# Relationship between myopia, axial length of eyeball and digit ratio among medical college students

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## ABSTRACT

**Aim:** The degree of myopia is related to the axial length of the eye. It has been hypothesized that there may be a link between eyeball axial length and cerebral development or that may be influenced by the same genes or factors. The second to fourth finger length ratio (2D:4D) has been hypothesized to be determined by prenatal sex steroids and thus considered a crude measure for prenatal androgen exposure. This study was aimed to explore the possible relationship between myopia, the axial length of the eyeball and the 2D:4D ratio (digit ratio) among medical college students of either sex. **Materials and Methods:** Cross-sectional institution based study with 102 students. The axial length of the eyeball in both eyes was calculated using USG-A scan. Digital X-rays of both hands were taken, and the digit ratios subsequently calculated. The data was analysed using GraphPadInStat 3. **Results:** Prevalence of myopia in the study population was 53.93%. Digit ratio (right, left and mean) of the myopes were higher compared to the non-myopes ($p<0.0001$)and higher in females than males ($p<0.0001$). However, digit ratio was not correlated with either degree of myopia or between axial lengths. **Conclusion:** Digit ratio is not correlated with axial length or degree of myopia.

**Keywords:** Myopia, axial length of eye, digit ratio.

There are a lot of environmental and genetic factors associated with the onset and progression of myopia[1]. It is also linked with enhanced mathematical ability, tendency of high intelligence quotient and left handedness. It has been hypothesized that there may be a link between eyeball axial length and cerebral development or that they may be influenced by the same genes or factors[2]. Prenatal testosterone has an organizing effect on the brain and other organs. Several theories have been put forward to account for the differences in lateralization with the perception that it occurs early in development in response to sex steroid exposure accounting for left handedness and high IQ.An idea of a common factor influencing the brain and ocular growth in-utero is plausible. The presence of sex hormone receptors in the eye encourages the idea of the role of prenatal sex hormones on ocular growth and development[3,4]. Some studies have also related higher serum testosterone levels to increased prevalence and progression of myopia in females[5]. However, it has been observed that any receptor antagonist or hormones applied after birth did not influence the digit ratio[6]. The second to fourth finger length ratio (2D:4D) has been hypothesized to be determined by prenatal sex steroids and thus considered a crude measure for prenatal androgen exposure[7]. Manning et. al. hypothesized that all traits which are sexually dimorphic can be correlated with digit ratio[6]. This study is aimed to explore the possible relationship between myopia, the axial length of the eyeball and the 2D:4D ratio in medical college students.

## Material and Methods:

This cross-sectional study was conducted in a medical college in West Bengal, India. The study was initiated after permitted by the institutional ethics committee with informed written consent of study subjects. Undergraduate students in the age range of 18-25 years of both sexes were invited to participate in the study. A total of 110 students participated in the study out of which, students with any recent or past systemic or ophthalmological comorbidities were excluded. People with a history of injury or illness affecting either of the two hands or fingers were also excluded.

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Table-1: Association of digit ratio with myopia in study population

| | MALE | | p-VALUE | FEMALE | | p-VALUE |
|---|---|---|---|---|---|---|
| | DIOPTRE | 2D:4D | WILCOXON | DIOPTRE | 2D:4D | WILCOXON |
| RIGHT | 2.16 ±1.78 | 0.93±0.02 | p<0.0001 | 2.78±2.05 | 0.93±0.02 | p<0.0001 |
| LEFT | 2.09 ±1.74 | 0.93±0.02 | p<0.0001 | 2.60±2.20 | 0.93±0.02 | p<0.0001 |
| MEAN | 2.13± 1.74 | 0.93±0.02 | p<0.0001 | 2.69 ± 2.1 | 0.93±0.02 | p<0.0001 |

Age and sex wise distribution of the population was assessed from the individual prescriptions and tickets issued from the Institution. The refractive status in undilated eyes was assessed by autorefractometer (Topcon, Japan) by a trained optometrist. Myopia was defined as spherical error of at least -0.5 dioptres. Spherical equivalent was calculated as sphere plus half negative cylinder.

