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EXPLORING THE LINK BETWEEN THE 2D:4D RATIO, BLOOD PRESSURE, AND LIPID PROFILE IN A MALE POPULATION FROM NORTH INDIA.

Dr. Ravindra Kumar Yadav*

*Assistant Professor, Department of Anatomy, Mahaveer Institute of Medical Sciences & Research, Bhopal, MP

Abstract:
Background: The 2D:4D finger length ratio, known for its sexual dimorphism and association with various traits, has been investigated as a potential marker for cardiovascular disease. This study aimed to determine if 2D:4D ratios correlate with coronary artery disease (CAD) in males, as assessed by ECG, 2D-ECHO, and coronary angiography.
Methods: This cross-sectional study included 100 male subjects aged 30-80 years, divided into two groups: 50 with diagnosed CAD and 50 without. Digital calipers were used to measure the lengths of the index (2D) and ring (4D) fingers of both hands, with measurements taken twice for accuracy. Data were analyzed using appropriate statistical methods.
Results: Males with CAD exhibited significantly higher 2D:4D ratios compared to those without CAD ($P < 0.01$). This finding indicates a positive correlation between elevated 2D:4D ratios and the presence of CAD in male subjects.
Conclusion: This study suggests that the 2D:4D finger length ratio may serve as a potential marker for predisposition to CAD in males. Higher 2D:4D ratios were associated with a significantly increased likelihood of CAD, as confirmed by clinical assessments.

Keywords: 2D:4D Ratio, Finger Length Ratio, Coronary Artery Disease (CAD), Cardiovascular Risk, Male Health.

Introduction:

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, necessitating the identification of reliable and accessible markers for early detection and risk stratification. Traditional risk factors, while valuable, do not fully account for the observed variability in CAD prevalence. Consequently, researchers have explored novel biomarkers that may offer additional insights into individual susceptibility. Among these, the ratio of the index finger (2D) to the ring finger (4D), known as the 2D:4D ratio, has garnered considerable attention.

The 2D:4D ratio is established during early fetal development and is believed to be influenced by prenatal exposure to sex hormones, particularly testosterone and estrogen. This ratio exhibits sexual dimorphism, with males typically displaying lower 2D:4D ratios compared to females. Furthermore, studies have linked the 2D:4D ratio to a range of physiological and behavioral traits, including athletic performance, cognitive abilities, and susceptibility to certain diseases.

Emerging evidence suggests a potential association between the 2D:4D ratio and cardiovascular health. Specifically, hypotheses have been proposed that individuals with higher 2D:4D ratios, indicative of lower prenatal testosterone exposure, may be at increased risk for CAD. However, the

existing literature presents mixed findings, and further research is needed to clarify this relationship, particularly in specific populations.
Given the potential of the 2D:4D ratio as a non-invasive and easily measurable marker, this study aimed to investigate its association with CAD in a cohort of male subjects. By comparing 2D:4D ratios between individuals with and without clinically diagnosed CAD, as assessed by ECG, 2D-ECHO, and coronary angiography, this research sought to determine whether this ratio could serve as a useful adjunct in the assessment of CAD risk in males. Understanding the relationship between 2D:4D and CAD may provide valuable insights into the underlying mechanisms of cardiovascular disease and contribute to the development of more effective preventive strategies.

Materials and Methods:
Study Design and Participants: This cross-sectional, observational study included 100 male participants aged 30 to 80 years, Department of Anatomy, MIMS, Bhopal. Participants were categorized into two groups: a case group (n=50) with angiographically, electrocardiographically (ECG), and echocardiographically (2D-ECHO) confirmed coronary artery disease (CAD), and a control group (n=50) without clinical evidence of CAD. Participants in the case group were randomly selected from individuals with documented CAD. For each participant in the case group, a control participant without CAD was recruited from the medical outpatient department (OPD), matched approximately by age.

Exclusion Criteria: Participants were excluded if they presented with:
- Apparent hand anomalies, including congenital malformations or acquired deformities.
- Active hand inflammation, trauma, or surgical history affecting finger length.
- Diagnosed genetic disorders or neurological diseases that could influence finger development.

Ethical Considerations: The study was conducted in accordance with the ethical guidelines of the [Name of Institutional Ethics Committee], and approval was obtained prior to data collection. All participants provided informed consent.

Anthropometric Measurements: The lengths of the second digit (index finger, 2D) and fourth digit (ring finger, 4D) were measured bilaterally using a digital sliding caliper (accuracy: 0.01 mm). Measurements were taken from the basal crease at the proximal base of the finger to the distal tip. Each finger was measured twice, and the average of the two measurements was recorded in millimeters (mm). The 2D:4D ratio was calculated by dividing the length of the index finger (2D) by the length of the ring finger (4D) for both the right and left hands.

