# Cardiothoracic Ratio, Vertical Height, Transverse Dimension of the Trachea of Nigerians Resident Port Harcourt, Rivers State, Nigeria 

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#### Abstract

Introduction: Cardiothoracic ratio and vertical height are important indicators of cardiac size. The chest radiograph provides excellent contrast between the air-filled, cardiac, and aortic outlines. Aim of the study: This study was aimed at determining the mean Cardiothoracic ratio, vertical height, transverse dimension of the trachea of Nigerians resident in Port Harcourt. Materials and Methods: This was a retrospective descriptive study carried out in the Radiology Radiology Department of the University of Port Harcourt Teaching Hospital, Rivers State. The study duration was 8 months (January-September, 2021), which involved four hundred and forty-eight ( 216 males and 232 females) normal chest radiographs of Nigerians in Rivers State, age between 13 and above. The radiographs were found to be normal by a qualified radiologist in the department. Random sampling was used to determine the sample size for the study. Results and Discussions: Males [VH(cm) 20.18 $\pm 2.78$; TDT(cm) 1.49 $\pm 0.38$; ACR $0.45 \pm 0.07$; CTR $41.93 \pm 3.62$ females; $\mathrm{VH}(\mathrm{cm}) 19.08 \pm 2.58$; TDT $(\mathrm{cm}) 1.42 \pm 0.27$; ACR $(\mathrm{cm}) 0.48 \pm 0.06$; CTR $41.50 \pm 3.40]$. The males had repeatedly higher values vertical height and cardiothoracic ratio than the females, while the females had a higher value for aorto-cardiac ratio. Conclusions: The values of vertical height, cardiothoracic ratio, transverse dimension of trachea, and aorto-cardiac ratio demonstrated sexual dimorphism, the males had consistently higher values than the females except for aorto-cardiac ratio. Keywords: Vertical height, Cardiothoracic ratio, Transverse dimension of trachea, and Aorto-cardiac ratio, Rivers State. Copyright © 2023 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC 4.0) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.


## Introduction

The middle mediastinum's hollow, musculoskeletal heart is intended to circulate both oxygenated blood for the systemic circulation and deoxygenated blood for the pulmonary circulation [1, 2]. Several studies have been done on the establishment of a normal heart diameter at different levels. The chest radiograph has proven to be of immense benefit and utmost importance in the initial diagnosis of cardiac and thoracic enlargements with increase in prevalence of cardiovascular dysfunction over the last decade [3, 4].

Cardiothoracic ratio and vertical height are important indicators of cardiac size. The chest radiograph provides excellent contrast between the airfilled, cardiac, and aortic outlines [5, 6]. Deviations from normal measurements suggest pathology. Heart size is usually measured on posteroanterior (PA) chest radiographs [7]. However, where this is not feasible, the
alternative use of an anteroposterior (AP) radiograph for assessment of heart diameter is traditionally considered unsatisfactory because of variables that include film-focus distance (FFD) and the anterior position of the heart in the chest, which together will influence magnification [8-10].

The examination of cardiothoracic ratio and vertical height are vital as it provides baseline values for the region, which could serve as a reference. Hence, this study was aimed at determining the mean cardiothoracic ratio, vertical height, transverse dimension of the trachea of Nigerians resident in Port Harcourt.

## MATERIALS AND METHODS

Research Design: This was a retrospective descriptive study.

## Study Area

The study was carried out in the Radiology Department of University of Port Harcourt Teaching Hospital, Rivers State.
Study Duration: The study spanned from the month of January 2021 till September 2021.

## Study Setting

Four hundred and forty-eight (216 males and 232 females) normal chest radiographs of adult Rivers aged between thirteen and ninety-one years were obtained. The radiographs were found to be normal by a qualified radiologist in the department.

## Sampling Technique

The study was carried out using a simple random sampling technique whereby samples were selected at random such that each x-ray film was chosen entirely by chance and each film had an equal chance of being included in the sample in order to achieve an unbiased sample. All chest radiographs that met the inclusion criteria were considered in this study.

