an ongoing joint Indo-Soviet anthropological project during 1978-79 from Udaipur district in Rajasthan state. Among other biological and cultural data, bilateral inked finger and palmar prints were also collected from 5 endogamous populations—four caste Hindus (Palival Brahmin, Rajput, Oswal and Meghwal) and a tribal group, the Bhil. Prints of 300 males, 100 from each group, aged 10 to 55 years, were obtained; prints of 20 individuals could not be utilized owing to imperfect printing. The ridge counts of digital patterns were scored after Holt (1958). For each digit both total and absolute ridge counts were determined. Using these counts, both total and absolute count for each hand were also calculated and finally the traits TFRC and AFRC for each group were determined. The names of the five groups studied, sample sizes and the abbreviations used are given in table 1.

## RESULTS

**Total Finger Ridge Count (TFRC)**

The means and standard deviations of the ridge counts for individual fingers, summed counts of each hand and trait TFRC are set out in table 2.

The highest mean ridge count, among all the groups and on both hands, is for digit I and the lowest, with the exception of Palival Brahmins, is for digit II. The mean ridge counts in decreasing order of magnitude on both hands are those for digits I, IV, V, III and II among Oswals, Meghwals, and Bhils; Palival Brahmins and Rajputs however show some departures from this pattern (table 2).

An examination of the standard deviations of the ridge counts on different fingers of either right or left hand will show that digit II, with the exception of the Palival Brahmins, is most variable and digit V, with the exception of the Oswal, is the least variable.

In general, the ridge counts of right hand digits are greater than the corresponding left hand digits; of the 75 homologous pairs among the 5 groups, 17 pairs (68%) had higher counts on the right digits, 7 pairs on the left digits and one pair had equal count. Summed counts on the right hand in all the five groups are greater compared to the left hand. However, bilateral differences between the digits or hands are statistically non-significant (table 4).

**Absolute Finger Ridge Count (AFRC)**

In table 3 means and standard deviations of the absolute ridge counts for individual digits, summed counts of each hand and trait AFRC are presented.

The highest mean ridge count on the right hand among all the groups is found in digit I and the lowest, with the exception of Bhlis, is in digit V; On the left hand the groups depict certain departures; in 3 groups digit IV and in 2 groups digit I depicts highest mean ridge count, and in 3 groups digit V and in 2 groups digit II have the lowest count. These differences were expected in view of the fact that whorls occur in higher frequency on the right digits I and IV compared to the corresponding left digits.

The mean ridge counts in decreasing order of magnitude on the right hand, with the exception of Meghwal, are those for digits I, IV, II, III and V; on the left hand the pattern is variable, though the order tends to be IV, I, III, II and V.

The standard deviations in respect of absolute counts on different digits depict greater inter-population variability compared to total counts. Thus, on the right hand, while in 3 groups digit I is most variable, in 2 other groups it is digit II. The left hand digits among the 5 groups depict even greater heterogeneity; except digit V which is least variable on either right or left hand and among all the groups, all the other four digits, one in each group, are most variable.

The counts on right hand digits, with the exception of digit III (in 3 groups) and digit V (in one group), are greater than the corresponding left hand digits. Summed absolute counts on the right hand in all the groups are greater compared to the left hand. However, the observed bilateral differences in all cases are statistically not significant (table 4).

#### Inter Population Variation

The values of mean summed total count on the right hand vary from 70.05 among Meghwal to 74.92 in Rajputs, and on the left hand between 67.45 in Palival Brahmins to 73.03 in Rajputs. The lowest TFRC, 137.78, is observed among Meghwal and highest, 147.95 among Rajputs. It is noteworthy that the 5 populations under study show homogeneous distribution in total count either on right or left hand or the trait TFRC as none of the t-values (table 5) are significant at 5% level.

