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Dermatoglyphic Traits in Koreans

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한국인의 지문

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적 요

한국인 2,925명 (남자:804, 여자:2,121)에 대하여 지문형과 pattern intensity index를 분석하였다. 지문형의 출현빈도는 남녀의 성차가 있었다. Whorls (남자 : 53.6%, 여자 : 45.7%)와 Radial loops (남자 : 2.9%, 여자 : 2.2%)는 남자에서 높이 나타났고, 반면 Archs (남자 : 1.9%, 여자 : 2.9%)와 Ulnar loops (남자 : 41.6%, 여자 : 49.2%)는 여자에서 출현빈도가 높았다. Pattern intensity index는 남자가 15.2가, 여자는 14.3으로 남자에서 높았다.

Polygene model의 유전을 하는 양적 형질인 지문 총 융선수를 776명(남자 : 426, 여자 : 350)에 대하여 계산한 결과 총 융선수는 남자가 140.4±41.2로 여자의 129.8±40.6보다 높았다. 지금까지 다른나라에서 보고된 총 융선수는 인종에 따라 121~170으로 인종적 차가 있었다. 총 융선수와 지능지수와의 상관관계는 없었다(r=−0.0027, N=343).

INTRODUCTION

Ridge configurations are genetically controlled, and the details of ridge arrangement are different in every individual. Dermal ridge differentiation occurs in early fetal development (Babler, 1978; Suzumori, 1980; Okajima *et al.*, 1981). From this time of formation until death, the dermal ridge character keeps up with growth in size, but its configuration does not change with aging.

Because of the above factors, a variety of finger ridge configurations have been studied by geneticists and anthropologists and used for personal identification. Although never

conclusive, ridge configuration is also an important aid in diagnosis of twin zygosity (Asaka, 1976; Lamy *et al.*, 1957) and congenital defects.

Racial and sex differences in dermatoglyphic variation are well documented in normal populations (Dankmeijer, 1938; Bener, 1979). Dermatoglyphic variation has also been found to occur in the presence of some chromosomal variations (Penrose, 1963; 1969; Penrose and Loesch, 1970a; 1970b; Suzumori, 1980; Okajima *et al.*, 1981) and in a number of disorders of some genetic etiology (Raphael and Raphael, 1962; Mellor, 1968). Much of the work on the subject has been admirably reviewed by Schaumann and Alter (1976).

This paper presents an investigation of the frequencies of qualitative and quantitative dermatoglyphic characteristics in Koreans. The frequencies of finger print patterns, the mean of total finger ridge count and the pattern intensity index of the Korean population were comparied with other racial populations as described in the literature.

The present study also extends the analysis of correlation between total ridge count and intelligence quotient (IQ).

SUBJECTS AND METHODS

The finger prints were taken from 2,925 children. The subjects, who consisted of 804 male and 2,121 female school children, were resident in Seoul, Korea.

Finger and palm prints were recorded with black ink. The finger print patterns, total ridge count and pattern intensity were analyzed. Clasification of pattern types and ridge counting followed the methods of Cummins *et al.* (1929), Schaumann and Alther (1976) and Alter (1966).

The ridge patterns of the fingertips were simply classified into four groups: arch, ulnar loop, radial loop and whorl. The classification of the group depends on the number of triradii present. The simple arch has no triradius and tented arch has a triradius in the center of the pattern. Both patterns include an arch. A loop has one triradius, laterally placed, with the ridge aspect open toward the ulnar side or radial diverted to ulnar loop and radial loop respectively. Whorls have two or more triradii and their pattern and size vary considerably. Ridges with a simple whorl arranged in a succession of concentric rings or ellipses are described as concentric whorls, while another configuration which spirals around the core in either a clockwise or a counter-clockwise direction is called a spiral whorl. A central pocket whorl is a pattern containing a loop within which a smaller whorl is located. In a twin loop the ridges emanate from each core, opening toward the opposite margin of the finger. In a lateral pocket loop whorl, ridges emanating from the core emerge on the same side of the pattern. Both types are grouped together as a double loop whorl. The simple whoral, central pocket whorl, and double loop whorl are all included in this study as whorls.

