

The Frequency of Whorl Patterns on the Fingertip of the Thai, Kinh H'mong Ethnic Students in Thuan Chau District, Son La Province

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Abstract

The study was conducted on 784 students aged 14 to 17 (383 male students and 401 female students), who were randomly selected, in Son La province. Following the standards of morphological and anthropological studies, this study aims to investigate the frequency of Whorl patterns on the fingertip of these students. The study shows that the frequency of Whorl patterns on students' fingertips is 10.89% higher than other types of fingerprint patterns. Whorl patterns are more likely to be found on finger IV with the rate of 15.04% and rarely seen on finger V (7.4%) in all three ethnic groups (Thai, Kinh, H'Mong). The Kinh ethnic group has a higher rate of Whorl pattern than the other two groups. Moreover, the distribution of Whorl patterns is higher on the right hand than the left hand. The frequency of Whorl patterns on fingertips of all 3 ethnic groups follows the following sequence: $W^c > W^s > W^{dl} > W^{cp}$.

Keywords: Fingerprint, The Whorl Pattern, Son La

Introduction

As one of the most mysterious innate human traits, fingerprints is unique, highly individual, and do not change throughout a person's life (Hoang Van Luong, 1998; Ngo Tien Quy & Ngo Tien Khai, 2009). During the formation process, the individual characteristics of the fingerprints have been specified in the genotype, but there is no regular inheritance from one generation to the next. It has been confirmed by scientists that there is no complete similarity of fingerprints between two people, even identical twins. With such high individuality, fingerprints are now being applied in various fields such as: tracing criminals, early identification of some diseases, brain fingerprinting, etc (Hoang Van Luong, 1998).

The ridge is normally formed in the 2nd month and completed in the 4th month of the fetus. After that, there are no changes in the structures and characteristics of the ridge throughout one's life. As a person matures, the section of the ridges may change, but their characteristics remain the same (Billington & Ridge, 2001; Greenberg et al., 1998). Via studies, scientists have found that: the biological natural development of the ridges is unique to each person, and there is no inheritance from one generation to another (Ngo Tien Quy & Ngo Tien Khai, 2009).

The ridges on the outermost knuckles (fingertip fingerprints): the structure of the central region (the central area of the fingertip) and the tripoints (delta) are used to classify the outermost knuckle prints. Tripoints is understood as a point on the ridge, directly opposite the midpoint of the dispersion of the limiting ridge.

In recent years, fingerprint biometrics has developed quickly due to the increase in the need of identifying types of human intelligence based on finger prints. In the world, there are also many studies on the relationship of some types of intelligence with fingerprints. However, in Vietnam,

there has not been any synchronous research that focuses on the relationship between fingerprints and types of intelligence. Clarifying the relationship between fingerprint structure and intellectual indicators is very necessary because it is he useful for human development strategy.

Methods

The research's participants are 784 students of Thai, Kinh, and H'Mong ethnic groups in Son La province, of which 383 are male and 401 are female. The research subjects were randomly selected and the study followed all the standards of morphological and anthropological studies (Ministry of Planning and Investment, 2022).

The study was conducted from September 2019 to October 2020.

The investigated anthropometric index is the fingerprints of the Thai, Kinh and H'Mong ethnic minority students aged 14, 15, 16, 17. The study applied the descriptive epidemiological design through a cross-sectional study combined with a retrospective study.

The data analysis was carried out at the "Anthropology lab" at the Center for Anthropology Research and Intellectual Development, University of Education, Vietnam National University, Hanoi. The data were processed using Excel 2010 and SPSS 2.0 software (Do Trung Dam, 2003).

Fingerprint identification method

There are 3 basic patterns for the outermost phalange ridges: Arch (A), Loop (L), Whorl (W). Furthermore, the 10 fingerprints is classified according to the Galton – Henry system:

- Proceed with 10 fingers. First, based on the above basic patterns of fingerprint, we use symbol letter for fingerprint boxes. Rules for writing letters in boxes are as followed:

+ The arch fingerprint is denoted by letter A (Arch)

- Symbol letter for simple arch is A^s

- Tented arch is A^t

+ Loop is denoted by letter L

- The loop that opens toward the ulna side of the hand (toward the pinkie) is symbolized as L^u (Ulnar Loop)

- The loop that flows in the direction of the radius bone is symbolized as L^r (Radial Loop)

+ Whorl (W) is divided into 4 types based on morphology.

