ASSOCIATION BETWEEN 2D:4D RATIO PREVALENCE AND FEMALES INVOLVED IN MOTORVEHICLE ACCIDENT

BY

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LIST OF ABBREVATION

MVA	Motorvehicle accident
2D	2nd digit (little finger)
4D	4th digit (ring finger)
KK	Kemalangan Kenderaan
RTA	Road Traffic accident
mAs	Milliamperage second
FFD	Focal Film Distance
SID	Source To Image Distance
kVp	Kilovoltage Peak
PA	Posterior Anterior
CAH	Congenital Adrenal Hyperplasia
OA	Osteoarthritis

ABSTRAK

Nisbah digit/ angka (2D:4D) dianggap sebagai penanda pendedahan hormon pranatal. Nisbah angka yang lebih rendah telah dicadangkan sebagai indeks testosteron yang lebih tinggi berbanding dengan pendedahan estrogen semasa perkembangan pranatal. Nisbah digit telah dikaitkan dengan pelbagai pembolehubah psikologi dimorph-jantina termasuk orientasi ruang, tingkah laku agresif atau sifat mengambil risiko. Kajian ini bertujuan untuk melihat kolerasi antara perempuan yang terlibat dalam kemalangan kenderaan (KK@MVA) dengan nisbah digit.

Nisbah digit telah dinilai menggunakan radiograf tangan. Setiap jari diklasifikasikan kepada tiga jenis mengikut panjang jari telunjuk dan jari manis: Jenis 1 (jari telunjuk lebih panjang dari jari manis) pola umum kaum perempuan, Jenis 2 (jari telunjuk =jari manis) pola pertengahan dan Jenis 3 (jari telunjuk pendek dari jari manis) pola umum kaum lelaki. Kedua-dua jari telunjuk dan manis di ukur bermula dari pangkal falanks proksimal hingga ke hujung falanks. Dua kumpulan pesakit telah dikenalpasti. Satu kumpulan pesakit yang terlibat dengan KK dan satu kumpulan lagi yang tidak terlibat (KK). Perkaitan antara kedua-dua kumpulan ini dan nisbah digit dikaji.

Keputusan menunjukkan bahawa kebanyakan perempuan yang terlibat dengan KK tergolong dalam jenis 3 nisbah digit yang mana merupakan pola lelaki. Sementara itu, mereka yang tidak terlibat dengan KK merupakan jenis 1 nisbah digit yang merupakan pola perempuan.

Oleh itu, keputusan kajian ini menimbulkan satu kesedaran baru tentang potensi perempuan yang mempunyai nisbah digit rendah (jenis 3) yang merupakan pola lelaki yang berkait dengan KK. Hasil kajian ini juga menyokong nisbah digit sebagai satu prediktor yang berpotensi untuk melihat kecenderungan kemalangan.

ABSTRACT

ASSOCIATION BETWEEN 2D:4D RATIO PREVALENCE AND FEMALES INVOLVED IN MOTORVEHICLE ACCIDENT

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Introduction: Digit ratio (2D:4D) is a putative marker of prenatal hormone exposure. A lower digit ratio has been suggested as an index of higher testosterone relative to estrogen exposure during prenatal development. Digit ratio has been associated with a variety of psychological sex-dimorphic variables, including spatial orientation, aggression, or risk-taking behaviour.

Objectives: The present study aimed to look for any correlation between female involved in motorvehicle accident (MVA) and digit ratio. Digit ratio was assessed via hand radiographs.

Patients and Methods: Each hand was classified into three types according to the relative length of the index and ring finger: Type 1 (index longer than ring) common female pattern, Type 2 (index = ring) intermediate pattern and Type 3 (index shorter than ring) common male pattern. For both index and ring fingers we measured from base of proximal

phalanx to tip of distal phalanx. Two group of patient was identified one which involved in (MVA) and another group not involved in (MVA) and the association between this 2 group and digit ratio was studied.

Result: The result showed that female which involved in MVA most of them having type 3 digit ratio which is male pattern 53.6% while those not involved in MVA are type 1 digit ratio which is female pattern 38.1%.

