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SHORT COMMUNICATION

DIGIT RATIO (2D: 4D) AND PERFORMANCE IN INDIAN SWIMMERS

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Abstract : It has been suggested that achievement in sports is correlated with a putative measure of prenatal testosterone the 2nd to 4th digit ratio (2D: 4D). It has been shown that digit ratio (2D: 4D) is negatively associated with prenatal testosterone, and it is also negatively associated with ability in sports. This study examined associations between 2D: 4D and performance of both male and female National level Indian swimmers. Age matched non-sports personnel formed the control. Lengths of second and fourth digits were measured after scanning both hands and their ratio calculated. Our results show lower 2D:4D values in males compared to females ($P<0.05$). Among male, but not female, swimmers had significantly ($P<0.05$) lower 2D: 4D ratio. Low 2D: 4D in male swimmers suggests they are more prenatally programmed via long-lasting extra genital effects of testosterone. 2D: 4D ratio could be used to identify young sports personnel who have potential to reach high levels of performance.

Key words : 2D: 4D ratio prenatal testosterone sports

INTRODUCTION

The ratio of lengths of second to fourth digits (2D: 4D) is a sexually dimorphic trait that is lower in males than in females (1). Sex differences in 2D: 4D ratios develop prenatally and remain relatively stable across the life span of an individual (2). Measure of 2D: 4D ratio as a non invasive retrospective bio marker for prenatal androgen exposure is widely adopted by researchers since there are practical difficulties in measuring testosterone exposure in developing fetus (3). 2D: 4D ratio has been shown to correlate with a wide range of physiological & psychological traits. They include autism (4), attention deficit disorder (5), fertility (6), myocardial infarction (7), visuo-spatial ability (8), homosexuality (9), age at menarche (10), eating disorders (11), depression (12) & athletic performance (13).

A low 2D: 4D ratio is found in athletes compared to the general population. A significant number of studies done in a

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variety of sports have yielded varying results. Low right 2D: 4D and low right – left 2D:4D difference (Δ r –l) are known to be predictors of high performance in rugby players (14). Compared to males with high 2D: 4D ratio, men with low ratio reported higher attainment in a range of sports. Professional football players also had lower 2D: 4D ratio than controls (15). 2D: 4D ratio is also known to vary substantially by ethnicity with more variability in 2D: 4D accounted for by ethnic differences than sex differences. However the magnitude of sex differences in 2D: 4D is similar across ethnic groups (16).

A few studies done previously have found a relationship between 2D: 4D ratios and masculinity in males (17) whereas others have failed to find a significant correlation between 2D: 4D ratio and masculinity traits (18). Though much research has taken place over the last decade in this field controversies still exist regarding the effect of prenatal testosterone on athletic performance. Also the relationship between 2D: 4D ratio and athletic performance in females is a matter of debate till date. Our study was undertaken to find out a possible relation between digit ratio and performance in male & female swimmers. This study also compares ethnic differences between Indian sports personnel & other populations.

MATERIALS AND METHODS

The study was conducted at Basavangudi Aquatic Club, a premier Aquatic centre in Bangalore which trains swimmers for national & international competitions. The study was approved by institutional ethics committee. A written informed consent was obtained from all the participants. 30 male swimmers & 26 female swimmers participated in the study. Swimmers in the age group of 18-25 years who were practicing regularly 30 hours/week for at least 5 years (Average duration of training was 9±1.7 yrs) and have participated in national level swimming competitions formed the study group. Age, weight, height & BMI matched subjects (25 males & 25 females) who did not participate in any sports formed the control group (Table I).

Both the hands of subjects were scanned with a HP scanjet scanner. Participants placed their relaxed hands lightly on the surface of the scanner with second to fifth fingers held parallel and the tip of the middle finger aligned with the wrist and elbow. Scanned hand images were scaled and later printed by a HP laserjet printer. Measurements of second and fourth fingers were taken from printouts with the use of vernier calipers (Quasmo, Range 0–150 mm, Accuracy±0.05 mm). These measurements

TABLE I: Anthropometric parameters of controls and study groups.

Parameters	*Male (control)*	*Female (control)*	*Male (swimmer)*	*Female (swimmer)*
Number of subjects	25	25	30	26
Age (year)	21±2.17	21±2.1	20±2.38	20±1.97
Height (cm)	171±5.30	161±5.11	173±6.09	160±5.25
Weight (kg)	65±6.66	56±5.8	66±7.19	57±6.03
BMI (kg/m^2)	22.07±2.24	21.82±1.73	22.07±2.12	22.2±1.95

Data presented are mean±SD.

were taken from the tip of the finger to the basal crease. Where two creases were visible at the base of the digit the proximal crease was chosen. A single reader conducted all the measurements. The 2D: 4D was calculated as the length of the second digit divided by the length of the fourth digit. (Δ r –l) was calculated as the difference between right and left 2D: 4D.