- Concentric whorl (W^c)

- Spiral whorl (W^s)

- Central pocket whorl (W^{cp})

- Double loop whorl (W^{dl})

+ DL₁₀: delta

+ Arch-Loop index is calculated by formula: $\frac{A \times 100}{L}$

+ Arch– Whorl index is calculated by formula: $\frac{A \times 100}{W}$

+ Whorl– Loop index is calculated by formula: $\frac{W \times 100}{L}$

Research Ethics

To get the best participation and cooperation from the participants during the research process, all research subjects and their parents were explained in detail about the purpose and content of the research. They also have the right to refuse to be part of the study.

All information of the subject is kept confidential and the collected data is used for research purposes only. All information can only be accessed by the researchers;

Results of the study are fully communicated to the participants.

The study was approved by the leadership of Chieng Ly, Thom Mon and Co Ma secondary schools, Thuan Chau district, Son La province

Results and Discussion

The Frequency of Whorl Patterns on Fingertips and Their Indicators

Whorl is a pattern that contains two or more deltas/tripoints and some of the ridges in a whorl make a turn through at least one circuit.

A whorl can be classified into 4 main types: concentric whorl – W^c , spiral whorl – W^s , central pocket whorl - W^{cp} and double loop whorl – W^{dl} .

Concentric whorl – W^c

Concentric whorl - W^c can be found in all fingers on a hand, with a fairly higher rate of occurrence compared to other finger patterns. The highest occurrence rate is on Finger IV (53.05%) and the lowest rate is on Finger V (24.85%).

Table 1 shows the general distribution of the Whorl on fingertips by hands and sex of the research participants.

Table 1. Frequency of occurrence of the Concentric whorl - W^c on the fingertips of students of the Thai, Kinh, H'mong ethnic groups in Thuan Chau district, Son La province. (%)

Sex \ Ethnic group		Thai	Kinh	H'Mong
Male	Right	38.31	41.97	37.71
	Left	33.39	38.36	37.10
	Average	35.85	40.16	37.40
Female	Right	32.56	34.88	31.51
	Left	28.32	34.08	31.37
	Average	30.44	34.48	31.44
General		33.14	37.32	34.42

Table 1 shows that the frequency of occurrence of Concentric whorl - W^c in all 3 ethnic groups is comparatively high. With the occurrence rate of 37.32%, more Kinh students having W^c pattern than the other two ethnic groups. The Thai group has the lowest rate of occurrence (33.14%).

Moreover, the occurrence rate of Concentric whorl - W^c is higher in male students than in females across the three ethnic groups.

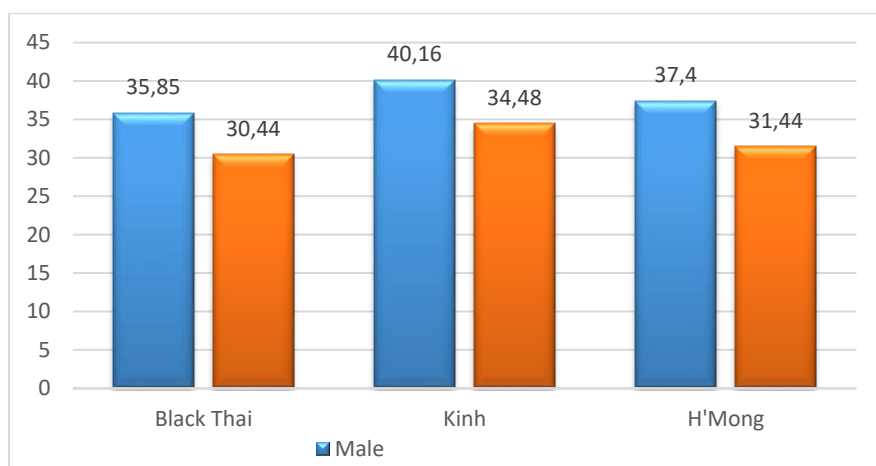


Figure 1. The frequency of occurrence of Concentric whorl- W^c among research subjects

Figure 1 shows that in the male groups, the Kinh ethnic students have the highest occurrence rate of W^c (40.16%), followed by HMong students with 37.40%, and finally the Thai students with 35.85%.

