Second Digits To Fourth Digits Ratio In Management And Science University Students: Sexual Dimorphism

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ABSTRACT: Several previous studies had indicated that 2D:4D ratio differ between male and female, in which males possessed low 2D:4D ratio while females possessed high 2D:4D ratio. Low 2D:4D ratio in male was associated with the high level of testosterone and low level of estrogen during prenatal age whereas the high 2D:4D ratio in female was associated with low level of testosterone and high level of estrogen during prenatal age. Thus, 2D:4D ratio is positively associated with estrogen and negatively associated with testosterone. This study investigates the 2D:4D ratio in male and female using 274 undergraduate students in a university aged between 18-28 years as subjects. 2D:4D ratio in different races Malay, Indian and Chinese was also explored. Measurement of the second and fourth digits was taken for both right and left hand by using a vernier calipers and the data was analysed using SPSS 20.0. Independent T-test indicates that there was no significant sex differences on 2D:4D ratio ($p>0.05$). One way ANOVA found that there was significant race difference on 2D:4D ratio but only in Malay, Indian and Chinese males ($p<0.05$). The determination of sex cannot be done by measuring 2D:4D ratio and there was no difference between races Malay, Indian and Chinese in 2D:4D ratio.

Keywords: Second digits, Fourth digits, 2D:4D ratio, Sexual dimorphism, Management and Science University students.

Introduction

The length of second digit known as index finger and fourth digit known as ring finger varies between male and female and further varies among individuals according to Manning et al. [1]. The study of second digit to fourth digit (2D:4D) ratio is often associated with the presence of hormone testosterone in male while for female is the presence of estrogen. This hormonal development has been studied and proved during the prenatal development through assessment of the human's behavioural and physiological markers that relate to prenatal androgen exposure as mentioned by Lutchmaya et al. [2] The presence of these hormones have made mostly for male to have lower 2D:4D ratio while for female has higher 2D:4D ratio value supported by Geetha et al. [3] This is why the 2D:4D ratio is sexually dimorphic.

The study of Manning et al. [5] supported the idea of sexually dimorphic by mentioning that the mean of 2D:4D ratio in male is lower than in female since 2D:4D is negatively related to the prenatal testosterone and positively related to prenatal estrogen. Finger length ratio is sexually dimorphic where most male possess lower second to fourth digit ratio as compared to female. Using the amniocentesis sample that helps in investigating the testosterone and estrogen level of the subjects, Lutchmaya et al. [2] suggested that the difference in digits ratio observed in male and female of two years old is a direct correlation to the prenatal sex steroid exposure. This is supported based on a study done by Galis et al. [6] which suggested that sexual dimorphism in second to fourth digits ratio is already present at the 14^{th} week of gestation, using deceased fetus as the subjects. Geetha et al. [3] observed sexual dimorphism in second to fourth digit ratio in all age group of subjects from three years old to more than twenty five years old. The study found that there was significant difference of digit ratio in right hands compared to left hands especially in people ranges from 21 years old and above.

High ratio of 2D:4D could be associated with germ cell failure, low sperm count, and high level of testosterone while low ratio of 2D:4D could be associated with high testosterone and sperm count as mentioned by Manning et al. [7]. Nadankutty et al. [8] measured 2D:4D ratio in both right and left hands for male and female using 300 students of Segi University College in Malaysia. The index and ring fingers were measured using vernier calipers and middle finger was used as the standard reference. The results showed that 2D:4D ratio of right and left hands varied but the 2D:4D ratio appear to be higher in males as compared to females.

Based on the study by Morishima et al. [9], fetus is exposed to the testosterone by two sources that is testes and adrenal glands while as for prenatal estrogen, the main source is from the enzyme aromatase that converts testosterone to estrogen from the adrenal glands and placenta. According to Manning et al. [5], testosterone and dihydroxytestosterone (DHT) influence the growth of dermis and epidermis of the digits. As for estrogen is the female hormone that help in the development of ovaries and growth of breast tissue. According to Peichel et al. [11] and Herault et al. [10], Hox genes control the differentiation of organs including testes and ovaries. Its function in limbs and genital bud differentiation can be seen when there is removal of the posterior Hox genes, there will be loss of the digits as well as genital bud derivatives and fertility which is mentioned in studies done by Peichel et al. [11], Kondo et al. [12], and Mortlock and Innis [13].

