The right hand second to fourth digit ratio (2D:4D) and its relationship with body composition indicators among young population

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Objective: Study examined 2D:4D among young adults with an attempt to explore its relation to body composition indicators and somatotyping in Indian population. Methods: 317 participants (190 women; 19-40 years), were examined for digit lengths, height, weight, skinfold thicknesses at various regions, and circumferences of chest, waist, hip, thigh and calf. Body somatotyping were calculated from measurements. Body composition indicators were compared among gender and whole study group between participants with 2D:4D<1 and 2D:4D>1. Results: Height, weight, arm circumference and BMI were significantly higher among women with 2D:4D<1 as compared to 2D:4D>1; further mesomorphy enhanced with lowered 2D:4D. 3D scatter plot for percent body fat, waist-hip ratio and 2D:4D showed increased body fat with increase in 2D:4D among men. Positive relation emerged between waist-hip ratio and 2D:4D, revealing significant fat deposition at the waist-hip region among women. Conclusion: Although gender is differentiated based on anthropometric characteristics and 2D:4D, digit ratio may have a modest role in understanding the body composition indicators in terms of association between lower 2D:4D with male type pattern of anthropometric indicators even among young Indian women.

Key words: Endomorphy, Mesomorphy, Ectomorphy, India, Gender difference
MATERIALS AND METHODS

Sample
Study sample comprised of 317 participants (127 men and 190 women), between the ages of 19-40 years (men = 21.9 ± 2.9 years; women = 21.7 ± 2.7 years). Study participants were recruited with word-of-mouth advertisement and visiting students to the Institute. The enrolled study participants were undergraduate/graduate course students of various universities from the state of Gujarat, India. Well detailed, written informed consent was sought from all the study participants before enrolling them to the study.

Measurements
All the participants were initially interviewed in detail to collect socio-demographic details. Further the details of self-informed age and lifestyle habits (dietary, smoking, tobacco, alcohol, and exercise) were recorded in the study specific pro forma. All the anthropometric measurements were recorded with bare body and shorts for the men folks by a trained male researcher. Recording for the women participants were done by a trained female researcher. All the length related measurements were performed for 3 times and the average of three values was considered as the respective measurement. The height was measured on a portable stadiometer with VR high speed counter (Holtain Ltd., Crosswell, Crymych, UK) with sensitivity of 1 mm. Weight was measured on a digital weighing scale with sensitivity of 0.1 kg. Bi-epicondylar breadths of humerus and femur were measured with a bone caliper (UNA & Co., India) according to standard protocol. The circumferences of chest, waist, hip, thigh and calf were measured with a non-elastic measuring tape. The skinfold thickness of chest, waist, hip, thigh and calf were measured with a non-elastic measuring tape. The skinfold measurements (biceps, triceps, subscapular, suprailiac, supraspinale and medial calf) were measured as per standard protocol with a skinfold caliper (Holtain Ltd., Crosswell, Crymych, UK). For the purpose of 2D and 4D length measurement, the right hand impression was traced on a portable stadiometer with VR high speed counter. The line joining the inter-digital web-spaces of second (index) finger to the midpoint of tip-line of index finger. Similarly, the 4D length was measured for the ring finger.

Calculated variables from anthropometric measurements
The three components of somatotype - endomorphy, mesomorphy and ectomorphy were calculated according to Heath-Carter technique. The following anthropometric parameters: weight; height; triceps, subscapular, supraspinale and calf skinfolds; humerus and femur breadths; and biceps and calf circumferences were used for determining the somatotypes. The somatotype calculation and analysis was performed on trial version of software from Sweat Technologies. Various ratios and parameters were calculated according to the standard formulae as mentioned in the Table 1.

