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# Digital Ratio and Academic Performances of College Students

**Adenowo, T.K.[1] and Oladokun, O.P.[2]**

[1]Department of Anatomy, Obafemi Awolowo College of Health Sciences, Olabisi Onabanjo University Teaching Hospital, Sagamu Ogun State
[2]Department of Health Information Management, Ogun State College of Health Technology, Ilese–Ijebu.

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**Abstract:** Earlier studies have associated 2D:4D of Humans to several anatomical and physiological differences, capable of predicting medical conditions and behaviours such as sporting capabilities. There however evidences linking digital ratios particularly 2D:4D to academic performances of college students. This study therefore aimed at elucidating the associations between Digital Ratio and Academic Performances among College students. This study employed a descriptive-cross sectional anthropometric designs, where a total of 247 students gave their consents. Conventional Index Finger - Ring Finger ratio and Anatomical Index Finger-Ring Finger ratios were determined in students at different Academic levels. The average 2D:4D value showed that the index fingers (2D) is typically shorter in males (0.94 ± 0.01 - 0.96 ± 0.05) compared to females (0.95 ± 0.05 - 0.96 ± 0.06). The conventional 2D:4D ratios for left (r = 0.021) and right (r = 0.01) hands and Anatomical 2D : 4D ratios for left (r = -0.074) and right (r = -0.094) hands all have weak correlation with the Students Cumulative Grade Point Average. The study conclusively provided a baseline record on the use of bodily anthropometric measurements to determine different levels of Academic Performances among College students.
**Keywords:** Academic Performance, Anthropometry, Biological Anthropometry, College– Students, Digital Ratio.

## 1.0 Introduction

Digital ratio is the ratio of the length of different fingers or digit of the hand, it is usually determined from the mid-point of the proximal digital creases at the metacarpal-phalangeal joint to the tip of each digit [1]. The digit ratio of the human hand has been a source of considerable research interest over the years. Although ten possible digital ratios are readily possible for research purposes, difficulties in measurement of the Thumb (1D) allows for only six ratios on each hand. The index finger (2D): ring finger (4D) remains the most extensively researched digital ratio [2]. The digital ratio for 2D:4D has been found to be constant since birth and has equally been a tool for determining sexual dimorphism, which have been found in species such as mice, Zebras and humans [3].

Previous studies have associated 2D:4D to different anatomical, functional, sexual preferences [4] and enhanced traits and abilities in specific sports [5]. The chances of developing certain medical conditions such as adrenal hyperplasia [6], autism [7], infertility [8] have been attributed to 2D:4D. The digit length is usually pre-determined before birth; it is believed to be set during the early second trimester [9, 10]. The circulating prenatal androgen during this phase plays significant roles in determining digital ratio and on the developing brain which also begins to form at the same period [10]. The level of prenatal androgen during this phase increases affinity for testosterone is believed to allude increased risk preferences, persistence and self-confidence which builds a personality that is vigilant and quicker in reaction and decision making [12].

School performance is tied to cognitive abilities, environmental background or status as well as behavioural attributes such as biological and psychological traits. These characteristics are partly driven by prenatal androgen exposure during the formative weeks of brain development. Measurement of the 2D:4D is an anatomical indicator to level of prenatal androgen exposure. Manning [13] observed an inverse relationship between 2D:4D and foetal androgen levels.

Links of 2D:4D to academic performances of students have been less explored and when explored, findings are mixed which is usually attributed to the limited sample size [14]. While Romano *et al.*, [15] reported a positive association between the examination grade and 2D:4D of adult males, Brosnan [16] observed no significant correlations between the digit ratio of British school children and performances in literacy and numeracy. Equally, Bull *et al.*, [17] observed no association between the 2D:4D of school children with visual-spatial and numerical tasks.

