Digit Ratio 2D:4D Variaton and the Relaitionships to Aggressivity in Sumatran Institute of Technology Students

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Abstract. The ratio index finger length (2D) to ring finger length (4D) or digit ratio 2D:4D is a trait of sexual dimorphism. The prenatal testosterone influences the digit ratio 2D:4D since the growth of the fetus in the womb. High levels of prenatal testosterone will affect the development of finger which is indicated by the increasing size of the index finger. High testosterone levels are thought to be associated with aggressiveness in humans. This aggressiveness is often found in adolescence to adulthood such as collage students. This study aims to analyze the digit variation of the 2D:4D ratio and the relationship to aggressiveness in collage students. This research was conducted in January until March 2023 at the Sumatra Institute of Technology with a sample of 295 respondents representing three majors. The method used in this study is the assessment of aggressiveness data using the Buss-Perry questionnaire and measuring the digit ratio 2D:4D using a digital caliper. In this study, the results of the right and left digit ratio in males had a score of 0,9812 and 0,9827, and in females had a score of 0,9824 and 0,9909. This shows thus male's digit ratio is lower than that of females. This study shows that the digit ratio is negatively correlated with physical aggressiveness. These results indicated a correlation between prenatal testosterone levels and aggressiveness, although it is not significant.

Keywords: Aggressiveness; Digits Ratio; Correlation; Collage Students; Prenatal Testosterone

1 Introduction

Human generally have behaviors that tend to be dominant in social life, one of which is aggressiveness. According to Buss & Perry (1992), aggressiveness is an emotional overflow, namely attacks on others which are expressed through direct actions such as physical and verbal violence and through indirect actions such as anger and hostility between individuals. Aggresiveness is influenced by several factors, one of which is

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biological factors related to the theory of natural selection. Individuals who are able to survive are dominant individuals to aggressive to maintain resources [1].

Aggressiveness often causes conflict between individuals, which is a problem that often occurs in adolescence, including in collage students, aggressiveness caused by hormonal factors such as prenatal androgen. Prenatal androgens has been active since individuals are still in the womb and affect human behavior, including aggressiveness [3]. From the time the fetus forms around the eight week of pregnancy, the hormone testosterone plays a role in the formation of the genitals, brain and other organ system. Prenatal testosterone is assisted in the formation of these organs by various genes, especially the Homebox (hox) group genes. The HOXA and HOXD genes, which affect the formation of fingers and toes, also play a role in supporting testosterone in organ formation [4]. This hormone also affect the growth of finger bones [3]. Hormones that play a role in the prenatal period are prenatal hormones including prenatal estrogen and prenatal testosterone [5]. Low levels of prenatal testosterone and high levels of prenatal estrogen will cause the ring finger to be shorter than the index finger, as in most females. Conversely, high levels of prenatal testosterone and low levels of prenatal estrogen will show a ring finger longer than the index finger, as ini males [1]. Therefore, the digit length ratio of the index finger (2D) and ring finger (4D) has a relationship with sexual dimorphism that has correlation with human behavior [6].

To data there has not been much research on 2D:4D digit ratio analysis on university students. Research on collage students needs to be done to analyze whether the digit ratio 2D:4D influenced by prenatal testosterone in adolescents has correlation with aggressiveness. Thus, the aim of this study to analyze the relationship between the ratio of the index finger and ring finger digit ratio 2D:4D to human aggressiveness, especially in collage student of the Sumatran Institute of Technology.

2 Materials and Method

2.1 Time and Place

The research was conducted from January to March 2023 which was approved by the Health Research Ethic Committee of the Faculty of Medicine, University of Lampung No: 970/UN26.18/PP.05.02.00/2023. This study used random sampling method in Sumatran Institute of Technology by interviewing respondents randomly without looking at demographic background. Data collection is demographic data, measurement of digit ratio 2D:4D, and aggressiveness. The data obtained were analyzed at the Biology Laboratory, Departement of Science, Sumatran Institute of Technology.