Among female students, the highest occurrence rate of W^c is seen in the Kinh ethnic group (34.48%); the H'Mong group comes after with 31.44% and the Thai group comes last with 30.44%.

From the number of W^c of all three ethnic groups, a formula formed for W^c is as followed:

Table 2. W^c formula of research subjects

Ethnic group	Sex	Formula for W^c
Thai	Male	IV > I > II > III > V
	Female	IV > V > I = II > III
	Both	IV > I > II > V > III
Kinh	Male	IV > I > II > III > V
	Female	IV > I > II > III = V
	Both	IV > I > II > III > V
H'Mong	Male	IV > II > III > I > V
	Female	IV > II > III > I > V
	Both	IV > II > III > I > V

Table 2 shows that there a resemblance in the formula W^c of all ethnic groups, with W^c being found mostly on finger IV in both male and female students of all 3 groups, while found least on finger V (except Kinh group who has the lowest rate of W^c on finger III).

Double loop whorl - W^{dl}

W^{dl} patterns occur at a low rate on the fingers of all three ethnic groups. There aren't any W^{dl} patterns found on some specific fingers of the ethnic groups under study: finger V of both hands of the Thai females; fingers II, III of the right hand and fingers II, IV, V of the left hand of Kinh males; finger V of the right hand of Kinh females; fingers IV, V of the right hand and finger V of the left hand of H'Mong males; finger V of the right hand of the H'Mong females.

Table 3. Frequency of occurrence of the double loop whorl - W^{dl} on the fingertips of Thai, Kinh, H'mong ethnic students in Thuan Chau district, Son La province (%)

Sex \ Ethnic group		Thai	Kinh	H'Mong
		Right		
Male	Right	2.00	2.79	1.07

	Left	1.39	1.31	1.22
	Average	1.69	2.05	1.14
Female	Right	1.31	3.52	4.32
	Left	1.90	3.68	4.32
	Average	1.61	3.6	4.32
General		1.65	2.83	2.73

Table 3 shows that the rate of encountering W^{dl} pattern in the Kinh ethnic group is 2.83%, which is higher than the other two ethnic groups.

As for the average occurrence rate of the W^{dl} pattern in 3 ethnic groups, female students have a higher rate (3.17%) in comparison with that of males (1.63%); the rate is also higher in the right hand (2.50%) than in the left hand (2.30%). However, the ratio is different for each ethnic group. The Thai ethnic group has a higher percentage of W^{dl} in females. Moreover, the percentage of W^{dl} distribution in the left hand is higher than the right hand among the Thai female, Kinh female, and H'Mong male students.

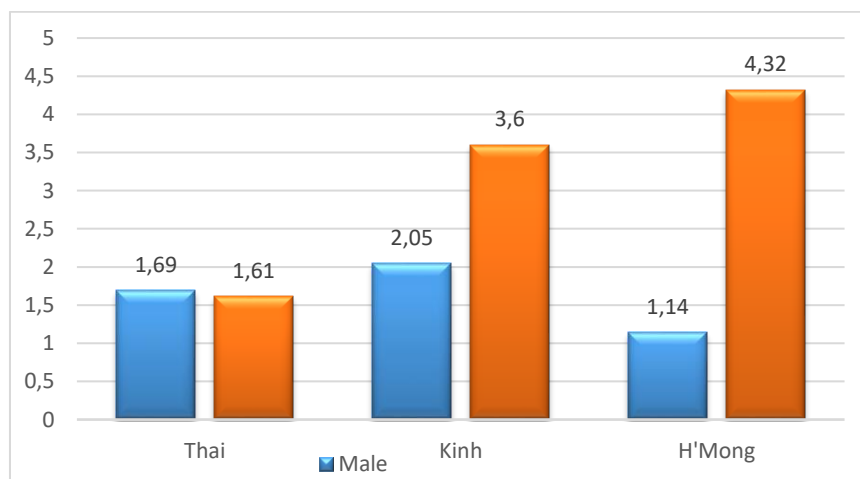


Figure 2. Frequency of occurrence of W^{dl} on research subjects

Figure 2 shows the distribution of double loop Whorl pattern by ethnicity and sex. For the male groups, the Kinh males have the highest distribution of W^{dl} (2.05%), while H'Mong males see the lowest rate (1.14%).

