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## Hardcore Sciences and Biological Sciences: Digit Ratio as an Anthropometric Differentiator

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### ABSTRACT

The second to fourth digit ratio (2D:4D) has been proposed as a putative biomarker for prenatal testosterone and covaries with the sensitivity of the androgen receptor (AR). Lateralization of the brain is strongly influenced by prenatal androgens, with differential exposure thought to account for cognitive sex differences. This study examines the possibility that prenatal hormones, as measured by the 2D:4D length may influence career choice. A total of 1210 academic staff drawn from all the tertiary institutions in Rivers State was used for this study. 679(56.12%) were males while (43.88%) were females. The subjects were grouped into two: hardcore sciences (A) and Biological sciences (B), according to their departments. The second to fourth digit length on both hands were measured with a digital venier caliper and the ratio calculated by dividing 2D by 4D. Data was analyzed using SPSS software. Result obtained showed no sexual dimorphism in hardcore science (0.96). There was sexual dimorphism in the biological sciences. A same sex difference was observed in the males across the two groups (A-0.96, B-0.97). The differences were statistically significant ( $p < 0.05$ ). This difference was not consistent in females (A - 0.96, B - 1.00). There was evidence of brain lateralization indexed by the pattern of digit ratio. There was no hand lateralization. We found an anthropometric difference in terms of 2D:4D between the hardcore science group and the biological science group in a typical masculine ratio associated with participants in the hardcore science group and high ratio associated with the biological science group. In conclusion, this study has provided a solution to the dilemma encountered by some people especially in career choice.

**KEYWORDS:** Hardcore science, Biological science, Digit ratio and Anthropometric differentiator.

### INTRODUCTION

Digit ratio commonly known as 2D:4D is the ratio of the length of the second digit and the length of the fourth digit typically measured from the bottom crease where the digit joins the hand to the tip of the digit<sup>1,2</sup>. Scientists have suggested that this ratio is affected by exposure to prenatal hormones (testosterone and oestrogen) in utero<sup>3,4</sup>. Digit ratio is a trait determined by the 14th gestational week and relatively stable throughout development<sup>5,6, and 7</sup>.

In men the second digit tends to be shorter than the fourth digit and in females the second digit tends to be the same or slightly longer than the fourth digit<sup>1</sup>. The index finger in males is generally about 96 % of the length of the ring finger which gives an average digit ratio for males of 0.96. The digit ratio would be 1.00 if the ring finger and index finger were the same lengths. Women generally have a digit ratio of about 1.00. They have what is termed a 'high digit ratio'. A stable means of 2D: 4D for males and females from 2 years of age through adulthood has been reported<sup>1</sup>.

It has been shown that the maternal waist to hip ratio is related to 2D: 4D. Women with high waist to hip ratio (a proxy for higher testosterone and lower estrogen concentrations<sup>8</sup> tended to have children with low 2D: 4D<sup>1</sup>.

Digit ratio has been reported to show strong ethnic differences<sup>3, 9, 10 and 11</sup>. Common genes, underline development of fingers and gonads<sup>12, 13</sup>. Allelic variation in androgen receptor sensitivity influences digit ratios. More masculine fingers ratios later are associated with androgen receptor alleles<sup>14</sup>. More evidence for a relationship between androgen concentration during development and finger ratio comes from children with congenital adrenal hyperplasia (CAH). Both males and females with CAH, and therefore high developmental androgen, exhibit more masculine finger length ratios than controls<sup>5,15</sup>.

The masculinising effect of prenatal testosterone on the brain has been shown to result in higher spatial ability<sup>16</sup>. A negative correlation has been found between right

hand 2D: 4D (lower ratios are more masculine) and higher numerical intelligence<sup>17</sup>. Furthermore, lower digit ratios in boys aged 6 – 11 were associated with higher numerical performance but girls were not found to have this correlation<sup>18</sup>.

The second to fourth digit ratio (2D:4D) has been proposed as a putative biomarker for prenatal testosterone and co-varies with the sensitivity of the androgen receptor (AR). Both prenatal testosterone and the AR play a central role in penile growth. Based on this evidence, we suggest that the digit ratio can predict adult penile size and that the effects of prenatal testosterone may in part explain the differences in adult penile length<sup>19</sup>.

