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Digit ratio (2D:4D) and handgrip strength in a Chinese population of Han ethnicity☆

Dan Shen [a], Zhanbing Ma [b], Lu Wang [c], Zhenghao Huo [a,b], Hong Lu [a,b,*], Junli Zhao [d], Wenli Qian [a]

[a] Key Laboratory of Fertility Preservation, Maintenance of Ministry of Education, Ningxia Medical University/Key Laboratory of Reproduction and Genetics in Ningxia, Yinchuan 750004, PR China
[b] Department of Medical Genetic and Cell Biology, Ningxia Medical University, Yinchuan 750004, PR China
[c] Clinical Medicine Science, Peking University Health Science Center, Beijing 100191, PR China
[d] Medical Reproductive Center of General Hospital, Ningxia Medical University, Yinchuan 750004, PR China

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ABSTRACT

Background: In humans, the relative lengths of the index finger to the ring finger (2D:4D) is a sexually dimorphic trait which correlated with prenatal sex steroids and has been increasingly used as a promising tool to evaluate the impact of prenatal hormone exposure in some traits, such as physical performance. Handgrip strength (HGS) is one potent index of physical ability and its relationship with 2D:4D ratio has been discussed in several ethnic groups.
Aims: To investigate whether there is a correlation between 2D:4D ratio and HGS in Chinese college students of Ningxia Han ethnicity.
Methods: 608 students (211 males and 397 females) of Han ethnicity were recruited from Ningxia medical university. Photocopies and HGS of both hands were collected at Yinchuan city, in the Ningxia province of China.
Results: Sexual dimorphism of 2D:4D and HGS were found, males had significantly lower 2D:4D and greater HGS than females. 2D:4D in both hands were significantly negative correlated with HGS in females and not in males.
Conclusions: 2D:4D ratio is negative correlated with HGS in a Chinese population of Ningxia Han ethnicity and this association should be considered on the anthropological research within an evolutionary concept in the future.

1. Introduction

Digit ratio, especially second-to-fourth digit ratio (2D:4D), is sexually dimorphic: males generally have a relatively shorter 2D:4D compared to females across ethnicities and countries [1]. Sex difference on 2D:4D is generally established during the first trimester of the embryo development coincided with sex steroids changing and be relatively stable across the lifespan without affection of puberty [2]. In humans, this dimorphic trait is influenced by the level of prenatal hormone exposure of the embryo [3]. Since the levels of prenatal testosterone (PT) and prenatal estrogen (PE) are difficult to directly assess, progress has been rapid in exploring surrogate measures of hormone exposure throughout the lifespan to better illuminate hormone-related events [4].

Based on evidence that 2D:4D might provide a window into the external environmental changes in terms of PT and PE exposure, low 2D:4D indicates high PT (low PE), whereas high 2D:4D indicates low PT (high PE). Many researchers have used 2D:4D as a promising index in studying hormone-related behavior, such as physical ability, to evaluate the impact of PT [5–11]. A meta-analysis by Hönekopp et al. [12] showed that athletic prowess is negatively correlated with 2D:4D of each hand for both sexes.

Handgrip strength (HGS) is considered to be one of the authentic parameters of physical ability [13]. Increasing evidence shows that HGS is also a sexually dimorphic trait, just as 2D:4D, with men being typically stronger than women [14]. In recent years, measures adopted to investigate the correlation between 2D:4D and HGS have been discussed in several ethnic groups [15–22]. However, the results of the association between 2D:4D and HGS are inconsistent. Low 2D:4D has been found to be correlated with high HGS in samples of European (German) and Asian (Mizos) men [15]. Subsequently, this finding has only been verified in a sample of US men [16], in Chinese men of Han [11] and Hani [17] ethnicity, in Turkish older men [18], and in boys from the UK [19]. A recent study including students and staff of two UK universities (ethnically mixed) has also reported that 2D:4D is a negative correlate of HGS in men in the challenge conditions [20]. Unlike with the findings mentioned previously, other studies including US and European samples failed to replicate the link between 2D:4D and HGS in men and

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* Corresponding author at: Department of Medical Genetics and Cell Biology, Ningxia Medical University, 1160 Shengli Street, Yinchuan, Ningxia, 750004, PR China.
E-mail address: chuan773@126.com (H. Lu).

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women [21–23], whereas Meltem et al. [18] found this link in both sexes in elderly patients with sarcopenia. Early experimental evidence suggested that PT improves HGS and muscle mass. Since the relationship between PT and 2D:4D is at least as well substantiated in women as it is in men, if lower 2D:4D is associated with increased adult HGS, then an association between them should be apparent in women as well as men [23]. Therefore, if this hypothesis is correct, we would guess that there should be a common link between 2D:4D and HGS in both sexes for any ethnicity in humans.

Zhao et al. have reported a negative correlation between right-hand 2D:4D and HGS in Chinese men of Han ethnicity (Shanxi province) [11]. Here, we consider an association between 2D:4D and HGS in both sexes from a different region of China (i.e. Ningxia province). Our aim was to investigate the correlation between 2D:4D and HGS, and, at the same time, to determine whether the findings of Zhao et al. could be generalized to other groups of Chinese Han ethnicity.

