Dermatoglyphic Traits in Thai Schizophrenia Patients: A Matching Case-Control Study

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Objective: *To compare fingerprint patterns, means of dermatoglyphic variables i.e., total finger ridge count, total a-b ridge count, pattern complexity index, and fingerprint pattern asymmetry between patients with schizophrenia and normal controls.*
Material and Method: *A cross-sectional, matching case-control was conducted. Thirty-four males and 34 females with schizophrenia and an equal number of age and sex matched normal controls were selected. Fingerprints and partial palm prints of all of the subjects were obtained using the Automated Inkless Fingerprint Imaging Software and the transparent-adhesive tape technique, respectively. Using paired t-tests ($p < 0.05$), the cases and controls, males and females separately, were compared for fingerprint pattern asymmetry, total finger ridge counts (TFRC), a-b ridge counts of the right (RABRC), left (LABRC), and both hands (TABRC), and pattern complexity index (PCI).*
Results: *Between cases and controls, neither sex had any significant differences in the mean scores for the pattern asymmetries, TFRC, right-left-ABRC and TABRC. However, the mean scores for PCI were significantly different between the male cases and controls (2.82 vs. 4.94, $p = 0.009$).*
Conclusion: *Only male patients exhibited average scores for complex patterns (whorls minus arches less than 2), which might be a biomarker for screening of schizophrenia in males.*

Keywords: *Dermatoglyphics, Schizophrenia, Thai, Pattern complexity index, Finger ridge count, a-b ridge count*

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Dermatoglyphic traits are formed between the 11and 24 week of foetal development[1] and remain unchanged thereafter. They are largely determined by the parents' genetic profiles[2,3] and the intrauterine environment, with foetal stress leading to simpler patterns of fingerprints[4]. Each individual has a unique dermatoglyphic configuration, which skin and brain share similar ectodermal origins, and cells migrate to the cortex at this period[5-7]. Dermatoglyphic traits have been used in detecting the biological and genetic background of schizophrenia[8-11]. According to theory, neurode-velopmental instability influences schizophrenia[7,12,22]. As several different genes and environmental factors aggregate (addictively or interactively) to determine the risk, the ridge count may express abnormality of the illness[12,13]. Because of dermatoglyphic abnormalities, schizophrenia patients have lower total finger ridge counts (TFRC). Even though this finding has not been confirmed[1,8,4,15], clinical reports from as early as 1935 show that schizophrenic patients have a significantly high incidence of abnormal dermatoglyphics (finger, palm, and footprints). Similar reports now cover over 4,000 schizophrenic patients from Denmark, Sweden, Germany, Italy, Spain, England, Australia, Chile, Mexico, and the United States[16]. The authors hypothesized that subjects with schizophrenia would have lower total *a-b* ridge counts (TABRC), lower (TFRC), and a lower pattern complexity index (PCI) than their control pairs.

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Material and Method

The Ethics (Research) Committee Review Board of Khon Kaen University approved the present study protocols (IRB No.00001189:HE500856). Research Funding was granted by the Faculty of