Statistical analysis
Difference in the observed anthropometric parameters as well as calculated variables from anthropometric parameters between men and women participants was analyzed using two tailed independent sample t test. Anthropometric parameters and calculated variables among men and women participants with respect to 2D:4D (more than 1 and less than one) was also observed with two tailed test. Distribution of 2D:4D with somatotypes and percent body fat among men and women participants were observed using scatter plots. The statistical significance level of p<0.05 was considered significant. The scatter plots were drawn with fitted lines for estimated means with marginal box plots between body composition indicators and 2D:4D. The Statistical Package for the Social Sciences (SPSS) for Windows Version 16.0 (Chicago, IL, USA) was used for statistical analysis.

RESULTS
The descriptive statistics of the observed anthropometric parameters and calculated variables are presented in Table 2. There was no gender difference for age \((t(315)=0.539, p=0.591)\); hip circumference \((t(315)=-0.895, p=0.371)\); thigh circumference \((t(315)=-0.895, p=0.991)\); BMI \((t(276)=0.036, p=0.971)\) (Table 2).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Measurements used</th>
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<tbody>
<tr>
<td>Body density (BD)</td>
<td>[1.1599 - [0.0717 \times \log(Bicep+Tricep+Subscapilar+Supra-iliac)]/(495/BD - 450)]</td>
<td>Biceps, triceps, sub-scapular, suprailiac skinfolds (mm) Body mass index (BMI)</td>
</tr>
<tr>
<td>Percent body fat (%BF)</td>
<td>[=495/(BD) - 450]</td>
<td>Body density</td>
</tr>
<tr>
<td>Waist-Hip ratio (WHR)</td>
<td>[=Waist circumference/Hiip circumference]</td>
<td>Waist circumference (cm) &amp; hip circumference (cm)</td>
</tr>
<tr>
<td>Waist-Height ratio (WHR)</td>
<td>[=Waist circumference/Height]</td>
<td>Waist circumference (cm) and height (cm)</td>
</tr>
<tr>
<td>Body surface area (BSA)</td>
<td>[=(Height)^{5.725} \times {(Weight)^{0.425} \times 0.007184}]</td>
<td>Height (m), weight (Kg)</td>
</tr>
<tr>
<td>Body adiposity index (BAI)</td>
<td>[=([Hip circumference]/([Height^{1.5}] - 18))]</td>
<td>Hip circumference (cm), height (m)</td>
</tr>
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</table>
Table 3 and Table 4 report the body composition indicators among men and women, respectively with 2D:4D more than one and less than one. Height was significantly higher among men with 2D:4D less than one as compared to 2D:4D more than one (p=0.047) as tabulated in Table 2. In case of women, height, weight, arm circumference and BMI were significantly higher with 2D:4D less than one as compared to the rest (Table 3).

On observing the graphical scatter plot of 2D:4D with somatotype values (endomorphy, mesomorphy, and ectomorphy), it is revealed that mesomorphy (muscular robustness) enhanced with lowered 2D:4D (Figure 1b), whereas endomorphic and ectomorphic characteristics remained unvarying among the men (Figure 1a,c). Among women, all the three somatotype characteristics were not following any pattern with the 2D:4D (Figure 1a-c).

Percent body fat was found to be inversely related with 2D:4D among men, whereas relative fatness was found increasing, among women with increase in their 2D:4D (Figure 1d).
Further, comprehensive three-dimensional scatter plot in terms of percent body fat, waist-hip ratio and 2D:4D (Figure 2) showed that the body fat increased with increase in 2D:4D among men, irrespective of any particular body site. However, women demonstrated increase in waist-hip ratio with increase in 2D:4D, revealing significant fat deposition at the waist-hip region.

**DISCUSSION**

To our knowledge, this is the first study to explore inter as well as intra-gender differences in 2D:4D and its relationship with body composition indicators among young Indian population. Study examined the second and fourth finger length ratio among young adults with an attempt to explore
its relation to various body composition indicators and body somatotyping. Study reiterated the findings of differential anthropometric body composition indicators and 2D:4D between men and women. Present work revealed that body composition indicators did not differ between 2D:4D less than or more than one among both men and women. Further, the study reports that women demonstrated endomorphic characteristics (relative fatness) as well as diminished musculoskeletal robustness with increase in 2D:4D.