Myopia was graded as high (>6D), moderate (3D-6D) and low (<3D) according to the American Optometric Association (AOA)[8,9]. The axial length of the eyeball in both eyes were calculated using USG-A scan (Appasamy associates,India) by single trained optometrist. Mean of three values obtained from each eye were taken as final axial length for each eyeball. Participants were asked to remove any jewellery, rings or other accessories that could interfere with finger length measurements. Digital X-rays of both hands were taken, each hand in supination with complete extension of each finger. The distances from the bases of the second and fourth proximal phalanxes to the tips of the corresponding distal phalanxes were measured digitally from the X-rays and the digit ratios subsequently calculated. The mean ratio of the left and right digit ratios was subsequently calculated[9,10].

## Results:

There were 110 subjects whose refraction and axial length of eyeball were measured and 105 subjects whose X-rays were taken. All three measurements were available for 102 subjects (male=62, female=40) and these data were used for analysis. The study population consisted of 4 age groups which included 10 students in the age range of 18-19 years (male=6, female=4), 58 students in the range 20-21 years (male=35, female=23), 32 students in between ages 22-23 years(male=19, female=13) and 2 students in the age range of 24-25 years (male=2, female=0). Myopia was classified as Low (<3 D), Moderate (3D-6D) and High (>6 D) according to the American Optometric Association (AOA). A total of 35 students were found in the low myopic group (male=23, female=12), 18 in the moderately myopic group (male=10, female=8) and 2 in the high myopic group (male=1, female=1).The data was analysed using GraphPadInStat 3. There is no age or sex difference in the prevalence of myopia in the study population. Prevalence of myopia in the study population was found to be 53.93% (male=54.84%, female=52.5%).

The mean refractive error of the right eye in males was -2.16±1.78D and -2.78±2.05D in females. In the left eye, the mean refractive error in males was found to be-2.09±1.74D and -2.60±2.2D in females. Digit ratio was 0.926±0.018 in myopic males and 0.914±0.022 in non-myopic males in the right hand and 0.927±0.018 in myopic males and 0.911±0.021in non-myopic males in the left hand. For females, the digit ratio in the right hand was 0.931±0.022 for myopes and 0.930±0.018 for non-myopes and in the left hand, it was 0.934±0.023 for myopes and 0.928±0.021 for non-myopes. Mean digit ratio for male myopes is 0.926±0.016 and 0.913±0.02 for non-myopes and for female myopes, the digit ratio is 0.932±0.021 and 0.929±0.018 for non-myopes. Digit ratio (right, left and mean) of the myopes were higher in value compared to the non-myopes and higher in females than their male counterparts. A two-tailed t test showed a significant difference both in the males and the females (Table-1). Spearman's correlation showed no significant association between digit ratio and myopia/refractive error. Mean axial length of the eye in males was 23.87mm in myopes and 23.50mm in non-myopes. For females, the mean axial length was 24.08mm in myopes and 23.09mm in non-myopes. Wilcoxon's matched pairs signed-rank test showed significant association between mean axial length and digit ratio in both myopes and in non-myopes, in both males and females. Spearman's correlation

Table-2. Association between digit ratio with axial length

| | Male | | Female | |
|---|---|---|---|---|
| | Myope | Non myope | Myope | Non myope |
| **Mean 2D:4D** | 0.93±0.02 | 0.91±0.02 | 0.93±0.02 | 0.93±0.02 |
| **Mean axial length** | 23.87±2.13 | 23.50±0.77 | 24.08±1.23 | 23.08±0.53 |
| **Wilcoxon Matched-pair signed rank test p value** | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| **Correlation coefficient r** | 0.027 | 0.015 | -0.03 | 0.07 |

(r)showed no significant association between digit ratio and axial length of eye in either myopes or in non-myopes (Table-2).

