

Higher Risk of Motor Vehicle Accident in Female Motorcyclist with Type 3 Digit Ratio (2D:4D)

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ABSTRACT

Introduction: Digit ratio is the ratio of the lengths between the 2nd Digit (index finger) and the 4th Digit (ring finger) which is measured from base of the proximal phalanx to the tip of distal phalanx. Digit ratio pattern has been associated with a variety of psychological sex-dimorphic variables, such as aggression, risk-taking behaviour and a possible higher risk for involving in Motor Vehicle Accident (MVA).

Aim: To assess the prevalence and significance of Type 3 digit ratio in female motorcyclists involved in the MVA.

Materials and Methods: This study was a comparative cross-sectional study that included 194 female motorcyclists which

were equally divided into MVA and non-MVA (control group). Radiograph of the right hand was used to calculate the digit ratio. The ratio were grouped into Type 1 (index>ring) common female pattern, Type 2 (index=ring) intermediate and Type 3 (index<ring) male pattern. Pearson's chi-square test was used to test the significance of association between the digit ratio pattern and the risk for MVA.

Results: The result showed the MVA group was strongly associated with Type 3 pattern (53.6%) ($p<0.05$), while the non-MVA group was associated with Type 1 pattern (86.6%).

Conclusion: The Type 3 digit ratio in female motorcyclists appears to be highly associated to involve in MVA.

Keywords: Behaviour, Finger pattern, Masculinization

INTRODUCTION

Digit ratio is defined as the ratio of the lengths of different digits or fingers, which is measured from the Metacarpo-Phalangeal Joint (MCPJ) to the tip of a finger [1]. It is particularly measured between the index finger (2nd Digit or 2D) and the ring finger (4th Digit or 4D). It has been suggested by Manning JT, that the ratio between these two digits is affected by exposure of testosterone while in the uterus [1].

Manning JT, had also reviewed evidence to suggest that the ratio of the length between the index and ring finger (2D:4D or digit) is somewhat sexually dimorphic. Generally, in males ring fingers are longer than index fingers which lead to low digit ratio (Type 3 finger pattern). Meanwhile, females typically have longer index fingers than ring fingers or high digit ratio (Type 1) or sometimes both digits are about the same length (Type 2). Manning JT, states "In general, it seems that digit is the most reliable of the predictors of hypermasculinization" [2].

In correlation to the previous studies [2,3], a female with the Type 1 finger pattern (female pattern) shows feminization behaviour such as soft, gentle, less aggressive and with less risk-taking behaviour. On the other hand, a female with Type 3 (male pattern) shows typical male behaviour such as aggressive, rough, impatience, risk taker and with a desire to complete task fast.

Individual with the Type 3 pattern has also been related to higher prenatal testosterone levels, higher sperm counts, and lower oestrogen concentrations [3]. Other traits that range from improved physical and athletic ability [3], to improve performance in examinations [4] had also been associated with the Type 3 pattern. In general, the Type 3 pattern has been considered a masculine surrogate marker; however, it is showed to have a risk factor for certain undesirable traits in men such as autism and myocardial infarction [5].

Recently, the 2D:4D digit ratio is also shown to be related to the Cysteine-Adenine-Guanine (CAG) sequence in the Androgen Receptor (AR) gene. The increase in CAG causes the AR gene to be insensitive to testosterone thus causing to signal for more

testosterone production in the embryo. The digit ratio is not related to adult sex hormone levels and it is related to androgen sensitivity rather than androgen concentration. Thus it explains why the digit ratio is constant from birth until late adulthood [6].

Researchers had used a variety of techniques for measurement of the digit ratio. The first method uses direct finger length measurement from hands as visual assessment [7]. A second method uses indirect finger length measurement from photocopies/scans [8] and the third method uses radiographs of hands for measurement [9].

From all the methods which have been used by previous studies, the radiograph method is most accurate since it is more objective and independent of any swelling or deformity of soft tissue around the particular fingers. The measurement obtained is very objective and with high accuracy because it only involves measuring the bony component [9].

Previous radiographic studies have noted that there is no digit ratio difference between the right and the left hand. The digit ratio is also not related to hand dominance [9,10].