For the female groups, the H'Mong group has the highest rate of double loop Whorl pattern, accounting for 4.32%, while the lowest rate is found in the Thai ethnic group with 1.61%.

The formula for W^{dl} of 3 ethnic groups is as followed:

Table 4. W^{dl} formula of research subjects

Ethnic group	Sex	Formula for W^{dl}
Thai	Male	I> II> III> IV = V
	Female	I> II> III> IV> V
	Both	I> II> III> IV> V
Kinh	Male	I> III> V> II = IV = 0
	Female	I> II = III> IV> V
	Both	I> III> II> IV> V
H'Mong	Male	III> I> II> IV> V
	Female	I>II = III> IV> V
	Both	I> III> II> IV> V

Table 4 shows that the ratio of W^{dl} on finger I of all ethnic groups is highest (except H'mong male students whose highest ratio of W^{dl} goes to finger III), and the lowest ratio of W^c is found mostly on finger V (except Kinh male students who has no W^{dl} on finger II and IV).

Spiral whorl - W^s

As regards the average rate of all 3 ethnic groups, the frequency of occurrence of W^s (both forward and backward spiral patterns) is highest on finger I (6.79%) and lowest on finger V (1.80%).

Table 4. Frequency of occurrence of the Spiral whorl – W^s on the fingertips of Thai, Kinh, H'mong ethnic students in Thuan Chau district, Son La province (%)

Sex		Ethnic group		
		Thai	Kinh	H'Mong
Male	Right	6.15	3.44	6.11
	Left	4.61	3.44	4.88
	Average	5.38	3.44	5.50
Female	Right	4.67	2.56	1.73
	Left	5.69	2.64	2.45
	Average	5.69	2.64	2.45
General		5.54	3.04	3.97

Table 4 shows that the occurrence rate of W^s is highest in the Thai group (5.54%), and lowest in the Kinh group (3.04%).

The average rate of W^s of males is higher than that of females (4.77% vs 3.59%) (while the contrary is true for the Black Thai group), and the occurrence rate of W^s in the right hand (4.11%) is higher than that in the left hand (3.95%). In the female group of all 3 ethnic groups, the rate of W^s pattern on the left hand is higher than on the right hand though certain differences are found when considering each ethnic group separately.

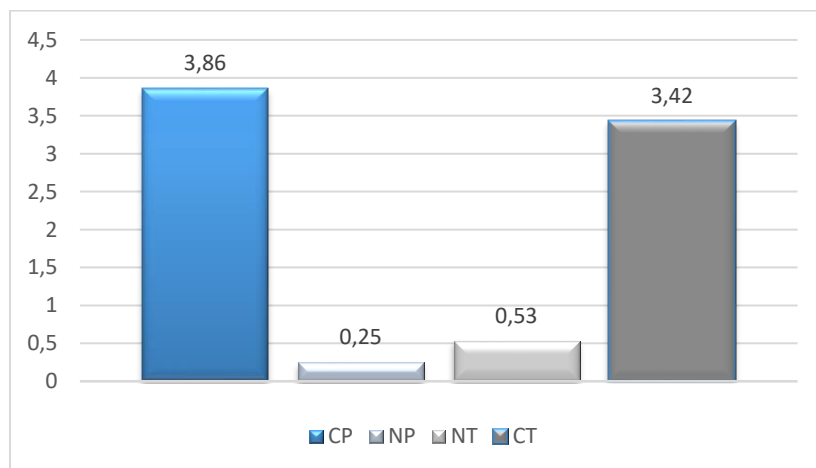


Figure 3. The distribution of spiral whorl patterns on two hands

In which: CP: W^s clockwise pattern on right hand

NP: W^s counterclockwise pattern on right hand

CT: W^s clockwise pattern on left hand

NT: W^s counterclockwise pattern on left hand

Figure 3 shows that, in the right hand, the CP pattern accounts for a large proportion (3.86%), compared to 0.25% of NP pattern. Meanwhile, in the left hand 3.42% is NT pattern, in

comparison to 0.53% of NT pattern. The formula for W^s patterns of all 3 ethnic groups is shown in Table 5