Many studies debate the existence of sex differences in skills such as visual-spatial and numerical ability, often focusing on the impact of environmental factors. However, biological factors may also be influential; specifically, prenatal androgen exposure may influence brain lateralization and subsequent development of such skills. Development and organization of the brain is influenced by the same prenatal androgens that determine 2D:4D, with testosterone the most likely candidate to influence cortical dominance. Development of the left hemisphere is thought to be slowed whilst development of the right hemisphere is promoted by the action of testosterone<sup>20</sup>. Therefore, males, experiencing greater prenatal testosterone exposure, are more likely than females to be right hemisphere dominant and to have lower 2D:4D. Males do excel on tasks reliant on right-hemisphere processing. Consistent male advantages in visual-spatial cognition are reported for adults, particularly on tasks requiring dynamic 3D processing<sup>21,22</sup> although no consistent advantages are reported in studies of children<sup>23</sup>. Young boys (4 years) have been found to perform better than girls on a task involving replication of spatiotemporal patterns tapped out on blocks<sup>24, 25</sup>, whilst sex differences in 3D mental rotation are typically not evidenced until early adolescence, although some workers differ on this<sup>26</sup>. Some studies also report a male advantage on standardised mathematical reasoning tasks<sup>27, 28</sup> and on mathematical tasks requiring spatial-mechanical skills or problems that utilize visualisation strategies<sup>21, 29, 30 and 31</sup>. Recently it has been reported that kindergarten boys out-performed girls on tasks assessing 'number sense'<sup>32</sup>. Whilst there is no definitive agreement as to what constitutes number sense, most researchers agree that the abilities to subitize, discern number patterns, compare numerical magnitudes and estimate quantities, count, and perform simple number transformations are key elements of number sense. Others posit a more specific definition of number sense including only non-symbolic and approximate skills that are independent of language<sup>33</sup>. However, the majority of studies report only trivial or no sex differences, particularly in the early school years, on measures of standardised mathematical

achievement<sup>34</sup> or number sense, for example counting, number knowledge, or visual number representation<sup>18</sup>. Visual-spatial skills and visual-spatial working memory are related to children's early counting<sup>35</sup>, and general mathematics ability measured by standardised achievement and curriculum assessments<sup>36</sup>, but few studies have considered biological factors that may result in individual differences in these abilities. Differences in prenatal testosterone exposure may partially account for between- and within-sex differences in these skills via their impact particularly on right-hemisphere development. Significant associations have been reported between mental rotation accuracy and 2D:4D, particularly in men<sup>37</sup>. Others find a relationship between low 2D:4D and mental rotation ability only in females<sup>16</sup>, or find sex differences in testosterone concentrations (measured by 2D:4D, amniotic fluid, or salivary testosterone levels) and mental rotation ability, but no relationship between the two<sup>38</sup>. Only one study of typically developing children has been conducted revealing that higher prenatal testosterone was associated with better mental rotation performance in girls but poorer performance in boys<sup>39</sup>. The main objective of this study is to document the values of the digit ratio of the academic staff in the hardcore and biological sciences within Rivers State.

## MATERIALS AND METHODS

A total number of 1210 Academic staff drawn from the departments of mathematics, computer science, Physics, Chemistry, Architecture, all available fields of Engineering, Agriculture, Biology, Biochemistry, Zoology, Physical and Health sciences, Medicine and Paramedical sciences and Plant science and biotechnology from University of Port Harcourt, Rivers State University of Science and Technology, Ignatius Ajuru University of Education, Rivers State Polytechnic, College of Education (Tech) all in Rivers State were recruited for this study. 679 were males (56.12%) and 531 (43.88%) were females. These subjects gave their informed consent and were willingly recruited for the study. Those having any form of hand deformity were excluded. The subjects were grouped two groups: A and B<sup>34</sup>.