Branas-Garza and Rustichini [18] noted an inverse link between 2D:4D and performances on tests of risk-taking and abstract reasoning. The low measured 2D:4D is reflective of higher values for 4D which is synonyms with higher levels of prenatal testosterone. Students with dominant personality tends to achieve higher academic performances in abstract-based reasoning test. However, the influence of gender on abstract reasoning and risk taking are not directly linked considering that higher risk-taking and abstract reasoning among males.

In terms of intellectual patterns, males are more fascinated by object of interest and laws governing reality than people and are usually systematic in their in their approach. This cognitive style is referred to as 'S-type; and variation of the S-extreme shows excessive systematising theory [18]. Baron-Cohen [19] provided a cognitive pattern which tends to cater for people more than any existing law, this cognitive style represents the end point of the S-type and is referred to as the E-type. These cognitive styles have been linked to the 2D:4D; a high digital ratio values of 2D:4D are correlated to lower values in empathy and higher levels of systematization [20-21]. Furthermore, women with lower 2D:4D ratios, or with more androgenisation, show a more systematic cognitive style [22], whereas women with no androgenisation show 'E type' cognitive style or greater empathy [23].

The primary objective of the College of Health Technology is to train middle-level manpower for the delivery of Primary Health Care services, students are expected to have a high level of empathy and the right balance of systematisation in the discharge of their duties. Till recent, there are limited research works on the relationship between 2D:4D and academic performance in this part of the world. This study therefore is aimed at providing a base-line data elucidating the relationship between 2D:4D ratio of the Students at different levels of Academic Performances in Ogun State College of Health Technology, Ilese-Ijebu.

## 2.0 Methodology

The study was conducted among the Students of College of Health Technology, Ilese Ijebu, Ogun State, Nigeria. The study employed a descriptive-cross sectional design to determine if relationship exists between the 2D:4D of the students and their Academic Performances. Ethical approval and permission from the College's management was obtained following the World Health Organisation's Ethical Guidelines on Demographic studies. Individual consents were also obtained from the Subjects after been enlightened on the objectives of the study. A total of Two Hundred and Forty-Seven (247) students were selected using Inclusive and Exclusive Techniques.

**Inclusive Criteria:** All subjects who gave their consents willingly were Subjects with no Gross Anatomical deformities or family history of such deformities.

**Exclusive Criteria**: Subjects who refuse to give their consents or those observed with Gross Anatomical defects and those with the family history of structural deformities were excluded from the study.

### 2.1 Anatomical Digital Ratio (2D:4D ratio)

The anatomical digit ratio was determined by taking measurements of 4D (Ring Finger) and 2D (Index Finger), while the subjects' hand was extended with the palm facing a hard and flat surface. The 1D (Thumb) was slightly abducted from the rest (2D – 5D) which were adducted for easy measurements of the 2D and 4D. The length of the 2D and 4D of both hands were recorded using a sensitive Vernier Calliper from the metacarpal-phalangeal joints to the tips of each digit (Figure 1).

**Figure 1. Photograph showing the Anatomical measurement of 4D length of a student's right hand.**

### 2.2 Conventional Digital Ratio (2D:4D ratio)

The conventional digital ratio (2D:4D) was determined by adopting the indirect measurement of Roy *et al.,* [24]. The students' freely extended hand was placed down with the palmar surface positioned on the glass of the scanning device (HP Deskjet 2100 Scanner) with less pressure applied. With slight abduction of the digits, the images were scanned and saved in Portal Document Format (PDF).

The collected image was manipulated and analysed using Foxit PDF reader Version: 9.0.1.1049 for digital measurements of 2D and 4D. Digit lengths were measured from the middle of the most Proximal Digital crease to the tip of the digit on the frontal surface of both hands (Figure 2).

The Digital lengths were recorded (in cm) and the 2D:4D was estimated as a ratio between the index finger (2D) length and the ring finger (4D) length. These values were recorded for the respective students.