Motor Vehicle Accident (MVA) has become a major issue debated in every country in the world. The total number of deaths in 2008 reported in Western Pacific Region was 139,156 [11] and Malaysia has contributed more than 6,000 deaths to the figure. The Malaysian authorities had reported an increment from 6,872 road traffic fatalities from a total of 414,421 MVA cases in 2010 to 6915 fatalities out of 477,204 MVA cases in 2013 [12].

The Royal Malaysian Police had reported that males riders (motorcyclists) were up to 10 times more likely to be involved in accident compare to female counterparts [13]. The report revealed that a certain group of users are exposed to a higher risk of involving with road traffic accidents. Male gender and inexperience motorcyclist with few years of driving experience were among the top factors to be associated with the accident cases [13,14].

In general, male gender is more prone to involve in MVA due to their aggressive attitude and risk-taking behaviour while handling the vehicles [14-16]. In theory, female which has male finger pattern

(Type 3) can also express a similar characteristic of male behaviour in view of higher exposure to testosterone during the intrauterine period. With this information on nature of gender and behaviour dimorphism, authors would like to explore more about the nature of women attitude and behaviour with Type 3 finger patterns, towards traffic violations and their involvement in MVA while handling the motor vehicle on their own.

For the purpose of the study, authors defined MVA as an accident or collision between two or more objects which took place on the road and one of which must be any kind of moving vehicle. Psychological and biological variables have also been discussed to explain the increased risk of traffic violations in younger drivers and males drivers. A study by Hatfield J and Fernandes R, had found that younger drivers exhibit lower risk-aversion and a higher propensity for taking accident risks as compared to older drivers [16].

In addition, these groups also have a higher tendency to seek novel, varied, and complex sensations and experiences on the road which leads to the braveness and risk-taking behaviours. The risks for the sake of such experiences are associated with risky driving and traffic violations [17].

There are studies on possible variables to associate male gender with increased risk for MVA [17-19]. To our knowledge, there are no reports correlating the digit ratio with females involving in MVA.

MATERIALS AND METHODS

This was a prospective study done at the Emergency Department. The Institutional Ethical Committee approval was obtained before commencing with the study. (Reference Number: USMKK/PPP/JEPeM {275.3.(10)}). All patients had consented to be included in the study and for the radiograph of their hands to be taken.

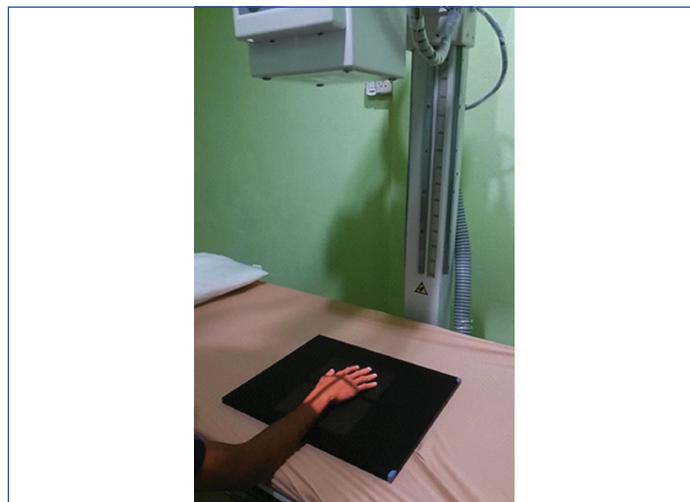
The Type 1 error was set at 0.05 (5%). The power of this study was set at 80%. Based on a previous study by Manning JT (2002), authors used 0.4 for the probability of exposure in controls (non-MVA) or P0 and 0.6 for the probability of exposure in case (MVA) or P1 is 0.6. The m value, which is the ratio of control to experimental subjects, was set at 1.

A total of 194 women who came to the Emergency Department of Hospital Universiti Sains Malaysia were included during the study period. The 194 participants were selected randomly and were divided into two groups; the first group consisted of women who were involved in MVA (MVA group). The second group consisted of female motorcyclists with no history of MVA who seek treatment not related to MVA at the emergency department (Non-MVA or control group). Each group of 97 participants which fulfilled the inclusion and exclusion criteria were included in the study. Socio-demographics (age and years of riding experience) of each volunteer were also documented. The patient selection was based on the triage system of patients, which is available in the emergency department. The system separates the MVA and the non-MVA patients. The staff at the emergency department who run the triage system were not involved in this study in order to minimise the selection bias.

