

Relevance of 2D:4D Ratio as a Marker of Depression in Adolescents of a South Indian Medical College – A Cross Sectional Study

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Abstract

Context: Digit ratio is a sexually dimorphic trait which is negatively correlated to prenatal testosterone exposure. 2D:4D ratio has been associated with numerous physiological, psychological and performance traits in adulthood. The alarming rise of depression in adolescents poses a huge worldwide threat. Men with lower 2D:4D ratios showed lower aggression scores while those with higher ratios had higher incidence of depression.

Aim: To compare the 2D:4D ratio of the adolescents between sexes and evaluate the association between digit ratio & depression.

Settings & Design: In the present cross sectional study, 269 adolescents of 18-19 years of age were included by stratified random sampling. A single trained examiner measured the 2D:4D ratios of the participants using digital vernier calipers. Depression scores were calculated using Beck's Depression Inventory.

Statistical analysis: Using SPSS version 17.0, comparison of digit ratios was done using unpaired Student t test.

Results: Mean 2D:4D ratio of the study population was 0.97 ± 0.082 . There was no significant difference in mean 2D:4D ratios (Males=Females) and mean depression scores between sexes (Males >Females). Mean 2D:4D ratios of the depressed individuals were lower than that of the non-depressed individuals. ($p=0.05$) There was no significant correlation between 2D:4D ratio and the depression scores.

Conclusion: The present study revealed borderline significance in difference in 2D:4D ratios between the depressed and non-depressed individuals among the study population. 2D:4D ratio could be used as a non-invasive tool to predictably forecast the proneness of child to depression in future.

Keywords: Digit ratio; 2D:4D ratio; depression; adolescence; prenatal testosterone

Introduction

2D:4D ratio or the ratio of the lengths of index finger (2D) and the ring finger (4D) is sexually dimorphic with

males showing lower ratios when compared to females. Digit lengths and ratios have been hypothesized to be proxy markers for prenatal androgen exposure.¹ The fourth digit tends to be longer than the second in men. On the other hand, in women, the two digits tend to be identical in length or occasionally the ring finger is longer.^{2,3} Masculine or lower 2D: 4D ratios indicate higher prenatal testosterone exposure and vice versa.⁴ An earlier study reported the average digit ratios to be 0.947 ± 0.029 and 0.965 ± 0.026 , respectively in males and females.⁵ In an Indian population, the mean digit ratios

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were found to be 0.96 and 0.97 in males and females, respectively.^{6,7} At the molecular level, studies have reported that prenatal sex steroids affect the expression of Hox A genes, which are also responsible for the growth of digits.⁸

Traits ranging from handedness, musical abilities, numerical and spatial skills and sporting capabilities have been reported to be associated with the digit ratios in different populations.⁹ Lower or masculinised 2D:4D ratios showed a relationship with better arithmetic, visual and spatial skills.¹⁰ Men with lower (masculine) 2D:4D ratios showed lower aggression scores while men with higher (feminine) ratios scored higher on a test for depression.¹¹

Depression is forecasted to be a huge burden on all nations with projections expecting depression to reach the second place in the ranking of disability-adjusted life years.¹² A school based cross sectional study among urban adolescents in South India reported 60.8% of the study population to be depressed.^{13,14} The findings of research conducted on the relationship between depression and digit ratios are highly variable. Further, the prevalence of depression amongst adolescents is also on alarming rise. Hence, we conducted the present study to understand the relevance of 2D:4D ratio as a marker of depression.

Material and Method

Study setting and population:

After obtaining ethical clearance and informed consent, the present cross sectional study was conducted on 168 adolescents of 18 – 19 years of age pursuing Medicine at South Indian Medical College. Participants with any history of injury in the second and/or fourth digits were excluded from the study.

Measurement of 2D:4D ratio:

The lengths of the second and fourth digits were measured from the fingertip to the ventral proximal crease using digital vernier calipers. It has been consistently shown that digit ratio is more strongly differentiated on the right hand than left.¹⁵ Further, personality and behavioural traits have also been found to correlate

more strongly with right hand digit ratio than left.^{7,15} Hence, we measured 2D:4D ratios of the right hand only. Two measurements were taken on the right hand by the same examiner. The examiner was well trained and the instrument was calibrated prior to the conduct of the experiment. The ratio was calculated by dividing the mean index finger length (mm) and mean ring finger length (mm) for the right hand.

