



## **RELATIONSHIP BETWEEN SECOND TO FOURTH DIGIT RATIO (2D:4D) AND ACADEMIC PERFORMANCE AMONG STUDENTS IN NIGERIA.**

**Anas, Y.I. <sup>1</sup> and Badamasi, M.I. <sup>1\*</sup>**

Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences , Bayero University Kano.

\*Corresponding author: badamasiibrahimmohammed@gmail.com

### **ABSTRACT**

**The second to fourth digit ratio (2D:4D), is a sexually dimorphic trait, with males on the average having lower ratios than females 2D:4D. It had been correlated with several psychosocial features. The present study is primarily aimed at investigating the existence of the association between digit ratio (2D:4D) with academic performance of 205 secondary school students (110 males and 95 females) in Kano State, Nigeria. Academic performance of the students was measured from the terminal examinations results in three key subjects (Maths, English and Biology) and these results were obtained from the schools managements. A significantly low 2D:4D (a correlate of high prenatal testosterone and low prenatal oestrogen) was observed in male students compared to females and the differences in digit size measurments between male and female students were also statistically significant ( $P < 0.05$ ). Female students performed significantly better in all the 3 subjects, but there was no correlation between the performance and any of the 3 subjects or their cumulative average with 2D:4D ratio of the right or left hand in the current study. However, a positive but negative correlation between the sizes of the left and right digits, with academic performance in all subjects in males and two subjects (English and Biology) in females were observed. It is therefore sufficient to conclude that 2D:4D ratio was not associated with better performance in the current study.**

**Key words: Anthopometry, Academic performance, undergraduate-students, Gender, Digit ratio**

### **INTRODUCTION**

It has been consistently reported from 19<sup>th</sup> century to date that men's 2D:4D ratios were averagely lower than those for females and this sexual dimorphism is well established by the 13th week of in utero life and remains so in all stages of the human development (Tektas *et al.*, 2019; Trivers *et al.*, 2006; Malas *et al.*, 2005; McIntyre *et al.*, 2005; Csatho *et al.* 2003a; Manning *et al.*, 1998; Williams *et al.*, 2003). The sexual dimorphism for the 2D:4D has been reported across ethnic groups and different primates and mammals (Burley and Foster 2004; Brown *et al.*, 2002).

A number of studies had suggested that the digit ratio was positively associated with prenatal estrogen and negatively associated with prenatal testosterone (Manning, 2002; Danborno *et al.*, 2007 and Breedlove, 2010). Specifically, it has been reported that the size of index finger (digit 2) is an indicator of prenatal estrogen levels while the length of the ring finger (digit 4)

appears to be determined by prenatal testosterone levels (Manning, 2002).

There are few studies in the literature that assessed for correlation between either the size of the fourth digit or second digit independently, with traits such as homosexuality and physical aggression (Manning, 2002; Robinson and Manning, 2000). There are numerous studies in the literature regarding the association between hand digit ratio and traits such as body height, body mass index, adult weight and birth weight (Danborno *et al.*, 2010, Klimek *et al.*, 2014). Thus, the more associations reported with the digit ratio compared to the dimensions of the digit alone strongly suggest that neither of the underlying hormones that influence the digit sizes is solely involved in the regulation of complex psychosocial traits (Zheng and Cohn, 2011; Mrazik and Dombrowski, 2010). A gender specific prediction of 2D:4D for psychological traits had also been reported.

Aggression, athleticism, masculinity, music talent were common among men with low 2D:4D ratio (Rammsayer and Troche, 2007; Hönekopp *et al.*, 2006; Luxen and Buunk, 2005; Bailey and Hurd, 2005; Pokrywka *et al.*, 2005; Rahman and Wilson, 2003; Csathó *et al.*, 2003a; Manning *et al.*, 2000). The same low values of 2D:4D ratio have been associated with women with high waist-to-hip ratio, masculine and are more athletic (Csathó *et al.*, 2003a; Manning *et al.*, 2000; Pokrywka *et al.*, 2005). A gender free role for 2D:4D ratio in predicting psychological traits had also been reported in the literature. Verbal intelligence and agreeableness are positively correlated with 2D:4D ratio while numerical intelligence and physical fitness were negatively correlated with it (Hönekopp *et al.*, 2006; Luxen and Buunk, 2005). Specifically, the negative correlations implies that a low 2D:4D correlated with numeric capabilities (Brosnan, 2006 and Brosnan *et al.*, 2011). The association of digit ratios with psychological and physical traits appears to be explained by the underlying influence of the changes in the hemostatic balance of testosterone and estrogen on neuronal proliferation, migration, differentiation, and apoptosis (Zheng and Cohn, 2011; Mrazik and Dombrowski, 2010; Manning, 2002). The current study was aimed at evaluating the relationship between 2D:4D ratio with academic performance among secondary school students in Gwale LGA, Kano, Nigeria.

