SHORT REPORT

The relationship between the digit ratio (2D:4D) and vertical jump performance in young athletes

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Abstract

Background: Digit ratio (2D:4D), a putative marker of prenatal testosterone, is a negative correlate of sports, athletic, and fitness performance.

Objectives: To describe the relationship between 2D:4D and vertical jump performance in athletes.

Methods: Sixty-one Division I American Football players from a Midwestern U.S. university had their 2D:4D measured digitally and their vertical jump performance measured using jump mechanography. The primary outcome was jump height, with secondary outcomes depicting jump execution also recorded. Linear relationships between 2D:4D and vertical jump performance were quantified using partial correlations adjusted for age, height, mass, and ethnicity.

Results: 2D:4D was a statistically significant weak negative correlate of jump height (partial r [95% confidence interval]: −0.26 [−0.48, −0.01]), indicating that athletes with lower 2D:4Ds (i.e., relatively longer 4th digits) jumped higher. Relationships with jump execution variables were negligible to weak and negative, but not statistically significant.

Conclusions: The significant relationship between 2D:4D and jump height probably reflects both the long-term organizational and short-term activational benefits of testosterone. Therefore, 2D:4D may be a useful indicator of explosive strength among young athletes.

1 | INTRODUCTION

Digit ratio (2D:4D), the ratio of the length of the second digit (2D; the index finger) and fourth digit (4D; the ring finger), is favorably associated with health, fertility, behavior, and athletic ability (Manning, 2008). 2D:4D is considered to reflect the balance between prenatal testosterone and estrogen (Zheng & Cohn, 2011), although debate exists regarding this association (McCormick & Carré, 2020; Swift-Gallant et al., 2020). Prenatal testosterone exposure has long-term organizational effects on the growth and development of numerous bodily systems (e.g., cardiovascular, musculoskeletal, central nervous systems; Zheng & Cohn, 2011), and may influence peak testosterone kinetics, behavioral responses (e.g., aggression), and physical performance in response to stress challenge (Crewther et al., 2011).

2D:4D has been consistently reported as a negative correlate of sports, athletic, and fitness performance. In their meta-analysis, Hönekopp and Schuster (2010) found that 2D:4D was a weak negative correlate of a range of sports/athletic/fitness performances, indicating that individuals with lower 2D:4Ds outperformed individuals with higher 2D:4Ds. However, Hönekopp and Schuster (2010)...
found substantial heterogeneity between studies, with stronger relationships between 2D:4D for long-duration exercise performance requiring high cardiorespiratory fitness (e.g., middle- and long-distance running) than for short-duration exercise performance requiring high muscular fitness (e.g., handgrip strength, sprinting). More recently, there has been a preponderance of studies examining relationships between 2D:4D and muscular fitness, most of which have measured muscular fitness as maximal handgrip strength (Pasanen et al., 2021). Several studies have, however, examined relationships between 2D:4D and explosive strength (measured as jump performance) and have failed to find statistically significant correlations (e.g., Kozieł et al., 2017; Ranson et al., 2015). None though, has used jump mechanography to assess vertical jump height and jump execution. The primary aim of this study, therefore, was to quantify the relationship between 2D:4D and vertical jump height in young athletes. The secondary aim was to examine relationships between 2D:4D and jump execution variables. We predicted that athletes with lower 2D:4Ds had higher jump heights and better jump execution.

2 | METHODS

2.1 | Study design and participants

This study used a cross-sectional design. Sixty-one males (aged 18–24 years), who competed for the University of North Dakota in American football at the National Collegiate Athletic Association (NCAA) Division I level, volunteered for this study. Mean ± SD for the sample were: age, 19.9 ± 1.4 years; height, 188 ± 7 cm; body mass, 102 ± 16 kg; right hand 2D:4D, 0.945 ± 0.028; and maximum jump height, 39 ± 7 cm. Participants who self-reported a major injury (e.g., dislocation, break) to the 2D, 4D, or lower body were excluded. All participants gave signed informed consent. The Institutional Review Board of the University of North Dakota approved this study (IRB-201711-120).

2.2 | Measures

Participants self-reported their age and ethnicity. Height was measured using a stadiometer (Model 213; Seca Corp., Hamburg, Germany) and body mass was measured using a force platform (Bertec Corp, Columbus, OH).

After a 5-min warm-up, participants performed two maximal vertical (squat) jumps (spaced 60 s apart) on the force platform using procedures described elsewhere (Fitzgerald et al., 2018). Jump height was calculated as the maximum of two vertical jump heights, with the average of two jumps used to calculate force-time variables (peak force, starting gradient, acceleration gradient, and the average and peak rate of force development) to reflect jump execution (Fitzgerald et al., 2018). Jump height and force-time variables were calculated using Visual Basic (Microsoft Corp., Redmond, WA). Jump height and force-time variables demonstrate good repeatability (Fitzgerald et al., 2018; McLellan et al., 2011).

2D and 4D lengths were measured using Cartesian coordinate geometry and digital photographs (Nikon Coolpix L11, Tokyo, Japan) of the palmar surface of each participant’s outstretched right hand using procedures described elsewhere (Hull et al., 2015). 2D:4D was calculated by dividing the 2D length by the 4D length. This method demonstrates very good repeatability and validity (vs. direct caliper measurements; Hull et al., 2015).

2.3 | Statistical analyses

Partial correlations (adjusted for age, height, mass, and ethnicity) were used to quantify linear relationships between 2D:4D and jump height and force-time variables. Negative correlations indicated that athletes with lower 2D:4Ds had higher jump heights and better jump execution, while positive correlations indicated that athletes with lower 2D:4Ds had lower jump heights and poorer jump execution. Correlations of 0.1, 0.3, and 0.5 were used as thresholds for weak, moderate, and strong, with correlations <0.1 considered to be negligible (Cohen, 1988).

3 | RESULTS

The adjusted partial correlation between 2D:4D and jump height was statistically significant, weak, and negative (partial r [95%CI]: −0.26 [−0.48, −0.01]), indicating that athletes with lower 2D:4Ds jumped higher irrespective of their age, body size, and ethnicity (Figure 1). Each 1 SD decrease in 2D:4D was associated with a 2 cm increase in jump height. Adjusted partial correlations between 2D:4D and force-time variables were negligible to weak and negative, but not statistically significant.

4 | DISCUSSION

This study showed that 2D:4D was a weak negative correlate of jump height (even after adjustment for age, body size, and ethnicity), but was not significantly related to jump execution. Our primary finding probably reflects
FIGURE 1 Forest plot of the partial correlations (adjusted for height, mass, age, and ethnicity) between 2D:4D and jump height and force-time variables. The black dots represented the correlations between 2D:4D and jump height and force-time variables, and the solid horizontal lines represented the corresponding 95% CIs. The dashed vertical lines represented Cohen’s thresholds for weak, moderate, and strong correlations. The solid vertical lines represented the variables, and the solid horizontal lines represented the correlations between 2D:4D and jump height and force-time variables. The black dots represented the height, mass, age, and ethnicity correlations. The solid vertical lines represented the lower 2D:4D correlation, and the solid horizontal lines represented the lower 2D:4D correlation.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
Investigation, project administration, writing (original draft): Jacob W. Disterhaupt. Conceptualization, methodology, supervision: John S. Fitzgerald. Conceptualization, supervision, Jesse L. Rhoades. Conceptualization, methodology, writing (original draft), writing (review & editing), visualization, supervision, Grant R. Tomkinson.

DATA AVAILABILITY STATEMENT
The data are available from the corresponding authors on reasonable request.

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