Group A – Hardcore sciences: Mathematics, Physics, Chemistry, computer science and Engineering departments

Group B- Biological Sciences: Medicine, Anatomy, Physiology, Microbiology, Biochemistry, Botany, Zoology departments, Physical and Health Education etc.

Second and fourth digit lengths were measured on the ventral (inferior) surface of the hand from the basal crease of the 2nd and 4th digits to the tip using digital venier calliper. The measurements were done twice and average mean value recorded. The measurements were done on the right and left hands. Values obtained were

tabulated. Digit ratio (2D:4D) was then calculated by dividing the length of the second digit by the length of the fourth digit and the values recorded for both hands<sup>2,3</sup>. The data was analyzed with descriptive

statistics: Mean, standard deviation and standard error and Analysis of Variance (ANOVA) using SPSS software.

**RESULTS**

**Table 1:** Results obtained for hardcore sciences and Biological sciences for male and female subjects.

Parameters	Males		Significant difference (p-value)	Females		Significant difference (p-value)
	Hardcore sc. n=390	Biological sc. n=289		Hardcore sc. n=294	Biological sc. n=237	
R2D(cm)		7.04±0.64	No (0.703)	6.69±0.48	6.96±0.50	Yes (0.001)
R4D(cm)	7.34±0.62	7.25±0.65	No (0.060)	6.95±0.48	6.95±0.50	No (0.798)
R2D:4D	0.96±0.04	0.97±0.04	Yes (0.001)	0.96±0.04	1.00±0.03	Yes (0.001)
L2D(cm)	7.13±0.57	7.17±0.63	No (0.417)	6.71±0.59	7.08±0.49	Yes (0.001)
L4D(cm)	7.42±0.62	7.38±0.70	No (0.379)	6.98±0.48	6.98±0.47	No (0.777)
L2D:4D	0.96±0.30	0.97±0.04	Yes (0.001)	0.96±0.07	1.00±0.05	Yes (0.001)

All values= Mean ± SE

**Table 2:** Comparison of Results obtained for hardcore sciences and biological sciences for male and female subjects.

Parameters	Hardcore sciences		Significant difference p-value	Biological sciences		Significant difference p-value
	Males n=390	Females n=294		Males n=289	Females n=237	
R2D(cm)	7.06±0.58	6.69±0.48	Yes (0.001)	7.04±0.64	6.96±0.50	No (0.094)
R4D(cm)	7.34±0.62	6.95±0.48	Yes (0.001)	7.25.65	6.95±0.50	Yes (0.001)
R2D:4D	0.96±0.04	0.96±0.04	No (0.225)	0.97±0.04	1.00±0.03	Yes (0.001)
L2D(cm)	7.13±0.57	6.71±0.59	Yes (0.001)	7.17±0.63	7.08±0.49	No (0.104)
L4D(cm)	7.42±0.62	6.98±0.48	Yes (0.001)	7.38±0.70	6.98±0.47	Yes (0.001)
L2D:4D	0.96±0.30	0.96±0.07	No (0.83)	0.97±0.04	1.00±0.05	Yes (0.001)

All values= mean ±SE

Table 1 compares the digit ratio of same sex subjects between males and females in the hardcore and biological sciences. Same sex differences were observed in the pattern of digit ratio of males in the hardcore (0.96) compared to males in the biological sciences (0.97) on both hands. Same sex differences were also observed between females in the hardcore sciences (0.96) and biological sciences (1.00) on both hands. These differences were statistically significant ( $p < 0.001$ ). The pattern of digit ratio observed in this study is an obvious indication of brain lateralization.

Table 2 compares the digit ratio of males and females in hardcore and biological sciences. Sexual dimorphism was not observed in the hardcore science (0.96) but was observed in the biological science group (males=0.97, females=1.00). This difference was statistically significant ( $p < 0.001$ ).

## DISCUSSION

The ratio of index finger to ring finger length (2D:4D) and its links to human characteristics has been the focus of much research in recent years<sup>3</sup>. The second to fourth digit ratio (2D:4D) has been proposed as a putative biomarker for prenatal testosterone and co-varies with the sensitivity of the androgen receptor (AR). Relative finger length, as a surrogate for prenatal hormonal exposure, has been shown to be related to a wide range of psychosocial factors including sporting potential, sexual orientation, personality, faculty membership, cognitive abilities and even the way men dance<sup>17,18,34</sup> and<sup>38</sup>.