Administration of Beck's Depression Inventory:

The BDI (Beck Depression Inventory) was used to measure depression. It is a self-reported questionnaire containing 21 questions with four possible responses to measure the intensity, severity & depth of depression.¹⁶ Each response is assigned a score ranging from zero to three, indicating the severity of the depression. The subject required about 10 minutes for completing the questionnaire.

Statistical Analysis

Statistical analysis was done using SPSS 16.0 and STATA 11.0. The correlation between 2D:4D ratio and mean scores for the depression questionnaire was tested using Spearman correlation coefficient. The mean 2D:4D ratios and scores of the Beck Depression Inventory were compared between the sexes and right & left hands using student t test and Mann Whitney U Test, respectively. Comparison between the mean 2D:4D ratios of the 5 groups based on depression scores was done using one way ANOVA.

Findings

The sample size of the present study was 270 (Males = 100; Females = 170) according to the stratification applied while sampling. The mean age of the study participants was 18.32 ± 0.988 . The mean 2D:4D ratio of the population was 0.97 ± 0.082 . The mean depression score of the study population was 11.84 ± 9.009 . Males had 2D:4D ratios that were almost equal to that of females. Males were found to have higher depression scores when compared to females, though not statistically significant. (Table 1)

Table 1: Comparison of 2D:4D ratio and depression scores of males and females

Variable	Sex	Mean	SEM	Mann whitney U/ T statistic	p value
Depression score	Male	12.62	1.064	8342.5 ¹	0.254
	Female	11.39	0.605		
2D:4Dratio	Male	0.968	0.0082	0.459 ²	0.647
	Female	0.964	0.0062		

¹ Mann Whitney U, ² t statistic

The study participants were broadly grouped into depressed and non-depressed individuals. Overall, 78 (28.9%) of the study participants were depressed. Thirty one (31%) males and 47(27.6%) females were found to be depressed. The mean 2D:4D ratios of the depressed individuals were lower than that of the non-depressed individuals. (Depressed: 0.950 ± 0.113 ; Non depressed: 0.971 ± 0.0604) The difference achieved borderline statistical significance. (t statistic = 1.941; p value: 0.053). However, there was no significant correlation between 2D:4D ratio and the depression scores. (Spearman correlation = -0.016, p=0.798).

The study participants were further categorized based on their depression scores into 5 groups – Normal (Score: 0 -10), Mild mood disturbance (Score: 11 -14), Borderline Clinical depression (Score:15 -20), Moderate depression (Score:0 -10), Severe depression (Score:0 -10) and extreme depression (Score:0 - 10). Using ANOVA, the differences between the mean 2D:4D ratios of the 5 groups were found to be statistically significant, however with a borderline p value of 0.055. (Table 2)

Table 2: Comparison of mean 2D:4D ratios across various categories of depression

Depression category	Mean	SD	95% CI for Mean		ANOVA F statistic	p value
			Lower Bound	Upper Bound		
Normal	0.975565	0.0727876	0.962885	0.988246	2.195	0.055**
Mild mood disturbance	0.962984	0.0382766	0.953344	0.972624		
Borderline clinical depression	0.976914	0.0340232	0.962547	0.991281		
Moderate depression	0.922647	0.1864526	0.848889	0.996406		
Severe depression	0.961823	0.0222793	0.948360	0.975286		
Extreme depression	0.944882	0.0357652	0.923269	0.966495		
Total	0.965281	0.0817864	0.955463	0.975098		

Discussion

Digit ratio is a sexually dimorphic trait. Analysis of amniocentesis samples showed that, digit ratio is negatively correlated to prenatal testosterone & positively to oestrogen levels. It has been reported that prenatal testosterone may modulate striatally based dopaminergic circuits and place boys at greater risk of disruptive behavioural disorders. Further, oestrogen at puberty may have certain effects on the serotonergic pathways and place girls at greater risk for mood disorders. Also, higher digit ratios, more commonly observed in females have been reported to be associated with depression.¹¹

The mean 2D:4D ratio of the study population was 0.97 ± 0.082 . The mean 2D:4D ratios of males and females were almost equal without any statistically significant difference. The ratios tabulated in the participants of the present study were similar with those reported by Bailey et al.¹¹ Lack of gender difference in the present study was in concurrence with the observations of Bull et al.¹⁷ Non significant differences between 2D:4D ratios between the sexes were observed in the adolescents by Austin et al.¹⁸ Findings similar to the present study were also observed in a study Meera Jacob et al.¹⁹ They reported almost equal digit ratio for the left hand and males had greater 2D:4D for right hand. In a study on association of digit ratios to ethnicity, the 2D:4D ratio was lower in males than in females and this was significant for the Uygur, Han and Jamaican samples.⁷