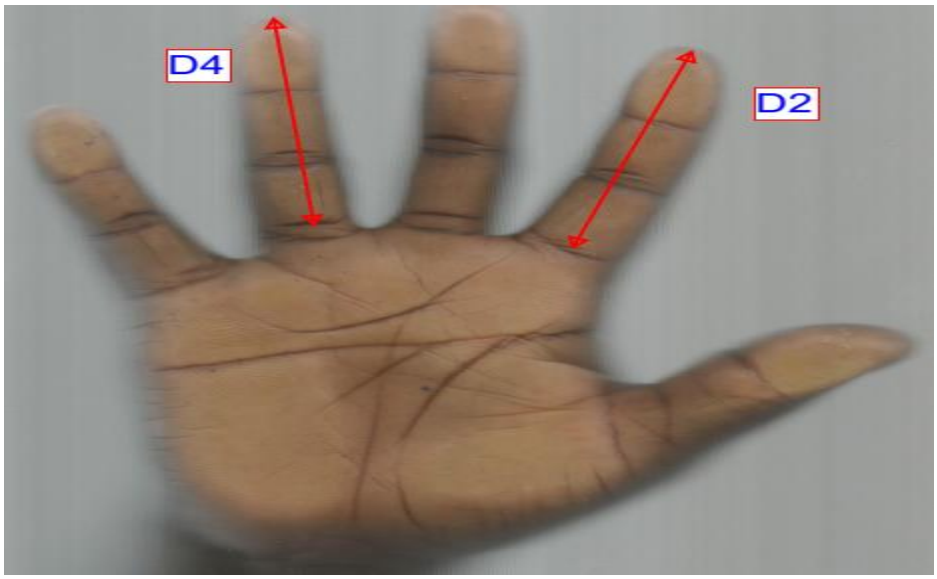



**Figure 2. A photograph showing the indirect measurement of the digital lengths of a student's right hand by image analysis system.**

### 2.3 Determination of the Levels of Academic Performances

The different levels of Student's Academic Performances were assessed by reviewing the following academic details of the students in the Institutional database:

The Cummulative Grade Point Average (CGPA) score was also graded as follows:

| | |
|---|---|
| a. Distinction (4.00–3.50) | 5 |
| b. Upper Credit (3.49–3.00) | 4 |
| c. Lower Credit (2.99–2.50) | 3 |
| d. Pass (2.49–2.00) | 2 |
| e. Probation (< 2.00) | 1 |

### 2.4 Data Analyses

Data obtained were coded and inputted into the Statistical Packages for Social Sciences (SPSS) for Windows version 21 (IBM Corporation WY, USA) for appropriate analysis. All data recorded were subjected to both descriptive and inferential statistics using Analysis of Variance (ANOVA) and the Pearson's correlation (r) between the Digital Profiles and Academic Standing of the students were also subjected to statistical co-efficient. The levels of significance were pegged at $P < 0.05$.

## 3.0 Results and Discussion

The results of the conventional and anatomical anthropometric measurements of the students is shown below (Table 1).

**Table 1. Shows the Mean ± SD of Conventional and Anatomical 2D:4D**

| | Conventional Measurements | | | | Anatomical Measurements | | | |
|---|---|---|---|---|---|---|---|---|
| | Left Hand | | Right Hand | | Left Hand | | Right Hand | |
| | **2D** | **4D** | **2D** | **4D** | **2D** | **4D** | **2D** | **4D** |
| Range | 2.80 | 3.90 | 2.90 | 3.70 | 4.50 | 5.60 | 4.00 | 4.10 |
| Mean (cm) | 6.71 | 7.08 | 6.65 | 7.05 | 9.21 | 9.64 | 9.17 | 9.65 |
| SD | 0.47 | 0.55 | 0.50 | 0.54 | 0.85 | 0.88 | 0.77 | 0.82 |
| **2D:4D ± SD** | $0.95 \pm 0.08^{+}$ | | $0.94 \pm 0.06^{+}$ | | $0.96 \pm 0.06^{++}$ | | $0.95 \pm 0.05^{++}$ | |
| Mean with the same superscript are not sig. diff at $P < 0.05$ | | | | | | | | |

The Digital ratios on the left (0.95 ± 0.08) and right (0.94 ± 0.06) hands of the Conventional Anthropometry and left (0.95 ± 0.08) and right (0.94 ± 0.06) hands of the Anatomical Anthropometry showed no significant differences for the Conventional Anthropometry (P value = 0.82) and Anatomical Anthropometry (P value = 0.93) respectively.