Statistical analysis

Data obtained in this study was analyzed statistically by using SPSS V.11.0. The results are expressed as mean, standard deviation. The data was analyzed using one-way ANOVA with post hoc Tukey's HSD test. The difference was considered statistically significant whenever P≤0.05.

RESULTS

Our study indicates that the ratio of 2nd to 4th digit is lower in males compared to the females in control group both in right & left hands. Among male swimmers a significant difference was found in 2D: 4D ratios of both the hands with swimmers having a lower ratio compared to their controls. Among females, swimmers had a slightly lower 2D: 4D ratio in both hands than their controls but the values was not statistically significant. 2D: 4D (Δ r –l) was lower in males compared to females. However there was no statistically significant difference between swimmers and controls in both the groups (Table II).

DISCUSSION

Results of the present study confirmed that the second to fourth digit ratio is lower in males compared to females as studied by majority of the researchers. Male swimmers had a significantly reduced 2D: 4D ratio compared to their controls. This is in consistency to other studies that have found significant negative correlations between various sports and digit ratio. Studies done on male rowers showed a significant negative correlation between rowing performance and digit ratio. Similar results were obtained when the relationship between directly measured 2D: 4D and fastest dry slope skiing time was examined in 72 competitive skiers and controls matched for age, sex and ethnicity (19). In this study the low 2D: 4D in men is a correlate for ability in many sports including swimming. This relationship is presumably due to influence of prenatal testosterone on development of right hemisphere and visuospatial ability. Our

TABLE II : Comparison of 2D: 4D ratio of both hands between swimmers and controls.

Parameters	*Male (control) (n=25)*	*Female (control) (n=25)*	*Male (swimmer) (n=30)*	*Female (swimmer) (n=26)*	*P Value*
2D: 4D Right	0.974±0.019	1.015±0.027**	0.957±0.026*	1.006±0.018	0.001
2D: 4D Left	0.979±0.018	1.011±0.042**	0.961±0.024*	0.1±0.022	0.001
2D: 4D (Δ r –l)	–0.004±0.018	0.003±0.035	–0.004±0.027	0.006±0.030	0.433

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and Tukey HSD test. The * depicts comparison with Male control. *P<0.05; **P<0.001.

results are in contrast to a few studies, which have not shown a correlation between digit ratio and masculinity. These studies opine that it may be true that prenatal testosterone levels are important in determining future masculinization, but the 2D: 4D ratio is not a reliable indicator of the testosterone levels (18).

In female swimmers our results show no significant difference in digit ratio compared to their controls. This finding is in accordance to a study conducted in female rowers but differs from studies done on female skiers and fencers. These studies have reported a significant negative correlation between digit ratios and sporting ability in female athletes (19, 22). This difference may be due to varied reasons. The type of sports played may have an effect on the results obtained since different sports require varied physical & mental abilities. Also wide ranges of differences are found in race & ethnicity in expression of digit ratios (16). Previous studies have shown that the educational level and the academic abilities are related to 2D: 4D (20).Women in academia have more masculine 2D:4D values (21) which explains a reduced 2D:4D gender difference in academic populations (20, 21). Assuming that our control sample from a university college environment has a higher mean level of education would possibly result in reduced female 2D: 4D ratios and would thus result in decrease in the difference between female swimmers and controls. A lower right to left 2D: 4D difference is known to be a predictor of high athletic performance in males. In the present study no significant differences are found in 2D: 4D (Δ r –l) between swimmers and controls in both male and female groups. Our study is in contrast to a study done in male rugby players which shows significant differences in 2D: 4D (Δ r –l) between rugby players and controls (14). This indicates that Indian sportsmen may have lesser levels of athletic performance compared to western counterparts though a significant negative correlation exists in digit ratios. This is evident by the higher 2D: 4D values obtained in our study compared to values obtained in other populations.

The physiological basis of relationship between the performance and lower 2D: 4D ratio has not been clearly established. Sporting success in adult life might be partly prenatally programmed via long-lasting extragenital effects of testosterone (22). Complex studies of gene polymorphism in elite athletes are on the verge of identifying specific genetic clusters that may favour either endurance or strength development (23). Additional research is required to identify the links between physical findings, physiology and genetics for better understanding.

Conclusion

The present study indicates that male Indian swimmers have a significantly lower digit ratio whereas female Indian swimmers do not show significant difference in digit ratios. Digit ratio evaluation may be considered as one of the screening tools to select prospective athletes for training & recruitment to sports camps after clearly establishing the relationship between digit ratios and athletic performance in various sports. Further studies need to be done in various other sports to clearly establish the relation between digit ratios and athletic performance in Indian sports personnel.

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