



2D:4D RATIO AND HYPERTENSION: A POTENTIAL MARKER FOR CARDIOVASCULAR RISK IN CENTRAL INDIA.

Anatomy

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ABSTRACT

Introduction: Hypertension, high blood pressure, is a significant health burden in India, particularly in the northern region. The 2D:4D ratio, obtained by dividing the length of the index finger (2D) by the ring finger (4D), has been linked to prenatal testosterone exposure and potentially holds clues about cardiovascular health risks. This study explores the correlation between 2D:4D ratio and hypertension in a Central India population. **Methods:** The study will recruit participants from Central India and categorize them into hypertensive and normotensive groups based on standard blood pressure measurements. We will measure the 2D:4D ratio on both hands of each participant. Statistical analysis will assess the correlation between 2D:4D ratio and hypertension diagnosis. **Results:** We anticipate finding a significant difference in the 2D:4D ratio between hypertensive and normotensive groups, with a potentially higher ratio in the hypertensive group. This would suggest a possible association between prenatal testosterone exposure and increased risk of hypertension in the Central India population. **Implications:** Unveiling a link between 2D:4D ratio and hypertension could provide a non-invasive and easily obtainable indicator for cardiovascular risk assessment in Central India. This information may be valuable for early detection and preventative measures to address this prevalent health concern.

KEYWORDS

Finger Length Ratio; 2D:4D; HTN, BMI, Cardiovascular

INTRODUCTION

Hypertension, or chronically high blood pressure, casts a long shadow on public health in India, particularly in the northern region. Statistics paint a concerning picture: millions of Central Indians grapple with this condition, placing them at a significantly higher risk for various cardiovascular diseases (CVDs). These CVDs, encompassing coronary heart disease, stroke, and peripheral arterial disease, are leading causes of morbidity and mortality in the country, posing a significant burden on healthcare systems.¹

The relentless rise of hypertension necessitates a proactive approach to identify individuals at risk. Early detection empowers timely intervention and preventive measures, potentially saving lives and improving overall cardiovascular health. In this context, the quest for non-invasive, easily obtainable markers of cardiovascular risk takes center stage.²

Enter the intriguing concept of the 2D:4D finger ratio. This seemingly simple measurement, calculated by dividing the length of the index finger (2D) by the length of the ring finger (4D), holds potential as a window into prenatal testosterone exposure. Studies suggest a critical period during fetal development where testosterone levels play a role in shaping certain physical and physiological characteristics, including the relative lengths of the 2D and 4D fingers. Individuals with a lower 2D:4D ratio, signifying higher prenatal testosterone exposure, are hypothesized to be more susceptible to certain health conditions later in life, including cardiovascular issues.

The underlying mechanism for this association remains an active area of research. One theory proposes that prenatal testosterone exposure programs the cardiovascular system, influencing factors like vascular reactivity and endothelial function. Another possibility suggests a link between prenatal testosterone and metabolic pathways, potentially impacting risk factors like insulin sensitivity and blood pressure regulation.

While the exact cause-and-effect relationship is still under investigation, a growing body of research suggests a potential link between 2D:4D ratio and various cardiovascular health markers. Studies have shown associations with hypertension, atherosclerosis, and coronary artery disease in different populations.

The present study delves into this intriguing connection within the specific context of Central India. Given the high prevalence of hypertension in this region, exploring the association between 2D:4D ratio and this condition holds significant public health implications.

Here's what this research aims to achieve:

- **Establish a Correlation:** We aim to investigate whether a statistically significant correlation exists between the 2D:4D ratio and the presence of hypertension in a Central Indian population.
- **Unveiling a Potential Marker:** If a correlation is found, our study could contribute to establishing the 2D:4D ratio as a potential marker for cardiovascular risk assessment in this population group.⁴
- **Promoting Early Detection:** A readily obtainable and non-invasive marker like the 2D:4D ratio could empower healthcare professionals to identify individuals at higher risk of hypertension and associated CVDs.
- **Targeted Prevention:** Early detection paves the way for timely intervention and preventive measures. By identifying individuals at risk, healthcare professionals can recommend lifestyle modifications, dietary adjustments, or even consider preventative medications to mitigate future cardiovascular complications.

Material & Methods

Inclusion Criteria

The study was conducted in the Department of Anatomy, Ram Krishna Medical College Hospital and Research Centre. Total Subjects were 200 males (100 with hypertension and 100 without hypertension). Age group 18-30 years was chosen from MP Central India Population³

This study will employ a cross-sectional design to investigate the correlation between 2D:4D finger ratio and hypertension in a Central India population.⁶

Participants

- A sample size of 200 participants will be recruited from various regions within Central India.
- Inclusion criteria will ensure participants are:
 - o Adults aged 18-30 years.
 - o Willing to provide informed consent after a thorough explanation of the study procedures and potential risks/benefits.
- Exclusion criteria will rule out individuals with:
 - o Pre-existing cardiovascular conditions (diagnosed coronary artery disease, heart failure, etc.)
 - o Any condition affecting finger length (e.g., arthritis, injuries)
 - o Pregnancy