The subjects included did not have congenital or acquired pathology (fracture, arthritic features) to their fingers. Only female motorcyclists were included in the study for both groups. Pillion riders were also excluded from the study. Authors also exclude subjects with underlying psychiatric history.

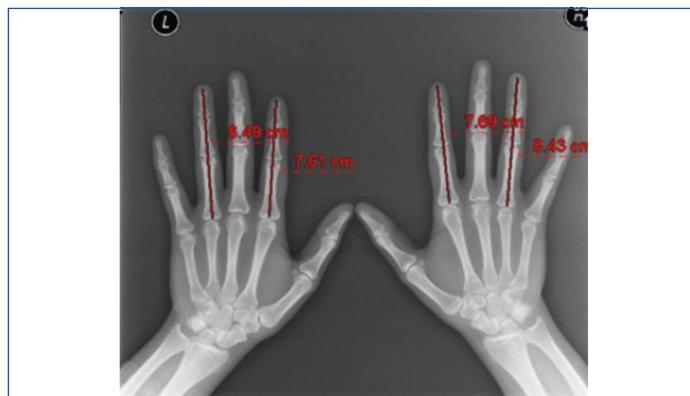
Since younger riders are shown to be more careless and incompetence in handling motor vehicle [14], authors only recruited subjects with valid license with at least five years of riding experience in this study in order to minimise bias of inexperience motorcyclists. Since in Malaysia, an individual is allowed to have a riding licence at age of 17 years, the youngest participants included in the study are at age of 22 years. A single plane Posteroanterior (PA) view plain radiograph of right hand from each subject was taken after written and informed consent was obtained. The participant was seated

adjacent to the X-ray table with the forearm and hand flat and prone on the table with no lateral angulation at the wrist. The hand was centred on the cassette with fingers slightly spread apart but flat. The X-ray beam was centred on the third Metacarpo-Phalangeal Joint (MCPJ). Images were obtained using a small focal point and a detail cassette. The source to image distance was set at 90 cm for every patient [Table/Fig-1]. Each film was scanned and was saved into Picture Archiving and Communication (PAC) system that enables straight-line measurements to an accuracy of 0.01 mm.



[Table/Fig-1]: The process of taking X-ray of right hand (PA view) for the measurement of digit ratio. The X-ray beam is centred on the third metacarpal. The distance from X-ray source to the film is set at 90 cm.

The distance of mid-point of the base of the proximal phalanx to the mid-point of the tip of the distal phalanx was measured digitally for the index and ring fingers of each subject [Table/Fig-2]. The data was collected and the ratio between index (2D) finger and ring (4D) finger was calculated and grouped into Type 1, Type 2 and Type 3.



[Table/Fig-2]: An example of a patient's PA view plain radiograph which was saved into the PAC system. The length of the particular digits was measured and the ratio was calculated which correlate with Type 3 pattern.

All measurements made were keyed into the Microsoft Access Database. The Type I error of this study was set as 0.05. The Pearson's chi-square test was conducted in order to study the association between 2D:4D ratio and MVA cases among the female participants.

RESULTS

Out of 194 subjects, 97 participants were included in the MVA group while the while the rest was included in the non-MVA group. The age for the MVA group ranged from 22-35 years with the mean±SD age of 28.56±4.12 years. The age for the non-MVA group ranged from 23-39 years with mean±SD age of 30.37±5.35 years.

The riding experience for the MVA group ranged from 5-16 years with mean±SD of 8.62±2.99 years and the riding experience for the non-MVA group ranges from 5-19 years with mean±SD of 9.97±3.27 years. [Table/Fig-3] summarises the demographic data

where the mean age of the non-MVA group was shown to be higher than the MVA group. Participants in the non-MVA group also had higher driving experience when compared to the MVA group. However, the differences between both data were not statistically significant (p -value >0.05).

Variables	MVA		Non-MVA		Independent t test p-value
	Mean	SD	Mean	SD	
Age (year)	28.56	4.12	30.37	5.35	0.94
Driving experience (year)	8.62	2.99	9.97	3.27	0.57

[Table/Fig-3]: Participants from the non-MVA group have higher mean driving experience and mean age at the time of accident when compared to the MVA group. However the p -value is not significant.

