

# Influence of digit ratio (2D:4D) on reaction time and athletic sprint performance: A short term pilot study

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## Abstract

Digit Ratio is the ratio between the lengths of index finger to that of Ring finger. Recent evidence suggests that the relative length of the 2nd to 4th finger (2D: 4D ratio) is a biomarker for prenatal exposure to testosterone. In our study, we investigated the influence of digit ratio on reaction time and performance of athletes in short duration aggressive sport events like 100 meters sprint. This observational study was conducted on 38 healthy athletes, 20 female and 18 male. Athletes practicing since one month are only allowed to participate in our study. The digit length was measured by using Digital Vernier calliper. The reaction time of the participants was calculated by using android mobile app named "Reaction Time". The results showed that the digit ratio of left hand done with Ventral method or by Dorsal method was significantly better than the right hand measurements ( $p < 0.05$ ). The outcome parameter of performance was analysed by Logistic regression and it showed that there is no significant correlation or influence of the factors like gender, digit ratio, and reaction time difference on the performance. The same results were obtained when the male and female performers were analysed separately by Logistic regression on the same parameters like digit ratio and reaction time difference. The "pearsons" correlation between sprint time and digit ratio of left hand, measured by "Dorsal" method showed statistically significant ( $p < 0.05$ ). correlation coefficient ( $R = 0.32$ ). The correlation coefficient ( $R = 0.32$ ) is showing moderate level of correlation between these two factors. The linear regression between digit ratio and sprint shows that there is a positive correlation between these two factors. The overall study shows that there is a moderate correlation between performance (sprint time) and digit ratio.

**Key Words:** Digit Ratio; 2D:4D Ratio; Vernier Caliper; Reaction Time; Testosterone; Athletes.

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## INTRODUCTION

Digit Ratio is the ratio between the lengths of index finger to that of Ring finger. The digit ratio 2D:4D has been established as a biomarker for prenatal exposure to

testosterone<sup>1</sup>. Zheng and Cohn (2011)<sup>2</sup> in their experiment have concluded that "Digit ratio is a life-long signal of prenatal hormonal exposure", i.e. the balance between testosterone and estrogen in a narrow window of early period of ontogeny. The same has been concluded by Von Dongen *et al* (2009)<sup>3</sup> and Lutchmaya *et al* (2004)<sup>4</sup>. Findings have also suggested that the digit growth and gonadal development are both influenced by the Hox genes<sup>5</sup>. There is also some evidence to suggest that the sex steroids produced by the developing gonads exert modulatory effects on the digit growth, the growth of digits of right hand being more sensitive<sup>6</sup>. Therefore, the 2D:4D ratio of right hand is more prominent than that in left hand due to the influence of prenatal exposure to testosterone as confirmed by Zheng and Cohn in their studies on mice<sup>2</sup>. Digit ratio has been negatively

associated with performance in competitive sports such as Soccer, Rugby, Basket ball, Endurance running, Rowing and middle distance running<sup>7</sup>. Therefore this study was undertaken to know if the digit ratio influences performance in short duration aggressive sporting events like in 100 meters sprinting event, which requires visual-spatial awareness, alertness, speed, and strength. Testosterone has been shown to have energetic effects in challenging situations. These testosterone levels have been observed as spikes in response to challenges involving aggression<sup>8</sup>. It has now become clear that improved muscular performance results from such spikes observed. Moreover, Foetal testosterone exposure has also been associated with long term effects on traits associated with physical power-which is a requirement in sporting activities<sup>9</sup>. Most of the studies till date have associated the digit ratio with sporting activities of long durations of 90-120 minutes or even more than that, but we tried to see if sporting activities requiring sudden bursts of muscular activity and an increased aerobic capacity like in 100 meters sprint. One of the most important things an athlete requires, participating in sprinting events, apart from strength is the visual-spatial awareness and alertness. Therefore we considered testing Reaction time of the subjects just 5 minutes before the beginning of event and 5 minutes after the event. Many studies till date have only confirmed the association between the ratio and performance in sporting activities in male-male competition. Therefore in our study we tried to see if such a relationship extends to realm of female athletes or not.