Similarly, in respect of mean absolute counts also, the groups show homogeneous distribution either on the right or left hand or the trait AFRC (table 5). However, the highest value of AFRC is observed among the Rajputs (206.64) and lowest among the Meghwal (183.60)

#### DISCUSSION

In general, the pattern observed in the present study in respect of the mean total ridge count and mean absolute count on different digits is in agreement with numerous previous investigations both from India and abroad (for total count among others see, Holt, 1958; Masalwala, 1963; Malhotra *et al.*, 1974, 1980), Banerjee and Banerjee 1975 and for absolute count see Malhotra *et al.*, 1980a, b).

It is interesting, though somewhat unexpected, that the 5 hierarchical endogamous groups from Rajasthan, showed homogeneous distribution for both the digital traits TFRC and AFRC. In respect of 5 blood groups and four red cell enzymes, a considerable heterogeneity was observed among these groups (Papiba *et al.*, 1982) and notably the Bhils, a tribal group, as expected, showed pronounced differences from the other four groups. Earlier, Malhotra *et al.* (1981) found a great deal of variation among these groups in respect of palmar hypothernar triradii.

The Bhils are widely distributed in several western and central Indian states. Earlier, Malhotra *et al.* (1980a) studied a sample of Bhils from Maharashtra and reported the values of TFRC as  $134.57 \pm 5.15$  and  $178.04 \pm 9.31$ , respectively, which are lower compared to the present study but statistically nonsignificant ( $t=0.97$  and  $0.72$  for TFRC, respectively).

It is interesting to note that, in general, the values of both TFRC and AFRC among the four castes are not very different from those of 25 castes reported from the state Maharashtra (Malhotra *et al.*, 1980a, b). However, the Bhils of Rajasthan depict a tendency towards higher counts compared to the Bhils and other tribal groups of Maharashtra.

TABLE 1: Dermatoglyphic data by endogamous groups

Population	No. of prints collected	No. of prints utilized	Abbreviation used	Ethnicity	Profession
1. Fallal Brahmin	100	98	PB	Hindu Caste	Agriculture
2. Rajput	100	98	RT	"	Agriculture
3. Oswal	100	97	OL	"	Trade
4. Mughwal	100	90	ML	"	Leather worker
5. Bhil (Tribe)	100	97	BL	Tribe	Agriculture and labour
Total	500	480			

TABLE 2: Means and Standard deviations for total finger ridge count (TFRC)

POPULATION FINGER	Palmar Brewhis		Rajput		Orseal		Mechwal		Bhill	
	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.
<b>Right</b>										
I	17.76±0.58	5.75	18.46±0.55	5.46	18.06±0.58	5.59	17.38±0.54	5.15	18.35±0.53	5.25
II	12.72±0.37	5.63	13.27±0.58	5.76	11.82±0.61	5.98	10.81±0.71	6.71	11.36±0.60	5.93
III	12.32±0.50	4.95	13.62±0.51	5.08	12.96±0.48	4.70	12.71±0.61	5.75	12.95±0.50	4.96
IV	16.23±0.52	5.14	16.04±0.53	5.28	16.62±0.52	5.13	15.76±0.54	5.11	16.03±0.47	4.66
V	13.08±0.45	4.44	13.35±0.47	4.68	13.48±0.48	4.72	13.41±0.48	4.60	13.70±0.41	4.05
<b>Left</b>										
I	15.87±0.53	5.26	16.93±0.53	5.21	16.16±0.53	5.22	15.87±0.49	4.70	17.05±0.57	5.65
II	10.71±0.65	6.39	12.41±0.55	5.45	11.39±0.62	6.08	11.00±0.66	6.29	10.90±0.58	5.74
III	12.72±0.53	5.21	13.69±0.59	5.80	13.11±0.54	5.37	12.66±0.59	5.57	12.84±0.61	6.04
IV	15.69±0.53	5.22	16.47±0.52	5.13	16.10±0.49	4.88	15.67±0.61	5.75	15.87±0.47	4.67
V	12.47±0.47	4.70	13.53±0.44	4.31	13.52±0.40	3.92	13.14±0.45	4.30	14.63±0.43	4.19
<b>Total (R)</b>	72.11±1.99	19.74	74.92±2.11	20.91	72.95±2.06	20.33	70.06±2.22	21.62	72.39±2.07	20.35
<b>Total (L)</b>	67.45±2.20	21.76	73.03±2.10	20.79	70.28±1.57	19.42	67.72±2.27	21.54	71.14±2.07	20.37
<b>TFRC</b>	139.56±4.08	40.41	147.95±4.11	40.68	143.15±3.95	38.87	137.78±4.38	41.61	143.54±4.05	39.93