The results of the present study suggest that 2D:4D and anthropometric body composition indicators are significantly different between men and women. As far as morphological characteristics are concerned, men had higher mesomorphy component, followed by ectomorphy and endomorphy, thus structural features towards dominant mesomorphy can be considered as male type features. Among women, endomorphy component was dominant followed by mesomorphy and later ectomorphy. In the present study, percent body fat in women was significantly higher than that of men which is in concordance with other related studies. The 2D:4D, a determinant of sexual dimorphism, was significantly different between men and women with lower ratio more linked with men and higher ratio with women. However, ectomorphic characteristics remained uniform with the range of 2D:4D. Current study observed that musculoskeletal robustness (mesomorphy score) among majority of men was within the range of 2-5. Also with increase in 2D:4D, the relative fatness showed an increasing trend.

Among women in the study population, with decrease in 2D:4D, musculoskeletal robustness as well as relative fatness were found increasing, which may be attributed to increased tendency of peripheral fat accumulation. Interestingly, decrease in 2D:4D was found related with increased percent body fat among women, further supporting the above statement. Among men, with increase in 2D:4D, percent body fat was increasing till 20% and further remained stable with the range of 2D:4D (Figure 1). This implies that there is no strong association between 2D:4D and anthropometric body composition indicators among men. Previous studies observed limited/no association between 2D:4D and any anthropometric measure among women. However, present study indicated some trend observations with lower 2D:4D ratio’s association with the male type pattern of anthropometric indicators. This result may be possibly due to difference in ethnicity, which needs to be further explored among different population with larger sample size.

We tried to investigate the hypothesized difference in body composition indicators with 2D:4D more or less than one among each groups. However, only the percent body fat was found lower in men with 2D:4D less than one, although no significant difference in men with 2D:4D more than one was observed. In case of women, height, weight, arm circumference and BMI were statistically different, although inter-gender difference in BMI did not exist. Fink et al. also reported positive relation of BMI with digit ratio among females. The results corroborate with a longitudinal study on larger population, wherein the investigators concluded that 2D:4D is not strongly associated with adult anthropometric measures, including those of adiposity. The three-dimensional plot with percent body fat, waist-hip ratio and 2D:4D ratios elucidates that men are more lateralized toward having higher percent body fat (Figure 2). In case of women however, they are more susceptible to increase in waist-hip ratio, which is moderately inverse to the results of the study by Fink et al.

Although both genders are differentiated on the basis of anthropometric characteristics and 2D:4D, the present study lead to the understanding that digit ratio may have a modest role in understanding the body composition indicators in terms of association between lower 2D:4D with male type pattern of anthropometric indicators even among young women.

Limitation of the study was use of tracing method for the 2D and 4D length measurements, which may not
accurately measure lengths of 2D and 4D, however it is one of the methods of finger length measurement. As it is the ratio measurement, inaccuracies in the finger length may not have influenced the study results. Strength of the study was understanding the body composition indicators and body typing in relation to 2D:4D. Further, this approach expresses the relationship of 2D:4D with body composition as well as inter-gender distinction among young Indian population.

CONCLUSION

The present study reiterated the findings of differential anthropometric body composition indicators and 2D:4D between men and women. Further, among men, anthropometric measurements did not differ with 2D:4D of more or less than one. Lower 2D:4D may seem to have modest association with male type measures of body composition among women. This study is an attempt exploring the relation between finger length ratio and body composition indicators among Indian population. Further studies with variable population may help in determining 2D:4D as a marker of obesity and associated lifestyle disorders.

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Authors Contribution:
JM – Designed the study, performed the experiment, analysed the data, drafted the manuscript, & reviewed the manuscript; BSB – Performed the experiment, analysed the data, reviewed the manuscript.

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