The study of digits ratio is important in the general study of anatomy in which it can be used in various field such as forensic for identification of unrecognised dead body, or to study the relationship between nature and human to obtain the exact timeline of human existence when geologist found ancient handprint on the wall of a cave as mentioned by Geetha et al. [3] Besides, information during natural disaster that involves high mortality rate can be obtained and analysed to identify remains and fragments of body at least for a quicker sex determination prior to subsequent DNA analysis. Malaysia has been known to be involved in natural disasters such as tsunami or flood, thus, body identification from the calamity can be done by observing 2D:4D ratio. During identification process, the sex determination is very important to further classify the victim matches to stature, sex and ethnicity.

Materials and Methods

Study design

The is a cross sectional study where the procedure was performed directly to the sample subjects randomly obtained. The data collection was first started by recruiting the subjects among students aged between 18-28 years in a university in Malaysia.

Data collection

A total of 274 subjects were recruited and they were further divided into Malays (53 males and 54 females); Chinese (30 males and 30 females) and Indians (53 males and 54 females). Each participant filled in the informed consent and a set of basic demographic information. The participants were given briefing about the procedure. The subjects then placed the right hand followed by the left hand on the flat surface of a table with the palm facing upward and the finger being positioned straight and slightly close towards each other. Using vernier calipers, the index finger length was measured by placing one end of the calliper at the palmar digital crease and the other end was placed at the tip of the finger at the distal phalanx segment. Data were carefully recorded for subsequent statistically analysis.

Results

The data obtained was firstly analysed using descriptive statistics to obtain the averaged second digits (2D) and fourth digits (4D) length of all subjects. The results show that for both right and left 2D and 4D, males recorded longer length than females. Both males and females have longer 4D than 2D (Table 1 and Figure 1). Significant difference was reported in averaged finger length for right and left second digit and fourth digit between male and female at *p*-values less than 0.05.

Table 1: Average finger length for male and female

Gender of respondents		N	Mean	Std. Deviation	Std. Error Mean	p-value
Right 2D (cm)	Male	127	7.38873	0.414865	0.036813	0.001
	Female	147	6.71169	0.415301	0.034253	
Right 4D (cm)	Male	127	7.51591	0.465966	0.041348	0.001
	Female	147	6.79477	0.399677	0.032965	
Left 2D (cm)	Male	127	7.37216	0.427616	0.037945	0.001
	Female	147	6.70262	0.417464	0.034432	
Left 4D (cm)	Male	127	7.50194	0.455812	0.040447	0.001
	Female	147	6.78712	0.419812	0.034625	

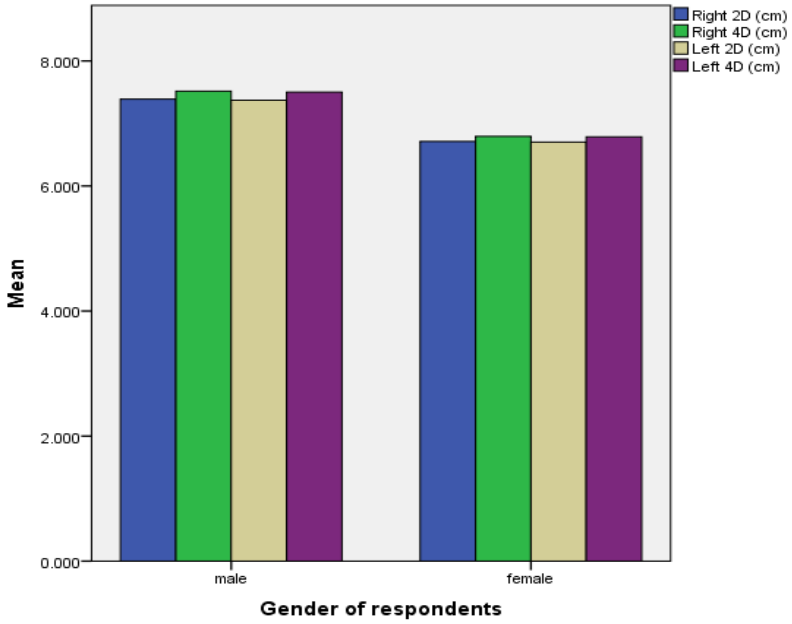

Figure 1: Average finger length of males and females

Independent T-test indicated that there was no significant sex differences on 2D:4D ratio ($p>0.05$) even though males recorded higher mean value of 2D:4D ratio compared to females (Table 2). One way ANOVA found that there was different mean value of 2D:4D ratio in males and females among the three different races. For both males and females, Chinese recorded highest mean value followed by Malay and Indian. However, significant race difference on 2D:4D ratio was only observed in Malay, Indian and Chinese males ($p<0.05$) (Table 3).

