# 2D:4D Ratio and Sex Role Orientation in Physical Education Prospective Teachers

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| Article info | Abstract | Research Article |
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The length of the 2nd and 4th fingers (2D:4D) is related to numerous sexually dimorphic behavioral and physiological states. Finger lengths vary in males and females and the male 2D:4D average is than the female 2D:4D. Evidence has been found in recent studies reflecting that the lengths of the second and fourth fingers correlate negatively with prenatal testosterone and positively with prenatal estrogen. The study aims to examine the correlation between the sex role of the physical education prospective teachers and the ratio of the second and fourth fingers (2D:4D). In this study, the 2D:4D ratio was measured on samples consisting of 105 female and 65 male university students. Participants were given and completed the Bem Sex Role Inventory (BSRI). It has been found that low 2D:4D ratios in males significantly correlate to high masculinity type tendency scores on the BSRI, and that the 2D:4D ratio in females is not a determinant of femininity or masculinity type personality-based sex role identities. This study revealed that the BSRI and the 2D: 4D ratio differed by sex roles in males and 2D:4D ratio for males can be considered as an indicator of tendency towards masculinity type personality.

## INTRODUCTION

In humans, the length ratio of the index and ring finger (2D:4D) is called sexually dimorphic trait. On average, males have shorter 2D:4D ratio than females. The difference in digit ratios starts to be observable in two-year-old children [1]. This variation in the 2D:4D ratio emerges during the fetal developmental period. The development of the fingers is completed in the uterus until the 13th week and remains stable after this period [2-4]. Studies have recently focused on examining the digit ratio averages and the correlation in humans, especially the second and fourth fingers (2D:4D). It has been suggested that the 2D:4D ratio in humans is a sexually dimorphic feature. This difference in digit ratio is associated with the androgen-estrogen balance in the uterus. It is said that the 2D:4D ratio correlates negatively with prenatal testosterone level [5, 6]. Direct correlation between fetal testosterone and the 2D:4D by analyzing the amniotic fluid supports this hypothesis [7]. In females, although it slightly differs, the index finger (2D, second finger) has almost the same length as the fourth finger (4D). In males, the index finger is ordinarily shorter than the fourth. It is suggested that the 2D:4D ratio reflects the exposure

to prenatal androgen and the androgen sensibility [5, 8]. It was found that the 2D:4D ratio becomes apparent when the human is two years old [1, 9]. According to 'the Manning hypothesis', the 2D:4D ratio of a human hand is a sexually dimorphic feature. In males, the fourth finger tends to be longer than the second (2D:4D $\leq$ 1), but in females, both tend to be equal [1, 10]. It is still uncertain that whether prenatal androgen and estrogen play a causal role in sexual dimorphism of the 2D:4D ratio and how these sex-based steroids affect finger development mechanisms [6].

These biological markers are common to a great extend in humans, with the sex difference in the 2D:4D ratio varying slightly or mediocre only. It was set forth by a large number of physiological and psychological study results on the 2D:4D digit ratio that it is associated with several matters such as autism and left handedness [7], aggression [11], depression [12], locus of control [13], academic achievement [14], muscular endurance [15], ability to sports [16], handgrip strength [17], sex role identity [18], personality [19], and age of pubertal onset [20].

Masculine and feminine type dimensions of personality can be defined according to the scores of their

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self-reported masculine and feminine gender-role identity scale. Males commonly demonstrate more ambitious and competitive behaviors, while females set out more attentive and socially agreeable behaviors [18].

Currently, there haven't been found any information on the 2D:4D and the gender role in physical education prospective teachers. In sum, the study sought to examine the relationship between the self-reported sexual-role identity (Bem Sex Role Inventory) and the 2D:4D ratio. At the same time, we intended to assert the sexual dimorphism of the 2D:4D ratio and sex roles of males and females, and the relationship between these two concepts. Our hypothesis is, by predicating on the previous findings on the research subject, that the low 2D:4D ratio in males is associated with the gender role identity [18, 21-24], and that the gender-based 2D:4D ratio finger length differs more in right hand [5, 25].