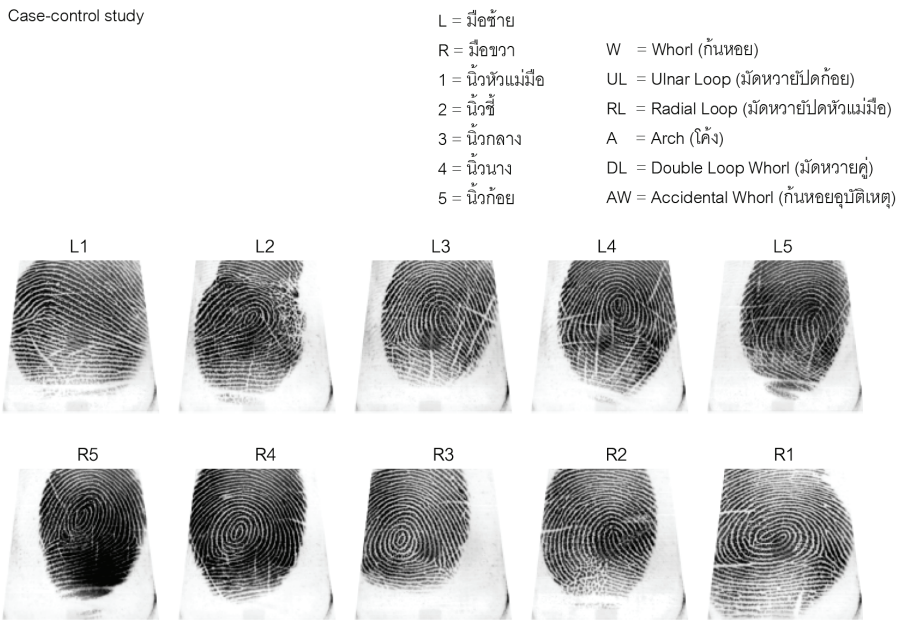

Fig. 1 Ten fingerprints of a female subject obtained by the Automated Inkless Fingerprint Imaging software [L1= arch; L2, R2 = radial loops, L3, L5 = ulnar loops; L4, R1, R3, R4, R5 = whorls]

Medicine (Grant No.I51114). The present study, conducted between November 2007 and October 2008, included individuals between 18 and 60 years of age attending the psychiatric outpatient service at Srinagarind Hospital who met the ICD-10 criteria for a diagnosis of schizophrenia. Normal sex- and aged-matched control subjects were recruited from among the medical students and health personnel at Srinagarind Hospital. After providing a complete description of the present study aims and protocols to the subjects, written informed consent was obtained.

Dermatoglyphic measures

Finger and partial palm prints of both hands were obtained from subjects. The fingerprint sensor and the automated inkless fingerprint imaging software[17] were used for fingerprinting. Briefly, touching each fingertip on a touch pad, the fingerprint sensor scanned from the left hand thumb, index, middle, ring, little finger, followed by the right hand of little, ring, middle, index, and thumb (Fig. 1). These fingertip images were stored into a database as a portable document format (pdf) prior to printing (Fig. 1).

The transparent-adhesive tape technique, which is a standard method commonly used in dermatoglyphic research, was used for partial palm prints at the base of the index finger (called *a* triradius) and the middle finger (*b* triradius). Briefly, a carbon-paper was applied at the bases of the index and middle fingers, then the transparent-adhesive tape was put on it and pealing up to stick on the blank paper (Fig. 2). Finger ridge counts (FRC) were measured for each digit separately. The *a*-*b* ridge count (*a*-*b* RC), which is the number of ridges intersected by a line drawn between the *a* and *b* triradii, and the pattern of each fingerprint was assessed by the second author (SN), who was not apprised to the subjects' status.

Statistical analysis

While the overall differences between the case and control groups were assessed. Dermatoglyphic

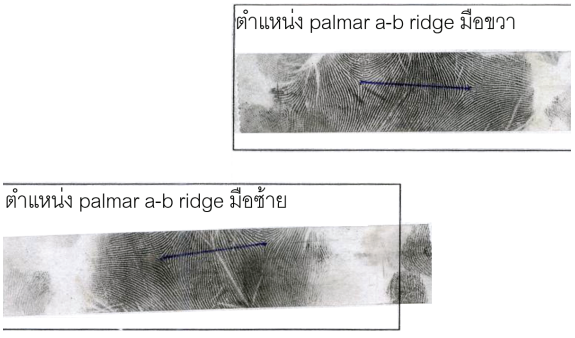

Fig. 2 Palmar *a*-*b* ridges of right and left hands

variables such as fingerprint patterns were identified based on Galton-classification into four types: arch, radial loop, ulnar loop, and whorl. The fingerprint pattern asymmetry (discordances of fingerprint patterns between homologous fingers on the right and left hand) and the fingerprint pattern scores were summed for all ten fingers and a comparison made between cases and controls.

