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Dermatoglyphics in Schizophrenia*

Part I: Qualitative Aspects

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Introduction

This paper reviews and reports on the frequencies of qualitative dermatoglyphic characters in schizophrenia. Dermatoglyphics is the name given by Cummins and Midlo (1943) to the study of the ridged skin found on the fingers, palms and soles. The biological value of dermatoglyphic investigation lies in the morphological constancy, from the time of formation until death, of the dermal ridge arrangements. The dermal ridges are fully formed by the fourteenth week of foetal development, therefore only genetic and prenatal environmental factors can influence ridge formation.

In the normal population the major source of variation is genetical, and racial and sex differences are well documented. Abnormal dermatoglyphic findings have been reported in a number of pathological conditions. Cummins and Midlo (1943), in a review of the literature, found mention of epilepsy, schizophrenia, mongolism, mental deficiency, neurofibromatosis, psoriasis, and congenital abnormalities such as polydactyly and spina bifida. More recently an association with congenital heart disease has been reported by Hale *et al.* (1961). Dermatoglyphic abnormalities have been found in other conditions with an abnormal karyotype besides mongolism, in Klinefelter's syndrome by Holt (1963), Turner's syndrome by Holt and Lindsten (1964), and trisomy 17 or 18 by Uchida *et al.* (1962) and Penrose (1963).

In schizophrenia the abnormal findings are related to sex difference in the distribution of finger-print patterns. Males have a higher proportion of whorls than females. The latter have a higher proportion of arches. These findings obtain for most normal samples, irrespective of racial group.

The previous investigations are listed in Table I. The three earliest, Poll (1935), Møller (1935), and Duis (1937) found the normal sex difference was reduced in their schizophrenic samples. Wendt and Zell (1951) reported a sex difference in their schizophrenic sample, but unlike most other observers

Table I

Investigations of Finger-Print Patterns in Schizophrenia

Investigation	Schiz. or Control	Sex	No.	W%	L%	A%
Poll, H. (1935)	Schiz.	M	232	28·5	65·8	5·7
	Schiz.	F	545	28·1	65·3	6·6
	Control	M	845	33·6	62·1	4·3
	Control	F	776	26·8	65·6	7·6
Møller, N. B. (1935)	Schiz.	M	450	27·0	65·3	7·7
	Schiz.	F	583	26·2	65·6	8·2
	Control	M	86654	29·8	64·8	5·4
	Control	F	14857	25·3	67·2	7·5
Duis, B. T. (1937)	Schiz.	M	416	30·2	64·6	5·2
	Schiz.	F	356	29·6	62·6	7·8
Wendt, G. G., & Zell, W. (1951)	Schiz.	M	243	32·0	64·3	3·7
	Schiz.	F	231	24·2	68·5	7·3
	Control	M	250	28·4	66·2	5·4
	Control	F	250	28·1	65·3	6·6
Pons, J. (1959)	Schiz.	M	113	29·1	66·2	4·6
	Control	M	157	29·0	67·0	4·0
Raphael, T., & Raphael, L. G. (1962)	Schiz.	M	100	32·1	58·9	9·0
	Control	M	5000	25·4	69·7	4·9
Beckman, L., & Norring, A. (1963)	Schiz.	M	100	30·1	62·9	7·0
	Schiz.	F	100	20·3	72·0	7·7
	Control	M	100	24·9	71·1	4·0
	Control	F	100	17·9	72·7	9·4

* The content of this paper was part of an M.D. thesis submitted to the University of Manchester, 1966. The individual quantitative results are given in extenso in the Appendix to the thesis.

not in their normal control group. Pons (1959), studying males only, found no difference between schizophrenics and controls, but Raphael and Raphael (1962), in their male sample, found the proportion of whorls and arches increased. Beckman *et al.* (1963) found an increase in the proportion of whorls in both sexes, but also an increase in male arches.

Palm prints of schizophrenics have been studied by Pons (1959) and Beckman *et al.* (1963). The former found an increase in the frequency of vestigial loops in the third inter-digital space and an unusual pattern, he termed Lr!, in the hypothenar area. The latter reported an increased frequency of patterns in the fourth inter-digital space, significant at the 5 per cent. level in both sexes.

Investigation

The aim of the present investigation was to find an explanation for the widely differing findings of previous investigators. It was hoped to achieve this by defining the diagnostic criteria, using sampling methods, and eliminating other conditions now known to be associated with variation of dermatoglyphic characters.

