 DOI: 10.18231/2394-2126.2017.0113

Right-Hand Digit Ratio (2D:4D) and Handgrip Strength: A correlation study from a university in North India

Prajna Paramita Samanta[1], Bijli Nanda[2,*]

[1]Associate Professor, Dept. of Anatomy, [2]Associate Professor, Dept. of Physiology, School of Medical Sciences & Research, Sharda University, Greater Noida

***Corresponding Author:**
Email: nbijli@yahoo.co.in

Abstract

Introduction: The digit ratio between the index and the ring finger of the right hand (2D:4D) shows sexual dimorphism and has been proposed as an indirect measure of prenatal androgen exposure. It has been implicated in many gender differences including performance in sports. However, reports in males and females are conflicting. Handgrip strength is a good overall measure of muscle strength and function. Hence, our aim was to study the 2D:4D in males and females and to look for any correlation between 2D:4D and handgrip strength**.**

Materials and Method: Scanned images of the right hand of young volunteers were analysed and the 2D:4D ratio was calculated. Handgrip strength was measured and results were correlated with 2D:4D.

Result and conclusion: 2D: 4 D ratio of males was significantly less than in females($p<0.001$)**.** 2D:4D ratio in males positively correlated with handgrip strength ($p<0.05$) but not in females.

Keywords: 2D:4D ratio, sexual dimorphism, Hand grip strength

Received: 2nd June, 2017 **Accepted:** 10th July, 2017

Introduction

The digit ratio is the ratio of the lengths of different digits. The length of a digit is measured from the midpoint of the proximal crease to the tip of the digit.(1) 2D:4D ratio is the ratio between the lengths of the second and fourth digits and it exhibits a sexually dimorphic pattern. Males have a ratio of less than 1 whereas females show a higher ratio.(1,2) 2D:4D ratio correlates positively with the FT/FE (fetal testosterone/fetal estradiol) ratio in amniotic fluid.(3) Hence, it has been proposed as an indirect proxy to prenatal androgen exposure. There seems to be no correlation of adult circulating testosterone levels with 2D:4D ratio.(4)

2D:4D ratio has been implicated in many gender differences e.g. low ratios have been associated with high sports performance.(5) 2D:4D ratios in volleyball players have been reported to be significantly lower compared to individuals not participating in sports.(6) Low 2D:4D has been linked to high sprinting speed, endurance and hand grip strength in school going boys. This correlation however was not found for girls.(5) 2D:4D ratio also showed not to forecast wrestling success.(7)

Handgrip strength (HGS) is a good overall measure of muscle strength and function status.(8,9) Adult males of Hani ethnicity have shown a significantly higher handgrip strength than females for both hands.(10) Various anthropometric measures of the hand have been tested in relation to HGS. Finger lengths, hand length,(11) and hand perimeter are important. A significantly negative association was found between 2D:4D and handgrip strength in Caucasian and Mizo males(12) but other studies, found no significant correlation in males or females irrespective of ethnicity.(13) Digit ratios have not shown a correlation with grip strength in women(14) or to other components of fitness like static strength and endurance in adolescent girls.(15) More research is needed to establish the relation between 2D:4D ratio in both sexes with handgrip strength.

Materials and Method

The study was carried out in a university in North India on 158 right handed healthy undergraduate student volunteers (19-25yrs). Participants were recruited for the study after putting up a notice for voluntary participation. Written informed consent was obtained from the volunteers. Any individual with hand deformity was excluded from the study. Those who had a history of hypertension, heart disease or were unable to perform the handgrip exercise for other reasons were also excluded from the study. Anthropometric measurements like height and weight were noted. In addition, the following specific measurements were carried out.

2D:4D ratio: All participants were asked to place both their hands, fingers together, on the surface of a scanner (Canon MP258). Scanned images were saved as pdf documents. The lengths of the second (2D) and fourth digits (4D) of the right hands were measured from the tip of the finger to the ventral proximal crease using the measurement tool in adobe. In case, there was a band of creases at the base of the digit, measurements were

done from the most proximal of these. The measurements were done twice and the average was calculated.[16] The 2D:4D ratio was computed.

The handgrip test: The handgrip test was performed with the subjects seated on a chair, shoulders abducted, elbow fixed at 90◦, forearm in neutral and wrist between 0◦ and 30◦ of dorsiflexion as recommended by American Society of hand therapists (ASHT). Each subject was tested for handgrip strength for right hand using Camry's digital handgrip dynamometer. Two measurements from each subject were noted. Handgrip strength was recorded as maximum kilograms of force during the procedure.[17] The higher of the two readings was used for further analysis of each hand.

