2D:4D RATIO

INVESTIGATION OF A SEXUALLY DIMORPHIC TRAIT IN THE HUMAN SKELETON

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INTRODUCTION

➢The ratio between the 2nd digit (index finger) and 4th digit (ring finger) length (2D:4D) is a sexually dimorphic trait.

➢Males tend to have a lower 2D:4D ratio because the 2nd digit is usually shorter than the 4th digit. Females tend to have a higher 2D:4D ratio because the 2nd and 4th digits are approximately of equal length. (Fig. 1)

➢The 2D:4D ratio is established by the 14th week of gestation. The higher the fetal testosterone levels, the lower the 2D:4D ratio.

➢Homeobox genes *Hoxa* and *Hoxd* control development of both genitals and digits.

➢Variations in 2D:4D ratios have been correlated with certain diseases, athletic ability, mental skills, and career choices.

➢Students can easily measure digit length directly or from photocopies using a metric ruler or digital calipers.

➢This exercise brings an investigative approach to the study of the human skeleton and introduces provocative discussions about development.

MATERIALS & METHODS

➢Metric rulers (150 mm) preferably transparent vinyl

➢Digital calipers, resolution of 0.01 mm (optional)

➢Photocopies of hands (optional)

➢Students measure the length (in mm) of the 2nd (index finger) and 4th (ring finger) digits of each hand (palm side) from the basal crease (metacarpophalangeal joint) to the finger tip (Fig 2).

➢Calculate the right and left 2D:4D ratio.

➢Compare 2D:4D ratio means in populations – males vs. females, athletes vs. non-athletes, older faculty/staff vs. college-age students, etc.

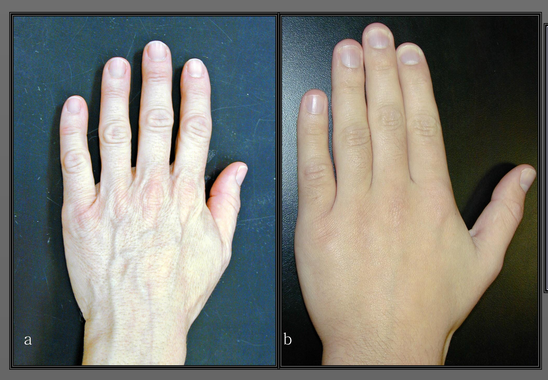
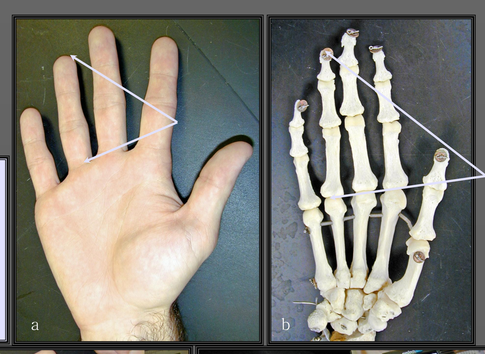


Fig.1. Left hand of a female (a) and male (b). a) In females, the 2nd digit is typically near equal in length to the 4th digit and the 2D:4D ratio = 1. b) In males, the 2nd digit is usually noticeably shorter than the 4th digit and the 2D:4D ratio < 1.



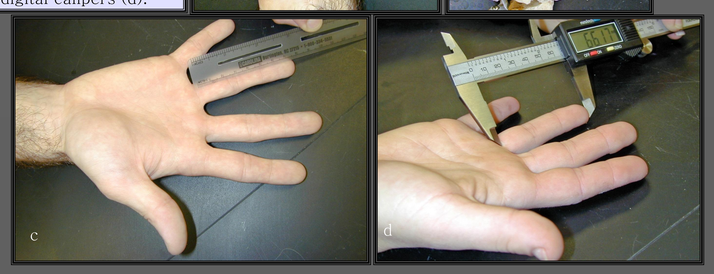


Fig. 2. Measuring digit length. a) Basal crease to finger tip of the 4th digit. b) Metacarpophalangeal joint to tip of distal phalanx of the 4th digit. Measuring digital length by transparent metric ruler (c) or by digital calipers (d).

RESULTS

➢No significant differences were found in measuring finger length directly or from photocopies with either a ruler or digital calipers (Table1).