Table 2: 2D:4D ratio in male and female

Gender of respondents		N	Mean	Standard deviation	p-value
Right 2D:4D	Male	127	0.9837	0.0348	0.242
	Female	147	0.9890	0.0396	
Left 2D:4D	Male	127	0.9846	0.0371	0.395
	Female	147	0.9886	0.0401	

Table 3: Ratio of right and left 2D:4D for male and female of Malay, Chinese and Indian.

Gender of respondents	2D:4D ratio	Races	N	Mean	Standard deviation	p-value
Male	Right 2D:4D	Malay	51	0.9927	0.0402	0.001
		Indian	49	0.9667	0.0249	
		Chinese	27	0.9977	0.0265	
	Left 2D:4D	Malay	51	0.9852	0.0392	0.565
		Indian	49	0.9809	0.4037	
		Chinese	27	0.9903	0.0283	
Female	Right 2D:4D	Malay	57	0.9852	0.0369	0.201
		Indian	60	0.9843	0.0374	
		Chinese	30	1.0000	0.0475	
	Left 2D:4D	Malay	57	0.9923	0.0377	0.335
		Indian	60	0.9827	0.0414	
		Chinese	30	0.9933	0.0414	

Discussion

For both male and female subjects, the length of 4D is more than length of 2D. This is similar to the study by Nadankutty et al. [8] in Malaysia who have recorded male and female with higher 4D length. Study done by Gayathri and Vallabhajosyula [14] that reported 2D and 4D

length of males are significantly higher than female. The different hormonal exposure in males and females foetuses may be the reason of different digits length. 4D has higher levels of androgen receptor (AR) and estrogen receptor (ER) than 2D as reported by Zheng and Cohn [15]. This is supported by the study done by Kumar et al. [16] regarding 2D:4D ratio and risk to heart disease which stated different length of finger may be due to the level of sex hormones in the body even before birth. All the similar results from the previous studies involved almost the same number of sample size, same age of respondents and used direct measurement method. These studies produced non-significant sexual dimorphism in 2D:4D ratio. The sexual dimorphism in digit ratio was stronger with X-ray measurement in comparison to the direct measurement as in study done by Xi et al. [4].

The relationship between 2D:4D and levels of sex steroids in adults are less clear. Manning et al. [7] mentioned in his study that pattern of prenatal determination of the sexual dimorphism in 2D:4D is consistent but does not prove sex differences in 2D:4D reflects foetal levels of sex steroid. This may be one of the reason for non-significant sexual dimorphism in 2D:4D ratio. Thus, sex steroids regulation of cell proliferation in developing phalanges warrants further investigation. Links between the development control of the urogenital system and pattern of finger growth may influence digits other than 2D and 4D. There are five possible finger ratios: 2D:3D, 2D:5D, 3D:4D, 3D:5D, and 4D:5D as in study by Gayathri and Vallabhajosyula [14] which would be interesting to further explored using the same samples.

In brief, based on the average length of 2D and 4D, most of the subjects in this study have longer 4D than 2D including female, which was contradicting to most of the previous study, see Figures 2 and 3. Even though the mean of 2D:4D ratio in female was higher than male, the study was not significant because 61.2% of the females had longer right 4D and 59.9% of females had longer left 4D. Thus, a study with larger sample size would be helpful to confirm that in Malaysia, the finger length of most people has longer 4D.