## Criteria for Subject Selection

All radiographs of participants who are Nigerians resident in Port Harcourt whose ages were between 13years and above, who had no pathological conditions, and had normal chest radiographs were included. While, subjects who did not know their health conditions and non-consenting adults were excluded from the study.

Instrument for data collection: All measurements were taken under good illumination from a view box with a standard rule and pencil.

Data Collection: The data for the various parameters were collected following the various methods:

## 1) Cardiothoracic Ratio

This is calculated by the division of the transverse cardiac diameter (heart diameter) over the transverse thoracic diameter (chest diameter).


Fig 1: Labeled x-ray image of the chest showing the cardiac diameter and the widest internal thoracic diameter

## 2) Vertical Height

Measured at the inferior border of the $1^{\text {st }}$ posterior costal cartilage to the dome of the diaphragm vertically.


Fig 2: x-ray image showing how the Vertical Height (VH) was measured.

## 3) Transverse Dimension of the Trachea

This was measured from both dark ends of the trachea.


Fig 3: Illustration on how the Transverse Dimension of the Trachea (TDT) was measured.

## Statistical Analysis

The data were analyzed using the SPSS (Statistical Package for Social Sciences) $16^{\text {th }}$ version and a z-test was used to determine if there is a significant difference and $\mathrm{P}<0.05$, was taken as statistically significant.

## RESULTS

The results showed the mean value of all measured parameters for subjects 18 years and above.

Table 1: Mean values of all and calculated measured parameters for adult males aged 18 and above

| Variables | Sample Size | Mean $\pm$ SD | Minimum | Maximum | Range |
| :--- | :--- | :--- | :--- | :--- | :--- |
| AGE | 167 | $44.15 \pm 21.54$ | 18.00 | 90.00 | 72.00 |
| VH $(\mathrm{cm})$ | 167 | $20.20 \pm 2.81$ | 11.20 | 28.60 | 17.40 |
| TDT $(\mathrm{cm})$ | 167 | $1.49 \pm 0.40$ | 1.00 | 5.50 | 4.50 |
| ACR | 167 | $0.46 \pm 0.068$ | 0.17 | 0.63 | 0.46 |
| CTR | 167 | $41.71 \pm 3.52$ | 34.00 | 49.76 | 15.76 |

Table 2: Mean values of measured and calculated parameters for adult females aged 18 and above.

| Variables | Sample Size | Mean $\pm$ SD | Minimum | Maximum | Range |
| :--- | :--- | :--- | :--- | :--- | :--- |
| AGE $(\mathrm{yrs})$ | 169 | $40.93 \pm 20.22$ | 18.00 | 91.00 | 73.00 |
| VH $(\mathrm{cm})$ | 169 | $19.08 \pm 2.58$ | 13.20 | 26.70 | 13.50 |
| TDT $(\mathrm{cm})$ | 169 | $1.43 \pm 0.27$ | 0.90 | 2.40 | 1.50 |
| ACR | 169 | $0.48 \pm 0.06$ | 0.30 | 0.68 | 0.38 |
| CTR | 169 | $41.44 \pm 3.40$ | 34.81 | 50.00 | 15.19 |

Table 3: Mean values of all measured and calculated parameters for both males and females from 13-91 years

| Variables | sex | Sample Size | Mean $\pm$ SD | Minimum | Maximum | Range |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| AGE | F | 232 | $34.09 \pm 20.58$ | 13.00 | 91.00 | 78.00 |
|  | M | 216 | $37.83- \pm 22.25$ | 14.00 | 90.00 | 76.00 |
| VH(CM) | F | 232 | $19.67 \pm 2.69$ | 11.20 | 26.70 | 15.50 |
|  | M | 216 | $20.18 \pm 2.78$ | 11.20 | 28.60 | 17.40 |
| ACR | F | 232 | $1.42 \pm 0.26$ | 0.90 | 2.40 | 1.50 |
|  | M | 216 | $1.49 \pm 0.38$ | 1.00 | 5.50 | 4.50 |
| CTR | F | 232 | $0.47 \pm 0.06$ | 0.30 | 0.68 | 0.38 |
|  | M | 216 | $0.45 \pm 0.07$ | 0.17 | 0.63 | 0.46 |
|  | F | 232 | $41.50 \pm 3.40$ | 34.81 | 50.00 | 15.19 |
|  | M | 216 | $41.93 \pm 3.62$ | 34.00 | 50.00 | 16.00 |