Subjects

The subjects were all within the age range 16 to 60 years and of British ancestry, defined as having grandparents born in the British Isles. Those with any condition said to be associated with abnormal dermatoglyphic characters were excluded.

The sample consisted of both acute and chronic schizophrenics. The chronic subjects were a 1 in 3 random sample of schizophrenics at three different mental hospitals. They had all been in-patients continuously for five or more years. Leonhard's classification of systematic schizophrenia as described by Fish (1958) was used, all the subjects having symptoms and signs which admitted them to one of its sub-divisions. The choice of diagnostic criteria was dictated by the need to match the physical parameter, which is fixed for the individual, with the most constant clinical features. The sample comprised 155 males and 157 females who were finger-printed, but only 100 males and 93 females who were also palm-printed, since palm prints were not taken from patients at one mental hospital.

The acute schizophrenics from four different mental hospitals were seen within 48 hours of admission. The clinical status was therefore assessed before substantial modification by treatment could occur. Patients with coarse brain disease, epilepsy, or clouding of consciousness due to toxic agents were excluded. All the subjects exhibited at least one of K. Schneider's (1959) first rank symptoms of schizophrenia. Finger and palm prints were taken from 77 males and 99 females.

The sub-categories hebephrenic, paranoid and catatonic schizophrenia were used in the further analysis of the results. Acute cases were classified as hebephrenic if the principal disorders were of thinking, affect and volition, with marked deterioration in personality; paranoid if there was predominance of delusions, with minimal disorders of thinking, affect and volition and a relatively well preserved personality; while subjects with motor disorders persistent for at least 48 hours were classified as catatonic.

Method

The finger and palm prints were taken after the clinical assessment. There was usually a delay before the patients were well enough to co-operate. The prints were analysed some 6 months later, without reference to the subject's clinical status. Most of the prints were made by an inkless method, "Kleen-Print" developed by Reed Research Laboratories.

All the finger-prints were "rolled". They were classified into three basic patterns—arches, loops, and whorls—using the same criteria as Holt (1961a), whose results (Holt 1964a) for a sample of the normal British population were used as the control group.

Classification of patterns depends upon the number of tri-radii. The simple arch has no tri-radius and is composed of a series of gently curving ridges with the convexity directed distally. Tented arches, included with simple arches, have more acutely curved dermal ridges and a tri-radius in the centre of the pattern. A loop has one tri-radius, laterally placed, with the open aspect diverted to the

radial or ulnar aspect of the digit. Whorls have two or more tri-radii and both true whorls and composites are included under this heading.

Analysis of the palm prints was restricted to determining the frequency of patterns in the third inter-digital space, which has been done by Fang (1950). He has published the only qualitative dermatoglyphic data available for the palm prints of the normal British population. Fang gives clear descriptions of dermatoglyphic configurations found in the third inter-digital space and his definitions of patterns were followed. The classification "pattern present" meant the presence of a whorl, loop, or vestigial loop in the third inter-digital space.

Results

Finger-Print Patterns

Table II gives the frequency of finger-print patterns in the male and female schizophrenic samples. Each is compared with the control group of the same sex.

Table II

Frequency of Finger-Print Patterns in Male and Female Schizophrenics Compared with Normal Population

	Males				Females			
	Schiz. (232)		Normal (500)		Schiz. (253)		Normal (500)	
Pattern	%	No.	%	No.	%	No.	%	No.
Whorls	28·6	664	28·3	1416	24·3	614	23·9	1196
Loops	67·3	1561	67·4	3370	72·1	1824	70·4	3520
Arches	4·1	95	4·3	214	3·6	92	5·7	284
	100	2320	100	5000	100	2530	100	5000

$\chi^2 = 0·717$, d.f. = 2, N.S.

$\chi^2 = 14·759$, d.f. = 2, $p < 0·001$
Difference between proportions:
Arches, C.R. = 3·95, $p < 0·001$

Schizophrenic males do not differ significantly from the control group. The difference in pattern frequency between the schizophrenic females and their control group is highly significant ($p < 0·001$). This can be largely attributed to the difference in the frequency of arches, which is highly significant ($p < 0·001$).

Analysis of the data in terms of types of symptoms, acuteness/chronicity and age of onset is not significant. However, analysis in terms of hebephrenic, catatonic, and paranoid schizophrenia does show consistent trends. The results are given in Tables III and IV.