TABLE 3 : Means and Standard deviations for absolute finger ridge count (AFRC)

FINGER	POPULATION		Pulvi Brahmin		Rajput		Oswal		Meghwel		Bhui	
	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.	Mean±S.E.	S.D.
Right	I	24.20±1.18	11.70	27.02±1.20	11.87	26.33±1.14	11.28	24.40±1.15	10.94	25.90±1.22	12.03	
	II	17.28±1.07	10.55	19.87±1.17	11.59	16.99±1.16	11.40	15.33±1.22	11.59	15.77±1.10	10.82	
	III	15.66±0.96	9.48	17.85±1.10	10.88	16.35±0.97	9.54	16.38±1.16	10.97	15.90±0.99	9.83	
	IV	23.98±1.10	10.87	24.96±1.18	11.73	24.89±1.08	10.63	21.46±1.16	10.97	24.08±1.12	10.99	
	V	14.92±0.71	7.00	16.79±0.82	8.12	16.33±0.82	8.04	15.31±0.74	6.98	16.00±0.72	7.11	
Left	I	21.81±1.07	10.57	23.98±1.06	10.49	22.22±1.15	11.31	21.59±1.07	10.13	23.08±1.16	11.43	
	II	14.91±1.14	11.31	17.95±1.09	10.80	14.97±1.07	10.58	15.18±1.17	11.08	14.48±1.04	10.23	
	III	15.82±0.99	9.77	18.53±1.15	11.60	16.32±1.04	10.28	16.11±1.13	10.74	16.24±1.06	10.22	
	IV	21.73±1.10	10.90	24.36±1.12	11.05	22.26±1.10	10.81	22.26±1.20	11.41	22.57±1.06	10.44	
	V	13.60±0.64	6.34	16.16±0.79	7.86	15.79±0.68	6.75	14.79±0.75	7.11	16.31±0.67	6.64	
Total (R)		98.04±4.05	40.07	106.43±4.49	44.40	100.82±4.31	42.44	91.78±4.28	40.59	97.95±4.24	41.00	
Total (L)		87.87±4.02	39.76	100.21±4.35	43.05	92.49±4.03	39.69	89.83±4.34	41.17	93.67±4.00	39.43	
AFRC		185.91±7.91	78.27	206.64±8.60	85.19	193.32±8.20	60.76	181.60±8.42	79.89	190.61±8.10	79.79	

TABLE 4. t-values for testing bilateral differences in mean ridge counts.