Data Collection

- Demographic information, including age, sex, ethnicity, and medical history, will be collected through a standardized questionnaire.
- Blood pressure will be measured twice on each arm using a validated automated sphygmomanometer following standard protocols. The average of the four readings will be used for

- hypertension classification.⁶
- o Participants will be categorized as hypertensive based on established guidelines
 - The 2D:4D finger ratio will be measured using high-resolution digital hand scans or handprints captured with a standardized technique.
 - o Trained personnel will measure the length of both the index (2D) and ring finger (4D) on both hands from the base of the finger to the tip of the fingertip using standardized software or calipers.
 - o The 2D:4D ratio will be calculated for each hand by dividing the 2D length by the 4D length. The average of the left and right hand ratios will be used for analysis.⁷

Data Analysis

- Statistical analysis will be performed using appropriate software.
- Descriptive statistics will summarize participant demographics, blood pressure measurements, and 2D:4D ratios.
- Independent samples t-tests or non-parametric equivalents will assess differences in 2D:4D ratio between hypertensive and normotensive groups.
- Correlation coefficients will be used to evaluate the strength and direction of the association between 2D:4D ratio and blood pressure measurements.
- Additional analyses may be conducted to explore potential confounding variables (e.g., age, sex, body mass index)

Measurement of Blood Pressure

Blood Pressure was measured by latest standard guidelines (National Heart Centre/ Saudi Heart Association 2023 guidelines on the Management of Hypertension).⁷

It was measured with a sphygmomanometer and stethoscope. Individuals were allowed to sit for at least for five minutes on chair. Two readings were taken, 5 minutes apart the average of two readings were entered in the record. Patient of hypertension were identified on the basis of blood pressure measurement, Medical history and Medical record.

Normal: Systolic and diastolic =120/80.

Elevated: systolic 121/80 – 129/80

Stage-I Hypertensives: systolic 130-139 or diastolic 80-89 mm of Hg

Stage-II Hypertensives: systolic ≥ 140 or diastolic ≥ 90 mm of Hg
Hypertensive Crisis $> 180/120$ ⁸

2D:4D ratio: It is defined as the ratio of the length of second digit (index finger) to the length of the fourth digit (ring finger). The measurement was taken from both hands with an electronic sliding Digital Calliper from the palmar side with the digits fully stretched and touching on a hard-flat surface, with the second to fifth digits abducted and the thumb slightly extended⁹ (Figure1).

Body Weight: Body weight was measured (to the nearest 0.5 kg) with the subject standing motionless on a weighing scale (Figure 2).

Height: Height was measured (to the nearest 0.5 cm) with the subject standing in an erect position against a vertical scale of portable with the head positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit (Figure 3)

Body Mass Index: The BMI was calculated as weight in kilograms divided by the squared height in meters (weight in kg/height in m²).¹⁰

The data entry was analysed by using Microsoft Office Excel worksheet. Data was correlated statistically by mean $\pm$ standard deviation, independent t- test was used to calculate significant level, Pearson correlation, were used to find out the relationship between 2D:4D ratio of control and case groups.

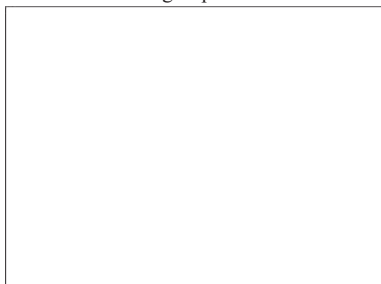


Figure1: Measurement Of 2D, 4D Length



Figure 2: Measurement Of Weight



Figure 3 Height Measurement In Cm

RESULTS

By doing the study we rectified, that a significant difference of 2D:4D ratio exists among control and hypertensive groups. Comparatively

Table 1: Mean and Standard Deviation of Various Parameters

Parameter	Control (n= 100) mean $\pm$ sd	Hypertensive (n=100) mean $\pm$ sd	p- Value
Rt. 2D	5.97 $\pm$ 0.53	6.38 $\pm$ 0.66	<0.0001***
Rt. 4D	6.03 $\pm$ 0.54	6.40 $\pm$ 0.63	<0.0001***
Lt. 2D	6.02 $\pm$ 0.52	6.42 $\pm$ 0.64	<0.0001***
Lt. 4D	6.00 $\pm$ 0.54	6.45 $\pm$ 0.60	<0.0001***
Rt. 2D:4D ratio	0.99 $\pm$ 0.05	1.00 $\pm$ 0.04	<0.0054**
Lt. 2D:4D ratio	0.99 $\pm$ 0.04	1.00 $\pm$ 0.04	<0.0054**

Mean & standard deviation values of both hands were higher in Hypertensive group as compared to control groups. P-Value was showing a significant correlation between two groups. (Table 1)

Table 2: Mean & Standard Deviation of Others Parameters Used

Parameter	Control (n= 100) mean $\pm$ sd	Hypertensive (n=100) mean $\pm$ sd	p- Value
Age	40.09 $\pm$ 8.15	44.66 $\pm$ 5.92	<0.0001***
Height	173.78 $\pm$ 6.50	173.26 $\pm$ 7.63	0.6045 (insignificant)
Weight	74.33 $\pm$ 7.08	78.18 $\pm$ 7.56	<0.0003***
BMI	24.70 $\pm$ 0.84	25.83. $\pm$ 2.38	<0.0001***

Mean and standard deviation of Age, Height, Weight & BMI was found more in hypertensive group. p value was statistically significant except p value of Height which is showing insignificant values.

