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Effects of Inbreeding on the Finger Print Patterns

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ABSTRACT Dermatoglyphic patterns on fingers clearly show a segregation of homozygotes for both high and low intensity patterns i.e., whorls with two triradii and arches with no triradii. The patterns with one triradii, as a whole, reduced with inbreeding, consistently in each sex. This agrees with earlier studies and confirms large additional effect of genes for finger print patterns. But, if the individual pattern types are considered, it appears that the radial components of the patterns (i.e., radial loops plus radial loops with whorls) exceed with inbreeding and more markedly in females. A non-linearity of the increased of pattern intensity and the proportion of whorl patterns on fingers with inbreeding cannot, of course, be so easily attributed to selection. This non-linearity is again more pronounced among the females in which the average effects of inbreeding of mean trNF is greater than males. This may suggest an additional influence of x-linked inbreeding in females and perhaps an epistatic interaction, which increases especially among females.

INTRODUCTION

The dermatoglyphic variations are not influenced by environmental factors other than *in utero* conditions is amply demonstrated by embryological studies (Cummins and Midlo, 1943). The genetic background of various aspects of the patterns were established by biometric studies by Penrose (1954), Holt (1960), Mukherjee (1966, 1967). A few limited Indian studies about the inbreeding effects on dermatoglyphics (Mukherjee et al., 1980; Mukherjee, 1989, 1990) in a number of population from different parts of India provide a consistent results. These results, suggesting homozygosity of extreme pattern intensities on fingers, and also agree with results on studies on the effects of village endogamy, which shows indirect effects of inbreeding (Marquer and Jakobi, 1976; Mukherjee and Chakravarti, 1964; Loesch, 1971; Roberts and Coope, 1972).

Besides, there is a critical importance of the studies of dermatoglyphic effects of inbreeding on quantitative characters in general. The idea that the characters with lower heritability showed inbreeding effect only in respect of the change of mean (depression) has to be placed in this context of average dominance / recessiveness of the concerned genes.

The dermatoglyphic results of inbreeding observed so far have certain problems, in view of the limitation of adequate samples of individuals with same F-values. The change of means which though consistent have only small amount of significance i.e., which may have been lower than even 5% probability. The present data have advantage of four precise degrees of inbreeding.

MATERIALS AND METHODS

The character studied are patterns classified by the method in accordance with the definitions given by Mukherjee (1966, 1967) and Penrose (1957). These methods are slightly modified from those provided by Cummins and Midlo (1943) in the following manner : (i) the loops were defined as patterns with single triradii associated with ridge covering at an angle of 180° or whatever is the value of the ridge count (ii) Plain arches were differentiated from tented arches which measured pattern intensities (iii) the pattern with true triradii which have not been obtained here, would be considered separately as superwhorl; (iv) the number of triradii on fingers is, therefore, slightly different from the value of pattern intensity index.

In pattern intensity index, all arches including tented arches or nascent loops with no ridge count but single triradii are counted as zero, and all whorls including superwhorls (earlier called accidental) were counted as two.

Inbreeding effects on autosomal can be studied only in the male samples, the inbred females are products of matings between son of father's sister and daughter of mother's brother (FSZ × MBD) or between son and daughter of mother's sister (MSZ × MSD) and would reflect autozygosity of X-linked genes as well. Thus, if a character shows greater effects of inbreeding in females, there would be an indication of some X-linked genes for the trait in addition to autosomal.

The analysis is based on finger prints of 76 male and 80 female offspring of unrelated parents (F=0); 95, 95, 90 male offspring of second cousins (F=0.0156), first cousins once removed (F=0.03125) and first cousins (F=0.0625) respectively; in case of female offspring the sample of same categories are 100, 105, 85, respectively. Total sample size was 726 (356 males and 370 females).

RESULTS AND DISCUSSIONS

The samples from both males and females display increased frequencies of both the high intensity patterns i.e., whorls with two triradii and plain arches with zero triradii, and the low intensity patterns i.e., plain arches with zero triradii, at the cost of patterns with a single triradii pooled together (i.e. loops and tented arches) (Table 1 and 2). This is true for each sex and for left and right hands separately. This would support the hypothesis of homozygosity of the extreme pattern intensities on fingers and heterozygosity of the pattern with the middle range of intensity. This would support some additive effect of the concerned alleles, which has been suggested earlier by familial correlations of pattern intensity (Mukherjee, 1966; Loesch, 1971).

Table 1: Per cent frequencies of patterns of finger print types with different levels of inbreeding among the male children

	Side	*Whorl*	*Loops*		*Tented*	*Arches*	*Fingers*
			Ulnar	*Radial*	*Arches*		*(N)*
	R	47.10	45.00	3.68	2.39	1.84	380
NI	L	43.94	48.16	2.89	2.37	2.63	380
	R+L	45.52	46.57	3.28	2.37	2.27	760
	R	47.57	44.21	3.78	1.89	2.52	475
2C	L	45.05	47.15	3.57	1.47	2.73	475
	R+L	46.26	45.68	3.68	1.68	2.63	950
	R	48.84	41.68	4.21	2.32	2.94	475
ICI	L	45.68	44.63	4.20	2.10	3.57	475
	R+L	47.26	43.16	4.21	2.21	3.26	950
	R	51.11	38.44	5.55	1.56	3.33	450
IC	L	46.67	40.89	5.34	2.67	4.50	450
	R+L	48.89	39.67	5.45	2.12	3.92	900
	R	49.14	41.49	4.49	1.93	2.93	1400
IN	L	45.78	44.28	4.28	2.07	3.58	1400
	R+L	47.46	42.89	4.39	2.00	3.25	2800

NI = non-inbred (F=0); 2C=Second Cousins (F=0.0156); ICI = First Cousins Once Removed (F=0.03125); IC = First Cousins (F=0.0625); IN = Total inbreeding (F=0.03598).