Fingers	Populations	Palival				
		Brahmins	Rajput	Oswal	Meghwal	Bhil
TFRC	I	1.70 (+) <sup>1</sup>	1.42 (+)	1.71 (+)	1.46 (+)	1.18 (+)
	II	1.65 (+)	0.76 (+)	0.42 (+)	0.14 (-)	0.39 (+)
	III	0.39 (-) <sup>2</sup>	0.06 (-)	0.15 (-)	0.54 (+)	0.10 (+)
	IV	0.51 (+)	0.41 (-)	0.51 (+)	0.08 (+)	0.17 (+)
	V	0.66 (+)	0.00 (-) <sup>3</sup>	0.04 (-)	0.29 (+)	1.11 (-)
Total		1.12 (+)	0.45 (+)	0.68 (+)	0.52 (+)	0.30 (+)
AFRC	I	1.95 (+)	1.79 (+)	1.79 (+)	1.27 (+)	1.18 (+)
	II	1.07 (+)	0.85 (+)	0.93 (+)	0.06 (+)	0.70 (+)
	III	0.08 (-)	0.30 (-)	0.06 (+)	0.09 (+)	0.17 (-)
	IV	1.02 (+)	0.26 (+)	0.59 (+)	0.09 (+)	0.69 (+)
	V	0.98 (+)	0.38 (+)	0.39 (+)	0.35 (+)	0.22 (-)
Total		1.26 (+)	0.70 (+)	1.00 (+)	0.46 (+)	0.64 (+)

1. Count on right side higher than the left side.
2. Counts on right side lower than the left side.
3. Equal counts on both sides.

TABLE 5: Inter-group t-values for both TFRC and AFRC traits

Population pairs	TFRC			AFRC		
	Right	Left	Total	Right	Left	Total
1. PB x RT	0.68	1.30	1.02	0.98	1.47	1.26
2. PB x OL	0.21	0.66	0.44	0.33	0.57	0.46
3. PB x ML	0.49	0.06	0.21	0.51	0.23	0.14
4. PB x BL	0.07	0.86	0.49	0.01	0.60	0.29
5. RT x OL	0.47	0.69	0.59	0.64	0.92	0.79
6. RT x ML	1.12	1.21	1.20	1.44	1.20	1.35
7. RT x BL	0.60	0.45	0.54	0.97	0.90	0.96
8. OL x ML	0.67	0.59	0.64	0.82	0.32	0.16
9. ML x BL	0.13	0.23	0.05	0.34	0.02	0.58
10. ML x BL	0.54	0.79	0.68	0.49	0.34	0.42

## SUMMARY

Digital patterns of 480 males belonging to four caste Hindus, Paliya Brahmins, Rajputs, Oswals and Meghwals, and a tribal group, the Bhils of Udaipur District in Rajasthan state were investigated for total (TFRC) and absolute finger ridge count (AFRC) traits. Interestingly, though somewhat unexpected, the 5 hierarchical groups were found to be homogeneous for both TFRC and AFRC quantitative traits.

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## LITERATURE CITED

- Banerjee, A. R. and D. K. Banerjee, 1975, Intercaste distance in dermatoglyphics in some Bengalee caste groups. *Ind. Jr. Phys. Anth. and Hum. Genet.* 1 : 29-39.
- Chakraborty, R., and K. C. Malhotra, 1981 Variation in asymmetry and interdigital diversity for three ridge count measures among the Dhangar caste-cluster of Maharashtra, India. *J. Hum. Evol.* 10 : 503-509.
- Chakraborty, R.; K. C. Malhotra and Y. Tateno, 1982 Variation in dermal ridges in nine population groups of Maharashtra, India. *Am. J. Phys. Anthropol.* 22 : 53-57.
- Chai, C. K., 1972 Biological distances between indigenous populations of Taiwan. In: *The Assessment of Population Affinities in Man.* J. S. Weiner and J. Hutzinger (eds). Oxford : Clarendon Press.
- Friedlaender, J. S., 1975 *Patterns of Human Variation.* Cambridge, Mass : Harvard University Press.
- Harvey, R. G., and S. Singh, 1980 Dermatoglyphics of the Waskia, Karkar island, Papua New Guinea. *Dermatoglyphics*, 8 : 19-44.
- Holt, S. B., 1951 The correlations between ridge-counts on different fingers. *Ann. Eugenics*, 16 : 287-297.
- Holt, S. B., 1958 Genetics of dermal ridges : the relation between total ridge count and variability of counts from finger to finger. *Ann. Hum. Genet.* 22 : 323-341.
- Holt, S. B., 1968 *The Genetics of Dermal Ridges.* Springfield : Charles C. Thomas.
- Jantz, R. L., 1974 Finger ridge counts and inter-finger variability in Negroes and Whites. *Hum. Biol.* 46 : 663-675.
- Jantz, R. L., 1975 Population variation in asymmetry and diversity from finger to finger for digital ridge counts. *Am. J. Phys. Anthropol.* 42 : 215-223.
- Jantz, R. L., 1976 The relation between total finger ridge-count and variability of counts from finger to finger : Genetic implications of racial variation. *Ann. Hum. Genet.* 40 : 221-224.
- Jantz, R. L., 1977 Sex and race differences in finger ridge-count correlations. *Am. J. Phys. Anthropol.* 46 : 171-176.