The ridge count is the number of ridges along a straight line connecting the triradius and core of the pattern. The triradius and core are not counted. The ridge count for an arch, both simple and tented, is zero. For a loop, there is a count of one. A whorl possesses two triradii, which have two different counts. Each count is made along a line drawn between the triradial point and the nearer point of the core.

A total finger ridge count represents the sum of the ridge counts of an individual's ten fingers. When in whorl patterns, only the larger count is used.

The pattern intensity index is expressed by counting the total number of triradii found on fingers per individual.

IQ was measured according to the test developed by Whang and Kim (1979).

RESULTS AND DISCUSSION

Frequency of finger print patterns and pattern intensity index,

The percentages of frequencies of finger print patterns of right and left hands in males and females for the Korean population are given in table 1. Finger print patterns of the left and right hands of the same individual are never exactly identical.

The relative frequencies of finger print patterns for males and females differ markedly in prenatal and postnatal samples. Babler (1978) analyzed fetal samples in which males had a higher frequency of arches than females (14.8% versus 12.2%) and a lower frequency of whorls. He suggested that the likelihood of spontaneous abortion was higher for fetuses with arches.

A difference in frequency of finger print patterns is not limited to the sexes, but also exists among different ethnic groups. Table 2 lists the frequencies of finger print patterns and pattern intensity indexes in different racial groups in each sex found in previous investigations. Females have generally lower frequencies of whorls and radial loops, but a higher number of arches and ulnar loops. These findings obtain irrespective of racial group.

Different ethnic groups exhibit highly significant variation in the frequency of pattern types of fingers: arches, radial loops, ulnar loops and whorls. For example, whorls vary

Table 1. Percentages of finger print patterns in males and females of the Korean population

	Males (N=804)				Females (N=2, 121)			
	Arch	Radial loop	Ulnar loop	Whorl	Arch	Radial loop	Ulnar loop	Whorl
Left hand	2.1%	2.6%	44.1%	51.2%	3.5%	2.6%	48.0%	45.9%
Right hand	1.7%	3.2%	39.1%	56.0%	2.3%	1.8%	50.4%	45.5%
Total	1.9%	2.9%	41.6%	53.6%	2.9%	2.2%	49.2%	45.7%

Table 2. The percentage frequencies of finger print patterns and pattern intensity indexes in different racial groups

	Number	PII*	Arch	Radial loop	Ulnar loop	Whorl	Authors
Koreans							
males	N= 804	15.2	1.9%	2.9%	41.6%	53.6%	present
females	N=2,121	14.3	2.9%	2.2%	49.2%	45.7%	study
males	N=6,768	14.6	2.3%	3.5%	46.2%	48.0%	Kunifusa,**
females	N=1,225	14.1	3.9%	2.7%	48.1%	44.9%	1937
Japanese							
males	N= 305	14.7	1.6%	3.4%	46.7%	48.3%	Matsuda,
females	N= 306	14.1	2.0%	2.5%	53.2%	42.4%	1973
Javanese							
males	N=1,000	13.3	2.7%	2.8%	58.5%	35.9%	Dankmeijer,
females	N=1,000	12.9	3.3%	2.1%	61.9%	32.7%	1938
Negroes	N= 343	12.2	6.4%	2.9%	61.9%	28.5%	Dankmeijer, 1938
Indian(Uttar Pradesh) Tharus							
males	N= 379	13.8	3.9%	1.8%	52.9%	41.4%	Srivastava,
females	N= 300	13.6	4.2%	1.6%	53.8%	40.5%	1965
Papua New Guinea & Faroe Islands							Suter & Harvey, 1981
Karkar							
males	N= 283	15.2	0.8%	0.4%	46.1%	52.7%	
females	N= 325	14.8	1.8%	0.2%	48.0%	50.1%	
Lufa							
males	N= 215	14.1	1.4%	1.0%	54.9%	42.7%	
females	N= 182	14.6	1.1%	0.6%	51.3%	47.0%	
South African Bushmen							Cummins, 1955
Kun							
males	N= 164	10.2	13.0%	3.8%	68.1%	15.1%	
females	N= 181	9.8	19.4%	2.9%	60.7%	17.1%	
Barakwéngo							
males	N= 44	12.6	5.2%	2.7%	61.4%	30.7%	
females	N= 61	11.6	9.6%	0.8%	63.8%	25.9%	
Kánikwe							
males	N= 23	13.2	7.0%	3.0%	51.3%	38.7%	
females	N= 34	12.6	6.2%	3.2%	58.5%	32.1%	
Haikom							
males	N= 17	12.8	2.4%	3.5%	63.5%	30.6%	
females	N= 20	11.4	10.5%	4.0%	61.0%	24.5%	