Statistical analysis: Statistical analysis was done using analysis toolpak in MS excel. The difference (2D-4D) was separately calculated for males and females. Descriptive statistics was done to determine mean +/- SE values for 2D length,4D length, 2D-4D, and 2D:4D ratio Unpaired t-test was done to look for any significant gender differences in 2D:4D ratio, 2D-4D values as well as hand grip strength(HGS) for the right hand. Correlation between HGS of the right hand and 2D:4D ratios were examined separately for males and females using the "correl" function in Excel and significance checked at "vassarstats.com".

Results

The present study depicts data from 71 young males and 87 females enrolled in the university. Mean age of participants was 20 yrs. Mean height of males ($1.71m^2$+/-0. 017S.E) was significantly greater than of females ($1.59m^2$+/-0.014SE); $p<0.001$. Mean weight of males (72.56kg+/-1.97) was significantly greater than for females (61.78kg +/-1.53SE); $p<0.001$. Mean BMI of males was 25.76+/- 1.71SE and females was 25.61 - 1.94SE. However, there was no significant difference between the BMI of males and females.

Right 2D:4D ratio was negatively correlated with height and weight in females but these were not significant. In males, height was positively correlated with 2D:4D ratio, but this too was not significant. However, weight was negatively correlated with 2D:4D ratio in males though this was not significant. Right 2D:4D ratio was positively correlated with BMI but the correlation was not significant.

The mean right hand 2D:4D ratio in males (0.96+/-0.004 SE) was significantly less than in females (0.98 +/-0.003 SE) ($p<0.01$) (Fig. 1). In addition, the mean length of the index finger of the right hand in females (2.67+/-0.02) was significantly less than in males (2.90+/-0.02); ($p<0.001$). There was also a significant difference in the lengths of the ring fingers of males (2.88+/-0.02) and females (2.68+/-0.02SE) ($p<0.001$). The difference in the lengths of the index and ring fingers (2D-4D) was significantly lesser in females (0.06+/-0.01SE) compared to males (0.13+/-0.01SE), $p<0.001$.

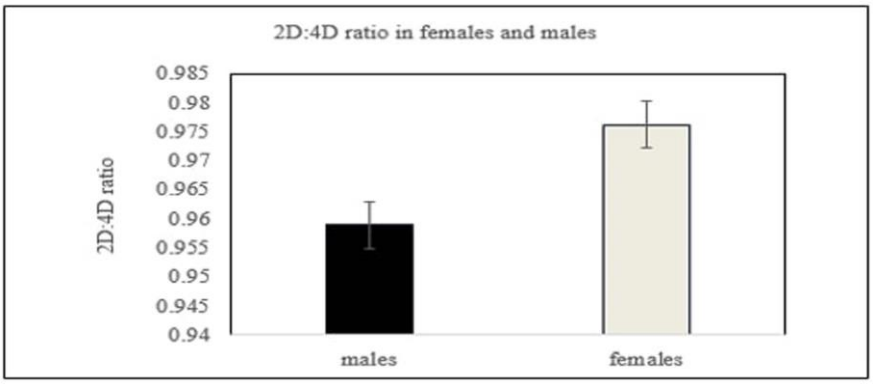

Fig 1: Comparison of 2D:4D ratio of Males vs females

Hand grip strength in males (40.59 +/-0.84SE) was found to be significantly greater than females (25.33Kg +/-0.48SE); $p<0.001$ (Fig. 2).

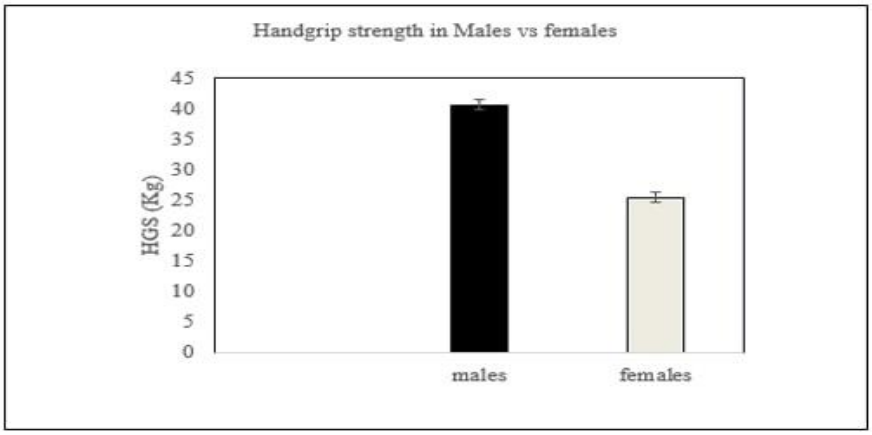

Fig. 2: Comparison of Handgrip strength of Males vs females

2D: 4D ratio showed a weak but significant negative correlation in males (r=0.27) with HGS; p<0.05 (Fig. 3). A negative correlation was also found between 2D:4D ratio and HGS in females but it was not significant.

