

Can the Second and Fourth Finger (2D:4D) Ratio Guide Physicians in Choosing Internal Medicine or Surgical Branch?

¿Puede la proporción del Segundo y Cuarto Dedo (2D:4D) Guiar a los Médicos en la Elección de Medicina Interna o Rama Quirúrgica?

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SUMMARY: This study investigates the relationship between the second and fourth finger ratio (2D:4D), physicians' propensity to choose an internal or surgical branch, and sex differences. On a voluntary basis, 177 physicians working in Elazig, 122 men and 55 women were enrolled in the study. Their hands were measured for 2D and 4D lengths, and the 2D:4D ratio was computed. In female doctors, the left hand's 2D:4D ratio is 1.01, compared to the right hand's 1.00. Male doctors' right 2D:4D ratio is 0.99, while their left 2D:4D ratio is 1.00. Male physicians' 2D:4D ratios were different from those of men in the general population, whereas female physicians' 2D:4D ratios were comparable to those of women in the general population. As a result, this study was the first to examine the relationship between the ratio of the second and fourth fingers (2D:4D), physicians' tendency to choose an internal medicine or surgical branch, and sex differences. While the 2D:4D ratio was higher than 0.98 in all physicians, it was low in women who disliked their profession and branch. Since there aren't many studies on this subject, data from in-depth studies that will be conducted in the future will help physicians who choose internal medicine and surgery make more informed decisions.

KEY WORDS: 2D:4D ratio; Digit ratio; Physician; Anthropometry.

INTRODUCTION

In recent years, many hypotheses have been proposed to express androgen sensitivity in the prenatal period. The length ratio (2D:4D) of the index finger (2nd finger, 2D) and ring finger (4th finger, 4D) of the hand, which is thought to be an indicator of the androgen level to which humans are exposed during the intrauterine period, remains constant throughout life after the 14th week of the prenatal period. This (2D:4D) ratio remains constant after the 14th week of gestation, and it has recently been the subject of numerous medical studies, such as obstetrics, endocrinology, and pediatrics, where the human body and disease symptoms differ according to the genetic and sociocultural structure (Vélez *et al.*, 2016; Balcı *et al.*, 2018; Ergul, 2019; Udicki *et al.*, 2023).

The ratio of the index finger to the ring finger (2D:4D) varies in humans according to sex. Several studies on the 2D:4D ratio have found a direct correlation between the 2D length and the level of estrogen hormone in women and

between the 4D length and the level of testosterone hormone in men. In general, the index finger is shorter than the ring finger in men ($2D:4D < 0.98$), whereas it is longer in women ($2D:4D > 0.98$) (Fig. 1). Some studies have reported that the length of the fourth finger in women is greater than that of the second finger (similar to men). Similarly, cases of the fourth finger being shorter than the second finger have also been reported in males, just as in females. Apart from all these possibilities, it has also been reported that the 2D:4D ratio is the same in both sexes (Jeevanandam & Muthu, 2016; Balcı *et al.*, 2018; Sani *et al.*, 2022).

Sex steroid hormones play a role in the epigenetic modulation of neuronal functions and fetal brain development during the early stages of the intrauterine period. Therefore, prenatal hormone exposure is critical for early brain organization. The effects of sex steroids on the brain and behavior are divided into organizational and activational effects. Organizational effects occur during the

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early stages of development, so they have lasting effects. Activating effects occur throughout life and are responsible for transient effects (Karaismailoglu & Erdem, 2013).

Because male and female brains process the same neurochemicals at different concentrations and through sex-specific connections, different divisions of labor develop between the cerebral hemispheres in males and females before birth. While the male brain is better at connecting coordinated activities with sensory information, the female brain tends to communicate between analytical and intuitive processing. As a result, women tend to take in more sensory and emotional information than men (Woolley, 2021). Testosterone is known primarily as a sex and aggression hormone. The dominant neurochemical has a profound effect on brain structures and functions. High testosterone concentrations at 16 and 24 weeks of gestation are critical in differentiating androgen-dependent tissues, including certain brain areas. Individual variations in testosterone compared to other hormones in the brain result in a volatile neuroendocrine environment that affects typical male behavior by employing different strategies for problem-solving and decision-making (Dreher *et al.*, 2016; Ostatníková *et al.*, 2020).