The mean depression score of the study population was 11.84 ± 9.009 . In the present study, males were found to have higher depression scores when compared to females, though not statistically significant. This was in concurrence with Bailey et al.¹¹ One out of every four secondary school students in Trinidad was found to have significant depression.²⁰ In urban adolescents of Chennai and South India, the prevalence was estimated to be approximately 60%.^{13,19}

The authors grouped the study population as two broad categories - depressed and non-depressed individuals. The cut off score of >16 was the criteria for depression. The mean 2D:4D ratios of the depressed individuals were lower than that of the non-depressed individuals. In the present study, there was no statistically significant correlation between 2D:4D ratios & depression. This finding in our study was contradictory to Bailey et al and Martin et al.^{1,11} The former showed

higher digit ratios to be associated with high scores of depression while low digit ratios showed correlation in the study conducted by the latter.

Austin et al. (2002) also failed to find a significant relationship between severity of depression and finger length ratio.¹⁸ However, the mean 2D:4D ratio of the depressed individuals was lower than those without depression. Martin, Manning and Dowrick have attributed the increased risk of clinical depression to high organizational testosterone in men.¹¹ They have reported data demonstrating a non-significant trend towards higher depression in men with more masculine finger length ratios. This finding was similar to the present study. On the contrary, depression being more common in women globally, Bailey et al hypothesised and then reported higher prevalence of depression in men with feminine ratios and low prenatal testosterone exposure.²¹

At the start of the present study, the authors hypothesised that higher or more feminine digit ratios should correlate with higher scores for depression within each sex. This hypothesis was predominantly assumed based on the fact that the risk and prevalence of major depression is about twice as high for females compared to males.²² The authors conducted a pilot study of measurement of 2D:4D ratios in 30 clinically diagnosed cases of Major Depressive Disorders and compared it with 30 healthy controls which reported that 84% of study population had higher digit ratios and the difference was statistically significant. (Submitted for publication elsewhere). The pilot study results were concurrent with those of Bailey P Hurd et al.^{11,23} However, when the authors pursued the study on a larger scale in 270 adolescents, lower 2D:4D ratios were associated with higher depression scores. The results of the main study were concurrent with Martin et al and contradictory to Bailey P Hurd et al.^{1,11}

Depression, being a sexually dimorphic trait is more likely to be influenced by prenatal testosterone. It was surprising to note borderline significance between the 2D:4D ratios of depressed and non-depressed groups, despite an adequate sample size of both males and females. One of the probable reasons could be that depression was rated using a different scale (Neo PI scale) by the other studies, while the authors of the current study used the Beck's Depression Inventory. It has been suggested that tests like Beck's Depression

Inventory and Zung Self rating depression scale might not be able to detect small differences in non-clinical populations.

Further, the study conducted by Bailey P Hurd et al used scanned copies of hands and digits and the lengths and ratios were calculated using the GNU Image Manipulation Program (GIMP) measure tool.¹¹ The present study used measurements taken by a single investigator using digital vernier calipers. Photocopies yielded lower digit ratio measurements when compared to digital callipers and hence the authors preferred the latter to pick significant differences, if any.^{24,25} The authors might have been unable to detect a highly significant correlation between depression scores and 2D:4D ratios due to a limited amount of variation in 2D:4D in the study population as well as using a state depression assay on a non-clinical population. Further, the role of uncontrolled effects of menstrual cycles and/or hormonal medications have been implicated in concealing the variations in depression scores in females and these factors were not taken into account in the present study.²⁵

Conclusion

Digit ratio, being constant since birth, can be used as a marker in the early identification of children prone to depression. It is a non-invasive measure that can predictably forecast the proneness of a child to depression in the future. Based on the digit ratios, one can plan early life style interventions to avoid or delay the onset of the depression or at the least, facilitate its early diagnosis. The present study revealed borderline significance in difference in 2D:4D ratios between the depressed and non-depressed individuals among the study population. Significant variations could be appreciated if future studies can be planned and conducted on even larger samples and subjects with a clinical diagnosis of depression.

Conflict of Interest: The authors hereby declare that there are no conflicting interests.

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