## METHODS and MATERIALS

### Ethical approval
This study was approved by the non-clinical research ethical committee of the Kahramanmaras Sutcu Imam University (Ethical protocol: P043-07) (20070202).

### Participants
A hundred and five female and sixty-five male physical education prospective teachers participated in the study. They were aged between 18 and 28 with an average of 20.75±1.56 years. Subjects' heights ($M$= 169.86±7.28 cm) and weights ($M$= 64.67±8.78 kg) were also recorded. Volunteers were interviewed to ensure that they were physically fit and had no psychiatric or neurological illness. The participants were fully informed about the purpose of the study and both signed an informed consent prepared according to the ethical standards laid down in the Declaration of Helsinki (revision 2013).

### Measurement of second to fourth digit ratio (2D:4D)
The second and fourth finger lengths and the distance between the baseline of the palm and the pulp in the proximal region were measured with the Digital Vernier Caliper with an accuracy of 0.01 mm [1, 26]. The 2D:4D ratio was determined by dividing the second finger length by the fourth finger length [27].

### Measurement of sex-role identity
Participants completed the BSRI. The BSRI was developed to measure individual personality traits related to masculinity and femininity [28, 29]. There are 60 Likert-type items (ranging from "never true" and "almost never true" to "always true" and "almost always true") in the BSRI (20 related to femininity, 20 to masculinity, and 20 non-sexual). A 40-item part of the scale on femininity and masculinity was used in this study. The validity and reliability study of the BSRI was adapted to Turkish by [30]. The Cronbach alpha coefficient was 0.73 for the femininity scale and 0.75 for the masculinity scale. Our research showed a good internal reliability (0.7 for femininity, 0.82 for masculinity).

### Statistical analyses
The data were analyzed using the IBM SPSS Statistics version 22. Normality of distribution was analyzed using the Kolmogorov Smirnov test and normal distribution was found to be appropriate. The paired t-test was used to compare 2D:4D ratio average of left and right hands (see Table 1) and sex roles (femininity-masculinity) scores as dependent variables (see Table 2). The unpaired t-test was used to compare 2D:4D ratio average of left and right hands and sex roles (femininity-masculinity) averages according to sexes (see Table 3). Pearson correlation analysis was performed between the 2D:4D ratios of both hands and sex roles. The alpha level for statistical significance was set at $P \leq 0.05$. Effect dimensions were calculated by Cohen'd ($d$) [31].

## RESULTS

**Table 1.** Paired t-test comparison of femininity and masculinity means by gender

| BSRI | M | SD | t | P | Cohen's d |
|------|-----|------|--------|--------|-----------|
| F-Masculinity | 5.66 | 0.52 | -9.583 | <0.000 | -0.72 |
| F-Femininity | 5.09 | 0.58 | | | |
| M-Masculinity | 5.62 | 0.45 | 0.66 | >0.5 | 0.07 |
| M-Femininity | 5.68 | 0.6 | | | |

*Note.* Females (F), Males (M), BEM Sex Role Inventory (BSRI), Standard Deviations (*SD*)

A paired t-test was performed to analyze the difference between sex-role types by sex. A statistically significant difference was found between the *femininity* and *masculinity* averages of females ($t_{(104)}$=9.583; $p$<0.05). The difference was medium effect according to [31] (Cohen's $d$=.72). However, no statistically significant difference was found between the *masculinity* ($M$=5.62±0.45) and *femininity* ($M$=5.68±0.6) averages of males ($t_{(64)}$=-.66; $p$>0.05) (see Table 1).

**Table 2.** Paired t-test comparisons of 2D:4D means and by gender

| Digit Ratio | Mean | SD | t | P | Cohen's d |
|---|---|---|---|---|---|
| F-Right-2D:4D | 0.99 | 0.034 | 1.084 | >0.28 | 0.063 |
| F-Left-2D:4D | 0.98 | 0.033 | | | |
| M-Right-2D:4D | 0.97 | 0.032 | 0.37 | >0.7 | -0.046 |
| M-Left-2D:4D | 0.974 | 0.029 | | | |

*Note.* Females (F), Males (M), Standard Deviations (SD)

As can be seen in Table 2, there was no statistically significant difference found in 2D:4D ratio averages of left and right hands in both males and females when compared with the paired t-test ($p > 0.05$).