Table 2: Per cent frequencies of patterns of finger print types with different levels of inbreeding among the female children

	Side	*Whorl*	*Loops*		*Tented*	*Arches*	*Fingers*
			Ulnar	*Radial*	*Arches*		*(N)*
	R	37.00	52.25	4.00	2.50	4.25	400
NI	L	31.25	55.25	4.00	3.80	5.76	400
	R+L	34.12	53.75	4.00	3.12	5.00	800
	R	46.80	42.80	5.40	1.20	3.80	500
2C	L	40.60	48.40	5.00	2.20	3.80	500
	R+L	43.70	45.60	5.20	1.70	3.80	1000
	R	48.00	39.42	6.28	1.71	4.57	525
ICI	L	43.23	41.71	6.28	3.43	5.34	525
	R+L	45.62	40.57	6.28	2.57	4.95	1050
	R	48.94	35.52	7.52	2.12	5.88	425
IC	L	44.23	37.88	7.05	3.29	7.52	425
	R+L	46.58	36.70	7.29	2.70	6.70	850
	R	47.86	39.44	6.34	1.65	4.69	1450
IN	L	42.62	42.89	6.06	2.97	5.45	1450
	R+L	45.24	41.17	6.20	2.30	5.07	2900

NI = non-inbred (F=0); 2C=Second Cousins (F=0.0156); ICI = First Cousins Once Removed (F=0.03125); IC = First Cousins (F=0.0625); IN = Total inbreeding (F=0.03501).

However, when groups of individuals representing four degrees of inbreeding classes are compared, while whorls and arches tend to increase with inbreeding in the males, the whorls only appear to do so in females. The increase of whorls in the females is disproportionately large in the offspring of second cousin marriage (F=0.0156) in comparison to that in the offspring of more closely related couples. In other words the effects of increase whorl frequencies and also that of arches is apparently non-linear especially in the females. The higher rate of increase of whorl frequencies with inbreeding have been found in females. This has led earlier workers (Mukherjee et al., 1990; 1996) to suggest the possible influence of some X-linked recessive genes with positive effect on pattern intensity i.e., for whorls on human fingers in addition to autosomal genes with additive effects. The arch frequencies on the whole tend to increase with inbreeding much less in females than in males. While, perhaps supporting the additional X-linked influence may be the results of non-linear possible epistasis effects of some sort.

If the loops are again divided into ulnar and radial types, the inbreeding effects on the frequencies of two types of loops are in opposite directions. It is the ulnar loops which get reduced in frequency, with each increase in the inbreeding level consistently in each sex and in each hand. But the radial loops increase with inbreeding level with about more or less equal consistency. The rates of increase with inbreeding appear to be similarly non-linear and exceed in females than in males as in the case of whorls. Thus, the ulnar loops should represent heterozygotes, because they get reduced in frequency with inbreeding in the present data. But increased radial loops alongwith whorls raise a question as to the increased homozygosity of the radial components of patterns, whether, these are within or outside the whorls or there are separate genes for the radial loops and whorls, the homozygotes which increase with inbreeding. It is likely that these radial loops components of patterns may really be influenced by some x-linked loci in view of the earlier suggestions from family studies (Walker, 1941). This is because of the fact that radial loops tend to show the greater inbreeding effects in females than in males. However, in the present sample, the frequency of radial loops in females is generally greater than males.

The mean values of trNF in male offspring on unrelated couples (NI), second cousins (2C), first cousins once removed (ICI), first cousins (IC) and pooled inbred (IN i.e., F>0) are 14.33 ± 2.42 (n=76); 14.53 ± 2.16 (n=95); 14.73 ± 2.20 (n=95); 14.89 ± 2.24 (n=90); 14.75 ± 1.28 (n=280), respectively and those in female offspring of the same type of couples are 13.42 ± 2.17 (n=80); 14.37 ± 2.04 (n=100); 14.56 ± 1.93 (n=105); 14.66 ± 2.08 (n=85); 14.52 ± 1.16 (n = 290), respectively.

The mean value of total number of triradii on fingers per individual appears to increase with inbreeding coefficient in each sex. It could also be noted that the magnitude of increase of mean trNF in the inbred individuals and specially in the offspring of second cousins is greater in the female than in the male. These accumulated results strengthen the hypothesis of some average recessiveness of genes with positive effects of pattern intensity on fingers. This does not preclude the possibility of a small x-linked influence in addition to additive genes for that trait.

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