## MATERIALS AND METHODS

This Prospective observational study was conducted on 38 healthy athletes satisfying the below mentioned selection criteria. Amongst 38 total athletes 20 were female and 18 were male athletes.

### Selection Criteria

#### Inclusion Criteria

- Athletes practicing since one month are only allowed to participate (certified by coach).
- And those who are willing to participate in the study.

#### Exclusion Criteria

- Athletes having any history suggestive of addiction like smoking and tobacco chewing as it could affect the results.
- Also Athletes who are on a medication of any kind that can improve skeletal muscle performance.

**Materials used:** Digital Vernier calliper, Wooden Table, Reaction time app installed on android mobile phone, stop watch.

**Method:** Institutional Ethics committee approval was taken before starting the study. It was undertaken as a part of ICMR-STC 2017, study project. A total of 18 male athletes and 20 female athletes were selected amongst the group of athletes those who fulfilled the inclusion and exclusion criteria required for the study. Written informed consent was taken prior to participation in the study. The whole study was carried out at Reshimbagh Ground, Nagpur after taking permissions from the concerned authorities. Data collection work was carried in the month of August and September over a period of 30 days. The digit length from the metacarpophalangeal crease to the tip of the fingers was measured by using digital Vernier calliper. The participant was asked to place his finger flat on glass piece and the length was measured from the other transparent side. This we designated as the "VENTRAL" (Standard) method as this was followed in most of the researches previously. We also measured the length from the dorsal surface of hand. The participant was asked to lay his hand flat on a wooden table platform and then the length was measured from the base of knuckles to the tip of finger. The intention was to include the complete lengths of phalanges itself and from the metacarpophalangeal joint clearly presenting as knuckles on the dorsum of the hand. We thought that this method is more anatomically correct and designated it as "DORSAL" Method. Readings taken by both the methods were tabulated and used for analysis. The reaction time of the participants was calculated by using android mobile app named "Reaction Time". The participants were first taught how the app works, and then allowed to practice it for 1 minute. Two sets of readings were taken, in each set 5 readings were taken and their average was treated as final reaction time reading. First set of reading was taken at the time of taking digit ratios and these readings were treated as casual reaction time. After the warm-up the sprint time and the reaction times before and after the event of 3 candidates at a time were noted down. The first set of reaction time designated as reaction time 1 (RT 1) were taken on announcement of the event at the starting line to see whether the excitement generated by the announcement of the event set in motion the underlying physiological change had any effect on the reaction time. Then the candidates were made to sprint 100 meters at the sound of whistle and their sprint time in seconds noted down. Then after a cool down period of 5 minutes again another set of reaction time measurements were taken to see any residual effects of the physiological change. The data was compiled in excel sheets first and then analysed further using 'Medcalc' (free trial version) software.

## OBSERVATION AND RESULTS

**Table 1:** Digit Ratio in Both Genders by different hands

	DR RH VENTRAL		DR RH DORSAL		DR LH VENTRAL		DR LH DORSAL	
	M	F	M	F	M	F	M	F
Mean	0.96	0.984	0.9156	0.9265	0.9594	0.9895	0.9061	0.941
Standard deviation	0.03835	0.03899	0.02357	0.03048	0.0378	0.04186	0.02852	0.02954
p-value							**	**

DR RH VENTRAL - Digit Ratio Right Hand by VENTRAL (Standard) Method; DR RH DORSAL - Digit Ratio Right Hand by DORSAL Method; DR LH VENTRAL - Digit Ratio Left Hand by VENTRAL (Standard) Method; DR LH DORSAL - Digit Ratio Left Hand by DORSAL Method; \*\* - Significant p-value.