Table III

Frequency of Finger-Print Patterns in Male Schizophrenic Sub-Categories

	Paranoid (85)		Hebephrenic (121)		Catatonic (26)	
Pattern	%	No.	%	No.	%	No.
Whorls ..	29·9	254	27·9	337	28·1	73
Loops ..	66·3	564	67·8	821	67·7	176
Arches ..	3·8	32	4·3	52	4·2	11
	100	850	100	1210	100	260

$\chi^2 = 1·276$, d.f. = 4, N.S.

Table IV

Frequency of Finger-Print Patterns in Female Schizophrenic Sub-Categories

	Paranoid (127)		Hebephrenic (93)		Catatonic (33)	
Pattern	%	No.	%	No.	%	No.
Whorls ..	23·1	293	26·3	245	23·0	76
Loops ..	72·7	924	71·6	666	70·9	234
Arches ..	4·2	53	2·1	19	6·1	20
	100	1270	100	930	100	330

$\chi^2 = 15·597$, d.f. = 4, $p < 0·01$
Significance of difference between proportions:

Arches
Hebephrenic *v.* Catatonic. C.R. = 3·47, $p < 0·001$
Hebephrenic *v.* Paranoid. C.R. = 2·79, $p < 0·01$

Whorls
Hebephrenic *v.* Paranoid. C.R. = 1·76, $p < 0·08$, N.S.

The overall test of association is not significant for the males, but is so for the females ($p < 0·01$). Both male and female hebephrenics show a deviation towards the whorl frequency of the opposite sex. The female hebephrenics also show a decrease in the proportion of arches, differing significantly from the paranoid and catatonic schizophrenics.

Palm Prints

(*a*) *Patterns in the Third Inter-digital Space*

Table V gives the frequency of third inter-digital space patterns in the schizophrenics.

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The normal values are obtained from Fang's (1950) data. He found little sex difference in the pattern frequency and the values for males and females are pooled.

TABLE V

Frequency of Patterns in the Third Palmar Inter-digital Space of Schizophrenic and Normal Subjects

	Schizophrenic (366)		Control (926)	
	%	No.	%	No.
Pattern	47·4	347	42·5	787
No pattern	52·6	385	57·5	1065
	100	732	100	1852

$\chi^2 = 5{\cdot}136$, d.f. = 1, $p < 0{\cdot}05$

The schizophrenics have a significantly higher frequency of third inter-digital patterns than the controls ($p < 0{\cdot}05$).

In Table VI the frequencies of third inter-digital patterns are given for the schizophrenic sub-categories. The overall test of association is significant.

TABLE VI

Frequency of Patterns in the Third Palmar Inter-digital Space of Schizophrenic Sub-Categories

	Paranoid (159)		Hebephrenic (166)		Catatonic (41)	
	%	No.	%	No.	%	No.
Pattern	42·8	136	49·4	164	57·3	47
No pattern	57·2	182	50·6	168	42·7	35
	100	318	100	332	100	82

$\chi^2 = 6{\cdot}500$, d.f. = 2, $p < 0{\cdot}05$

Significance of difference between proportions:

Catatonic *v.* Paranoid, C.R. = 2·36, $p < 0{\cdot}02$

The frequency of patterns present is greatest in the catatonics, and is significantly higher than in the paranoid schizophrenics ($p < 0{\cdot}02$). Although the hebephrenic pattern frequency is also higher than the paranoid schizophrenic frequency the difference between proportions does not reach a significant level ($p < 0{\cdot}06$).

(*b*) *Lr!*

The frequency of the pattern designated Lr! by Pons (1959) has also been determined. There are 11 (1·5 per cent.) such patterns in a total of 732 palm prints. In Pons' control group of Spaniards the incidence is 0·6 per cent. The frequency of Lr! in the British population is not known.

CONCLUSIONS

The discrepancies between the findings in earlier investigations of schizophrenic finger-print patterns may be partly explained by the present results. Variation in pattern frequency is associated with the schizophrenic sub-category. Hebephrenics show the reduction in sex difference found by Poll (1935), Møller (1935), and Duis (1937). The females in Beckman and Norring's (1963) study showed a similar deviation towards the opposite sex. All these findings could be due to a relatively greater proportion of hebephrenics in the schizophrenic sample. It is more difficult to find a reason for the increase in frequency of whorls reported by Raphael and Raphael (1962) and Beckman and Norring (1963) in male schizophrenics. In the present investigation male paranoid schizophrenics showed an increase in whorl frequency but it was not significant. Nevertheless perhaps there was a preponderance of paranoid schizophrenics in the published work.