Table 5. The formula for W^s patterns of research subjects

Ethnic group	Sex	Formula for W^s
Thai	Male	I=II> IV> III> V
	Female	I> III> II> IV> V
	Both	I> II> III> IV> V
Kinh	Male	I=II> IV> III = V
	Female	I> III=IV> II> V
	Both	I> II> IV> III> V
H'Mong	Male	II> I> IV> III> V
	Female	I> II> III> IV> V
	Both	II> I> IV> III> V

Data from Table 5 reveal that, the rate of seeing W^s pattern is highest on Finger I (though H'Mong male students have the highest W^s on Finger II), and lowest on Finger V.

There is no clear rule for the distribution of W^s on Fingers II, III, IV.

Central pocket whorl - W^{cp}

Central pocket whorl - W^{cp} has a low occurrence rate compared to the other two patterns (2.02% on average), and is mostly seen on finger IV, sometimes on finger V, and rarely on finger I.

Table 6. Frequency of occurrence of the Central pocket whorl - W^{cp} on the fingertips of the Thai, Kinh, H'mong ethnic students in Thuan Chau district, Son La province (%)

Ethnic group		Thai	Kinh	H'Mong
Sex				
Male	Right	1.54	4.10	2.44
	Left	2.00	0.82	1.98
	Average	1.77	2.46	2.21
Female	Right	2.34	2.40	1.44
	Left	1.75	2.56	0.86
	Average	2.04	2.48	1.15
General		1.91	2.47	1.68

The data from Table 6 show that the occurrence rate of W^{cp} pattern is highest in the Kinh ethnic group (2.47%), and lowest in the H'Mong ethnic group (1.68%).

The frequency of occurrence of W^{cp} is higher in males (2.15%) than in females (1.89%), and higher in the right hand (2.38%) than in the left hand (1.66%).

The formula for W^{cp} patterns of all 3 ethnic groups is shown in Table 7.

Table 7. The formula for W^{cp} patterns of reserch subjects

Ethnic group	Sex	Formula for W^{cp}
Thai	Male	II> V> I =III> IV
	Female	V> I> II=III> IV
	Both	V> II> I> III> IV
Kinh	Male	V> IV> III> II> I
	Female	II> IV> I=V> III
	Both	IV> V> II> III> I

H'Mong	Male	IV> V> III> I> II
	Female	IV> III> V> I> II
	Both	IV> V> III> I> II

Data from Table 7 show the distribution of W^{cp} on fingertips does not follow any clear rule. The rate of W^{cp} is highest on finger IV (lower rate is seen on finger V or II).

General comments on Whorl fingerprint (including W^c, W^{dl}, W^s, W^{cp})

Table 8. Whorl fingerprint of research ethnic groups (%)

Ethnic group		Thai	Kinh	H'Mong
N		267	247	270
Finger	I	11.49	13.72	10.02
	II	10.38	11.44	11.45
	III	8.34	9.12	10.08
	IV	14.76	14.68	15.68
	V	7.82	8.11	6.27
Average		10.56	11.41	10.70

Comments:

The W patterns occurs more frequently than other fingerprint patterns, with the highest rate of occurrence being found on finger IV and the lowest rate on finger V in all 3 ethnic groups: Thai, Kinh, and H'Mong.

The Kinh ethnic group has higher rate of W patterns than in other ethnic groups.

A higher distribution of Whorl pattern is recorded on the right hand than on the left hand.

The order of the frequency of the Whorl patterns of all 3 ethnic groups is: W^c> W^s> W^{dl}> W^{cp}.

Tripoint– DL₁₀ indexes and their relation to the Whorl pattern

The number of deltas/tripoints in different fingerprint type is not the same. According to previous studies, the DL₁₀ index ($DL_{10} = \frac{L+2W}{A+L+W} 10$) ranges from 0 - 20. Normally, the Arch pattern does not have any delta/tripoint, the Loop pattern has 1 delta/tripoint and the Whorl pattern has 2 deltas/tripoints. DL₁₀ represents the average delta/tripoint index of the research group and the number of deltas/tripoints depends mainly on the Whorl pattern.