**MATERIALS AND METHODS**

The subjects that participated in this study were students of Nasarawa secondary school of Gwale Local Government Area, Kano State, Nigeria. An introduction letter was obtained from Anatomy department of the Yusuf Maitama Sule University Kano, and an information sheet regarding the study design was presented to the management of the school for onward dissemination to parents. Only students whose parents gave a verbal consent for the study

were recruited for the current study. A proforma for recording data was adapted with its relevant sections on socio-demography and measurements of interest (anthropometric and academic performance). Anthropometric measurements on participants were carried out by the researcher and aided by two well-trained assistants. The measurement carried out included measurements of the hand digit length using a digital vernier caliper (Neiko) which has an accuracy of about 0.05mm. The measurement was carried out on the ventral surface of the hand from the basal crease of the digit to the tip of the digit and this approach was adapted from an earlier work (Manning *et al.*, 1998, Danborno *et al.*, 2010). This measurement approach has been reported to have high degree of repeatability and all measurements were made in duplicates and then the average values were recorded as the measurement value so as to increase the accuracy of the results (Manning *et al.*, 1998). Assessment of the academic performance of the recruited students was carried out using the grades and / or scores the individual student earned during their terminal exams. The grades for the terminal exams were retrieved directly from the teachers of the students.

**RESULTS**

The measurements of digit length in males and females were carried out in the current study and the mean results were presented in Table 1. The female digit measurements were lower than those of the males while the values for the 2D : 4D ratio obtained in both the right and left hands were higher among females compared to males. The statistical evaluation of the level of difference in the individual digit measurement values obtained from females compared to males was observed to be statistically significant with P ≤ 0.05, whereas the difference in the values of the ratio were not significant (Table 1).

**Table 1: The mean hand digit length of the secondary school student of Nasarawa school, Gwale, Kano state**

Digit measured	Mean ± SD N = 205	Mean ± SD (Males) n = 110	Mean ± SD (Females) n = 95
Left 2D (cm)	61.160 ± 6.730	62.997± 6.664**	59.041 ± 6.179**
Left 4D (cm)	63.590 ± 6.860	65.556 ± 6.649**	61.311± 6.417**
Right 2D (cm)	61.350 ± 6.710	63.263± 6.579**	59.143 ± 6.193**
Right 4D (cm)	63.610 ± 6.920	65.674 ± 6.683**	61.227 ± 6.443**
Right2D: 4D	0.970 ± 0.020	0.963 ± 0.018	0.966 ± 0.0232
Left 2D:4D	0.960 ± 0.018	0.961 ± 0.015	0.963 ± 0.021
2D:4D ratio	0.963 ± 0.017	0.962 ± 0.144	0.965 ± 0.020

Statistical evaluation was done using the Mann-Whitney U test for the difference in the digit lengths in females and males. \* p value for the comparison between female and male digit lengths ≤ 0.001 (Left second digit (Left 2D), P = 0.000004; Left fourth digit (Left 4D), P = 0.000003); Right second digit (Right 2D), P = 0.000001; Right fourth digit (Right 4D), P = 0.000001).

In the results obtained in the terminal test for the three (3) subjects evaluated, it was observed that the females obtained a higher

score for each subject compared to their male counterparts and the difference in scores were statistically significant ( $P \leq 0.05$ ) (Table 2).

**Table 2 : The academic scores in a terminal exam among secondary school students of Nasarawa school, Gwale, Kano state**

Subject	Mean ± SD N = 205	Mean ± SD (Males). n = 110	Mean ± SD (Females). n = 95
Maths	48.522 ± 12.357	47.390± 12.446*	49.926 ± 12.168*
English	50.951 ± 9.665	49.591 ± 9.631*	52.526 ± 9.512*
Biology	70.766 ± 15.895	65.918± 15.078**	76.400 ± 15.003**
Cummlative assessment (CA)	56.749 ± 10.459	54.273 ± 10.219**	59.618 ± 10.042**

Statistical evaluation was done using the Mann-Whitney U test for the difference in the scores obtained by males and female in each subject. \* p value for the comparison between female and male score  $\leq 0.05$  (Maths test,  $P = 0.017$ ; English test,  $P = 0.012$ ); \*\*p value for the comparison between female and male score  $\leq 0.001$  (Biology test,  $P = 0.000003$ ; Cummulative assessment,  $P = 0.000058$ ).

In the evaluation of relationship between measurement of the digit sizes in the right and left hand, with scores of academic performance, only the scores for biology was significantly correlated with the digit dimensions, but it was not correlated with the 2D : 4D ratio (Table 3).