Out of the 247 students studied, 180 students were females (72.87%) and 67 students were males (27.12%). The digit ratios on the Left (0.94 ± 0.12) and Right (0.94 ± 0.06) hands in males showed no significant disparity for the Conventional Anthropometry (P > 0.05) (Table 2). In the Females, the Anthropometry equally showed no statistical difference in the Digital Ratio of the Left Hand (0.95 ± 0.05) and the Right Hand (0.95 ± 0.06) at alpha significant level of P < 0.05. However, the Digital Ratio on both Hands were observed to be significantly lower in the Males compared to Females (P < 0.05).

**Table 2. Shows the Mean ± SD of Conventional and Anatomical 2D:4D**

| Gender | **Conventional 2D:4D** | | **Anatomical 2D:4D** | |
|---|---|---|---|---|
| | Left Hand | Right Hand | Left Hand | Right Hand |
| Male | 0.94 ± 0.07 | 0.94 ± 0.06 | 0.96 ± 0.05 | 0.95 ± 0.05 |
| Female | $0.95^{*}$ ± 0.02 | $0.95^{+}$ ± 0.06 | $0.96^{**}$ ± 0.06 | $0.95^{++}$ ± 0.05 |
| * (P < 0.05) F & M; ** (P > 0.05) F & M; $^{+}$ (P > 0.05) LT & RT; $^{++}$ (P < 0.05) LT & RT. | | | | |

No statistical difference was reported in the Digital Ratios of both Hands between the Female and Male students (P > 0.05) when the Anatomical method of Anthropometry was used (Table 2). However, the Digital Ratios on the Right Hands of the students was significantly lower than Digital Ratio on their Left Hands (P < 0.05). The Anatomical method of evaluating the Digital Ratio could be said to be more sensitive as it considered the full length of the bony components of the digits as compared with the conventional and common methods, which neglect the distal parts of the metacarpals. These observations conform with previous findings of Gillam *et al.,* [25] where gender differences were recorded within healthy subjects. The results also showed lower ratios in males in comparism to females. Mcfadden and Shubel, [26] also reported that the 2D:4D are generally higher in females and sexual dimorphism predicts a higher ratio in the right to left hands of healthy subject [27].

The Students' Academic Performance was also evaluated by the Cumulative Grade Point Average score attained in their most recent examination (Table 3).