**Table 3.** Unpaired t test comparisons female and males sex roles and 2D:4D mean scores

| | Males | | Females | | | | |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | t | P | Cohen's d |
| Right-2D:4D | 0.97 | 0.03 | 0.99 | 0.03 | 2.57 | <0.011 | 0.39 |
| Left-2D:4D | 0.97 | 0.03 | 0.98 | 0.03 | 2.33 | <0.02 | 0.37 |
| BSRI-Masculinity | 5.62 | 0.45 | 5.66 | 0.52 | -0.72 | >0.47 | 0.11 |
| BSRI-Femininity | 5.68 | 0.6 | 5.09. | 58 | 6.18 | <0.000 | 0.97 |

*Note.* BSRI=BEM Sex Role Inventory, Standard Deviations (SD)

When sexes and right and left hand 2D:4D ratios ($t_{(168)} = 2.57$; $p < 0.05$) of the participants were compared, a significant difference was found in the right and left hand 2D:4D ratios by sex ($t_{(168)} = 2.33$; $p < 0.05$). The difference in both hands have low effects according to [31] (see Table 3).

When the *femininity* and *masculinity* averages of male and female participants were compared with the unpaired t-test (see Table 3), no statistically significant difference was determined in *masculinity averages* ($t_{(168)} = .72$; $p > 0.05$), while a statistical difference was determined in *femininity averages* ($t_{(168)} = 6.18$; $p < 0.05$). According to, this difference demonstrates the strongest effect among other variables (Cohen's $d = .97$).

Male sex role scores and 2D:4D ratios of right and left hands were compared with Pearson *r*-test, *and masculinity scores* showed statistically significant correlation with both right-hand (r= -.348, $p < 0.05$) and left-hand (r= -.318, $p < 0.05$) 2D:4D ratios. According to Cohen, this correlation was a medium effect [31]. There was no statistically significant relationship between sex role scores and right and left hand 2D:4D ratios of females ($p > 0.05$; see Fig. 1a, b – 2a, b).
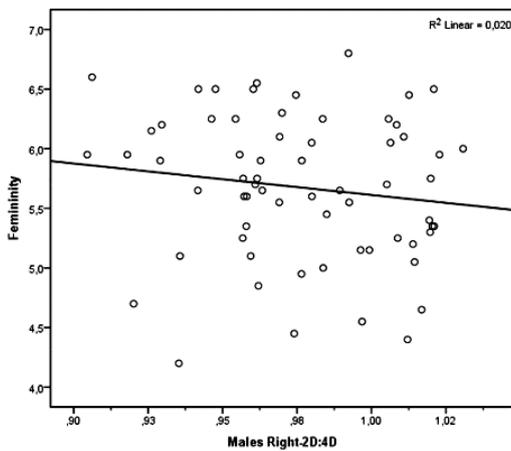


**Figure 1a.** The relationship between male right hand finger length ratios (2D:4D) and femininity scores.
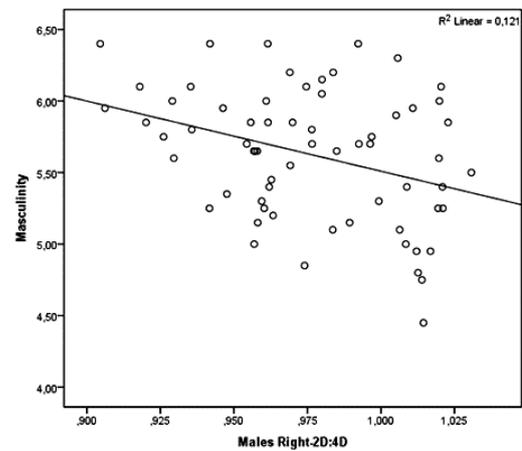


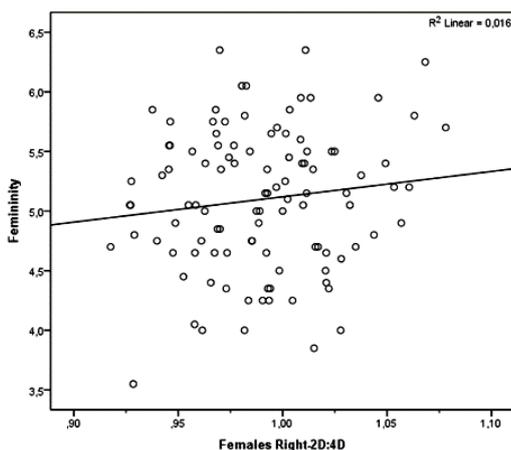**Figure 1b.** The relationship between male right hand finger length ratios (2D:4D) and masculinity scores.