Therefore, this study sought to determine the length of the 2nd and 4th fingers of both hands and the 2D:4D ratio of physicians who are specialists in internal medicine and surgery and to determine whether they differ from the norm by making comparisons. In this way, we investigated whether the ratio of the 2nd and 4th fingers (2D:4D) can guide physicians in choosing internal medicine or surgery specialties.

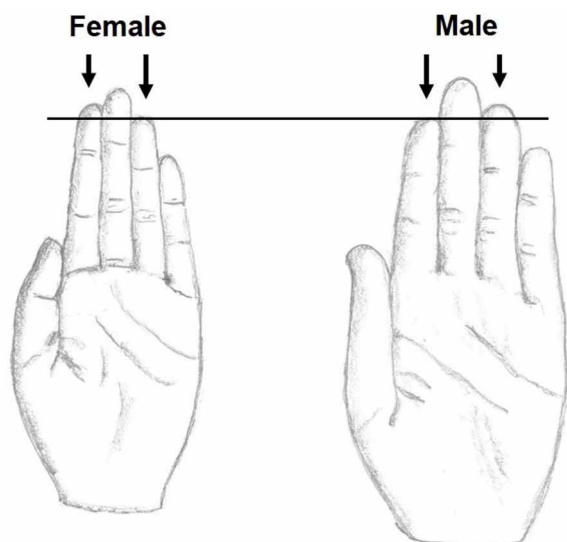


Fig. 1. 2D and 4D lengths for the general population by sex. Left hand and palmar face.

MATERIAL AND METHOD

Ethics approval. This study was approved by the Firat University Ethics Committee for Non-Interventional Research on 03/11/2022 and with the meeting number 2022 13-16.

Participants. A total of 177 physicians, 122 men and 55 women, practicing in public and private hospitals in the Elazig province, were enrolled in the study voluntarily. Those who had a chronic disease and pathology or underwent surgery were excluded from the study. All those who voluntarily participated in the study were informed before the measurements, and voluntary consent forms were completed and signed before the measurements were started.

2D:4D measurement. During finger measurements, the dorsal aspect of both hands of the subjects to be measured was held tensed on a flat, hard surface with the palmar surfaces facing upward. The thumb was slightly extended, and the other four fingers were kept in the adduction position. The length between the proximal crease separating the second and fourth fingers from the palm and the fingertip was measured on the hand's palmar surface. Measurements were made using a calibrated millimetric sliding caliper (Balci *et al.*, 2018).

Statistical analysis. IBM SPSS Statistical Package version 22.0 was used for the statistical analysis of the data. Categorical measurements were summarized as numbers and percentages, and continuous measurements as mean and standard deviation. Whether continuous measurements met the assumption of normal distribution was tested using the Kolmogorov-Smirnov test and the Shapiro-Wilk test. The T-test for independent groups was used to compare continuous measurements between groups. The Kruskal-Wallis test compared non-normally distributed numerical measurements between more than two groups.

RESULTS

In our study, of the 177 physicians whose fingers were measured, 122 (68.9 %) were male, and 55 (31.1 %) were female. While the 2D:4D ratio of the right hand in female physicians is 1.00, the 2D:4D ratio of the left hand is 1.01. The right 2D:4D ratio of male physicians is 0.99, while the left 2D:4D ratio is 1.00. While the 2D:4D ratio of male physicians was different from that of males in the normal population, the 2D:4D ratio of female physicians was similar to that of females in the normal population.