An index of pattern complexity was constructed by subtracting the number of arches from the number of whorls. The index ranges from -10 to +10 with higher scores indicated greater complexity. Since there are dermatoglyphic differences between males and females, all comparisons among each sex were undertaken separately. The authors used two-tailed t-tests with an alpha level of $p < 0.05$ for paired samples to test for significant differences in mean scores of TFRC, *a-b* ridge counts, fingerprint pattern asymmetry, and index of pattern complexity. All analyses used SPSS programming (version 11.0).

Results

Between November 2007 and October 2008, 68 patients with schizophrenia and 68 normal controls were enrolled. The baseline characteristics are presented in Table 1. Demographic variables in both groups were similar except occupation in the controls who all worked at the university.

The distribution of fingerprint patterns in cases and controls are shown in Table 2. The percentages of fingerprint patterns: arches, radial loops, ulnar loops, and whorls were calculated on each digit of right and left hands were compared. On each digit, loop was the most abundant pattern, ranging from 77.9% on digit V to 39.3% on digit I among the cases and from 72.1% on digit V to 36.8% on digit I among the controls. Whorls were less commonly found than loops on digit IV (61.8% among the cases vs. 58.8% among the controls) and digit I (60.3% in both groups). There was a difference between the two hands. Whorls were found more often on digit I of the right hand than on the left (60.3% and 45.6%, respectively among the cases vs. 60.3% and 55.4%, respectively, among the controls). There were no radial loops on digit IV on either hands among either the cases or the controls. Likewise, among the controls, on the left digit II, there were two times as many radial loops found (14.7% and 7.4%, respectively) and 1.3 times as many ulnar loops among the cases than the controls (47.1% and 36.8%, respectively). Fingerprint pattern asymmetry (discordances of fingerprint patterns between homologous fingers on the right and left hand) was calculated. A mean score of 0 indicated the same pattern, while ≥ 1 indicated a significantly different pattern. The mean scores for pattern asymmetry between male and female cases were lower than the controls but not statistically so (Table 3).

Table 4 presents the different fingerprint patterns summed for all of the cases and controls for each of the 10 fingers. Thus, in line 1, the 34 males with

Table 1. Demographic characteristic of schizophrenic patients and healthy controls

Demographic characteristics	Schizophrenic patients	Healthy controls
Sex		
Male	34	34
Female	34	34
Age (mean $\pm$ SD) (range)	34.69 $\pm$ 9.73 (18-66)	34.69 $\pm$ 9.78 (18-64)
Male (min-max)	35.56 $\pm$ 9.19 (18-59)	35.29 $\pm$ 9.56 (18-57)
Female (min-max)	31.58 $\pm$ 6.92 (23-44)	31.42 $\pm$ 7.20 (22-45)
Occupation		
Farmer	6 (8.8%)	0
Government officer	12 (17.6%)	54 (79.4%)
Student	8 (11.8%)	6 (8.8%)
Labor	15 (22.0%)	7 (10.3%)
Unemployed	12 (17.6%)	0
Merchant	10 (14.7%)	0
Others	5 (7.4%)	1 (1.5%)
Previous finger or hand injury from accident	2 (2.9%)	2 (2.9%)
Previous chemical exposure to hand or finger	0	1 (1.5%)

Table 2. Frequencies of four basic fingerprint patterns on the ten fingertips in cases with schizophrenia vs. controls

	Cases (n1 = 68)										Controls (n2 = 68)									
	I = Thumb		II = Index		III-Middle		IV = Ring		V = Little		I = Thumb		II = Index		III-Middle		IV = Ring		V = Little	
	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)	L (%)	R (%)
W	45.6	60.3	38.2	41.2	20.6	25.0	54.4	61.8	19.1	22.1	54.4	60.3	44.1	45.6	29.4	26.5	54.4	58.8	25.0	25.0
UL	52.9	39.7	47.1	44.1	73.5	73.5	45.6	36.8	77.9	77.9	41.2	36.8	36.8	41.2	66.2	70.6	42.6	39.7	72.1	72.1
RL	0	0	7.4	7.4	1.5	0	0	0	0	0	0	0	14.7	5.9	0	0	0	0	0	0
A	1.5	0	7.4	7.4	4.4	1.5	0	1.5	2.9	0	4.4	2.9	4.4	7.4	4.4	2.9	2.9	1.5	2.9	2.9