The present results suggest a possible association between an increased frequency of third inter-digital space patterns and catatonic schizophrenia. An association between mongolism and this dermatoglyphic character is well established. Fang (1950) found a frequency of 75·3 per cent. in the palm prints of 205 subjects with mongolism. This is 23 per cent. greater than the normal and 8 per cent. more than the catatonic schizophrenics. Some support for a relationship between catatonia and mongolism will be found in the Discussion in Part II.

The results show an association between the frequency of certain qualitative dermatoglyphic characters and the sub-categories of schizophrenia. These patterns are largely genetically determined but the mechanism of inheritance is complex. The nature of the association can be better evaluated by using quantitative dermatoglyphics, the genetics of which are better understood.

Part II: Quantitative Study

The inheritance of dermatoglyphic characters has been extensively studied. Qualitative studies of the frequencies of pattern types in families, reviewed by Cummins and Midlo (1943), have suggested a genetic mechanism but failed to elucidate the mode of inheritance. This difficulty has been largely resolved by measuring some feature of the pattern. Holt (1961b) studying a British population, found that the total finger ridge-count (the sum of an individual's ten ridge counts) is almost wholly determined by a small number of neutral genes of additive effect. The contribution from environmental factors which must operate during the third and fourth month of foetal life when the ridges are developing is estimated to be about 5 per cent.

Quantification of the palm print patterns is more difficult because of their complexity. Penrose (1954) has used the atd angle to replace the qualitative differentiation of the axial triradii of the palm as t, t′ and t″. The results of family studies suggest a recessive mode of inheritance. The early pre-natal environment has greater effect on the atd angle than on the total finger ridge-count.

The finger prints of 232 men and 253 women and the palm prints of 177 men and 189 women, as described in Part I of this paper, were measured.

Method

The method of ridge counting is fully described by Holt (1949) who gives figures for a normal British population (largely from London and Birmingham) which can be compared with those of the present study obtained in Birmingham, Lichfield, Manchester and Macclesfield, in the absence of any evidence of regional differences in dermatoglyphics.

Rolled finger-prints are used. The ridge-count is the number of ridges cut by a straight line drawn between the triradius and core of the pattern. The triradius and core are not counted. The ridge-count for an arch is 0, because the arch has no triradius. A loop, which has one triradius, has one ridge-count, and a whorl, which has two triradii, has two ridge-counts. Only the larger of the two whorl counts is used for the total finger ridge-count, which is the sum of the ridge-counts from an individual's fingers.

The instructions for determining the atd angle of the palm are given by Penrose (1954), who gives normal values for a British sample. The palmar triradii a, d and the axial t are delineated. The atd angle is subtended by the most medial d triradius and the most lateral a triradius at the most distal axial, or t triradius. An individual's left and right atd angles are added to give the sum of atd angles.

Results

Total Finger Ridge-Count

The means for the total finger ridge-counts of the schizophrenics are given in Table VII. They are compared with the means of the normal sample of the same sex.

The difference between the male means is highly significant ($p < 0.001$), but for the

Table VII

Total Finger Ridge-Counts in Schizophrenic and Normal Samples

Subjects	No.	Mean	S.D.	Significance of Difference
Male				
Schiz.	232	132·24	45·01	$t = 3.695$, d.f. = 1055
Normal	825	144·98	51·08	$p < 0.001$
Female				
Schiz.	253	134·20	49·07	$t = 1.944$, d.f. = 1076
Normal	825	127·23	52·51	$0.1 > p > 0.05$

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females does not reach an acceptable level of significance. The means of the schizophrenics deviate from normal towards the means of the opposite sex.

Analysis of variance of the total finger ridge-counts of the schizophrenics fails to show significant differences between the catatonic hebephrenic and paranoid sub-categories, and between the acute and chronic groups. The interaction between the diagnostic sub-categories and acuteness/chronicity is not significant. Analysis of variance of the acute schizophrenics' total finger ridge-counts shows no significant differences between patients with different categories of schizophrenic symptoms.