2. Material and methods

2.1. Subjects

Subjects in the present study included 608 Han ethnicity students (211 males and 397 females) who were recruited from Ningxia medical university (age: 15–25 years, mean age ± SD = 18.99 ± 1.39). This study was conducted at Yinchuan, which is located in the Ningxia province of China. The ancestors of all participants lived in Ningxia, whose parents kept original Han ethnicity without having blood relationship with each other.

2.2. Ethnical statement

The study received approval from the Ethics Committee of Ningxia Medical University. All participants gave informed written consent prior to having been given information about the study.

2.3. Measurements and data collection

According to previous study [1], participants were instructed to put their hands on a flat surface of a desk and straighten their fingers as much as possible with the palm facing upward. Photocopies of both hands were obtained by using a digital camera (DSCW520; Sony, Tokyo, Japan). Abnormal or damaged finger were excluded. We input the image to computer, with the Photoshop software (v: 7.0) to mark two points of index and ring fingers (the creases and the fingertips). After printing the image, we used electronic venire calipers to measure bilateral hands from the tip of the finger to the center of the digit crease proximal to the palm (0.01 mm). Such measurement was made in duplicate for each finger by the same observer. Re-measurement reliability was higher for the first and second 2D:4D (intraclass correlation coefficients, r_1, left-hand 2D:4D $r_1 = 0.988$, $F(1,607) = 80.450$, $P < 0.001$; right-hand 2D:4D $r_1 = 0.937$, $F(1,607) = 15.815$, $P < 0.001$). We concluded that our measurements of both hand 2D:4D reflected real differences between individuals. Then the mean 2D:4D of each hand and the right-left hand 2D:4D(△R-L 2D:4D) = right hand 2D:4D–left hand 2D:4D were calculated.

HGS in kilograms force for each hand were measured by an electronic dynamometer (Xiangshan EH101, China). All participants were tested second times for both hands, with an interval of 5 min between each trial. Re-measurement reliability was higher for the first and second measurements of HGS (intraclass correlation coefficients, r_1, right-hand HGS $r_1 = 0.984$, $F(1,607) = 61.291$, $P < 0.001$; left-hand HGS $r_1 = 0.983$, $F(1,607) = 57.855$, $P < 0.001$). Then we calculated the mean strength of the two trials for each hand.

2.4. Statistical analysis

The following statistical tests were used: The independent-samples *t*-test was used to test the difference of age, 2D:4D and HGS between males and females. The simple linear regression analysis was used to assess the relationship between 2D:4D and HGS. SPSS 17.0 statistical software was performed to analyze all data, with a significance (2-tailed) level of $P \le 0.05$.

3. Results

3.1. Sex difference

Mean values and distribution of age, 2D:4D ratio, HGS in males and females are shown in Table 1.

The range of age in males was similar to that in females. No significant difference was found between males and females on age ($t = 1.889$, $P > 0.05$) (Table 1).

The range of 2D:4D in both sexes was also similar. There were no significant differences between left hand and right hand in both sexes (males: $t = 0.175$, $P = 0.861$; females: $t = 0.231$, $P = 0.817$). The 2D:4D ratio of males were significantly lower than females for both the left ($t = -5.391$, $P < 0.001$) and right hands ($t = -5.318$, $P < 0.001$) (Table 1). No significant difference was observed on △R-L 2D:4D ($t = -0.010$, $P = 0.992$).

In the same sex, the range of HGS in both hands was similar. However, in the different sex, males had longer range of HGS than females. In both sexes, left hand shown significantly lower HGS than right hand (males: $t = -3.970$, $P < 0.001$; females: $t = -5.661$, $P < 0.001$). In both hands, males shown significantly higher HGS than females (left hand: $t = 30.911$, $P < 0.001$; right hand: $t = 29.347$, $P < 0.001$) (Table 1).

3.2. Relationship between 2D:4D and HGS

In order to test whether there is an association between 2D:4D and HGS, the simple linear regression analysis was conducted in this study. For males, there was a weak but not significant correlation between 2D:4D and HGS on both hands (Table 2, Fig. 1). For females, a significantly negative correlation between 2D:4D and HGS was found on both hands (Table 2, Fig. 2).

Table 1
Descriptive statistics of participants in males and females.

Index	Males (N = 211)		Females (N = 397)	
	Mean (SD)	Range	Mean (SD)	Range
Age (years)	19.14 ± (1.42)	16–24	18.91 ± (1.37)	15–25
Left-hand 2D:4D	0.9361 ± (0.0334)	0.8417–1.0320	0.9513 ± (0.0331)*	0.8679–1.0368
Right-hand 2D:4D	0.9355 ± (0.0340)	0.8502–1.0360	0.9508 ± (0.0336)*	0.8516–1.0360
Left hand HGS (kg)	43.89 ± (8.29)△	19.00–68.00	23.94 ± (5.99)	5.10–44.80
Right hand HGS (kg)	47.27 ± (9.18)△,+	18.23–76.10	26.44 ± (6.43)+	6.77–48.50

* $P < 0.001$ (difference of 2D:4D ratio between males and females).
△ $P < 0.001$ (difference of HGS between males and females).
\+ $p < 0.001$ (difference of HGS between left hand and right hand).