In this study, a strong statistical difference was observed in the 2D:4D ratio between the males in the hardcore sciences (0.96) as compared to males in the biological sciences (0.97). Males of the hardcore science had the lowest digit ratio otherwise known as masculinised digit ratio suggesting a high prenatal testosterone secretion. The observed masculine digit ratio among males in the hardcore sciences is in tandem with the report that high levels of prenatal testosterone and low levels of prenatal estrogens are associated with a low 2D:4D ratio, and men usually have a lower 2D:4D ratio than women<sup>3</sup>. Prenatal testosterone promotes the growth of the fourth digit and minimizes the growth of the second digit resulting in a masculine digit ratio<sup>1</sup>. It also masculinises the brain by promoting the development of the right hemisphere resulting, among other things, in higher spatial ability<sup>16, 17</sup> and higher musicality<sup>37</sup>. However, this result contradicts earlier report that male scientists had digit ratio consistent with the female standard of 1.0034. Digit ratio of 1.00 is termed a high digit ratio<sup>3</sup> which is indicative of increased oestrogen secretion<sup>1</sup>. On the other hand, cross-cultural differences in masculinity may have played a role in the modification of the digits. A sexual dimorphism was not observed in the hardcore sciences between males and females; both sexes had digit ratio of 0.96. This digit ratio is consistent with the male standard of 0.96. The non sexual dimorphism in the

hardcore sciences agrees with earlier report<sup>34</sup> but contradicts his values of 1.00. It therefore suggests that females with high concentration of testosterone would be more adept in numeracy rather than literacy<sup>18</sup>.

Sexual dimorphism was observed when the males and females of biological sciences were compared. Males of biological sciences had digit ratio of 0.97 while the females had digit ratio of 1.00. Sexual dimorphism in digit ratio has been reported elsewhere<sup>1, 3, 4, 9, 11,17and18</sup>. The differences observed were found to be statistically significant ( $p < 0.05$ ). Furthermore, sexual dimorphism of 2D:4D has been reported in different parts of the world: United States of America (Males 0.96, Females 1.0), United Kingdom (Males 0.98, Females 1.00)<sup>3</sup>. In Nigeria it varies according to the ethnic groups. Among the Igbos: (Males  $0.96 \pm 0.02$ , Females  $1.0 \pm 0.06$ )<sup>9</sup> Yorubas: (Males  $0.96 \pm 0.03$ , Females  $1.00 \pm 0.05$ )<sup>10</sup>; Urhobos: (Males  $0.96 \pm 0.02$ , Females  $1.0 \pm 0.02$ )<sup>9</sup> Ikwerres: (Males  $0.98 \pm 0.003$ , Females:  $1.00 \pm 0.002$  Andonis: Males  $0.95 \pm 0.002$ , Females  $0.96 \pm 0.002$ )<sup>11</sup>.

The same sex difference observed in this study has been reported elsewhere<sup>34</sup> when he reported a study that examined the digit ratio amongst an academic community. No sex differences were found and there was a significant difference between the Science Faculty and Social Science Faculty. Social Scientists of both sexes had a ratio consistent with the male standard (0.98) whilst hardcore Scientists had a digit ratio consistent with the female standard (1.00).

The result of the present study provides evidence of brain lateralization as shown in the pattern of digit ratio across the different groups. Some ratios were masculine while others were feminine. These results suggest differences in the prenatal concentration of testosterone and oestrogen. This observed evidence of brain lateralization is consistent with earlier studies<sup>17,34</sup>.

## CONCLUSION

The present study is probably the first on digit ratio of academic staff population in Nigeria. The findings in this study have revealed that academic staff across hardcore and biological sciences have digit ratio that is typical to them: The hardcore sciences (males, 0.96; females, 0.96); biological sciences (males, 0.97; females, 1.00). This information may be a useful guide in choosing career in line with established values.

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