The total finger ridge-count means for the hebephrenic catatonic and paranoid schizophrenic sub-categories show a similar pattern in both sexes. The hebephrenic and paranoid schizophrenics both deviate from their normal mean towards the normal mean of the opposite sex and these deviations are the same size in both sexes. They are greater in hebephrenics. The catatonic schizophrenics of both sexes have smaller mean total finger ridge-counts than normal and the means are of the same order.

When the means of the schizophrenic sub-categories are compared with those of normals of the same sex the preliminary analysis of variance shows a significant difference between the male means. It is therefore permissible to make individual comparisons between the normal mean and the means of the schizophrenic sub-categories. The difference between the female means is not significant on analysis of variance and so individual comparisons cannot be made. The total finger ridge-count means for the schizophrenic sub-categories are given in Table VIII with the differences from the normal mean and the significances of these differences.

The difference between the normal mean and the mean of the male catatonics is highly significant, $p < 0{\cdot}01$. The difference between the normal and hebephrenic means is also significant ($p < 0{\cdot}05$). The probable reason for the female "difference between means" not reaching significance is that the mean of the catatonics is less than the normal and the means of the hebephrenic and paranoid schizophrenics are greater. All the male means are less than the normal.

The Sum of atd Angles

The means of the sum of the atd angles for the schizophrenics are given in Table IX. They are compared with the sample of normals of the same sex.

The means of the male and female schizophrenics are higher than those of normals of the same sex, and the differences between the means are highly significant ($p < 0{\cdot}01$).

TABLE VIII

Total Finger Ridge-Count Means in Schizophrenic Sub-Categories and Difference from Normal of Same Sex

Subjects	No.	Mean	S.D.	Difference from Normal Mean	Significance of Difference
Male[1]					
Normal	825	144·98	51·08		
Hebephrenic ..	121	133·11	50·02	−11·87	t = 2·432,* d.f. = 944
Paranoid ..	85	136·24	40·38	−8·74	N.S.
Catatonic ..	26	115·08	51·00	−29·90	t = 2·992,† d.f. = 849
Female[2]					
Normal	825	127·23	52·51		
Hebephrenic ..	93	139·11	47·31	+11·88	
Paranoid ..	127	134·80	46·91	+7·57	
Catatonic ..	33	117·25	48·35	−9·98	

*$p < 0{\cdot}05$, † $p < 0{\cdot}01$

[1] Males, analysis of variance, "between sample means" $p < 0{\cdot}01$.

[2] Females, analysis of variance, "between sample means" not significant.

TABLE IX

Sum of Palmar atd Angles in Schizophrenic and Normal Samples

Subjects	No.	Mean	S.D.	Significance of Difference
Male				
Schiz.	177	89·10	15·78	t = 2·974, d.f. = 685
Normal	510	85·04	15·27	p < 0·01
Female				
Schiz.	189	92·50	15·95	t = 4·741, d.f. = 697
Normal	510	85·92	15·70	p < 0·01

TABLE X

Means of the Sum of Palmar atd Angles of Schizophrenic Sub-categories compared with Normal Samples

Subjects	No.	Mean	S.D.	Difference from Normal Mean	Significance of Difference
Male[1]					
Normal	510	85·04	15·27		
Catatonic ..	17	94·42	16·62	+9·38	t = 2·295,* d.f. = 525
Paranoid ..	63	89·36	16·00	+4·32	t = 2·032,* d.f. = 571
Hebephrenic ..	97	87·99	15·82	+2·95	t = 1·692, d.f. = 605
Female[2]					
Normal	510	85·93	15·70		
Catatonic ..	24	101·71	24·71	+15·78	t = 2·792,† d.f. = 532
Paranoid ..	96	90·64	12·21	+4·71	t = 3·301,† d.f. = 604
Hebephrenic ..	69	91·90	15·56	+5·97	t = 2·988,† d.f. = 577

*p < 0·05
† p < 0·01
[1] Analysis of variance, "between sample means," p < 0·01.
[2] Analysis of variance, "between sample means," p < 0·01.

Analysis of variance gives a highly significant difference between the means (p < 0·01) of the schizophrenic sub-categories and the normal samples. Individual tests of significance of the difference between the normal and the means of the paranoid hebephrenic and catatonic schizophrenics can then be made. The results are given in Table X.

All the means of the female schizophrenic sub-categories are significantly higher (p < 0·01) than the normal. The means of male catatonic and paranoid schizophrenics also differ significantly from the normal (p < 0·05). The catatonic schizophrenics have the highest mean sum of atd angles.