* PII: Pattern Intensity Index. ** As cited in Kimura, 1974.

considerably from 53.6~45.7% (males-females) among Koreans to 2.4~10.5% among the Haikom bushmen of South Africa. Table 2 illustrates the high variability of pattern type frequencies among racial groups.

The pattern intensity index are 15.2 for male and 14.3 for female in the present sample. Females have a lower finger pattern intensity than males (Ducros, 1978). The pattern intensity index has been used to compare the frequencies of finger print patterns in different populations. The pattern intensity index shows a variation of 15.2~9.8 for countries in different parts of the world (Palto and Gajdusek, 1972) (table 2).

Frequency distribution of total ridge count.

Figure 1 shows the distribution of total finger ridge count for 426 males and 350 females. The mean for males (140.4±41.2) is higher than that of females (129.8±40.6). This result is similar to that found by other researchers (Ducros, 1978). The means for the sexes are highly significant different ($t=3.59$, $p<0.0001$). This may be largely associated with different finger patterns, because of the lower whorl frequencies for females than for males.

Although ridge counting is a somewhat arbitrary measurement, it is a way of expressing pattern size. There is wide agreement that most dermatoglyphic configurations conform to heritability. Holt (1952, 1956, 1957) has made analyzes of total ridge count in families. According to Holt, the inheritance of total ridge count is due to additive genes, with dominance almost absent.

Table 3 compares the means of different countries' populations of the same sex. In

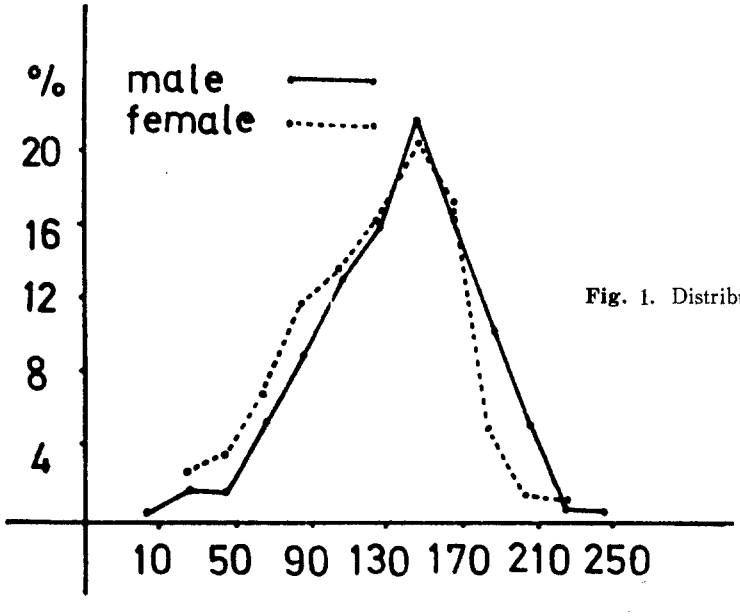

Fig. 1. Distributions of total ridge count

Table 3. Means for total ridge count in different racial population

Racial	Male		Female		Authors
	Mean	No.	Mean	No.	
Korean	140	N=426	130	N=350	present study
Eskimo	170	N=100	161	N=100	Ducros, 1978
Papua New Guinea & Faroe Islands					Suter & Harvey, 1981
Karkar	161	N=283	153	N=325	
Lufa	153	N=215	152	N=182	
Japanese	151	N=313	142	N=313	Matsuda, 1973
British	145	N=825	127	N=825	Holt, 1955
Portuguese	141	N=100	126	N=100	da Cunha & Abreu, 1954
Swedish	140	N=204	121	N=188	Böök, 1957
French	132	N=351	121	N=360	Lamy et al., 1957
Indian					
Uttar Pradesh Tharus	131	N=279	122	N=215	Srivastava, 1965

almost every country, the total finger ridge count of males is higher than that of females. However, there are some differences in total finger ridge count among different racial groups. The Korean data seems to be lower than intermediate level.