Thus, the dimensions of the digit measurement of the second right, second left , fourth right and fourth left digits were significantly correlated with the scores in Biology only and the association was observed to be a negative correlation (Table 3).

**Table 3: Correlations between digital anthropometric parameters with academic scores from terminal examination among secondary school students of Nasaraw school, Gwale, Kano state**

			M(%)	E(%)	B(%)	CA
Spearman's rho	L2D	Correlation Coeff	.019	-.069	-.166*	-.102
		Sig. (2-tailed)	.784	.328	.018	.145
	L4D	Correlation Coeff	.030	-.053	-.170*	-.096
		Sig. (2-tailed)	.669	.449	.015	.172
	L2D/L4D	Correlation Coeff	-.049	-.103	.019	-.043
		Sig. (2-tailed)	.490	.143	.781	.537
	R2D	Correlation Coeff	.022	-.080	-.185**	-.115
		Sig. (2-tailed)	.749	.254	.008	.100
	R4D	Correlation Coeff	.018	-.072	-.195**	-.121
		Sig. (2-tailed)	.795	.307	.005	.084
	R2D/R4D	Correlation Coeff	.059	-.020	.063	.049
		Sig. (2-tailed)	.402	.775	.371	.483
	2D : 4D	Correlation Coeff	.026	-.070	.050	.015
		Sig. (2-tailed)	.709	.316	.474	.831
	M(%)	Correlation Coeff	1.00	.628**	.455**	.809**
		Sig. (2-tailed)		.000	.000	.000
	E(%)	Correlation Coeff		1.000	.497**	.795**
		Sig. (2-tailed)			.000	.000
	B(%)	Correlation Coeff			1.000	.837**
		Sig. (2-tailed)				1.000

\*\* . Correlation is significant at the 0.01 level (2-tailed); \* . Correlation is significant at the 0.05 level (2-tailed). Coeff is coefficient, B is Biology, E is English, M is Maths, 2D is second digit, 4D is fourth digit, L is Left R is right.

The correlation between measurements of the R2D, L2D, R4D, and L4D with the scores in Maths, English, Biology and Cumulative average were found to be statistically significant and was positively correlated among males students (Table 4). However, none of the correlations

between the academic scores (Maths, English, Biology and Cummulative average) with the 2D : 4D ratio of the right and left hands as well as the average of 2D : 4D ratio of both hands were statistically significant (Table 4).

**Table 4: Correlations between digital anthropometric parameters of digit with academic scores from termina examination among male secondary school students of Nasaraw school, Gwale, Kano state**

			M(%)	E(%)	B(%)	CA
Spearman's rho	L2D	Correlation Coeff.	.276**	.211*	.263**	.283**
		Sig. (2-tailed)	.004	.027	.006	.003
	L4D	Correlation Coeff	.297**	.226*	.271**	.296**
		Sig. (2-tailed)	.002	.017	.004	.002
	L2D/L4D	Correlation Coeff	-.076	-.061	.050	-.001
		Sig. (2-tailed)	.433	.523	.601	.990
	R2D	Correlation Coeff	.273**	.191*	.244*	.267**
		Sig. (2-tailed)	.004	.045	.010	.005
	R4D	Correlation Coeff	.284**	.197*	.229*	.259**
		Sig. (2-tailed)	.003	.040	.016	.006
	R2D/R4D	Correlation Coeff	-.031	-.004	.120	.065
		Sig. (2-tailed)	.748	.968	.211	.501
	2D : 4D	Correlation Coeff	-.059	-.037	.097	.041
		Sig. (2-tailed)	.543	.704	.315	.670
M(%)		Correlation Coeff	1.000	.617**	.468**	.801**
		Sig. (2-tailed)	.	.000	.000	.000
E(%)		Correlation Coeff		1.000	.526**	.798**
		Sig. (2-tailed)		.	.000	.000
B(%)		Correlation Coeff			1.000	.848**
		Sig. (2-tailed)			.	.000
CA		Correlation Coeff				1.000

\*\* . Correlation is significant at the 0.01 level (2-tailed); \* . Correlation is significant at the 0.05 level (2-tailed). Coeff is coefficient, B is Biology, E is English, M is Maths, 2D is second digit, 4D is fourth digit, L is Left R is right.

The correlation between measurements of the R2D, L2D, R4D and L4D with the scores of academic performance (in all the subjects, except Maths) among females were statistically significant. However, the result for the

correlation between the academic performance scores (Maths, English, Biology and Cumulative average) with the 2D : 4D ratio of the right and left hands was not statistically significant (Table 5).