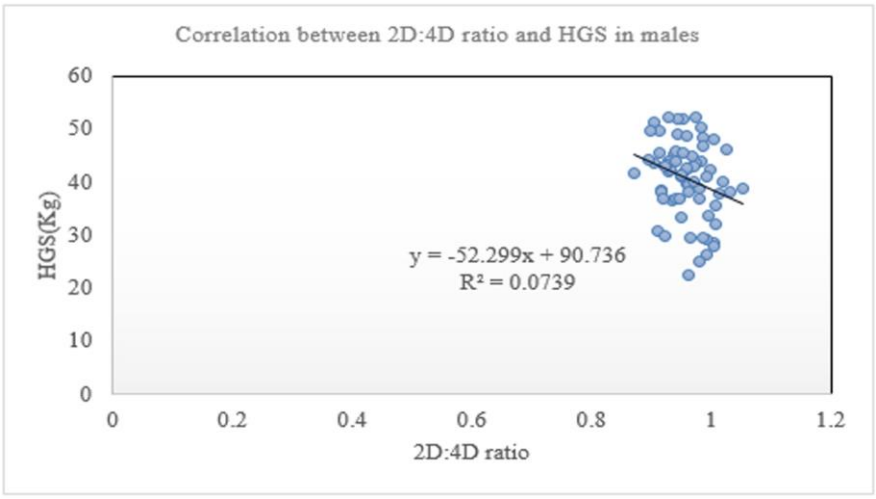

Fig. 3: Correlation of 2D:4D ratio and Hand grip strength of right hand in males

Discussion

2D:4D measurements from photocopies of the hand correlate strongly with measurements from X-rays.[18] In our study we used scanned images along with a computer based measurement tool (adobe measurement tool).

We found sexual dimorphism in the 2D:4D ratio in the study population with females showing a greater ratio compared to males. Our findings confirmed reports by earlier studies.[19]

Studies have shown a positive correlation for 2D:4D to stature, BMI and waist circumference in girls, but the same correlation was not found for boys. Low prenatal testosterone and high prenatal oestrogen levels have been associated with large body size in girls.[5] In our study we found a significant difference in height and weight between males and females, but no significant difference was found for BMI. Moreover, we did not find any significant correlations between any of the anthropometric variable tested, with the 2D: 4D ratios of the right hand in either males or females.

Body height was found to have a high predictive value for hand grip strength in prepubertal boys, followed by girls.[20] Handgrip strength showed a significant association with various anthropometric variables (BMI, height, weight and gender) in Italian children of age 9-10 years.[21] We found no significant correlation of HGS with height, weight or BMI. It is possible that our results differed because we tested in the adult population.

High prenatal testosterone and low prenatal oestrogen is implicated in hand grip strength in boys. In our study we found a higher grip strength in males compared to females. Similar to studies in Caucasian and Mizo males,[12] HGS was significantly negatively correlated with 2D:4D ratio in males. However, our results did not agree with other studies controlling for ethnicity.[13] It appears that such results may be specific for certain populations and may not be generalized to

the whole male population. Our results were similar to many other studies on females.[5,15] We found no correlation of 2D:4D with HGS in females. 2D:4D has been reported to differentiate between basketball players competing at different standards but could not differentiate between players within the same competitive standard.[22] Our study shows that 2D:4D cannot differentiate between different handgrip strengths amongst females but is sensitive enough to be able to differentiate handgrip strengths of males from females. It can also differentiate between different strengths in males. Sexual dimorphism in strength has been linked to the evolutionary selection pressure associated with competition among males.[23] Our results seem to further complement this theory.

Conclusion

2D: 4D ratio of the right hand of males was significantly less than in females ($p<0.001$). 2D:4D ratio positively correlated with handgrip strength in males ($p<0.05$) but not in females.