Conclusion: Therefore, the result of this study creates a new awareness as to the potential female with low digit ratio (type 3) which is male pattern associated with MVA and this also provide some support for the digit ratio as potential predictor of accident proneness.

Dr Shaifulzain b Ab. Rahman : Supervisor

CHAPTER 1

INTRODUCTION

Digit ratio is defined as the ratio of the lengths of different digits or fingers, which is measured from the bottom crease or the metacarpo-phalangeal joint to the tip of the finger. It is particularly measured between the 2nd Digit (index finger) and the 4th Digit (ring finger). It has been suggested by John T. Manning in his books “Digit Ratio: A Pointer to Fertility, Behavior and Health” that the ratio between these two digits is affected by exposure testosterone while in the uterus (Manning J, 2002).

Manning had also reviews evidence to suggest that the ratio of the length between the index and ring finger is somewhat sexually dimorphic. More specifically, it is the ratio of the length of the index finger (2nd digit, or “2D”) and the ring finger (4th digit, or “4D”) that is sexually dimorphic. Generally, males have a ring finger that is longer than their index finger. Females typically have index finger longer than ring fingers or both about the same length. He states: “In general, it seems that 2D:4D is the most reliable of the predictors of hypermasculinization” (Manning J et. 2003).

Many spatial abilities are sexually dimorphic and appear to be influenced by prenatal testosterone (Hampson et al, 1998). X. J. Chai and L. F. Jacob concluded that females with low digit ratio were more accurate in their orientation (X. J. Chai and L. F. Jacob, 2012).

Measurement for the 2D:4D ratio has also been debated as to which elements of the finger (phalanges, metacarpals or both). J. Robertson et al. concluded in their study that both the phalanges and metacarpals contribute to variation in the 2D:4D ratio (J. Robertson et al., 2012). Base on their visual classification, three types of the 2D:4D ratio was recorded according to whether the index finger was longer (Type 1), equal to (Type 2) or shorter than the ring finger (Type 3).

In a study by W. Zhang et al., they have found that Type 3 (male pattern) 2D:4D ratio is associated with Osteoarthritis, especially knee Osteoarthritis. The risk is independent of other major Osteoarthritis risk factors (W. Zhang et al., 2008). This is further supported by B. Ferraro et al., in their study of site specific Osteoarthritis and the index to ring finger length ratio (B. Ferraro et al., 2010). Ferraro et al. concluded that the Type 3 finger pattern was significantly associated with knee Osteoarthritis and it is also an indicator of Osteoarthritis predisposition.

In correlation with previous study in general type 1 (high 2D:4D ratio) which show which is female pattern will show feminization such soft, less risk taker, gentle ,less aggressiveness ect. While type 3 (low 2d:4D ratio) which is male type phenotypically will masculinization which producing typical male morphology and behaviour. For an example in general male usually rough and anything need to be done fast, aggressiveness, highly risk taker, not patience and some others.

In general male gender is more proness to involve in accident in collaboration with their attitude and controlling their emotion while handling the vehicles. However female which have male pattern (type 3 ratio) will also expressed the similar characteristic of male behaviour in view of higher exposure to testosterone in intrauterine. With this nature of human behaviour and morphology, we would like to explore more the nature of women attitude and behaviour which has male pattern digit ratio (type 3), towards traffic violations and their involvement in MVA while handling the motorvehicle by their own.