2.2 Subject Determination

Respondents in this study were students of the Sumatran Institute of Technology. The total respondents are 295 people consisting of 147 males and 148 females representing three majors in campus. Respondents who were assessed were healthy individuals and had never had an accident or injury to the finger so that the data obtained described

prenatal exposure to testosterone while the individual was in the womb.

The sample size was calculated using the *Slovin* formula as follows:

$$n = \frac{N}{1 + N\ (e^2)}$$

Description:

n: number of samples/sample members

N: number of elements/members of the population
e : *error* level/ error tolerance limit (0.06).

Calculation of the student population of Sumatera Institute of Technology:

$$n = \frac{N}{1 + N\ (e^2)}$$

$$n = \frac{18.449}{1 + 18.449\ (0{,}06^2)}$$

$$n = 277{,}762722\ (278)$$

So, the total number of respondents in the study was at least 278 students.

2.3 Data Collection Technique

Data in this study were collected using questionnaires, and 2D:4D digit ratio measurements. Respondent were interviewed regarding personal data, such or, *handedness*, income, sex GPA, UKM, major and class year. Researchers measured aggressiveness using Buss & Perry questionnare. The questionnaire contains 29 questions consisting of two groups of statements that support aggressiveness and statements that do not support aggresiveness, which are rated on a Likert scale from one to five: scale one (strongly disagree), scale two (disagree), scale three (sometimes), scale four (agree), and scale five (strongly agree) according to the respondent's personality.

From the questions on the questionnaire, the average of each aggressiveness on the respondents was calculated. The average score of each aggressiveness from the respondent's answer calculated using the formula below:

$$\text{Average score} = \frac{likert\ scale\ selected\ from\ each\ statement}{statement\ count}$$

Example:

$$\text{Physical aggressiveness} = \frac{2+3+2+3+4+5+2+2+3+2+4+5+4++5+ 2+3+2+3+4+2+1+2+3+4+5+3+3+3+3+2}{8}$$

$$= 11{,}12$$

2.4 Finger 2D:4D Ratio Measurement

Measurement of the 2D:4D ratio of the index and ring fingers was performed using an *MTE digital caliper* with a maximum scale of 150 mm and an accuracy of 0.2 mm. Finger lengths of the index finger (2D) and ring finger (4D) were measured from the basal proximal crease to the fingertip and a straight line was drawn to compare the lengths of the index and ring fingers (Figure 1). Subjects with injuries were excluded from the study [8].

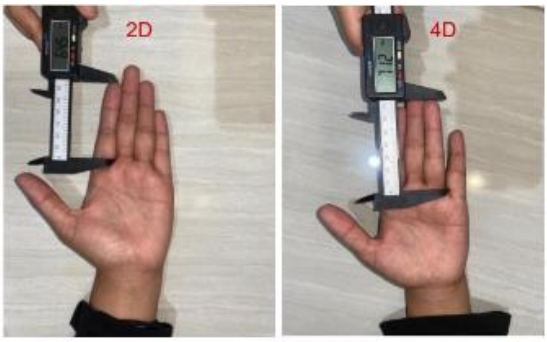

Fig 1. Measurement of (A) index finger and (B) ring finger using digital caliper (Source: personal documentation)

The relationship between digit ratio (2D:4D) and aggressiveness in students of Institut Teknologi Sumatera was analysed using the correlation test, which measures the relationship of two variables with quantitative results. If the correlation coefficient value is close to +1 (positive one), the value of both variable X and Y is high and has a positive correlation. On the contrary if the coefficient value is close to -1 (negative one), the data value of variable X is high and Y is low and has a negative correlation. [9]. Data were analysed using the R 4.2.3 version.

3 Results and Discussion

3.1 Result

This study used anthropometric measurements, specifically the lengths of the index finger (2D) and ring finger (4D). the average size of the ring finger of students is shorter than the size of the index finger in both male and female students (Table 1).