References

1. Manning JT, Scutt D, Wilson J, Lewis-Jones DI. The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. Hum Reprod. 1998;13(11):3000-3004. doi:10.1093/humrep/13.11.3000.
2. Williams TJ, Pepitone ME, Christensen SE, et al. Finger-length ratios and human sexual orientation. Nature. 2000;404:455-456.
3. Lutchmaya S, Baron-Cohen S, Raggatt P, Knickmeyer R, Manning JT. 2nd to 4th digit ratios, fetal testosterone and estradiol. Early Hum Dev. 2004;77(1-2):23-28.doi:10.1016/j.earlhumdev.2003.12.002.
4. Beaton AA, Rudling N, Kissling C, Taurines R, Thome J. Digit ratio (2D:4D), salivary testosterone, and handedness. Laterality. 2011;16(2):136-155. doi:10.1080/13576500903410369.
5. Ranson R, Stratton G, Taylor SR. Digit ratio (2D:4D) and physical fitness (Eurofit test battery) in school children. Early Hum Dev. 2015;91(5):327-331. doi:10.1016/j.earlhumdev.2015.03.005.
6. Panda K, Majumdar P, Umesh V, Sudhakar HH. Ratio of second to fourth digit as a predictor of performance in elite Indian volley ball players. Natl J Physiol Pharm Pharmacol. 2014;4(2):106-108. doi:10.5455/njppp.2014.4.011020132.
7. de laCruz-Sánchez E, García-Pallarés J, Torres-Bonete MD L-GJ. Can Our Fingers Alone Raise Us Up to the Sky? Analysis of the Digit Ratio Association with Success in Olympic Wrestling. Coll Antropol. (2015);39(3):515-9.
8. Wind AE, Takken T, Helders PJM, Engelbert RHH. Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? Eur J Pediatr. 2010;169:281-287. doi:10.1007/s00431-009-1010-4.
9. Norman K, Stobäus N, Gonzalez MC, Schulzke J-D, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. Clin Nutr. 2011;30(2):135-142. doi:10.1016/j.clnu.2010.09.010.
10. Zhao D, Yu K, Zhang X, Zheng L. Digit Ratio (2D:4D) and Handgrip Strength in Hani Ethnicity. PLoS One. 2013;8(10):e77958. doi:10.1371/journal.pone.0077958.
11. Häger-Ross C, Schieber MH. Quantifying the independence of human finger movements: comparisons of digits, hands, and movement frequencies. J Neurosci. 2000;20(22):8542-8550. doi:20/22/8542 [pii]\par.
12. Fink B, Thanzami V, Seydel H, Manning JT. Digit ratio and hand-grip strength in German and Mizos men: Cross-cultural evidence for an organizing effect of prenatal testosterone on strength. Am J Hum Biol. 2006;18(6):776-782. doi:10.1002/ajhb.20549.
13. Gallup AC, O'Brien DT, White DD, Wilson DS. Handgrip strength and socially dominant behavior in male adolescents. Evol Psychol. 2010;8(2):229-243.
14. van Anders SM. Grip strength and digit ratios are not correlated in women. Am J Hum Biol. 2007;19(3):437-439. doi:10.1002/ajhb.20634.
15. Peeters MW, Van Aken K, Claessens AL. The Left Hand Second to Fourth Digit Ratio (2D:4D) Is Not Related to Any Physical Fitness Component in Adolescent Girls. PLoS ONE.2013;8(4):1-7. doi:10.1371/ journal.pone.0059766.
16. Al-Zaid FS, Alhader AA., AL-Ayadhi LY. The second to fourth digit ratio (2D:4D) in Saudi boys with autism: A potential screening tool. Early Hum Dev. 2015;91(7):413-415. doi:10.1016/ j.earlhumdev. 2015.04.007.
17. Mohan V, Shafiqah N, Shamsaimon B, et al. Fore Arm Circumference and Hand Length Predicts Maximal Hand Grip Strength among Malaysian Population. Middle-East J Sci Res. 2014;21(4):634-639. doi:10.5829/idosi.mejsr.2014.21.04.83171.
18. Manning JT, Trivers RL, Thornhill R, Singh D. The 2nd:4th digit ratio and asymmetry of hand performance in Jamaican children. Laterality. 2000;5(2):121-132. doi:PWB804VV0D7MEMNH [pii].
19. Phelps VR. Relative index finger length as a sex-influenced trait in man. Am J Hum Genet. 1952;4(2):72-89.
20. Jürimäe T, Hurbo T, Jürimäe J. Relationship of handgrip strength with anthropometric and body composition variables in prepubertal children. HOMO- J Comp Hum Biol. 2009;60(3):225-238. doi:10.1016/j.jchb.2008.05.004.
21. Montalcini T, Ferro Y, Salvati MA, Romeo S, Miniero R, Pujia A. Gender difference in handgrip strength of Italian children aged 9 to 10 years. Ital J Pediatr. 2016;42(1):16. doi:10.1186/s13052-016-0226-y.
22. Frick NA, Hull MJ, Manning JT TG. Relationships between digit ratio (2D:4D) and basketball performance in Australian men. Am J Hum Biol.2017;29(3). doi:10.1002/ajhb.22937. Epub 2016 Nov 6.
23. Ribeiro E, Neave N, Morais RN, et al. Digit ratio (2D:4D), testosterone, cortisol, aggression, personality and hand-grip strength: Evidence for prenatal effects on strength. Early Hum Dev. 2016;100:21-25. doi:10.1016/j.earlhumdev.2016.04.003.