The study found that the 2D:4D ratio of the right hand was 0.99, and the 2D:4D ratio of the left hand was 1.004 in men who were surgical specialists. This ratio was greater than 0.98 (>0.98), which is similar to the 2D:4D ratio of men in the normal population. In addition, this ratio was the same for men who liked or disliked the profession of medicine and surgery and was greater than 0.98. However, the number of male physicians disliked their profession and surgery was very small, amounting to only 5 individuals.

The 2D:4D ratio of the two hands of women who chose the surgical branch and disliked the medical profession and the surgical branch was 0.97, the opposite of the 2D:4D ratio (>0.98) of women in the normal population. However, the number of female physicians who disliked their profession and specialty was only 3. The 2D:4D ratio was greater than 0.98 among women who chose surgery and liked their profession and specialty.

The ratio of right-handed 2D:4D was 1.01, and the ratio of left-handed 2D:4D was 1.00 among women who chose the internal medicine branch. This ratio was greater than 0.98, as in women in the normal population. In addition, the 2D:4D ratio was similar among women who liked their occupation and the internal branch.

The 2D:4D ratio of both hands was 0.99 in men who chose the internal branch, which was higher than the 2D:4D ratio (>0.98) of men in the normal population. Moreover, the 2D:4D ratio was similar among male physicians who liked and disliked their profession and internal medicine.

DISCUSSION

Little is known about the effects of prenatal androgens on academic performance, professional life, decision-making, and career choice. This study was the first to examine the relationship between the ratio of the second and fourth fingers (2D:4D), physicians' tendency to choose an internal medicine or surgical branch, and sex differences.

Prenatal exposure to androgens has been shown to influence people's decision-making routines about brain development and future behavior later in life. Although the hormone testosterone, one of the prenatal androgens, is an important factor in the formation of secondary sex characteristics in males, it is also an important hormone in many academic, economic, social, and skill behaviors, decisions, and characters of people. It is believed that the 2D:4D ratio may predict the effect of testosterone and,

depending on that effect, certain human behaviors and performance. While the popular debate about the effects of testosterone on men usually refers to aggression and anti-social behavior, recent research suggests that testosterone improves behaviors associated with achieving and maintaining a high social status (Zitzmann, 2006; Hines *et al.*, 2015).

One of the effects of the hormone testosterone, which is more abundant in males than females, on intrauterine life is its effect on the 2D:4D ratio. After the 14th week in the prenatal period, the 2D:4D ratio remains constant, less than 0.98 in people with more testosterone hormones. In contrast, this ratio is greater than 0.98 in people with more estrogen hormones (Manning & Taylor, 2001).

While the 2D:4D ratio of the right hand was 1.01 in women who chose the internal branch, the 2D:4D ratio of the left hand was 1 and was greater than 0.98, as in women of normal society. This ratio was similar in female physicians who liked and disliked their profession and internal medicine. For men who chose internal medicine, the right 2D:4D ratio was 0.99, the left 2D:4D ratio was 0.99, and it was found to be greater than 0.98, unlike men in normal society. This ratio was similar in men who liked and disliked their profession and internal medicine. In a study by Coco *et al.* (2011), a significant relationship was found between the 2D:4D ratio and performance on the medical school entrance exam and salivary testosterone levels. It was also found to increase performance in situations requiring rapid decision-making and risk-taking but did not affect performance in situations requiring a more analytical and planned approach. These results showed that testosterone might be an important factor in physicians' performance but that testosterone does not influence the analytical approach, which is one of the important differences between surgery and internal medicine.