**Figure 2a.** The relationship between female right hand finger length ratios (2D:4D) and femininity scores.
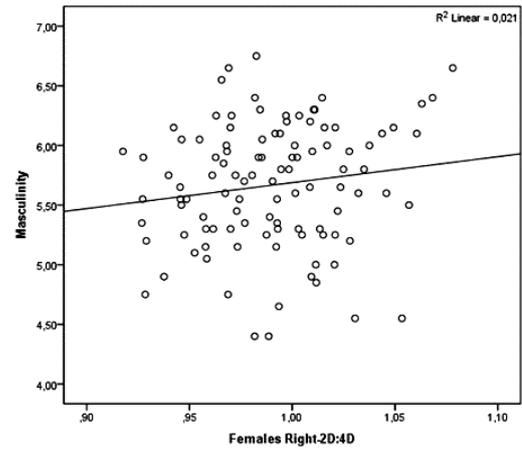


**Figure 2b.** The relationship between female right hand finger length ratios (2D:4D) and masculinity scores.

## DISCUSSION

We used the BEM sex role scale in both male and female physical education prospective teachers to investigate the relationship between sex role and 2D:4D finger length ratio. In this study, the dimorphic 2D:4D ratios according to sexual orientation in university students was revealed. It was determined that there is a correlation between the 2D:4D ratios and sex roles accordingly with sex, that, in males, there is a negative correlation between masculinity and the right-hand 2D:4D ratio, but no negative correlation in females.

While the low 2D:4D ratio is associated with the masculine sex role type, it has been shown that the high 2D:4D ratio is related to the feminine sex role type and the digit ratio is related to various psychological characteristics [32]. Females with smaller digit ratios were found to have higher masculinity scores in the Bem Sex Role Inventory as in the literature [18, 32]. Males with a smaller 2D:4D ratio were found to be perceived as more masculine,  and this situation presents a common feature with the literature [33].

As the conclusion of our study, it was determined that males had higher BSRI-Masculinity score and lower BSRI-F score compared to females with respect to BSRI-M sex role adaptation, and [24] revealed similar results by the findings.

In predicting human morphology and behavior, it was seen that the 2D:4D in the right hand was more specific than the 2D:4D in the left hand and revealed more precise information about prenatal testosterone levels [1, 9, 10, 21, 34].

Interestingly, our study revealed that, on the contrary of the study of [24] on the correlation between the left-hand 2D:4D digit ratio and sex role in males, the right-hand digit ratio is strongly related to masculinity and sex role, similarly with the study of [35]. But this case was not associated similarly with [24] between females.

 Earlier studies indicate that masculinity and femininity can be at different levels in both males and females. The meta-analysis (28 studies from 10 countries, 46% unpublished) of the relevant literature showed that, in males, only left hand (but not the right hand) reasonably positively correlate with the 2D:4D ratio and femininity [32]. Kim et al. (2014)  reported that right hand has a high sensitivity for prenatal androgenes and shows a strong sex variation compared to left hand [19].

The study has some limitations as the male and female participants are not equal in numbers and it is only implemented on physical education prospective teachers. We believe that providing a wider and equal number of male and female participants in future studies will enhance the credibility of the results.

## CONCLUSION

In conclusion, there is no significant correlation     between the 2D:4D ratios and sex role orientation of females in our study. However, a negative correlation was determined in the BSRI-Masculinity score of 2D:4D ratios of both hands and sex role orientation of males, yet there wasn't found a correlation for females.

### *Conflict of interest*

The authors declare that they have no conflict of interest.

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