Analysis of variance of the sum of atd angles in terms of acuteness or chronicity, and diagnostic sub-categories gives a significant difference between the sub-categories in the females, but not in the males. The results for the females are given in Table XI. All possible differences between the means of the three sub-categories can be examined by Scheffé's method, as

TABLE XI

Female Schizophrenics, Analysis of Variance Sum of Palmar atd Angles in Terms of Diagnostic Sub-Categories and Acuteness or Chronicity

Source	D.F.	S.S.	M.S.	Variance Est.
Diagnosis ..	2	2,394	1,197	4·822†
Chronic/Acute	1	7	7	
Interaction ..	2	245	122·5	
Residual ..	183	45,426	248·23	
Total	188	48,072		

†p < 0·01

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described by McNemar (1962). The catatonic mean is significantly higher than the means of the hebephrenic and paranoid schizophrenics.

TABLE XII

Significance of Difference between Means of Diagnostic Sub-Categories, Scheffé's Method

Difference/Sampling Error Variance			
	Mean	Paranoid	Hebephrenic
Catatonic ..	101·71	3·638†	3·104†
Hebephrenic ..	91·90	0·599	0
Paranoid ..	90·64	0	

Confidence limits: $p < 0.05$*, Scheffé's $K > 2.473$
$p < 0.01$†, Scheffé's $K > 3.082$

DISCUSSION

These findings may be interpreted by looking for an association between schizophrenia and those conditions with similar dermatoglyphics. Alternatively the schizophrenic sample may differ dermatoglyphically from the general population only by virtue of the relative frequencies of the normal genes controlling dermal ridge formation.

The dermatoglyphic findings in catatonic schizophrenia resemble those in mongolism. In the catatonics the means of the total finger ridge-counts of both sexes were reduced. Holt (1964b) similarly found the mean total finger ridge-count of male mongols was 130·29 and for females 124·44. The means of the sum of the atd angles in catatonics were greater than the values for normals and the other two schizophrenic sub-categories. Penrose (1954) found the means of the sum of the atd angles increased in mongolism, the value for male mongols being 137·31 and for females 138·72.

This similarity between the quantitative dermatoglyphic characters in catatonic schizophrenia and in mongolism is supported by the results of the qualitative investigation in Part I. An increased frequency of patterns in the third interdigital space was found in the palm prints of schizophrenics. The frequency was highest in the catatonic sub-category, being approximately midway between normal and the value in mongols found by Fang (1950).

Walker (1956) has suggested the possibility of a relationship between mongolism and schizophrenia. She described two families in which the last born children had mongolism. The siblings immediately before the mongols in birth order developed schizophrenia. These schizophrenic siblings had dermatoglyphics characteristic of mongolism but were otherwise normal and of average intelligence. One of them developed catatonic schizophrenia. The diagnosis of schizophrenia in patients with mongolism obviously presents considerable difficulties. Earl (1934) described psychoses occurring in low grade defectives. In mongols he found catatonic symptoms which he considered were evidence of true schizophrenia. Rollin (1946) has described a primitive type of catatonic schizophrenia occurring in a group of disturbed mongols.

The mean total finger ridge-counts of both hebephrenic and paranoid schizophrenics deviated towards the normal mean of the opposite sex. These deviations were greater in hebephrenics. Changes in the same direction are found in Klinefelter's and Turner's syndrome. Penrose (1967) gives the mean total finger ridge-counts for Klinefelter's syndrome as 133·6 and for Turner's syndrome as 178·6. In a review of the psychopathology of Klinefelter's syndrome by Pasqualini *et al.* (1957), there are no cases with schizophrenia. In a later review, however, Hoaken *et al.* (1964) cite three reports of schizophrenia in this condition and describe a case of their own. The frequency of chromatin-positive males among schizophrenics was found by Polani (1961) and Tedeschi and Freeman (1962) to exceed that expected (5 out of 530 and 3 out of 248 respectively). Cowie *et al.* (1960) did not find any chromatin-positive males among 100 schizophrenics.

There are few accounts of abnormal mental states in Turner's syndrome. Slater and Zilkha (1961) described a case of XO mosaicism who had an episode of mental illness diagnosed as schizophrenia. In the four cases of Turner's syndrome described by Mellbin (1966) one had schizophrenia and he quotes Milcu *et al.* (1964) who give an account of a similar case.