Table 1. Average data of 2D:4D finger measurements of ITERA students

Measurement	Gender		Total (mm)
	Male (mm)	Female (mm)	
2D right	71,51 (±4,17)	65,80 (±3,69)	68,64 (±68,64)
4D right	72,88 (±4,56)	66,50 (±3,91)	69,68 (±69,68)
2D left	71,85 (±4,15)	65,89 (±3,49)	68,86 (±68,86)
4D left	73,11 (±4,47)	66,49 (±3,79)	69,79 (±69,79)

The 2D:4D digit ratio of males was slightly lower in both the right and left hand compared to females. Males scored 0,9827 in the right hand and 0,9894 in the left hand, while females scored 0,9894 in the right hand and 0,9909 in the left hand (Table 2)

Table 2. Digit ratio 2D:4D ITERA students

Gender	Right	Left
Male	0,9812	0,9827
Female	0,9894	0,9909

This study measured the level of aggressiveness using an aggressiveness questionnaire based on Buss & Perry (1992). Table 3, the average data on the level of aggressiveness of students, dominated by hostility aggressiveness with a score of 3,01, and anger aggressiveness with a score of 2,92.

Table 3. Average aggressiveness level of ITERA students

Aggressiveness	Gender		Total
	Male	Female	
Physical	2,57 (±0,54)	2,29 (±0,50)	2,43 (±0,54)
Verbal	2,69 (±0,61)	2,57 (±0,64)	2,63 (±0,63)
Anger	2,76 (±0,71)	3,06 (±0,60)	2,92 (±0,67)
Hostility	2,95 (±0,61)	3,07 (±0,56)	3,01 (±0,59)

Based on Table 4, the low 2D:4D digit ratio on right hand was correlated with physical aggressiveness with a p= 0,05. Low 2D:4D digit ratio is related to high prenatal testosterone.

Table 4. Correlation of 2D:4D digit ratio with aggressiveness

	Measurement	Pearson correlation (r)	*p-value*
Ratio (2D:4D) right	Physical aggressiveness	-0,11	0,05*
	Verbal aggressiveness	-0,01	0,91
	Anger aggressiveness	0,01	0,89
	Hostility aggressiveness	0,08	0,13
Ratio (2D:4D) left	Physical aggressiveness	-0,09	0,12
	Verbal aggressiveness	-0,09	0,09
	Anger aggressiveness	0,03	0,58
	Hostility aggressiveness	0,07	0,19

Based on Table 5, there are no results showing significant scores in each aggressiveness category based on sex.

Table 5. 2D:4D correlation with aggressiveness by gender

Measurement		Male		Female	
		Pearson correlation (*r*)	***p-value***	**Pearson correlation (*r*)**	***p-value***
Rasio (2D:4D) Kanan	Physcial aggressiveness	-0,03	0,63	-0,12	0,12
	Verbal aggressiveness	-0,03	0,69	-0,05	0,49
	Anger aggressiveness	-0,02	0,77	-0,01	0,85
	Hostility aggressiveness	0,11	0,17	0,03	0,66
Rasio (2D:4D) Kiri	Physcial aggressiveness	-0,06	0,41	-0,05	0,51
	Verbal aggressiveness	-0,12	0,14	0,07	0,36
	Anger aggressiveness	-0,06	0,45	0,08	0,30
	Hostility aggressiveness	0,01	0,87	0,12	0,14

Linear models were conducted to analyse demographic factors that possible to influence the level of aggressiveness in students. These factors include sex, handedness, income, GPA, and class year. From the data, there are no demographic factors that affect aggressiveness.

Table 6. Linear model of aggressiveness factors in ITERA students

Factors	Estimate	Std. Error	*T value*	Pr(>|t|)
Female gender	0,0228	0,0537	0,424	0,672
Left handedness	-0,1627	0,1627	-1,000	0,318
Income	0,0023	0,0257	0,089	0,929
GPA	-0,0642	0,0812	-0,791	0,430
Class Year	-0,0328	0,0230	-1,428	0,154

3.2 Discussion

Research on digit variation of 2D:4D ratio and its relationship with aggressiveness in students of Institut Teknologi Sumatera shows that the average finger size in males and females was dominated by the fourth digit (longer ring finger). Then, the digit ratio 2D:4D in males was lower than females. The average aggressiveness of respondents is dominated by indirect aggression, namely anger and hostility, both in males and females. Low digit ratio 2D:4D correlated with physical aggressiveness of students. The results show that demographic data such as sex, handedness, income, GPA, and class year had no effect on aggressiveness in collage students.