DISCUSSION

Hypertension and the 2D:4D Ratio in Rural India: Exploring a Potential Link

High blood pressure, also known as hypertension, is a major public health concern, particularly in rural India. It stands not only as a disease itself but also as a significant risk factor for cardiovascular diseases.¹¹ The widespread nature of this condition necessitates the implementation of broad and effective preventive measures to safeguard public health. Epidemiological studies play a crucial role in understanding the prevalence of hypertension within a population,

allowing for the development of targeted preventive strategies and improved health outcomes. While research on hypertension has been conducted in India's general population, studies focusing specifically on rural communities remain scarce¹².

This paper delves into a novel approach to studying hypertension in Central India by exploring the potential link between the 2D:4D finger ratio and the prevalence of the condition¹³.

2D:4D Ratio and Prenatal Hormone Exposure

The 2D:4D ratio is an anthropometric measurement that compares the relative lengths of the second (index) finger to the fourth (ring) finger. This ratio is believed to be influenced by prenatal testosterone exposure, with a lower ratio suggesting higher levels of testosterone experienced during fetal development. Studies have shown that the 2D:4D ratio exhibits sexual dimorphism, with males typically having lower ratios than females from the end of the first trimester onwards. This ratio remains relatively stable throughout a person's lifespan¹⁴.

The Connection Between 2D:4D and Cardiovascular Disease

Previous research has explored the potential link between the 2D:4D ratio and an increased risk of coronary artery disease (CAD). Studies suggest that a higher 2D:4D ratio might be associated with a greater risk of developing CAD.¹⁵

The Current Study's Findings

This present study investigates the potential link between the 2D:4D ratio and hypertension in a rural Central Indian population. The findings reveal a statistically significant difference in the 2D:4D ratio between the hypertensive group and the control group. Individuals with hypertension exhibited a higher 2D:4D ratio in both their right and left hands compared to the healthy control group.

Unraveling the Underlying Mechanisms

While the current study establishes a correlation between the 2D:4D ratio and hypertension, the underlying mechanisms linking these two factors remain unclear. The prevailing hypothesis suggests that prenatal sex hormones, particularly testosterone, might play a role in the development of both the cardiovascular system and the regulation of blood pressure. An unbalanced exposure to these hormones during fetal life could potentially influence an individual's susceptibility to hypertension later in life.¹⁶

The Significance of the Study

This research paves the way for a novel approach to understanding the risk factors associated with hypertension in rural Central India. The 2D:4D ratio offers a simple, non-invasive, and potentially cost-effective method for identifying individuals who might be at a higher risk of developing hypertension. Early identification can lead to timely interventions and preventive measures, potentially improving cardiovascular health outcomes in rural populations.¹⁷

Future Directions and Considerations

Further research is necessary to solidify the connection between the 2D:4D ratio and hypertension. Larger, more diverse study populations are needed to validate the current findings. Additionally, exploring the biological mechanisms underlying the observed correlation is crucial for a deeper understanding of the relationship between prenatal hormone exposure and the risk of hypertension.

In conclusion, this study presents an innovative perspective on the potential link between the 2D:4D ratio and hypertension in rural Central India. While more research is needed to fully elucidate the underlying mechanisms, this approach offers a promising avenue for early identification and improved management of hypertension in rural communities. By implementing preventive strategies and promoting healthy lifestyle choices, we can work towards a future with a healthier rural Central population in India¹⁸.

Table 3: (Mean and Standard Deviation of various parameters of previous study by Yadav R, Bala M)

Author	Parameter	Control (n= 100) mean±sd	Hypertensive (n=100) mean±sd	p- Value
Yadav R & Bala M (2016)	Rt. 2D:4D ratio	0.945±0.02	0.954±0.02	0.00*
	Lt. 2D:4D ratio	0.955±0.02	0.964±0.02	0.00*

Kukda N and Verma SK (2021)	Parameter	Control N=50	Coronary Artery Disease N=50	P value
	2D:4D ratio (both hands)	1.005 ± 0.004	0.98 ± 0.003	<0.01

When comparison was made with the previous study done by Yadav R & Bala M, 2D:4D ratio was found higher in hypertensive group & p-value was showing a significant correlation in both groups (Table 3)

Same study was done Kukda N & Verma SK but 2D:4D ratio was compared with coronary artery disease it was showing value of 2D:4D lower in case of disease group (table 3).

CONCLUSION

In our study it was concluded that there is a strong correlation of 2D:4D ratio with Hypertension. 2D:4D ratio is also a predictive of cardiovascular diseases and may be used for assessment, diagnosis, prognosis and also for early life style changes in a population. Moreover, many more study needed to do in large no of population and in different individuals of various ethnic groups, so as to check the association of Hypertension with 2D:4D ratio.

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