W = whorl; UL = ulnar loop; RL = radial loop; A = arch

schizophrenia averaged 0.21 arches, 0.12 radial loops, 6.65 ulnar loops, and 3.03 whorls. Regarding pattern complexity index scores, the cases with schizophrenia showed the least complex patterns and controls the most but the differences were not statistically significant (overall $p = 0.67$). The male cases showed a significantly lower pattern of complexity ($t = -2.792$, $df = 33$, $p = 0.009$) and the average whorl pattern complexity was significantly lower ($t = -2.925$, $df = 33$, $p = 0.006$) but the average ulnar loops pattern was significantly higher ($t = 3.260$, $df = 33$, $p = 0.003$) than the male controls.

The analysis of TFRC yielded a non-significant effect in comparison with cases vs. controls ($t = -0.59$, $df = 67$, $p = 0.56$). The male patients exhibited lower finger ridge counts than the male controls but the difference was not statistically significant (143.09 ± 34.15 vs. 153.79 ± 33.75, $t = -1.232$, $df = 33$, $p = 0.23$), while female patients did not differ from the controls ($p = 0.69$). Differences in TABRC for patients vs. controls did not achieve statistical significance (76.31 ± 9.49 vs. 76.68 ± 7.92, $t = -0.26$, $df = 67$, $p = 0.80$). Sex was not significant in either model (Table 5).

Discussion

The present study shows no differences in mean scores of pattern asymmetry between cases and controls of both sexes, consistent with Mellor's study[7] and Saha et al[18] but contrast to Markow and Wandler[19] and Reilly et al[20] which found greater asymmetry among cases than the controls. Our study failed to find patient-control differences in TFRC, TABRC, consistent with Yousefi-Nooraie et al[11] and Saha et al[18] but inconsistent with several studies[1,7,14,19,21] which reported reduction in TFRC and TABRC (Table 6). The reason for inconsistent with those studies might be a rather small sample size, different design and different statistical methods. However, this study shows only male schizophrenia had a significantly less proportion of whorl pattern than controls consistent with the Paez's study[22].

There are sex differences in fingerprint pattern in which healthy Thai males have more whorls and less ulnar loops than females (48.6% and 41.8% for whorls; 45.0% and 51.4% for ulnar loops)[23]. Nanakorn et al[24] reported the PCI in healthy Thai males was slightly higher than females (4.59 and 4.01 respectively). The present study has similar results of male controls to those two studies in Thai subjects, but female controls have less PCI and whorl patterns. It might be a selection bias in female controls that did

Table 3. Pattern asymmetry scores of 34 matched pairs of males and females

Males (68) Asymmetry scores	Cases (34)	Controls (34)	Paired differences	SEM	Paired t-test, p-value (sig. 2-tailed)
Mean ± SD	1.12 (0.92)	1.62 (1.10)	-0.38	0.26	0.16
Females (68) Asymmetry scores	Cases (34)	Controls (34)	Paired differences	SEM	Paired t-test, p-value (sig. 2-tailed)
Mean ± SD	1.38 (1.10)	1.56 (1.08)	-0.18	0.27	0.52

Table 4. Mean fingerprint pattern scores summed over ten fingers (SD), Difference paired t-test significant (2-tailed) $p < 0.05$