**Table 5: Correlations between digital anthropometric parameters with academic scores from a terminal examination among secondary school female students of Nasarawa school, Gwale, Kano state**

			M(%)	E(%)	B(%)	CA
Spearman's ho	L2D	Correlation Coeff	-.177	-.265**	-.450**	-.387**
		Sig. (2-tailed)	.086	.010	.000	.000
	L4D	Correlation Coeff	-.187	-.240*	-.461**	-.387**
		Sig. (2-tailed)	.070	.019	.000	.000
	L2D/L4D	Correlation Coeff	-.037	-.162	-.010	-.105
		Sig. (2-tailed)	.719	.116	.924	.312
	R2D	Correlation Coeff	-.177	-.275**	-.472**	-.403**
		Sig. (2-tailed)	.087	.007	.000	.000
	R4D	Correlation Coeff	-.196	-.252*	-.488**	-.413**
		Sig. (2-tailed)	.056	.014	.000	.000
	R2D/R4D	Correlation Coeff	.168	-.052	.017	.062
		Sig. (2-tailed)	.103	.618	.867	.548
	2D : 4D	Correlation Coeff	.112	-.108	.020	.008
		Sig. (2-tailed)	.281	.296	.847	.936

\*\* . Correlation is significant at the 0.01 level (2-tailed); \* . Correlation is significant at the 0.05 level (2-tailed). Coeff is coefficient, B is Biology, E is English, M is Maths, 2D is second digit, 4D is fourth digit, L is Left R is right.

## DISCUSSION

The results from this study suggested that there were correlations between second digit length of the right hand and that of the left hand with the digit measurements of the right and left fourth digit irrespective of gender. In addition, the second digit length was correlated with the 2D : 4D ratio of the left hand and that of the average value from the 2D : 4D ratio of both hands. The correlation between the size of the fourth left digit with the size of the right and left second digit as well as the left second digit and the 2D : 4D ratio of the left hand when the entire population was analysed was observed. In males, the same result of correlation was observed for the left fourth digit except that the association with the right 2D : 4D ratio and the that of the average from the 2D : 4D ratio of both hands was not significant. In females all assessment between L4D with all the three forms of 2D : 4D ratio in this study were not significant. The evaluation in male students and entire study population for the relationship between the size of the right fourth digit (R4D) and all the other digit in this study were significantly correlated, except for the 2D : 4D ratio from the right hand and the average 2D : 4D ratio from both hands. The same result was observed when the evaluations was carried out among the female students except that all the three different formats of the 2D : 4D ratios in the study were not significantly correlated with the size of R4D.

In the entire population, only the scores for biology were negatively correlated with the digit dimensions. In males students, all the individual and cumulative average scores from Maths, English and Biology were positively correlated with the digit sizes while in females, only Biology, English and Cumulative average scores were negatively correlated with the size of the digits measured in the study. It is pertinent to note that none of the three different forms of 2D : 4D ratio (R2D : 4D; L2D : 4D and 2D : 4D) was significantly correlated with any of the examination scores in this study.

The significantly higher measurements for 2D : 4D values among female compared to males in the current study was in keeping with earlier reports in the literature (Tektaş *et al.*, 2019).

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Similarly, in the current study there was no correlation between digit ratio and academic performance including performance in Math, and this observation was in tandem with an earlier finding in the literature (Tektaş *et al.*, 2019). There were literature reports that revealed an association between academic performance and digit ratio and thus these reports were in contrast to the current finding (Brosnan, 2011; Brosnan, 2006). The current finding was also in contrast with an earlier report of a significant correlation between 2D:4D and success in admission tests for a school in Italy (Coco *et al.*, 2011). There are literature reports that suggest that high prenatal level of testosterone may be associated with better performance in numerical abilities among Boys and Men (Tektaş *et al.*, 2019; Mrazik and Dombrowski, 2010; Fink, 2006). The biological basis for the effect of prenatal testosterone on intelligence is hinged on the fact that it influences neuronal proliferation, migration, differentiation, and apoptosis. Specifically, it promotes the development and organization of dense neuronal networks in areas related to cognition, learning and memory, either by decreasing apoptosis of brain cells during development, or increasing migration of cells to one of those areas (Lenz *et al.*, 2012; Mrazik and Dombrowski, 2010). Nevertheless, the females in the current study performed better in all the subjects evaluated including Maths. The inconsistencies in the association between digit sizes, digit ratio and academic performance in this study is in keeping with such findings in earlier studies (Galizzi and Nieboer, 2015, Brañas-Garza *et al.* 2013). These inconsistencies may be because the regulation of these features are not dependent on testosterone and estrogen levels only, but other factors such as prenatal corticosterone and genetic factors that have also been implicated in the determination of academic performance (Warrington *et al.*, 2018; Lilley *et al.*, 2010).

## CONCLUSION

Lower 2D:4D ratio were observed among the male students and the digit ratio were not correlated with the academic performance of both male and female students, including their performance in Maths.

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