Statistical Analysis: Data were compiled and analyzed using [Name of Statistical Software, e.g., SPSS, R]. Descriptive statistics (mean ± standard deviation) were calculated for continuous variables. Independent samples t-tests were used to compare the 2D:4D ratios between the case and control groups. A p-value of < 0.05 was considered statistically significant.
To assess the association between 2D:4D ratio and CAD, relative risk (RR) and attributable risk (AR) were calculated. The null hypothesis was that there is no association between the 2D:4D ratio and the presence of CAD.

Results:
- **Mean Finger Lengths (mm):**
  - CAD Group: 2D = 71.5 (SE ± 0.57); 4D = 70.7 (SE ± 0.61)
  - Non-CAD Group: 2D = 72.2 (SE ± 0.65); 4D = 69.9 (SE ± 0.79)
  - Differences in mean 2D and 4D lengths between CAD and Non-CAD groups were not statistically significant (P = NS).

- **Mean 2D:4D Ratio:**
  - CAD Group: 1.005 ± 0.004
  - Non-CAD Group: 0.98 ± 0.003
  - The difference in mean 2D:4D ratio between CAD and Non-CAD groups was statistically significant ($P < 0.01$).
- **Distribution of 2D:4D Ratio:**
  - CAD Group: 39 (78%) had 2D:4D ratio ≥ 1; 11 (22%) had 2D:4D ratio < 1.
  - Non-CAD Group: 36% had 2D:4D ratio ≥ 1; 64% had 2D:4D ratio < 1.
- **Statistical Analysis:**
  - Chi-square (χ^2) = 17.96, degrees of freedom (Df) = 1, $P < 0.01$.
  - Relative Risk (RR) = 2.16.
  - Attributable Risk (AR) = 53%.

Discussion:

The findings of this study reveal a statistically significant association between the 2D:4D finger length ratio and coronary artery disease (CAD) in male participants. Specifically, the mean 2D:4D ratio was significantly higher in the CAD group (1.005 ± 0.004) compared to the non-CAD group (0.98 ± 0.003), with a p-value of <0.01. This suggests that a higher 2D:4D ratio is associated with an increased likelihood of CAD in males. While the mean lengths of the index finger (2D) and ring finger (4D) individually did not show statistically significant differences between the two groups, the *ratio* of 2D:4D proved to be a significant discriminator. This highlights the importance of considering the relative lengths of these digits rather than their absolute values. Further analysis of the distribution of 2D:4D ratios revealed that 78% of the CAD group had a ratio equal to or greater than 1, whereas only 36% of the non-CAD group exhibited this characteristic. This distribution was statistically highly significant ($\chi^2 = 17.96$, df = 1, $p < 0.01$), reinforcing the strong association between a higher 2D:4D ratio and CAD. The calculated relative risk (RR) of 2.16 indicates that males with a 2D:4D ratio of 1 or greater are approximately 2.16 times more likely to have CAD compared to those with a ratio less than 1. The attributable risk (AR) of 53% suggests that 53% of the CAD cases in this study population could be attributed to having a 2D:4D ratio of 1 or greater. These findings align with existing literature suggesting that the 2D:4D ratio, a marker influenced by prenatal testosterone exposure, can serve as a predictor of CAD risk. A higher 2D:4D ratio, indicative of lower prenatal androgen levels, has been consistently linked to increased susceptibility to cardiovascular diseases. The results of this study corroborate these observations, demonstrating a strong correlation between elevated 2D:4D ratios and the presence of CAD in males. The lack of significant differences in the individual finger lengths (2D and 4D) between the groups underscores the importance of the ratio itself as a marker. This suggests that the relative balance of prenatal hormonal influences, as reflected in the 2D:4D ratio, is more critical than the absolute size of individual fingers. The study's conclusions, suggesting that the 2D:4D ratio may be useful in the diagnosis, prognosis, and early lifestyle intervention for cardiovascular diseases, are supported by the statistically significant findings. However, it is important to acknowledge the limitations of this study, including its relatively small sample size and the specific demographic of the participants. Future research should aim to validate these findings in larger, more diverse populations, including different ethnic groups, to assess the generalizability of the results. Additionally, longitudinal studies are needed to determine the predictive value of the 2D:4D ratio for the development of CAD over time. Further studies should also investigate the specific mechanisms through which prenatal hormonal influences, as reflected in the 2D:4D ratio, contribute to the development of CAD.

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