**Table 2:** Comparative Measurement showing Digit Ratio in both genders by different methods

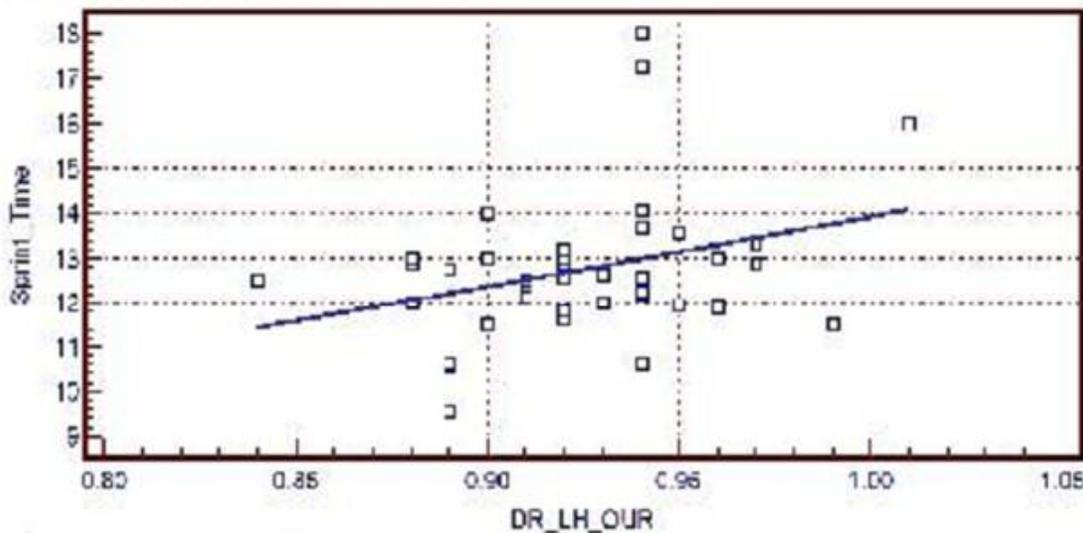
	DR RH		DR RH		DR LH		DR LH	
	MV	MD	FV	FD	MV	MD	FV	FD
Mean	0.96	0.9156	0.984	0.9265	0.9594	0.9061	0.9895	0.941
Standard deviation	0.03835	0.02357	0.03899	0.03048	0.0378	0.02852	0.04186	0.02954
p-value	**	**	**	**				

DR RH - Digit Ratio Right Hand; DR LH - Digit Ratio Left Hand; V - VENTRAL (Standard) Method; D - DORSAL Method; M- male; F - female; \*\* - Significant p-value.

**Table 3:** Showing drop in Reaction Time just before sprint event

	Casual RT		RT 1		RT difference	
	M	F	M	F	M	F
Mean	312.6	309.4	279	290.2	33.52	19.75
Standard deviation	37.85	32.44	17.9	26.69	31.12	29.14
p-value			*	*		

RT - Reaction Time; M- male; F - female; \* - Significant p-value.



**Figure 1:** Graph showing the Correlation between Digit ratio (Male and female together) and Sprint time in seconds

## DISCUSSION

Table number 1 shows that the age distribution of both genders is comparable. The digit ratio of left hand done with Ventral method (measurements done on the anterior aspect of the palm) or by Dorsal method (measurements done on the posterior aspect of the palm) is significantly better than the right hand measurements (p-value less than 0.05). This shows that the left hand measurement by

any method is more precise for the purpose of calculation of digit ratio. Table Number 2 shows that the measurements done by “Dorsal” method done on the posterior aspect of the hand is significantly different in both genders in both the hands. This indicates that “Dorsal” method is more discriminatory between male and female genders. It has been shown in the earlier Tables 1 and 2 that digit ratio of left hand by “Dorsal”