## Discussion:

The study is aimed to explore the possible relationship between myopia, the axial length of the eyeball and the 2D:4D ratio among medical college students. The prevalence rate of myopia was found to be 53.93% which is consistent when compared to the reported prevalence from India (54%)[11]. This percentage is less in comparison to previous studies in Singapore (83%) and Taiwan (92.8%).These findings are however, consistent with findings from Danish and Norwegian medical college students showing 50% and 50.35% prevalence rates respectively[12]. There is no sex difference in the prevalence of myopia in the present study which is consistent with findings of other studies done in medical college students[11,12]. Studies have shown correlation between higher intelligence, education levels and myopia[13-16]. The higher prevalence of myopia in medical students could be attributed to their higher educational levels. The digit ratio (right, left and mean) of the myopes is found to be higher in value compared to the non-myopes and higher in females than their male counterparts which is consistent with other studies[6]. Manning et al. hypothesised that prenatal sex steroids affect the expression of HOX gene responsible for growth of digits and thus digit ratio can be used as a window for in-utero levels of sex steroid exposure[17]. The relative lengths of the second and fourth digits [digit ratio (2D:4D)] is thought to correlate negatively with prenatal testosterone and positively with prenatal estrogen[6]. Studies have shown that computer based measurement of digit ratio is superior to manual measurements[18]. It has also been observed that the digit ratio remains stable in children across periods of rapid growth and receptor antagonists and hormones applied after birth do not influence 2D:4D[7]. Digit ratio is sexually dimorphic with male showing lower ratios compared to females with relative finger length being fixed by the end of week 14 of intrauterine life. Recent studies show that in-utero levels of IGF-1 influence prenatal sexual development and IGF-1 has a stimulating effect on gonadotropin secretion, which in turn increases testosterone secretion from the testis[19,20]. The present study showed no significant difference in digit ratio (right, left, mean) between males and females and the values were lower compared to other studies in Indian population (male 0.96, female 0.97) [20]. Measurements were done by digital X-ray of the hand of each subject in some studies, and this method of measurement was adopted in the present study[21]. The digit ratio (right, left, mean) was significantly higher in myopes when compared to non-myopes among both males and females in the present study. Animal experiments in the study of myopia have shown that one of the possible modulators which trigger retinal, choroidal and sclera growth is IGF-1[22]. The digit ratio (right, left, mean) was also significantly higher in both male and female subjects with greater axial length of eyeballs. Most of the studies have taken measurement of right hand 2D:4D, hence data for comparison with left and mean are not available. Previous studies had measured manually with Vernier calliperor used digital photographs for measurement[11,23]. Due to the ethical considerations of radiation exposures, not many studies have been done using digital X-rays till date. A large population-based study is required to determine the digit ratio of Indian ethnicity for comparison. But, in this study, we have taken only a small and specific population of individuals as subjects. All these factors could account

for the difference in values in the present study with respect to previous studies. The present study showed a lack of correlation between axial length and digit ratio and no significant correlation between myopia and digit ratio. This could be attributed to several possible factors such as the sample size being inadequate or the possibility of some non-linear correlation between the two variables. The presence of statistically significant association between axial length or myopia with digit ratio might even be the result of a sampling bias or even just a chance finding. Further research in this area in a wider population and age group will help ascertain the findings of the present study.

The aim of the study was to determine the relationship between degree of myopia and axial length of eye with the digit ratio of the second and fourth digits in medical college students. Digit ratio can be used to estimate in-utero exposure to sex steroids which might be associated to the axial length of eye and myopia, thus helping in predicting risk of myopia in children and understanding its pathogenesis. This study warrants further research in this area on a wider population and age group. The recent surge in the number of studies on digit ratios, especially in India may open more avenues to be explored in this regard.

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