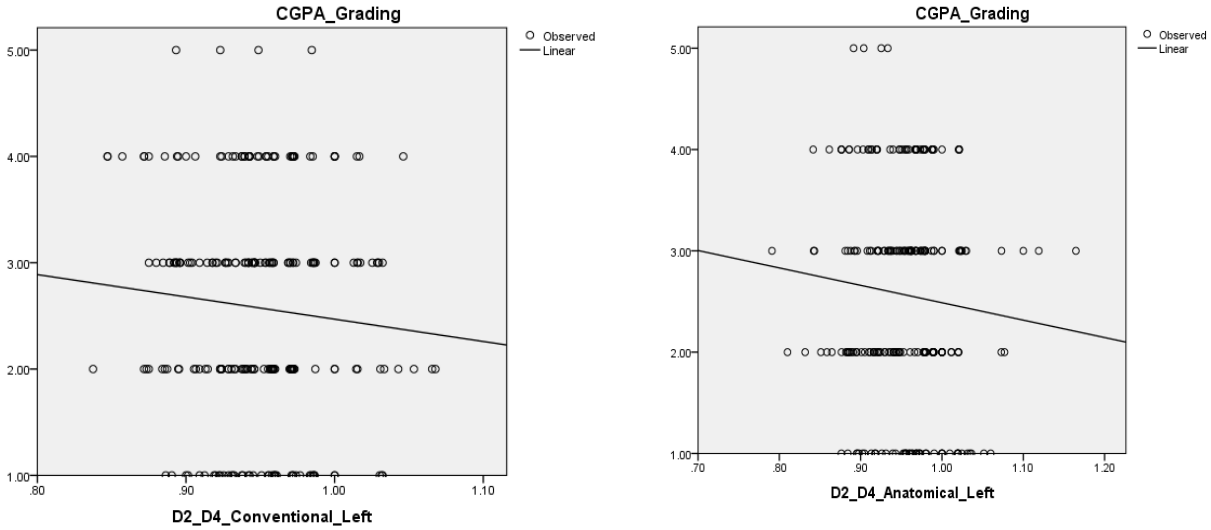
**Table 3. Shows the Students' CGPA grading frequency**

| **CGPA Grading** | **Frequency** | **Percent (%)** |
|---|---|---|
| Distinction | 5 | 2.02 |
| Upper Credit | 48 | 19.43 |
| Lower Credit | 78 | 31.58 |
| Pass | 70 | 28.34 |
| Probation | 46 | 18.62 |
| **Total** | **247** | **100** |

Figure 3 showed that the conventional 2D:4D ratios for left (r = 0.021) and right (r = 0.01) hands has a weak correlation with the students Cumulative Grade Point Average while Anatomical 2D : 4D ratios for left (r = -0.074) and right (r = -0.094) hands have a weak negative correlation with the student's Cumulative Grade Point Average.

Manning [10] attributed the measure of 2D:4D to intrauterine hormones during prenatal periods; a low digit ratio indicated high Prenatal Testosterone (PT) exposure in relation to prenatal oestrogen

and a high digit ratio signifies a low prenatal testosterone level in relation prenatal oestrogen [28 & 29]. Hopp *et al.*, [30] related levels of Prenatal Testosterone (PT) to levels of intelligence or learning abilities of students; the level of intra-uterine testosterone has a direct influence on the levels of intelligence and learning skills. This relationship is attributed to the influence of prenatal testosterone to control the proliferation, movement, differentiation and apoptosis of neurons.




Mean sig at P-value < 0.05

**Figure 2. Linear regression curve-fitting for 2D and 4D ratios of left hand and CGPA**

Romano *et al.*, [15] showed the ability of 2D:4D in the prediction of physical high-risk performances and decision making that improves fitness and organisations. He conversely showed a positive association between the digit ratio and adventure taking traits (e.g. verbal semantic fluency) that ensures students gain more experiences and exposures. In contrast, Brosnan *et al.*, [31] reported a negative and significant correlation between digit ratio and students studying Java Programming. In his study, the role of gender was not considered.

Hopp *et al.*, [30] equally opined that 2D:4D is negatively associated with academic grades (both practical and theoretical grades) although this relationship is influenced by other factors such as gender, hours of study and age. All these previous studies showed that a non-linear relationship exist between 2D:4D and academic performances of students. The relationship is influenced by dictates of the course under-study.

The result observed in this study is in cognisance to works of Nye *et al*., [14] who studied university students from separate countries to show the non-linear association between the variables, further suggesting that other factors such as culture, course of study or gender plays determining factors to the relationship.

## 4.0 Conclusion

Digital ratio is sexually dimorphic and had earlier been used as a window for in utero exposure to Androgens, especially Testosterone. This study conclusively showed that 2D:4D ratio could not individually play an important role to determine Students' Academic Performances using a low sample size and multicultural subjects as ours.

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