- Janz, R. L., 1979 On the levels of dermatoglyphic variation. In : *Dermatoglyphics-Years Later*. W. Wertelecki and C. C. Plato (eds). Alan R Liss, Inc., New York. pp. 53-62.
- Lasch, D., 1983 *Quantitative Dermatoglyphics*. Oxford : Oxford University Press.
- Lasch, D., and N. G. Martin, 1982 Directional and absolute asymmetry of digital ridge counts. *Acta Anthropogenetica*, 6 : 22-98.
- Malhotra, K. C., 1978 Micro evolutionary dynamics among the Gavdas of Goa. In *Evolutionary Models and Studies in Human Diversity*. R. J. Meier et al., (eds). Mouton & Hague, pp. 293-314.
- Malhotra, K. C., B. V. Bhanu and G. M. Kanhere, 1974 Quantitative analysis of finger prints : Gavda data. In : *Human Population Genetics in India*. L. D. Sanghvi et al., (eds). Orient Longman : Bombay, pp. 215-225.
- Malhotra, K. C., R. Chakraborty, B. V. Bhanu and P. M. Fulmali, 1980 Variation in dermal ridges in nine population groups of Maharashtra, India. Intra and inter population diversity. *Hum. Hered.*, 30 : 307-315.
- Malhotra, K. C., R. Chakraborty and B. V. Bhanu, 1980b Quantitative analysis of finger ridge counts among 20 Dhanger castes. Abstract. Int. Symp. in Dermatoglyphics, Patiala, 1980.
- Malhotra, K. C., B. Karmakar and M. Vijayakumar, 1981 Diversity in hypothenar triradii among some population groups from India sub-continent. *Ind. J. Phys. Anthropol. and Hum. Genet.*, 7 : 179-188.
- Maivalwala, J. D., 1963 Quantitative analysis of finger ridge counts of the Parsi community in India. *Ann. Hum. Genet.*, 26 : 305-313.
- Maivalwala, J. D., 1977 *Dermatoglyphics : An International Bibliography*. The Hague : Mouton.
- Papiba, S. S., B. N. Mukherjee, S. M. S. Chahal, K. C. Malhotra and D. F. Roberts, 1982 Genetic heterogeneity and population structure in north-west India. *Ann. Hum. Biol.*, 9 : 235-251.
- Parsons, P. A., 1964 Finger print pattern variability. *Acta Genet.*, Basel, 14 : 201-211.
- Robert, D. F., and E. Coope, 1972 Dermatoglyphic variation in the South Midlands. *Heredity*, 29 : 293-305.
- Rothhammer, F., J. V. Neel, F. da Rocha and G. Y. Sundling, 1973 The genetic structure of a tribal population, the Yanomamo Indians, VIII. Dermatoglyphic differences among villages. *Am. J. Hum. Genet.*, 25 : 152-166.
- Schaumann, B., and M. Alter 1976 *Dermatoglyphics in Medical Disorders*. Springer-Verlag, Berlin.
- White, N. G., and P. A. Parsons, 1973 Genetic and socio-cultural differentiation in the aborigines of Arnhem Land, Australia. *Am. J. Phys. Anthropol.*, 38 : 5-14.