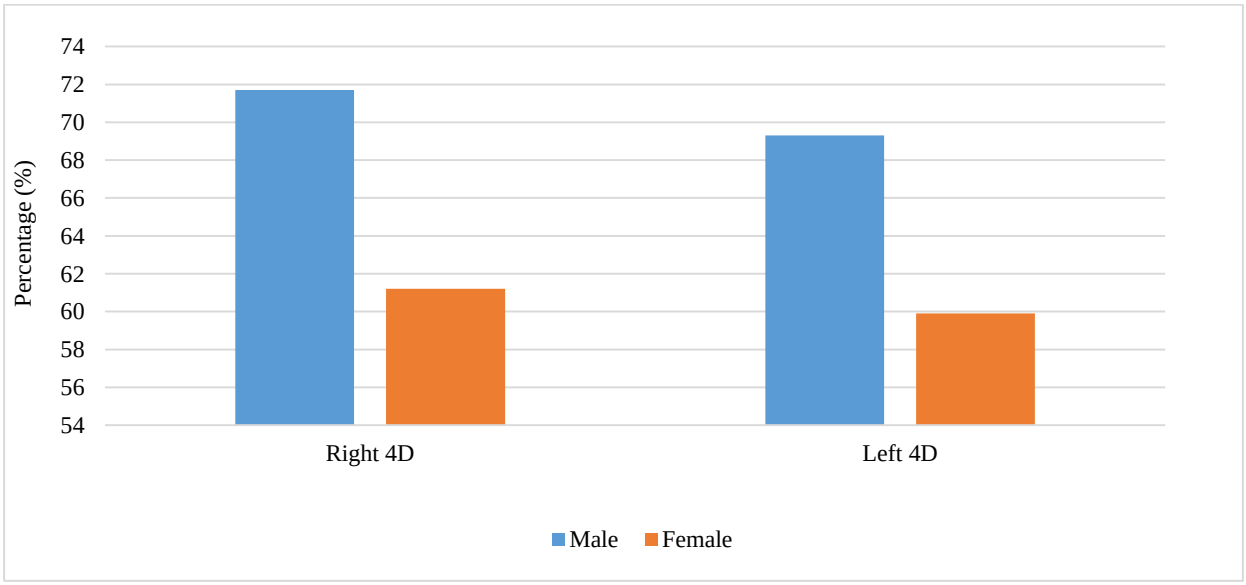

Figure 2: The percentage of males and females with longer 4D than 2D

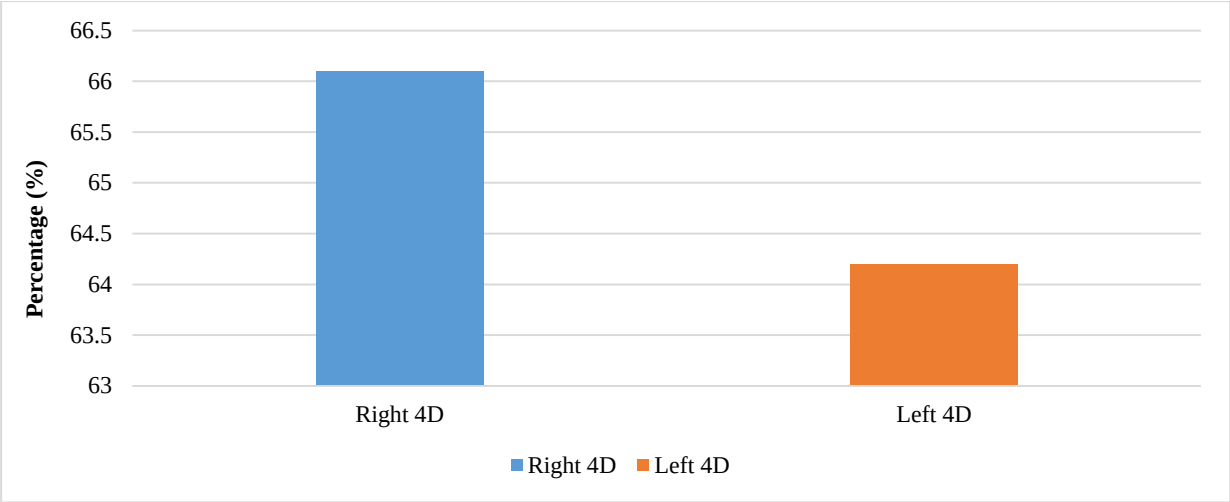

Figure 3: Overall university students with longer 4D than 2D

Our study showed that the ethnic differences on 2D:4D ratio was only significant for males in right 2D:4D ratio. This could be contributed to the observations that the males possesses obvious hands morphological variation in the right hand. A study of sexual dimorphism in North Indian population also found that sex difference was slightly higher in the right hand indicating sensitivity of right hand 2D:4D ratio to foetal androgens. However, sex differences varied with population and ethnic groups as mntioned by Dey and Kapoor [17]. Varied hand morphology could be contributed by different environment from different population group. The difference in hand morphology of three different races in this study might be due to factors such as food habits, culture, occupation, and lifestyle as postulated in the previous study.

Even though the race difference on 2D:4D ratio in this study was only significant for male in right 2D:4D ratio, different mean values among races could still indicate variation in 2D:4D ratio value among Malay, Chinese and Indian. Different races in Malaysia, in general, still have different features that can differentiate them. As mentioned by Kyriakidis and Papaioannidou [18], variation in digit ratio and their pattern of laterality as well as sexual dimorphism among population groups could be attributed to different digit pattern expression which reflect differences in the influence of genetic or environmental parameters.

Conclusion

The study found that average length of 4D was longer than 2D for both males and females. This however was contradicting to most of previous study which found that female had longer 2D compared to male. There was difference in average length of right and left second and fourth digits in male and female. The study also found that there is no sexual dimorphism in 2D:4D ratio among subjects students. The results also showed that race difference on 2D:4D ratio was only significant in right hand of Malay, Indian and Chinese males.

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