➢Mean right 2D:4D ratio for female students (0.98) was significantly different from mean right ratio for male students (0.94). Left 2D:4D ratios for female (0.98) students were slightly higher than male (0.97) students (Table 2). In the general population males have a mean 2D:4D ratio of 0.98 and women a mean digit ratio of 1.0.

➢Mean right (0.98) and left (0.96) 2D:4D ratios for the women's soccer team were slightly lower from the mean 2D:4D ratios (0.99 and 0.97 respectively) for college female students (Table 3). Previous studies of woman professional teams had shown 2D:4D ratios approaching the masculine digit ratio.

➢Mean right and left 2D:4D ratios for college-age males (right 0.94, left 0.97) were not significantly different from ratios for older male faculty and staff (right 0.95, left 0.96). Mean right and left 2D:4D ratios for college-age females (right 0.98, left 0.98) were slightly lower than ratios (right 1.00, left 0.99) for female faculty and staff (Table 4). It was thought that younger males would have a digit ratio approaching the female mean because of the recent abundance of estrogen-mimicking chemicals in the environment.

Table 1. Comparison of mean 2D, 4D, and 2D:4D ratio for right and left hands when measured by ruler and digital calipers directly or from xeroxed copies. N=2. +/-standard deviation.

METHOD	MEAN R2D (mm)	MEAN R 4D (mm)	MEAN R2D:4D	MEAN L2D (mm)	MEAN L4D (mm)	MEAN L2D:4D
Ruler Directly	71.00 ±5.66	72.00 ±4.24	0.99 ±0.02	70.00 ±7.07	73.00 ±7.07	0.96 ±0.00
Ruler Xerox	71.00 ±5.66	71.50 ±4.95	0.99 ±0.01	70.50 ±6.36	72.50 ±7.78	0.97 ±0.02
Calipers Directly	69.39 ±4.76	69.72 ±4.79	1.00 ±0.00	70.82 ±4.53	70.03 ±4.70	1.01 ±0.00
Calipers Xerox	70.85 ±8.14	70.46 ±5.32	1.00 ±0.04	70.51 ±7.51	70.15 ±8.01	1.01 ±0.01

Table 2. Mean 2D:4D ratios for right and left hands of male college students compared to female college students (spring '09). *ANOVA Single Factor p<0.0065, +/- standard deviation.

POPULATION	N	MEAN R 2D:4D*	MEAN L 2D:4D
MALE STUDENTS	7	0.94 ±0.20	0.97 ±0.20
FEMALE STUDENTS	14	0.98 ±0.03	0.98 ±0.04

Table 3. Mean 2D:4D ratios for right and left hands of female college students (fall '08) compared to female college soccer players.
+/- standard deviation.

POPULATION	N	MEAN R 2D:4D	MEAN L2D:4D
FEMALE STUDENTS	18	0.99 ±0.05	0.97 ±0.05
WOMEN'S SOCCER TEAM	11	0.98 ±0.04	0.96 ±0.03

Table 4. Mean 2D:4D ratios for right and left hands of college students compared to faculty and staff.
YOB = year of birth,
+/-standard deviation.

POPULATION	N	MEAN R 2D:4D	MEAN L2D:4D
COLLEGE AGE MALES YOB 1988-1990	7	0.94 ±0.20	0.97 ±0.20
OLDER MALES YOB 1934-1975	11	0.95 ±0.04	0.96 ±0.04
COLLEGE AGE FEMALES YOB 1987-1990	14	0.98 ±0.03	0.98 ±0.04
OLDER FEMALES YOB 1939-1973	10	1.00 ±0.02	0.99 ±0.02

DISCUSSION & FUTURE WORK

➢2D and 4D lengths are easily measured directly or from photocopies by either ruler or digital calipers.

➢Mean 2D:4D ratios for college males were <1; 2D:4D ratios for college females were higher and approached 1.

➢Mean 2D:4D ratios for women soccer players were slightly lower than college females from the general population.

➢Mean 2D:4D ratios for college-age males and females did not differ significantly from those of older college faculty and staff.

➢The 2D:4D ratio will be used to investigate fluctuating asymmetry during 2009 – 2010.

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SUPPLIES & SOURCES

Rulers, transparent vinyl (150 mm), $0.55 – 0.75 each
Digital calipers (0.01 mm resolution), $70-$100

Carolina Biological Supply Company www.carolina.com
Edmund Scientifics scientificsonline.com
Ward's Natural Science wardsci.com

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