	Arches	Radial loops	Ulnar loops	Whorls	Pattern complexity index (whorls minus arches)
Male (n = 68)					
Cases (n = 34)	0.21 (0.64)	0.12 (0.41)	6.65 (2.28)	3.03 (2.34)	2.82 (2.55)
Controls (n = 34)	0.15 (0.44)	0.23 (0.50)	4.53 (3.01)	5.09 (3.28)	4.94 (3.47)
p-value	0.661	0.325	0.003	0.006	0.009
Female (n = 68)					
Cases (n = 34)	0.32 (0.64)	0.21 (0.59)	4.74 (3.05)	4.74 (3.35)	4.41 (3.74)
Controls (n = 34)	0.59 (1.64)	0.18 (0.37)	5.85 (2.54)	3.38 (2.66)	2.79 (3.51)
p-value	0.329	0.801	0.109	0.061	0.058
Total (n = 136)					
Cases (n = 68)	0.26 (0.64)	0.16 (0.51)	5.69 (2.84)	3.88 (3.00)	3.62 (3.74)
Controls (n = 68)	0.37 (1.21)	0.21 (0.44)	5.19 (2.84)	4.24 (3.09)	3.87 (3.51)
p-value					0.67

not exclude subjects with relatives of schizophrenia. Only males with schizophrenia had less whorl patterns and more ulnar loops, in accordance with Fatjo-Vilas[25] males showed an increased rate of ectodermic derivative abnormalities than females which supports the hypothesis of an early developmental deviance[26] for which males tend to have at greater risk for a neurodevelopmental subtype of schizophrenia than females. The pattern complexity index mean scores (whorls minus arches ≤ 2) may be one of the bio-markers for primary screening of schizophrenia among high-risk males in Thai communities.

Interestingly, the present study found that on the left digit II, controls had two times of radial loops more than cases (14.7% and 7.4%, respectively). Valentile[27] similarly reported that it was eight times more likely to find a radial loop on the index finger of a normal person than a Mongoloid. Radial fingerprint pattern on the left digit II might be an indicator for neurodevelopmental stability or potential cognitive ability, which needs further studies.

The limitations of the present study include the relatively small sample size; and the absence of information on family history and obstetric complications for, the presented participants. Previous findings suggest that schizophrenia patients with a positive family history of schizophrenia differ from patients without a family history on several dermatoglyphic measures[8,14]. Strengths of the present study include the blind rating of dermatoglyphics.

Conclusion

Dermatoglyphic traits (TFRC, TABRC, pattern asymmetry) of schizophrenia patients do not differ from those of control persons. Only male patients had significantly less complexity than the controls that had more arch and low whorl patterns than the controls. The PCI value less than two might be a biomarker in male schizophrenia.

Table 5. Total finger ridge counts and total *a-b* ridge counts in schizophrenia cases and normal controls

	Males			Females			Total		
	Cases	Controls	p-value	Cases	Controls	p-value	Cases	Controls	p-value
TFRC	143.09 ± 34.15	153.79 ± 33.75	0.23	127.91 ± 32.42	124.41 ± 41.05	0.69	135.50 ± 33.92	139.10 ± 40.12	0.56
RFRC	73.41 ± 16.91	77.82 ± 18.65	0.34	64.68 ± 16.36	62.32 ± 20.13	0.59	69.04 ± 17.09	70.07 ± 20.79	0.74
LFRC	69.68 ± 18.60	75.97 ± 16.67	0.18	63.24 ± 16.99	62.09 ± 21.37	0.80	66.46 ± 17.97	69.03 ± 20.27	0.42
TABRC	75.71 ± 10.44	76.97 ± 6.81	0.57	76.91 ± 8.54	76.38 ± 8.98	0.77	76.31 ± 9.49	76.68 ± 7.92	0.80
RABRC	37.53 ± 5.95	38.65 ± 4.36	0.41	38.29 ± 4.28	38.12 ± 5.07	0.85	37.91 ± 5.15	38.38 ± 4.70	0.56
LABRC	38.18 ± 5.01	38.32 ± 3.63	0.88	38.62 ± 5.15	38.26 ± 4.63	0.74	38.40 ± 5.05	38.29 ± 4.13	0.89

TFRC = total finger ridge count; RFRC = right finger ridge count; LFRC = left finger ridge count; TABRC = total *a-b* ridge count; RABRC = right *a-b* ridge count; LABRC = left *a-b* ridge count