Table 9. The Whorl fingerprint and DL₁₀ index of three ethnic groups

Ethnic group	n	Male				Female			
		Right		Left		Right		Left	
		W	DL ₁₀	W	DL ₁₀	W	DL ₁₀	W	DL ₁₀
Thai	267	12.00	12.39	10.35	11.95	10.22	11.61	9.67	11.22
Kinh	247	13.08	12.84	10.98	12.06	10.84	12.12	10.76	12.06
H'Mong	270	11.83	12.47	11.30	12.19	9.75	11.80	9.93	11.38

The data of Table 9 reveal that in the male groups, the DL₁₀ index in the right hand is higher than in the left hand, which is consistent with the conclusion that the frequency of occurrence of the Whorl pattern is higher on the right hand than on the left hand. In the female group, the DL₁₀ index also corresponds to a higher rate of The Whorl pattern on the left hand than on the right hand.

The DL₁₀ index of the Kinh ethnic group is the highest, followed by the H'Mong ethnic group, and finally the Thai ethnic group.

The relationship among basic fingerprint patterns and related indicators

Table 10. The relationship among basic fingerprint ridge patterns

Ethnic group Fingerprint	Thai	Kinh	H'Mong
A	3,52	2,73	3,043
L	25,34	24,24	25,53
W	10,56	11,41	10,70
$\frac{A \times 100}{L}$	13,89	11,26	11,917
$\frac{A \times 100}{W}$	33,34	23,92	28,44
$\frac{W \times 100}{L}$	41,66	47,10	41,91
DL ₁₀	11,79	12,26	11,95

Table 10 shows that the Thai ethnic group has a higher percentage of the A pattern than the H'Mong and Kinh ethnic groups.

Meanwhile, the H'Mong ethnic group has the highest rate of L pattern, followed by the Thai and Kinh ethnic groups.

The rate of encountering Whorl pattern in the Kinh ethnic group is highest, while that of the Thai ethnic group is lowest.

The ratio of the Loop and the Whorl patterns is highest in the Thai ethnic group, and lowest in the Kinh ethnic group. However, the Loop and DL₁₀ indexes of the Kinh ethnic group are greatest (corresponding to the largest number of Whorl pattern). These indexes are lowest in the Thai ethnic group.

Table 11. Comparison of Whorl formula in this study with previous ones

Ethnic group	Ethnic group	Công thức vân vòng		
		Tran Thi Minh 2021	Hoàng Van Luong 1998	Nguyen Dinh Khoa 1983
Thai	Thai	IV> I> II> III> V	I> IV> V> II> III	-
Kinh	Kinh	IV> I> II> III> V	IV> I> II> V> III	I> IV> II> III> V
H'Mong	H'Mong	IV> II> III> I> V	IV> I> II> III> V	IV> II> I> III> V

The study of 784 samples in all three ethnic groups (Thai, Kinh, and H'Mong) reveals that the frequency of occurrence of W pattern is highest in finger IV. According to Hoang Van Luong 1998, the frequency of occurrence of W pattern in the Black Thai ethnic group (n=191) is greatest in finger I. Meanwhile, Nguyen Dinh Khoa 1983 claimed that it is among Kinh people that W pattern occurs most frequently in finger I (n=84). This error is likely due to different sample sizes and sampling locations.

Conclusion

The W patterns have a higher rate of occurrence than other fingerprint patterns, with the highest rate of occurrence being found on finger IV and the lowest rate on finger V in all 3 ethnic groups: Thai, Kinh, and H'Mong. The Kinh ethnic group has higher rate of W patterns than other ethnic groups. A higher distribution of Whorl pattern is recorded on the right hand than on the left hand. The frequency of occurrence of the Whorl patterns of all 3 ethnic groups follows the order: $W^c > W^s > W^{dl} > W^{cp}$. The W finger patterns has the highest value in the Kinh ethnic group, and lowest in Thai ethnic group. The rate of W^{dl} and W^s is highest in the Thai

ethnic group and lowest in the Kinh group. The index of W^{dl} và DL_{10} of the Kinh ethnic group is highest (equal to the biggest number of W patterns), and the lowest is Thai ethnic group..

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