method is more discriminatory between male and female. Hence, here after we take digit ratio of left hand by “Dorsal” method is taken for all for the calculations and analysis. Table Number 3 shows that the drop in the reaction time, between the casual and the Reaction time 1, is significant in both genders. This indicates that various physiological factors play a significant role to enhance the individual’s reactivity before the actual event of sprint. For the sake of analysis we divided the sprint time measurements in both genders into two categories the top 50% performers and below 50% performers. The top 50% performers were labelled as “performers” and the rest were “non- performers”. The outcome variables as performer and non performer were then analysed for the various influencing factors like gender, digit ratio and a reaction time difference. For this analysis we have used digit ratio of left hand taken on the posterior aspect by “Dorsal” method. (Reaction time difference was calculated from casual reaction time - the reaction time 1, which is just before the event of sprint.) The outcome parameter of performance was analysed by Logistic regression and it showed that there is no significant correlation or influence of the factors like gender, digit ratio, and reaction time difference on the performance. The same results were obtained when the male and female performers were analysed separately by Logistic regression on the same parameters like digit ratio and reaction time difference. We repeated the similar Logistic regression analysis on winner vs. loser. Here the winners were top 3 among the males and females respectively. The rest of the population regarded as loser. Here also the statistical analysis yielded no significant correlation or influence of the factors like gender, digit ratio and reaction time difference on performance as winners and losers. But when the entire population of both genders were analysed for “pearsons” correlation between sprint time and digit ratio of left hand, measured by “Dorsal” method, there was a correlation coefficient (R) - equal to 0.32 which was statistically significant ( p less than 0.05 ). The correlation coefficient (R = 0.32) is showing moderate level of correlation between these two factors. The linear regression between these two factors of digit ratio and sprint time is depicted in the graph number 1, which shows that there is a positive correlation between these two factors.

**Earlier studies on digit ratio and gender difference in sport performance:** Honekopp *et al* (2006)<sup>7</sup> found that a composite measure of physical fitness was negatively related to right hand 2D:4D in men and left hand 2D:4D in women, the study also suggests negative association between 2D:4D and performance in soccer, running and skiing. Our study have shown negative correlation with athlete performance. Paul *et al* (2006)<sup>10</sup> in their study also

suggests that low 2D:4D ratio is related to increased female sports ability. Manning *et al* (2014)<sup>1</sup> suggests 2D:4D correlate with T spikes produced under challenge and it may also be linked to response to such spikes. In consequence, low 2D:4D may be a predictor of high performance in sports and high aggression when provoked. Study done by Longman and co-workers (2011)<sup>9</sup> indicate that digit ratio is a predictor of ability in rowing, a sport which requires both cardiovascular efficiency and high power output, in males but not females. This in turn suggests that foetal testosterone exposure has long-term effects on traits associated with physical power in males but not females, suggesting a sex-difference in the capacity to respond to such exposures. Most of the above studies are in accordance with our findings. The implication of the study suggest that the digit ratio would not be a good indicator of prediction of performer versus non performer but there is a moderate level correlation between digit ratio and sprint time, that means the digit ratio can predict the high potential athletes among the group. When reaction time difference was correlated with sprint time in both genders there wasn't any significant correlation between them.

## CONCLUSION

The overall study shows that there is a moderate correlation between performance (sprint time) and digit ratio. The digit ratio could be utilised for screening the population for their predictable higher better performance among a large population of potential athletes. The digit ratio could also be one of the parameters for choosing athletics (sprint running) as a professional sport. Also the study shows that the left hand measurements and that too on the posterior aspect measurements of the digit lengths and thereby the digit ratios derived from them are better and more discriminatory amongst both the genders. The drop in the reaction time is not significantly correlated with the performance of sprinting.

## SUMMARY

This study was designed as a Pilot Study to see that whether the digit ratio is negatively correlated to the athletic sprint performance? And whether such a relationship existed in female athletes too? This study gives us the result in context to Indian athletes. After a month long study on 38 healthy athletes we conclude that- digit ratio is negatively correlated to the athletic sprint performance, when the whole population is considered together, and the correlation is ‘Moderate correlation’ (r=0.32 ). It is finally concluded that – the method devised by us, called “DORSAL” method was more discriminatory and the digit ratio of Left hand showed more significant correlation than the Right hand

with the athletic sprint performance in all the athletes. The digit ratio could also be one of the parameters for choosing as athletics (sprint running) as a professional sport. There was no correlation found between the digit ratio and the reaction time.

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