Key* VH - Vertical Heigh, TDT - Transverse Dimension of Trachea, ACR - Aorto-cardiac Ratio, CTR- Cardiothoracic Ratio

The results shows comparisons of the mean values of the measured and calculated parameters. The table below shows a comparison of mean values of the measured parameter for Cardiothoracic Ratio of present study to past study. It compares the mean values of
various measured Cardiothoracic Ratio obtained from past study carried out on other human populations with that of the present study. It was observed that, there were ethnic differences.

Table 4: A comparison of mean values of Cardiothoracic Ratio of present study to past studies

| Author | Ethnic Group | Age Group | Males CTR <br> Mean $\pm$ SD | Females CTR <br> Mean $\pm$ SD |
| :--- | :--- | :--- | :--- | :--- |
| Mensah et al., (2005) | Ghanaians | $20-29$ | $44.0 \pm 0.04$ | $46.0 \pm 0.04$ |
|  |  | $40-49$ | $47.0 \pm 0.041$ | $48.0 \pm 0.04$ |
|  | $50-59$ | $48.0 \pm 0.05$ | $49.0 \pm 0.01$ |  |
|  | $60+$ | $48.00 \pm 0.00$ | $52.0 \pm 0.05$ |  |
| Present Study | Nigerian <br> population | $20-29$ | $42.68 \pm 3.52$ | $41.23 \pm 2.77$ |
|  |  | $42.10 \pm 3.45$ | $41.94 \pm 4.40$ |  |
|  |  | $50-59$ | $41.20 \pm 3.54$ | $40.99 \pm 3.09$ |
|  | $60+$ | $40.53 \pm 2.90$ | $41.88 \pm 1.89$ |  |

Key* CTR= Cardiothoracic Ratio

## DISCUSSIONS

## Summary of Results

Males [VH (cm) 20.18 $\pm 2.78$; TDT (cm) $1.49 \pm 0.38$; ACR $0.45 \pm 0.07]$; females [VH (cm) $19.67 \pm 2.69$; ACR (cm) $0.47 \pm 0.06]$; CTR (cm) 41.50 $\pm 3.40]$.

The males had repeatedly higher values vertical height and cardiothoracic ratio than the females, while the females had a higher value for aorto-cardiac ratio.

## Implications of findings

Cardiothoracic ratio is a very simple and useful tool in screening for cardiovascular diseases [11]. When normal value for the local population is known, it serves as a baseline for proper assessment [12].

The mean values of the Cardiothoracic Ratio in our study for both males and females were $41.93 \pm$ 3.62 and $41.50 \pm 3.40$ respectively. This measured parameter was significantly higher in males than in females. This correlates with the findings of Mohamed et al. [13] who carried out a research on 50 normal subjects. His results showed that the mean value for cardiothoracic ratio was higher in males than in females with their mean values being $0.44 \pm 0.036$ and $0.41 \pm$ 0.029 respectively. The males and females in our study had less cardiothoracic ratio than the values reported by Mohamed et al., [13]. Again, our present findings corroborates the report of Oladipo et al., [14] who reported increasing values for the males as compared to the females.

Changes in tracheal dimensions occur in variety of conditions. For example, generalized widening is a characteristics feature of trachecobronchomegaly and tracheacheomalacia: generalized narrowing is seen in tracheobrochonpathia osteochondroplastia and may be a feature of relapsing polychondritis. Knowledge of normal tracheal
dimensions on conventional chest radiographs is essential to the diagnosis of these conditions [15]. The Transverse Dimension of the Trachea (TDT) for both males and females were $1.49 \pm 0.38$ and $1.42 \pm 0.26$ respectively. It was observed to be significantly higher in males than in females ( $\mathrm{p}<0.05$ ).

## CONLUSIONS

The present study showed that the males had repeatedly higher values vertical height and cardiothoracic ratio than the females, while the females had a higher value for aorto-cardiac ratio, which depicts sexual dimorphism in the values.

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