So far, there are no reports correlating the 2D:4D ratio with ladies involved in motor vehicle accidents. This study was carried out to determine the association between 2D:4D ratio prevalence and females involved in motovehicle accident.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Knowledge of the digit ratio is essential because the correlation of the ratio serve as marker for prenatal testosterone level. The index to ring finger length ratio (2D:4D) is a trait that is sexually differentiated in a variety of species (Bailey A et al 2005). In humans, males typically have shorter second (index finger) digits which refers as 2D compared with fourth (ring finger) digits which refer as 4D. Whereas in women the fingers are more equal in length or index finger is longer compare to ring finger (Manning J et al 2004). Low 2D:4D length ratios have been associated with higher prenatal testosterone levels, higher sperm counts, and lower estrogen concentrations (Manning J). Reduction in this 2D:4D ratio has been shown to have a number of associations, ranging from sexual ability (Honekopp J et al 2010), physical and athletic ability (Manning J et al 2004), "masculine" facial shape to offspring (Paul S et al 2006) and performance in examinations (Romano M et al 2006). It has been considered a masculine surrogate marker and a risk factor for autism, myocardial infarction, and human immunodeficiency virus in men (Manning J et al 2004).

It also been considered the smaller 2D:4D length ratio is associated with an increased risk of knee osteoarthritis especially tibiofemoral component. (W.Zhang). However, it has not been examined as a possible risk factor for females which involves in motorvehicle accident (MVA), a condition that can be related both biomechanically to physical activity and hormonally to high testosterone level.

MVA is male predominant area where the percentage of male involvement comparatively higher compare to female. However female which presented with male type digit ratio pattern is also proneness to involve in MVA in view of their psychosocial behavioural pattern is like man.

We therefore undertook this comparative cross sectional study to examine the pattern of the type of digit ratio weather type 1, 2 or 3 is really influences female involved in MVA. By this information gain will give us some information whether any such association is independent of other established risk factors for MVA. This will make the female which handling the vehicle will be more cautious and beware of surrounding environment which predisposing them to involved in motorvehicle accident.

2.2 Digit Ratio (2D:4D) Evolution

The 2D:4D digit ratio is sexually-dimorphic, probably due to testosterone action through the perinatal period. It is characterize that the 2D:4D ratio in newborn infants, in between the pre- and postnatal surges of testosterone, and relate it to the mother's 2D:4D and to testosterone levels in the amniotic fluid.

In humans, the ratio of the index finger (2D) to the ring finger (4D) is sexually dimorphic, as women have a larger mean 2D:4D ratio than men (Manning J et al 2004), a tendency previously described in several populations. As many somatic sex differences result from prenatal androgen masculinization, it has been suggested that prenatal testosterone is responsible for the sex difference in mean 2D:4D ratio.

Strong evidence for the role of androgen comes from the association between the 2D:4D ratio and congenital adrenal hyperplasia (CAH), a condition of elevated androgen production, as both males and females with CAH have smaller 2D:4D than controls (Brown WM et al 2002). Also female dizygotic twin fetuses growing next to males were found to have lower ratio than the ones growing next to females suggesting the influence of some level of androgen diffusion (Van Anders SM 2006).

More recently, an experimental study (Zheng Z et al 2008) with a mouse strain known to be sexually dimorphic, provided compelling evidence that prenatal testosterone and estrogen determine mouse 2D:4D during embryonic development, with sex steroids controlling digit development by regulating the skeletogenic expression of at least 19 genes.

The 2D:4D ratio at birth should thus reflect a genetic background subjected to a given level of prenatal androgen and estrogen exposure. (Garn et al 1975) measured human embryos and fetuses to find that phalangeal length ratios later found in adulthood are attained early in gestation, by the end of the 13th week. Since then some authors assumed that the 2D:4D sexual dimorphism is established during early prenatal development, with the 2D:4D ratio remaining stable there after. (Sarkar. B et al 2007)

However if sex steroids determine digit growth, their effect may not be limited to the prenatal period only, as exposure to testosterone proceeds non-uniformly until the first years of life.

Human perinatal testosterone production comprises three peaks, a mid-gestational and two postnatal peaks (Princ e FP 2001). The mid-gestational peak takes place between weeks 14 and 18, although most prenatal androgen effects occur in between 7 and 12 weeks. Serum testosterone rises to a first postnatal peak around two months of neonatal age, falling again to childhood levels by 4 to 6 months. A third (second postnatal) peak is found from puberty onwards to adulthood.