No correlation between total ridge count and IQ was found in this study ($r=-0.0027$, $N=343$).

There are inborn anomalies in dermatoglyphic patterns: aplasia, dissociation, and ridges-off-the end.

Ridge aplasia is a very rare congenital malformation of epidermal ridge characterized by absence of the ridge over the hands. In this study, any aplasia was not found. Baird (1964) noted that this syndrome was inherited through autosomal dominant genes.

Dissociated ridges are also rare dermatoglyphic traits among normal individuals, but relatively frequent in certain medical diseases. They seem to be inherited as an autosomal dominant gene with incomplete penetrance (David, 1973a, 1973b) or sporadically. Dissociated ridges are broken into short pieces so that they look like dots, rather than like a line. There is one ridge dissociation in this sample. Furuya (1961) also investigated ridge dissociation in healthy Japanese individuals. Raphael and Raphael (1962) found an increased frequency of ridge dissociation with schizophrenia, but other studies (Mellor, 1968) failed to confirm the report of an increased frequency of ridge dissociation with schizophrenia.

Ridges-off-the-end have been described as one of the features of a dermatoglyphic syndrome which is an autosomal dominant trait (David, 1973a). This is an arrangement in which the ridges vertically run off the end of the fingertip instead of transversing it. No

ridges-off-the-end were found in this study.

SUMMARY

The frequencies of finger print patterns and the pattern intensity index among 2,925 Koreans (804 males, 2,121 females) are analyzed. Total finger ridge counts was calculated for 776 Koreans (426 males and 350 females). Comparisons are made with results among other racial populations in a review of the literature.

Certain differences exist between males and females in both qualitative (finger print pattern) and quantitative (total ridge count) dermatoglyphic traits. Males have higher frequences of whorls (53.6% for males, 45.7% for females), and radial loops (2.9% for males, 2.2% for females), while the frequencies of archs (1.9% for males, 2.9% for females) and ulnar loops (41.6% for males, 49.2% for females) are higher in females.

The pattern intensity index for males (15.2) was higher than that for females (14.3).

The mean of the total ridge count was higher (140.4±41.2) in males than in females (129.8±40.6).

There was no correlation between total ridge count and IQ ($r=-0.0027$, $N=343$).

Total ridge count among different racial groups was found to vary slightly.

REFERENCES

Alter, M., 1966. Dermatoglyphic analysis as a diagnostic tool. *Medicine* **46**:35-56.

Asaka, A., 1976. Correlation coefficients of pattern intensity of fingers (PI) in twin families. *Jap. J. Human Genet.* **21**:127-129.

Babler, W.J., 1978. Prenatal selection and dermatoglyphic patterns. *Am. J. Phys. Anthrop.* **48**:21-28.

Baird, H.W., 1964. Kindred showing congenital absence of the dermal ridges (fingerprints) and associated anomalies. *J. Pediatr.* **64**:621-631.

Bener, A., 1979. Sex differences and bilateral asymmetry in dermatoglyphic pattern elements on the fingertips. *Ann. Hum.*, Lond. **42**:333-342.

Böök, J.A., 1957. Frequency distributions of total finger ridge-counts in the Swedich population. *Herditas* **43**:381-389.

Cummins, H., H.H. Keith, C. Midlo, R.B. Montgomery, H.H. Wilder and I.W. Wilder, 1929. Revised methods of interpreting and formulating palmar dermatoglyphics. *Am. J. Phys. Anthro.* **12**:415-473.