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Potential conflicts of interest

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Table 6. Comparisons of means (1SD) of TFRC, TABRC among cases and controls with previous studies

Dermatoglyphic variables	Fearon et al (2000)		Saha et al (2003)		Avila et al (2003)		Yousefi-Nooraie et al (2008)		Present study	
	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls
FRC										
Male			n = 118	n = 122			n = 34	n = 34	n = 34	n = 34
Right	NA	NA	73.6 (22.8)	74.5 (27.6)	NA	NA	77.4 (25.5)	74.9 (23.5)	73.4 (16.9)	77.8 (18.7)
Left	NA	NA	69.8 (22.8)	71.7 (23.9)	NA	NA	76.8 (28.3)	75.5 (28.0)	69.7 (18.6)	76.0 (16.7)
TFRC-M	NA	NA	143.5 (44.8)	144.7 (50.1)	NA	NA	NA	NA	143.1 (34.2)	153.8 (33.8)
Female			n = 63	n = 106					n = 34	n = 34
Right	NA	NA	66.2 (26.2)	68.3 (26.1)	NA	NA	NA	NA	64.7 (16.4)	62.3 (20.1)
Left	NA	NA	62.3 (26.4)	66.0 (27.5)	NA	NA	NA	NA	63.2 (17.0)	62.1 (21.4)
TFRC-F	NA	NA	126.7 (51.2)	133.7 (53.1)	NA	NA	NA	NA	127.9 (32.4)	124.4 (41.1)
All (male + female)	n = 102	n = 72			n = 86	n = 46			n = 68	n = 68
Right	65.0 (22.6)	65.6 (24.7)	NA	NA	NA	NA	NA	NA	69.0 (17.1)	70.1 (20.8)
Left	61.4 (23.0)	61.3 (25.2)	NA	NA	NA	NA	NA	NA	66.5 (18.0)	69.0 (20.3)
TFRC-All	126.4 (44.4)	126.9 (49.0)	NA	NA	114.2 (42.3)	140.0* (50.1)	NA	NA	135.5 (33.9)	139.1 (40.1)
ABRC										
Male			n = 118	n = 122			n = 34	n = 34	n = 34	n = 34
Right	NA	NA	42.2 (5.4)	41.1 (6.3)	NA	NA	41.4 (5.2)	40.1 (4.9)	37.5 (6.0)	38.7 (4.4)
Left	NA	NA	42.5 (5.6)	41.5 (6.2)	NA	NA	43.4 (5.4)	42.2 (5.3)	38.2 (5.0)	38.3 (3.6)
TABRC-M	NA	NA	84.5 (10.2)	82.6 (11.7)	NA	NA	NA	NA	75.7 (10.4)	77.0 (6.8)
Female	NA	NA	n = 63	n = 106					n = 34	n = 34
Right	NA	NA	41.4 (5.7)	42.0 (5.5)	NA	NA	NA	NA	38.3 (4.3)	38.1 (5.1)
Left	NA	NA	42.2 (4.7)	42.9 (4.9)	NA	NA	NA	NA	38.6 (5.2)	38.3 (4.6)
TABRC-F	NA	NA	83.9 (9.1)	85.3 (9.9)	NA	NA	NA	NA	76.9 (8.5)	76.4 (9.0)
All (male + female)	n = 116	n = 75							n = 68	n = 68
Right	38.9 (8.6)	40.9 (7.8)	NA	NA	NA	NA	NA	NA	37.9 (5.2)	38.4 (4.7)
Left	39.2 (8.4)	41.7* (7.5)	NA	NA	NA	NA	NA	NA	38.4 (5.1)	38.3 (4.1)
TABRC-All	78.0 (16.1)	82.6* (14.7)	NA	NA	NA	NA	NA	NA	76.3 (9.5)	76.7 (7.9)