There two studies which done by (McIntyre 2005 and Trivers R 2006) which provide solid evidence that the digit ratios increase from infancy to adulthood, especially between ages one and five, although the magnitude of the change is small. Similarly, Galis et al. which working with 327 deceased human fetuses (14 to 42 weeks old) reported that the prenatal 2D:4D in both sexes was lower than has been reported for children and adults, suggesting that it may increase after birth.

More recently, McIntyre and Alexander, in a sample of 74 young children (3–5 months old) also found relatively low 2D:4D values, and Knickmeyer et al. followed 2D:4D during the postnatal testosterone surge (0–2 years old) to conclude that 2D:4D ratios change, apparently modulated as well by postnatal testosterone.

The secondary sex differences arising prior to puberty, namely the 2D:4D ratio, are usually attributable to the effects of prenatal and/or early postnatal testosterone production.

2.3 Radiographic Assessment of Digit Ratio

A scientometric analysis of modern research on the second-to-fourth digit ratio (2D:4D), a widely studied putative marker for prenatal androgen action, is presented. However, despite considerable interest in this ratio several basic questions have yet to be answered. First, we do not know which elements of the finger (phalanges, metacarpals or both) contribute to the variation of this ratio.

Previous radiographic studies have measured phalangeal 2D:4D ratios but have not examined the possible contribution from metacarpals. There is no study done weather the 2D:4D metacarpal ratio is also smaller in men than in women. Secondly, ratio differences between the right and the left hand have been identified in some studies but other studies are not. If there are significant such differences could relate to handedness and to relative speed of hand performance (Manning & Bundred, 2001a).

Research into the 2D:4D ratio has a long history (Peters et al. 2002), using a variety of measurement techniques, first including direct finger length measurement from hands as visual assessment (Manning et al. 1998) secondly indirect finger length measurement from photocopies/scans (Lutchmaya et al. 2004) and (3) radiographs of hands (Vehmas et al. 2006).

From all the method 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 high accuracy because only measuring the bony component

Previous radiographic studies have measured 2D:4D ratio of phalangeal and metacarpal of right and left hand which also show smaller ratio in men than in women. (W. Zhanget al 2008). There is no digit ratio differences between the right and the left hand have been identified.

However in certain condition where there is congenital or developmental abnormalities there are significance difference in between two limbs. In our study we measure both limbs and come out with the mean of the both fingers ratio which to avoid any differences in between both limbs

2.4 Females Involvement in Motovehicle Accident

Road accident has become a major issue debated in every country in the world. The total number of deaths reported in Western Pacific Region is 139,156 (WHO, Western Pacific Region, 2009) and Malaysia has contributed more than 6,000 deaths. In 2010, the police reported out of 6,872 fatalities, approximately 60% of traffic deaths were motorcycle riders and pillion passengers in Malaysia (RMP, 2010).

The report also indicated that male and young riders were over represented in the total accident casualties. In fact, there are relationship between the increase of road accident and the growth in the register vehicle. Road Transport Department (RTD) was reported motorcycles comprise of 50% of the total registered vehicles in Malaysia (RTD, 2010) with an average annual growth rate of about 2.1% per year.

This data also has been used to explain that certain group of users are exposed to a higher risk of accidents. It was found that the males were 1.5 times more likely to be involved in accident compare to female counterparts. The greatest risk of accident was found in young and novice motorcyclist which aged below 20 years old. (RTD 2010)

From the data its shows that young generation which obtained their driving and riding license having tendency of overconfidence level while handling the motorvehicle. This is why they tend to lack of compliance with traffic rules and regulation which made them proneness to involve in MVA.

In view of this carelessness and incompetence while handling the motorvechile in our study we recruited patient which at least have driving and riding experience of at least 5 years. By selection of this particular group of patient which familiar to rules and regulation and also well known the surrounding traffic environment, the result obtained will be more valuable and precise rather the MVA occur because of self carelessness.

Road accident data can be used as evidence to support road safety researchers and policy makers in planning for new interventions and regulations. The accident data are used widely as indicator to evaluate the road safety intervention and to determine the road safety level in the whole country. Furthermore, it also measure the effectiveness of road safety program and assessing traffic impact.