The 2D:4D ratio of physicians' right and left hands in surgical branches performing invasive procedures such as neurosurgery, obstetrics, and thoracic surgery, which require more attention and skill than internal medicine branches of the medical profession, was found to be 1.00. While this rate, above 0.98, was normal in women, it was higher in men than in the normal population. The 2D:4D ratio was greater than 0.98 in men who liked or disliked the profession of physician or surgeon, but the number of these physicians was only 5 individuals. The 2D:4D ratio was greater than 0.98 for female physicians who chose the surgical branch and liked both the profession of medicine and the branch, and the 2D:4D ratio was 0.97 on the right

and 0.97 on the left for women who chose the surgical branch and disliked both the profession of medicine and surgery, proving to be the opposite of the 2D:4D ratio of women in the normal population. The fact that the 2D:4D ratio is greater than 0.98 in female physicians who choose the surgical branch and like their profession and the branch suggests that testosterone is a less effective factor in choosing surgery and internal medicine. Folland *et al.* (2012) found no relationship between the 2D:4D finger ratio and muscle strength, testosterone, and the androgen receptor CAG repeat genotype. This study also supports the idea that testosterone is of little importance in choosing branches of surgeons who use motor-muscular movements more actively than the internal branch.

According to callosal theory, prenatal testosterone mediates early axon pruning in callosal tissue. Thus, the higher the prenatal testosterone, the more lateralization occurs in the brain. For this and many related reasons, adult males generally outperform females in spatial abilities. This suggests that testosterone may be less effective in decision-making (Ostatníková *et al.*, 2020).

Individual differences in general cognitive abilities can be measured by the intelligence quotient (IQ), which assesses skills such as planning, reasoning, comprehension, abstraction, and learning. IQ also predicts several important life goals, including educational success, occupational success, social mobility, and job performance. In a study by Ostatníková *et al.* (2020), although no difference was found in the average IQ between males and females, the ratio of males to females in the mentally gifted group and also in the mentally retarded group was in favor of males. This raises the possibility that this could be caused by the effects of the testosterone hormone, which is more dominant in males than females in the prenatal period.

As a result, in our study, for the first time, physicians who chose surgery and internal medicine were researched in terms of the right and left 2D:4D ratios, and whether they liked their medical profession and their chosen specialties. The 2D:4D ratio is influenced by many factors, such as the fact that male and female brains process the same neurochemicals in different concentrations via sex-specific connections, genetic factors, and the influence of androgens in the prenatal period. In our study, the 2D:4D ratio was higher than 0.98 in all physicians. On the other hand, the 2D:4D ratio was low in women who disliked their profession and industry. Since there are not many studies on this topic, the data obtained from detailed studies to be conducted in the future will guide physicians who choose surgery and internal medicine in making their choices more accurately.

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RESUMEN: Este estudio investiga la relación entre la proporción de los dedos segundo y cuarto (2D:4D), la propensión de los médicos a elegir una rama interna o quirúrgica y las diferencias de género. De forma voluntaria, se inscribieron en el estudio 177 médicos que trabajaban en Elazığ, 122 hombres y 55 mujeres. Sus manos se midieron en longitudes 2D y 4D, y se calculó la relación 2D:4D. En las médicas mujeres, la relación 2D:4D de la mano izquierda es 1,01, en comparación con 1,00 de la mano derecha. La relación 2D:4D derecha de los médicos hombres fue 0,99, mientras que la relación 2D:4D izquierda fue 1,00. Las proporciones 2D:4D de los médicos hombres fueron diferentes de las de los hombres en la población general, mientras que las proporciones 2D:4D de las mujeres médicas fueron comparables a las de las mujeres en la población general. Como resultado, este estudio fue el primero en examinar la relación entre la proporción del segundo y cuarto dedo (2D:4D), la tendencia de los médicos a elegir una rama de medicina interna o quirúrgica y las diferencias de sexo. Mientras que la relación 2D:4D fue superior a 0,98 en todos los médicos, fue baja en las mujeres que no les gustaba su profesión y rama. Dado que no hay muchos estudios sobre este tema, los datos de estudios en profundidad que se realizarán en el futuro ayudarán a los médicos que eligen medicina interna y cirugía a tomar decisiones más informadas.

PALABRAS CLAVE: relación 2D:4D; proporción de dígitos; Médico; Antropometría.

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