Cummins, H., 1955. Dermatoglyphics of Bushmen (South Africa). *Am. J. Phys. Anthrop.* **13**:699-709.

da Cunha, A.X. and M.D.A. Abreu, 1954. Impressoes digitais de Portuguese. *Contri Antrop.* Portug. **5**:315.

Dankmeijer, J., 1938. Some anthropological data on finger prints. *Am. J. Phys. Anthropol.* **23**:377-388.

David, T.J., 1973a. Ridges-off-the end syndrome in two families, and a third family with a new syndrome. *Hum. Hered.* **23**:32-41.

David, T.J., 1973b. Severe ridge dissociation and "ridges-off-the-end" in the same person. *Hum. Hered.* **23**:42-45.

Ducros, J., 1978. Finger ridge counts of the Ammassalimiut Eskimo of Greenland and other Eskimo population groups: The founder effect and interbreeding. *Man.* **13**:651-656.

Furuya, Y., 1961. Genetics of patternless finger dermatoglyphe. *Jap. J. Human Genet.* **6**:102-117.

Holt, S.B., 1952. Genetics of dermal ridges: inheritance of total finger ridge-count. *Ann. Eugen.* (London) **17**:140-161.

Holt, S.B., 1955. Genetics of dermal ridges: frequency distributions of total finger ridge-count. *Ann. Hum. Genet.* (London) **20**:159-163.

Holt, S.B., 1956. Genetics of dermal ridges: parent-child correlations for total finger ridge-count. *Ann. Hum. Gent.* (London) **20**:270-281.

Holt, S.B., 1957. Genetics of dermal ridges: sib-pair correlations for total finger ridge-count. *Ann. Hum. Gent.* (London) **21**:352-362.

木村邦彦, 1974. 皮膚紋理의 人類學的應用. 遺傳. **28**:22-29.

Lamy, M., J. Frézal, J. De Grouchy and J. Kelly, 1957. Le nombre de dermatoglyphes dans un échantillon de jumeaux. *Ann. Hum. Genet.* (London) **21**:374-385.

Matsuda, E., 1973. Genetic studies on total finger ridge count among Japanese. *Jap. J. Human Genet.* **17**:293-318.

Mellor, C.B., 1968. Dermatoglyphics in schizophrenia. *Br. J. Psychiatry* **114**:1387-1397.

Okajima, M., H. Ikeuchi, and A. Tonomura, 1981. Dermatoglyphics of two fetuses with trisomy 21 diagnosed by amniocentesis. *Jpn. J. Human. Genet.* **26**:61-64.

Penrose, L.S., 1963. Finger prints, palms and chromosome. *Nature* **197**:933-938.

Penrose, L.S., 1969. Dermatoglyphics. *Scientific American* **221**:72-84.

Penrose, L.S., and D. Loesch, 1970a. Topological classification of palmar dermatoglyphics. *J. Ment. Defic. Res.* **14**:111-128.

Penrose, L.S. and D. Loesch, 1970b. Comparative study of sole patterns in chromosomal abnormalities. *J. Ment. Defic. Res.* **14**:129-140.

Plato, C.C. and D.C. Gajdusek, 1972. Dermatoglyphics of the Asmat and Tjitak peoples of West New Guinea. *Hum. Biol.* Oceania **1**:255-258.

Raphael, T. and L.G. Raphael, 1962. Fingerprints in schizophrenia. *J.A.M.A.* **180**:215-219.

Schaumann, B. and M. Alter, 1976. Dermatoglyphics in medical disorders. New York Springer-Verlag.

Srivastava, R.P., 1965. A quantitative analysis of the fingerprints of the tharus of Uttar Pradesh. *Am. J. Phys. Anthrop.* **23**:99-106.

Suter, D. and R.G. Hrvey, 1981. A developmental approach to the interpretation of dermatoglyphic data from Papua New Guinea and the Faroe Islands. *Annals of Human Biology* 8:161-170.

Suzumori, K., 1980. Dermatoglyphic analysis of fetuses with chromosomal abnormalities. *Am. J. Hum. Genet.* **32**:859-868.

黃禎奎, 金純澤, 1979. 知能綜合檢査. 大韓私立中高等學校長會