2.5 Overview Road Traffic Accident /Motovehicle Accident

Accidents, tragically, are not often due to ignorance, but are due to carelessness, thoughtlessness and over confidence. William Haddon (Head of Road Safety Agency in USA) has pointed out that road accidents were associated with numerous problems each of which needed to be addressed separately.

Human, vehicle and environmental factors play roles before, during and after a trauma event. Accidents, therefore, can be studied in terms of agent, host and environmental factors and epidemiologically classified into time, place and person distribution.

For the purpose of the study, a Road Traffic Accident (RTA) or Motovehicle Accident (MVA) was defined as accident, which took place on the road between two or more objects, one of which must be any kind of a moving vehicle.

Several demographic and psychosocial factors have been discussed to strengthen road traffic security and traffic violations (e.g., speeding, violations resulting in fatal accidents, driving while intoxicated, violations resulting in personal injury, driving with a suspended license, passing where prohibited, illegal parking. Among these most consistently been associated with traffic violations. For example,it has been shown that younger and inexperienced drivers are more frequently involved in road accidents (e.g., Williamson, 2003) and males have a higher risk for traffic violations than females (e.g.,Simon and Corbett, 1996).

In other part of world the highest number of MVA victims globally were found was male compare to female and the common age group of 20 and 29 years (Nilambar Jha 2003). However, in few studies 16 to 30 years and 15-35 years age groups were more involved in RTA (Dhingra N. et al 1991).

This shows that the people of the most active and productive age group are involved in MVA, which adds a serious economic loss to the community. Similar observations were also made by others in other part of world.

Psychological and biological variables have also been discussed to increase risk for traffic violations and, moreover, these variables might partially explain why younger drivers and males are more prevalent among traffic violators. For example, in a recent study,(Hatfield and Fernandes 2009) found that younger drivers exhibit lower risk-aversion and a higher propensity for taking accident risks as compared to older drivers In addition, there is high tendency to seek novel, varied, and complex sensations and experiences, and the braveness to take risks for the sake of such experiences are associated with risky driving and traffic violations.

It is interesting to note that males and younger individuals have higher scores on sensation seeking than females and older individuals (Zuckerman,
1994).

2.6 Previous Digit Ratio Study

Few studies was conducted regarding the association of index to ring finger ratio to underlying human psychosocial behaviour and human pathology.

Osteoarthritis (OA) is a common complex disorder with multiple risk factors. Clinically determined markers of risk could prove useful for identifying people for appropriate targeting of primary prevention measures. The ratio of the lengths of the second digit (2D), or index finger, to the fourth digit (4D), or ring finger, is a sexually dismorphic trait such that males tend to have a lower mean 2D:4D ratio than females.

The type 3 finger length pattern is associated, to a statistically significant degree, with OA of the knee. The type 3 finger length pattern (ring finger longer than index finger) appears to be an indicator of OA predisposition. Consideration of this pattern in clinical assessments may be an added aid as clinicians screen patients for OA risk. Furthermore there is also study shows the association between the risk of cancer and digit ratio.

A high digit ratio difference between the index and ring finger, or with a longer index finger was found among men with oral cancer, compared with men with pre-cancerous oral lesions or no lesions, which have low digit ratio.(Manning J T 2011)

Men with long index fingers and shorter ring fingers have a 33 percent reduced risk of prostate cancer. If they're younger than 60, the risk is even less 87 percent. (Manning J Tet all 2011). Low 2D:4D in male and female was associated with fast skiing times. 'Manning et al,2002)

Significant impairment in their cognitive empathy, and that this effect is powerfully predicted by a low 2d:4d ratio. (Jack Van Honk et al 2011). Females with low digit ratio were more accurate in their orientation abilities and personality that normally favor males(X. J. Chai et al 2009).