Prenatal testosterone shapes anatomical development including the development of finger bones. Human finger bones will continue to grow in proportion to the amount of prenatal testosterone produced by the mother's body. According to a team of researchers from Swansea University, ring fingers that are longer than the index finger indicate more prenatal testosterone production [1]. In Table 2 the results obtained were in accordance with Manning's research, that the 2D:4D digit ratio in males is lower than in females. Prenatal production of testosterone has a critical period that is around the eighth week to the 24th week of pregnancy which results in sex differences in the human fetus [10].

Prenatal testosterone affects brain development by producing prenatal testosterone in the eighth week which then causes the lateralisation process in the males brain.

Prenatal testosterone and its relationship with brain development are related to personality, one of which is a person's temperament such as aggressiveness. Several studies have found that mothers who produce high levels of testosterone during pregnancy tend to have children with more masculine traits [7]. Masculine is related to male gender which includes individual personality and character, where males must have courage and aggressiveness, and be able to take risks [12].

Aggressiveness is divided into four categories, namely physical aggressiveness, anger, and hostility. Each category can have different results according to sex. The results of the average level of aggressiveness in students of the Sumatran Institute of Technology show that indirect aggression in the form of anger and were more dominant in both males and females. The results of this study are in accordance with the statement of Björkqvist in his research that females show higher results in indirect aggression, namely anger and hostility [13]. However based on Björkqvist's research, males use more direct aggression in the form of physical aggression and verbal aggression [13]. Our research shows more aggressiveness of anger and hostility in females. According to Jiang (2022) there is one type of personality related to indirect aggressiveness, namely *agreeableness*. *Agreeableness* is a personality where individuals tend to be cooperative, kind, polite, and friendly. Low level of direct aggression in students perhaps influenced by environment that can change attitudes to conform social norms. If a person shows direct aggression in the form of clear physical and verbal aggression, it can potentially become a criminal act that can harm the individual [14]. Based on this explanation, it can be seen that the personality of Sumatran Institute of Technology students to tends to be *agreeableness* reflecting in higher average score of indirect aggressiveness [15].

A lower 2D:4D digit ratio in the right hand correlates with physical aggressiveness due to the production of more testosterone during pregnancy. From research referring to studies on twins, it was found that male and female twins show more physical aggressiveness due to the influence of higher prenatal testosterone. This is because there are male fetuses that produce more prenatal testosterone compared to female and female twins [16]. Our study refleet low 2D:4D ratios correlated with physical aggression.

In this study, demographic factors measured such as GPA, Student Activity Unit (UKM) and income had no effect on aggressiveness. Factors that are thought to trigger aggressiveness in students are a static and passive physical environment such as the family environment, peers and individual residences that are less healthy and comfortable for carrying out daily life activities so that this can lead to anti-social actions related to aggressiveness. Then it is suspected that there are non-physical environmental factors. Non-physical environmental factors are problems of emotional disturbance, personality, and self-control in the individual [17]. In general, aggressiveness in modern humans still exists regard less the diverse of demographic backgrounds. Thus, it is suspected that aggressiveness is still needed. Aggressiveness continues to evolve over time as a natural mechanism for survival, self-protection and competitive behaviour that can be beneficial in various aspects of life [1].

4 Conclusion

From the results of research on the variation of the 2D:4D digit ratio and its relationship to aggressiveness in ITERA students, it can be concluded that the variation of the 2D:4D digit ratio correlated with aggressiveness, especially in physical aggressiveness. Research on the variation of the 2D:4D digit ratio and its relationship to aggressiveness needs to be studied further in traditional communities that can be more expressive in showing aggressiveness.

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