The distributions of type of digit ratios among both groups are presented in [Table/Fig-4]. Higher percentage of Type 3 digit ratio can be observed in MVA group while higher percentage of Type 1 digit ratio was among Non-MVA group.

Types of 2D:4D ratio	MVA (n=97)		Non-MVA (n=97)		Pearson's chi-square test	
	n	%	n	%	χ^2	p-value
I	37	38.1	84	86.6	57.011	$p < 0.005$
II	8	8.3	8	8.2		
III	52	53.6	5	5.2		

[Table/Fig-4]: Cross tabulation and Pearson chi-square test for association of 2D:4D Ratio and MVA.

The p -value is significant indicating a significant association between the types of 2D:4D ratio and the occurrence of MVA among female motorcyclists presented to the HUSM.

The Pearson chi-square test was used to statistically relate for association of type of digit ratio with the occurrence of MVA among female riders [Table/Fig-3]. The p -value obtained from the test was <0.05 . This means that there was a significant association between the types of 2D:4D ratio and the occurrence of MVA among the female motor cyclists.

Among the MVA group, the Type 3 finger pattern contributed to the highest number with 52 participants (53.6%). On the other hand, among non-MVA group, the Type 1 finger pattern contributed to the highest number with 84 participants (86.6%). It is also interesting to note that participants with Type 3 finger pattern only contribute to 5.2% of all the non-MVA participants.

DISCUSSION

To our knowledge, this is the first study to explore the possible association between the types of 2D:4D ratio and females involved in MVA. This study shows a positive association between females involved in MVA and the digits ratio where the low 2D:4D ratio (Type 3) in female appears to be highly associated to involve in MVA. Present results draw a similar conclusion as a study done by Schwerdtfeger A et al., among all male drivers [17]. The study had shown positive association in traffic violation among males with more predominant male 2D:4D pattern. This is supported by Manning JT et al., which stated that individual with higher exposure of prenatal testosterone will tend to develop aggressiveness or recklessness regardless of their gender [3].

In general, it is a known fact that males pay more insurance premium than females for on the road automobile protection. Many literature and reports had associated males with higher risk for MVA thus explaining higher premium of automobile insurance than females [14, 15].

Other than gender, age and experience of riders or drivers are among two other main factors that determine the insurance premium. Thus, a young male automobile user will require a higher insurance premium than an older female counterpart. Authors eliminated bias in age and riding experience by including participants with riding experience of >5 years.

Women with Type 3 digit ratio manifest a covert aggressiveness, such as inability to contain emotion in stressful situation especially during an activity that requires concentration such as driving. This explains why certain female will have tendency to drive or ride like male which will lead to traffic violations [20].

Majority of the females with Type 3 digit ratio are not aware of this underlying issue following higher intra-uterine testosterone exposure [3,21]. By screening and identifying female riders with Type 3 digit ration pattern, authors can alert them beforehand about their possible covert aggressiveness during stressful situation such as during handling automobile. A simple screening via visual inspection to determine the digit ratio before taking automobile license will give the authority some information regarding their expected social behaviour during driving or riding. The authority could then design a potential countermeasure such as riding skill education program to improve their risk perception, hazard identification and decision-making skill.

Although most automobile insurance premiums are based on driving history and records, male gender still command higher premium due to higher risks associated with MVA [14]. The present study proposes similar consideration for females with Type 3 digit ratio at the beginning of acquiring of their license until their riding records prove otherwise. This implementation is likely to be beneficial for this female group by making them aware of the reason behind the higher initial premium. In return, the higher premium acts as a constant reminder of their possibility of being aggressive behind the wheels and hopefully will help reduce the future number of MVA in females. Hopefully, it will also act as a target for them to have clean driving or riding records in the future.

LIMITATION

One of the present study limitations lies in limited socio-demographic of the participants. In future study, authors would like to include other variables such as education level, household income and estimated time spent on vehicles.

CONCLUSION

In summary, this preliminary study of 2D:4D ratio which was conducted on participants who were randomly recruited from the general population, showed that females with Type 3 digit ratio (male pattern) have a higher risk to involve in motor vehicle accident.

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