Currently there is increasing evidence for the hypothesis that prenatal androgens might also increase risk preferences in later adult life. For example, Coates et al. (2009) recently found that male has higher tendency of financial traders. Where long-term profitability was inversely related to digit ratio. This indicating there are more financial risk taking in individuals with type 3 digit ratio or a more masculinized. This finding is correlate with other hormonal research which documented that testosterone facilitates risk taking behaviour in gambling tasks (Apicella et al., 2008).

Other studies examined associations between digit ratio and personality variables that are related to risk taking behaviour. The personality trait sensation seeking has been inversely related to digit ratio (Fink et al., 2006). Sensation seekers underestimate or accept physical, social, legal, and financial risks as the price for the reward provided by the sensation or experience itself.

However so far, there are no reports correlating the 2D:4D ratio with ladies involved in motor vehicle accidents.

2.7 Rational Of The Study

The use of 2D:4D digit ratio to predict reaction in human is not uncommon. With the information gain, better understanding of human behavior has been achieved. Recently, more ladies are taking charge of their own daily activity and thus drive and ride themselves to their destination.

Digit ratio has been associated with a variety of psychological sex-dimorphic variables, including spatial orientation, aggression, or risk-taking behavior. The present study aimed to relate digit ratio to traffic violations for a female of frequent car drivers and motorcycle riders.

Taken together, there is converging evidence that prenatal androgen exposure as assessed via digit ratio might be related to risk-taking behaviour and, thus, to risky driving and traffic violations as well. To extent to our knowledge and reading, however, there are no studies available that have examined any associations between digit ratio and MVA. In this exploratory study we expected, in accordance with other research, an inverse relationship; that is, we expected more traffic accident to be associated with a lower digit ratio among females.

The ratio of the finger length of the index finger (2D) relative to the ring finger (4D) (2D:4D; digit ratio) represents a putative marker of prenatal hormone exposure. Specifically, the length of the fourth finger (ring finger) seems to be affected more strongly by testosterone exposure during fetal development, whereas the length of the second (index) finger seems to be more closely related to prenatal estrogen exposure

(Manning 2002). There is evidence of few studies suggested that exposure to prenatal androgens such that higher testosterone level relative to estrogen exposure, is associated with a lower digit ratio. This association seems to be influenced by the action of the Homebox (so-called Hox) genes, which control differentiation of digits and the urogenital system including testes and ovaries (Kondo et al., 1997; Pauls et al., 2006). Indeed, males have been found to exhibit a lower digit ratio (i.e., relatively shorter index finger length than ring finger length) than females, reflecting a preponderance of ontogenetic testosterone over estrogen exposure.

This difference has been found to emerge during intrauterine development. Thus, digit ratio represents a promising variable as one of the independent factor relating females involved in MVA. Thus 2D:4D digit ratio represent represents promising result for examining organizational effects on the developing of women with type digit ratio which is male like pattern..

This study is undertaken to see whether there is any correlation between 2D:4D digit ratio with women involves in motor vehicle accident. The findings obtained are useful in giving new information and understanding as to why accident occurred among women and whether more traffic violations for individuals with higher prenatal testosterone exposures (lower 2D:4D ratio).

CHAPTER 3

OBJECTIVES

3.1 General Objectives

To identify correlation of 2D:4D ratio in ladies associated with motor vehicle accidents.

3.2 Specific Objectives

3.2.1 To correlate 2D:4D ratio type with ladies involved in motor vehicle accident

3.2.2 To evaluate the difference if exist between the 2D:4D ratio in same individual obtained from different limbs

3.2.3 To assess the end result between the types of 2D:4D ratio in ladies involve in MVA and normal population

3.3 Research Question

3.3.1 Is there any difference in incidence of motor vehicle accident risk between the types of 2D:4D ratio?

3.3.2 Is there any difference in the 2D:4D ratio measured from different limbs?

3.4 Hypothesis

There is significant difference of 2D:4D ratio among the types of 2D:4D ratio in ladies involved in motor vehicle accident.

CHAPTER 4

METHODOLOGY

4.1 Study Design

This study was a comparative cross sectional study

4.2. Study Area

Accident & Emergency Department, Hospital Universiti Sains Malaysia.

