



## Physical Anthropology Section - 2012

### H18 Determination of Sex from 2nd to 4th Digit Ratios of the Hand

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After attending this presentation, attendees will be familiar with the developmental basis for differences in 2<sup>nd</sup> and 4<sup>th</sup> digit ratios of the hand between males and females and the practical application of this knowledge to the determination of sex from skeletal remains.

This presentation will impact the forensic science community by demonstrating that, despite its initial promise, the 2<sup>nd</sup> to 4<sup>th</sup> digit ratio does not appear to be an accurate method for determining sex from hand bones. The results of this discriminant function analysis suggest that total length of the 2<sup>nd</sup> and 4<sup>th</sup> digits or a combination of phalanx lengths provide a more accurate means for determining sex.

The ratio between the length of the 2<sup>nd</sup> digit (index finger) and 4<sup>th</sup> digit (ring finger) is strongly influenced by fetal testosterone in utero and has been shown to vary significantly between males and females (Manning et al.; Manning).<sup>1,2</sup> In general, males are expected to exhibit a lower 2D:4D ratio (ring finger longer than index finger) while females exhibit a ratio closer to 1.00 (ring finger and index finger of identical length). Garn has shown that this ratio is fixed by the 14<sup>th</sup> gestational week, suggesting that 2D:4D may be appropriate as a factor to differentiate males and females using skeletal remains.<sup>3</sup>

For this study the utility of finger length, phalanx lengths, and 2D:4D ratios for discriminating between males and females in a population of 342 adult individuals (171 Females, 171 Males) from the Terry collection are tested. All individuals were classified as "White." Metacarpals and phalanges were measured using a mini-osteometric board from Paleo-Tech Concepts to the closest hundredth of a millimeter. Statistical tests were made using PASW Statistics (SPSS) version 18 for the Windows 7 operating system. Fingers missing bones were dropped from the analysis, as were outliers that failed a Grubb's Test. A D'Agostino-Pearson K<sup>2</sup> omnibus test was used to evaluate whether measurement distributions were normally distributed.

Significant differences existed between 2D:4D ratios of males and females for the right and left hands (One-Way ANOVA: right:  $F=8.767$ ,  $p\text{-value}=0.003$ ; left:  $F=18.424$ ,  $p\text{-value}=0.000$ ). Three Discriminant Functions were used to evaluate the ability of measures to differentiate males and females. The sum of phalanx lengths for the 2<sup>nd</sup> and 4<sup>th</sup> digits yielded a correct classification rate of 81.2% for the right hand and 85.3% for the left hand. A step-wise discriminant function analysis of phalanx length was also conducted for right and left elements independently. Length of the distal 2<sup>nd</sup> phalanx and medial and distal 4<sup>th</sup> phalanges yielded a correct classification rate of 84.3% for the right hand. For the left hand the medial and distal 4<sup>th</sup> phalanges correctly classified 82.8% of individuals. Contrary to the initial expectations, 2D:4D ratio correctly classified only 58.1% of individuals for the right hand and only 58.8% for the left hand.

These results show that despite the ability of the finger bones to differentiate males and females with a reasonable degree of accuracy (> 80%), digit ratio, at least as measured from hard tissue, does not. This may be due to several factors. The racial category "White" used by the Terry collection may obscure important differences between sub-populations from the European continent. In addition, the historic nature of the Terry collection may mean that its individuals exhibit more "feminized" digit ratios (males and females differed by only about 1%) due to developmental, health, and nutritional dissimilarities with current populations. Further work is needed to determine if these conclusions are applicable to other population groups.

#### References:

1. Manning JT, Scutt D, Wilson J, Lewis-Jones DI. The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. *Hum Reprod* 1998;13:3000-4.
2. Manning JT. *Digit ratio: a pointer to fertility, behavior, and health*. New Brunswick, N.J: Rutgers University Press, 2002.
3. Garn SM, Burdi AR, Babler WJ, Stinson S. Early prenatal attainment of adult metacarpal-phalangeal rankings and proportions. *Am J Phys Anthropol* 1975;43:327-32.

#### Sex Determination, Digit Ratios, Discriminant Function Analysis