An increased maternal age has been reported in patients with chromosome abnormalities in

which non-disjunction during oogenesis is of aetiological importance. The evidence in mongolism has been reviewed by Penrose and Smith (1966). An increased maternal age has been reported for XXY males by Court Brown *et al.* (1964). An increased maternal age in schizophrenics has been reported by Barry (1945) and Goodman (1957), but Granville-Grossman (1966) was unable to confirm these findings.

Raphael and Shaw (1963) and Money and Hirsch (1963) made karyotype surveys of schizophrenics and found the frequency of abnormalities was about 1 per cent. None of the subjects in the present investigation showed the physical stigmata associated with an abnormal karyotype and all, as far as could be determined, were of normal intelligence. It would therefore seem unlikely that our dermatoglyphic findings could be attributed to undetected chromosome abnormalities.

Holt (1961b) has made an extensive study of family data on the total finger ridge-count and has deduced that inheritance is due to a small number of additive genes without dominance. The smaller mean total finger ridge-count in paranoid and hebephrenic males may be due to a relative increase in the frequency of low count genes in the schizophrenic sample compared with the normal population. The converse would apply for the female sample.

Such a shift in gene frequency can only be explained in terms of genetic theories of schizophrenia. Huxley *et al.* (1964) favoured the monogenic theories propounded by Böök (1953) and Slater (1958). The penetrance and expressivity of the single gene is modified by environmental factors and other genes. The genes determining the total finger ridge-count may therefore act as modifying genes. If this hypothesis applied the greater the difference from the normal mean total finger ridge-count the greater would be the dose of adverse modifying genes. Hebephrenia should therefore be a severer phenotypic manifestation of the schizophrenic genotype than paranoid schizophrenia. This accords with Kraepelin's (1919) view of hebephrenia as the most unfavourable form of the illness.

Penrose (1967) has suggested that the total ridge-count is an autosomal trait which is independently influenced by the sex chromosomes. Basing his study on the total finger ridge-count in patients with sex chromosome abnormalities, he attributes the non-specific influence of the sex chromosomes to the chromosome size. The less the amount of chromosome material the greater the amount of cellular oedema, and consequently male cells are relatively more oedematous. The finger bulbs are greater in size and therefore there is an increase in the pattern size. The findings in the present investigation can only be explained on this hypothesis by postulating that cells of female hebephrenics are for some reason more oedematous than normal and those of males less so. If the deviations from the normal total finger ridge-count mean found in this investigation are due to a change in frequency of the autosomal genes then the effects of these genes, increasing the count in females and decreasing it in males, would be diminished by the mechanism suggested by Penrose.

The possible nature of a relationship between schizophrenia and the total finger ridge-count is difficult to envisage. The association between physical habitus and schizophrenic sub-category has been reviewed by Rees (1957). Leptosomatic body build is more closely related to the development of hebephrenic than paranoid schizophrenia. The total finger ridge-count as a measure of the finger-print pattern size could be a pleiotropic effect of genes determining body build.

The results of this investigation require confirmation, preferably using a different racial sample. Unfortunately published quantitative dermatoglyphic data are limited for populations other than British. The results warrant karyotype studies of individual catatonic schizophrenics in whom the dermatoglyphics vary widely from the normal. The possible relationship between finger-print pattern size and body build might be investigated in normal as well as schizophrenic subjects.

Summary

Part I studies the qualitative and Part II the quantitative dermatoglyphics in 232 men and

253 women suffering from schizophrenia. Diagnostic criteria and other important variables were controlled.

The finger-print patterns of the women, particularly the hebephrenics, differed significantly from those of normal women, and approached those of normal men. There was no pattern difference, however, between normal and schizophrenic men.

The palm prints of 366 schizophrenic individuals, particularly the catatonics, showed a significant increase in pattern frequency in the third interdigital space compared with the normal.

Contradictory findings of previous investigations are explained by the relative proportions of the different schizophrenic sub-categories in their total samples.

The mean total finger ridge count of 232 schizophrenic men was significantly lower than the mean for normal men, while the mean for the 253 women was slightly, but not significantly, higher than for normal women. There were quantitative differences between the diagnostic sub-categories.

The mean sum of the atd angles of the palm prints was significantly higher in both sexes who were schizophrenic, particularly the catatonics, than in normals.

The findings in catatonic schizophrenia resemble those in mongolism. It is suggested that the genes determining dermatoglyphic characters may also modify the expression of the schizophrenic genotype.

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