4.3 Reference Population

All female patient had treatment in Hospital Universiti Sains Malaysia

4.4 Inclusion Criteria

For Patient Sustained Motorvehicle Accident

1. All female patient which riding motorcycle or driving car
2. Age between 25 years old to 45 years old
3. Minimum 5 years experience of driving cars or riding motorcycle
4. Sustained long bone fracture of upper and lower limb

Inclusion criteria for patient not involved in motorvehicle accident

1. All female which riding motorcycle and driving car
2. Age between 25 to 45 years old
3. Minimum 5years of driving car and riding motorcycle
4. Visited emergency department or orthopaedics outpatient clinic for other than trauma reason

4.5 Exclusion Criteria

1. Pregnant lady

2. Patient with hand injuries

3. Patient with any congenital deformity

4. Patient with sign of osteoarthritis and history of hand infection or trauma

4.6 Sampling Method

Randomize sampling method was used. All patient that fulfilled the inclusion criteria were included in this study after obtaining informed consent in order to perform x-ray and digit measurement. The consent was also obtained to fill in their socio demographic particular.

4.7 Research Ethical Approval

Ethical approval was obtained from the Ethics Committee, Health Campus, University Sains Malaysia on the on the 6th of February 2014 (Reference Number :USMKK/PPP/JEPeM [275.3.(10)]).

4.8 Sampling Size Calculation

The sample size of this study was calculated using SPSS Power software. The calculation was done by applying the two proportion sample size where the parameters that have been used for were as follows;

i. Type I Error (α)

The Type I error probability for a two sided test which is the probability of falsely reject the null hypothesis (Dupont and Plummer, 1990). The type I error for this study was set at 5%.

ii. Power (1-β)

The probability of correctly rejecting the null hypothesis that the relative risk (odds ratio) equals 1 given *n* case patients, *m* control patients per experimental patient, and a Type I error probability, α (Dupont and Plummer, 1990). For this study, the power used was set at 80%.

iii. P_0

For case-control studies, p_0 is the probability of exposure in controls. In prospective studies, p_0 is the probability of the outcome for a control patient (Dupont and Plummer, 1990). The P_0 values used in this study were based on the literature review.

iv. P_1

For case-control studies, p_1 is the probability of exposure in cases. In prospective studies, p_1 is the probability of the outcome in an experimental subject (Dupont and Plummer, 1990). In this study, the values of P_1 were obtained by the expert opinion.

v. m

For independent prospective studies *m* is the ratio of control to experimental subjects while for independent case-control studies, *m* is the ratio of control to case patients (Dupont and Plummer, 1990).

vi. The P_0 value used in this study indicates the proportion of Type I 2D:4D ratio among non-MVA which is 0.4 (Manning et all 2002). Meanwhile the P_1 value indicates the proportion of Type II 2D:4D ratio among MVA which was set as 0.6 and the *m* value was set as 1. Thus, the minimum sample size obtained was 97 for each group which equivalence to 194 for both group. 20% dropout was considered which means that, the required sample size was 233. At the end of the data collection, total number of respondents collected was 240. Thus, the power obtained by the study was 98.9%.

4.9 Method

Participant's women who was divided into 2 groups, one of the group which involved in motovehicle accident and another group which not involve in motovehicle accident which seak treatment at accident and Emergency Department Hospital Universiti Sains Malaysia. Total of 194 where 97 of each group of patient which fulfilled the inclusion and exclusion criteria were selected for this study. After obtained written informed consent to undergo a plain radiograph of both hand. Volunteer socio demographics (age, level of education, years experience of driving/riding/) were documented.

4.9.1 Hand Radiographs

Separate radiographs were taken of right and left hands. 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 metacarpophalangeal joint. Images were obtained using a small focal point and a detail cassette. Exposures and distances were: 48 kV; 3.2 mA.s; 90 cm source to image distance . Each film was scanned and was save into PAC System that enables straight-line measurements to an accuracy of 0.01 mm.