* $p < 0.05$

FRC = finger ridge count; TFRC = total finger ridge count; ABRC = *a-b* ridge count; TABRC = total *a-b* ridge count; NA = not available

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แบบลายเส้นผิวหนังบนฝ่ามือ และนิ้วในผู้ป่วยโรคจิตเภทคนไทยเปรียบเทียบคู่กับกลุ่มควบคุม

สุวรรณา อรุณพงค์ไพศาล, สมทรง ณ นคร, ไพบูลย์ มงคลถาวรชัย, สุรพล วีระศิริ, สมจิตร์ มณีกานนท์, แก้วใจ เทพสุธรรมรัตน์

วัตถุประสงค์: *เพื่อเปรียบเทียบแบบลายนิ้วมือ ค่าเฉลี่ยของตัวแปรแบบลายเส้นผิวหนังบนฝ่ามือ และนิ้วได้แก่ จำนวนเส้นลายนิ้วมือทั้งหมด จำนวนเส้นลายฝ่ามือบริเวณฐานนิ้วชี้และนิ้วกลางทั้งหมด ดัชนีความซับซ้อนของแบบลายนิ้วมือ และอสมมาตรของแบบลายนิ้วมือ ระหว่างผู้ป่วยโรคจิตเภทกับคนปกติ*

วัสดุและวิธีการ: *เป็นงานวิจัยแบบภาคตัดขวาง จับคู่ด้าน อายุ เพศ ระหว่างผู้ป่วยโรคจิตเภทชาย 34 คน หญิง 34 คน เปรียบเทียบกับคนปกติ เพศชาย 34 คน หญิง 34 คน เทคนิคที่ใช้ในการพิมพ์ลายนิ้วมือด้วยโปรแกรมพิมพ์ภาพลายนิ้วมืออัตโนมัติปราศจากหมึก ส่วนการพิมพ์ฝ่ามือบริเวณฐานนิ้วชี้และนิ้วกลางใช้เทคนิคเทปกาวใส สถิติวิเคราะห์หาความแตกต่างของค่าเฉลี่ยของอสมมาตรของลายนิ้วมือ จำนวนเส้นลายนิ้วมือทั้งหมด จำนวนเส้นลายฝ่ามือบริเวณฐานนิ้วชี้และนิ้วกลางข้างขวา-ซ้าย และทั้งสองมือ ดัชนีความซับซ้อนของแบบลายนิ้วมือ ระหว่างกลุ่มผู้ป่วยและกลุ่มเปรียบเทียบใช้ paired t-test โดยกำหนดนัยสำคัญทางสถิติที่ $p < 0.05$*

ผลการศึกษา: *ไม่พบความแตกต่างของทั้งค่าเฉลี่ยอสมมาตรของแบบลายนิ้วมือ ค่าเฉลี่ยของจำนวนเส้นลายนิ้วมือทั้งหมด และค่าเฉลี่ยของจำนวนเส้นลายฝ่ามือบริเวณฐานนิ้วชี้และนิ้วกลางข้างขวา-ซ้าย และทั้งสองมือระหว่างผู้ป่วยจิตเภทกับกลุ่มควบคุมในทั้งสองเพศ แต่พบความแตกต่างอย่างมีนัยสำคัญของค่าเฉลี่ยดัชนีความซับซ้อนของแบบลายนิ้วมือในผู้ป่วยชาย (2.82 ในกลุ่มผู้ป่วยโรคจิตเภท 4.94 ในกลุ่มคนปกติ, $p = 0.009$)*

สรุป: *พบความแตกต่างอย่างมีนัยสำคัญในค่าดัชนีความซับซ้อนของแบบลายนิ้วมือ (จำนวนลายนิ้วมือแบบก้นหอยลบด้วยแบบโค้ง) ในผู้ป่วยโรคจิตเภทผู้ชาย ซึ่งค่าดังกล่าวถ้าน้อยกว่า 2 อาจใช้เป็นตัวชี้วัดทางชีวภาพเพื่อคัดกรองโรคจิตเภทในผู้ชาย*