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Original Research Article

Selected Radiological Chest Morphometry of Nigerians Resident in Port Harcourt, Rivers State, Nigeria

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Abstract

Background: The chest radiograph provides excellent contrast between the air-filled, cardiac, and aortic outlines. Deviations from normal measurements suggest pathology. This study was aimed at measuring the selected normal chest morphometry of Nigerians residing in Port Harcourt to establish a baseline for people in a normal condition. ***Materials and Methods***: This was a retrospective descriptive study carried out in the 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 adult Rivers aged between 18 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:*** For adult males aged 18 and up, the mean values of all measured parameters were: TAD (cm): 4.15 ±21.54; TCD (cm): 10.88 ±1.55; WITD (cm): 26.06 ±3.25; and mean age (yrs): 44.15 ±21.54. TAD (cm) was 5.11±0.69 in females, TCD (cm) was 10.8±21.50, WITD (cm) was 26.05±2.98 and the mean age (yrs) was 40.93±20.22. In the two variables (TCD and WITD), the males had slightly higher values than the females, although not significantly higher, while the females had a higher TAD, also not significantly higher. ***Conclusions:*** The correlation between the transverse aortic diameter and the transverse cardiac diameter for female subjects; the correlation between the transverse aortic diameter and the transverse cardiac diameter for male subjects; and the correlation between the transverse cardiac diameter and the widest internal thoracic diameter were all positively correlated (r = 0.611, r = 0.566, r = 0.822, P 0.05).

Keywords: TAD, TCD, WITD, Nigerians, Rivers State.

INTRODUCTION

Chest radiography is the most commonly used modality for the detection of cardiomegaly and the evaluation of the cardiothoracic ratio. It is an important indicator of cardiac size [1]. With the increase in prevalence of cardiovascular dysfunction over the last decade, the chest radiograph has proven to be of enormous benefit and utmost importance in the initial diagnosis of cardiac and thoracic enlargements [2].

The chest radiograph provides excellent contrast between the air-filled, cardiac, and aortic outlines [1, 2]. Deviations from normal measurements suggest pathology. Heart size is usually measured on posteroanterior (PA) chest radiographs [2]. 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 [1, 2].

The determination of the heart's size plays a crucial role in the clinical diagnosis of a healthy or failing heart. In this measurement, various imaging methods abound, but the chest x-ray has appeared to be the most common and the most readily used due to its affordability and simplicity [3]. A postero-anterior chest radiograph will show the aortic arch diameter as part of the structures, and a radiological examination of the heart will invariably include the aorta [3, 4]. Increases in the transverse diameter of the arch aorta have been severally associated with hypertension and cardiac dysfunction [5, 6]. Enlargement of the aortic shadow as seen in the chest radiograph has been associated with

symptomless [7] made a strong association between the aortic diameter and blood pressure.

Several studies have been done on the establishment of a normal heart diameter at different levels [8]. This morphometry is essential as it provides baseline values for the region, which could serve as a reference. Hence, this study was done to provide baseline information for 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 the University of Port Harcourt Teaching Hospital, Rivers State.

Study Duration

The study spanned from January 2021 until 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 18 and above, who had no pathological conditions, and had normal chest radiographs were included. 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 parameters considered in this study are transverse aortic diameter (TAD), transverse cardiac diameter (TCD), and widest internal thoracic diameter (WITD). The following methods were used to collect data for the various parameters:

1) Transverse aortic diameter

This was measured from the 1st intercostal space between the 1st and 2nd ribs on both the right and left sides.

Fig 1: x-ray image of the chest showing how the Transverse Aortic Diameter (TAD) is measured

2) Transverse Cardiac Diameter

Taken horizontally from about the 4th intercostal space running from the right to the left.

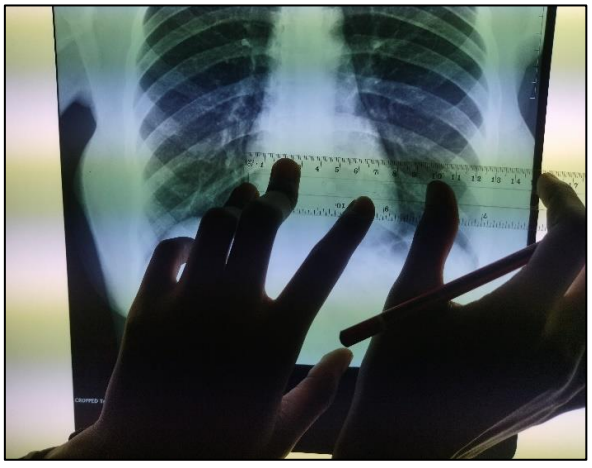

Fig 2: x-ray image showing measurement of the Transverse Cardiac Diameter (TCD)

3) Widest Internal Thoracic Diameter

This was measured horizontally from the 8th coastal cartilage of both the right and left side. The inner widest point of the ribcage is usually the landmark.

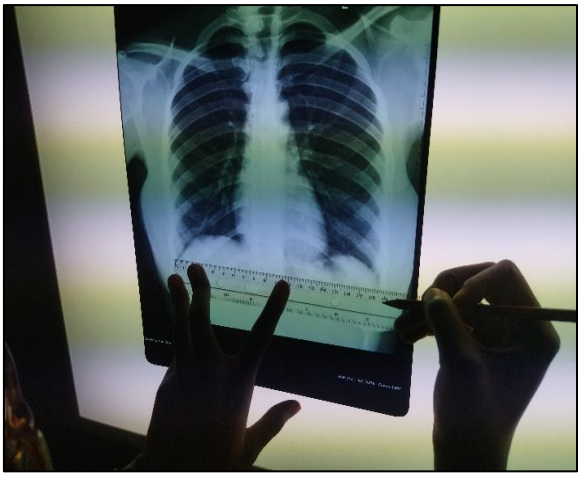

Fig 3: x-ray image showing measurement of the Widest Internal Thoracic Diameter (WIDT)

Statistical Analysis

The data were analyzed using the SPSS (Statistical Package for Social Sciences) 16th version and a z-test was used to determine if there is a significant difference and $P<0.05$, was taken as statistically significant. A correlation and regression analyses were done to determine the relationship that exists between variables.

RESULTS AND DISCUSSIONS

The results were presented in mean, standard deviation, minimum value and range of the measured and calculated parameters. The sample size for the study was 216, age ranged from 18years and above with age 34.09 as the mean age of the distribution. The parameters were all measured in centimeters.

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

Variables	Total count	Mean±SD	Minimum	Maximum	Range
AGE	167	44.15±21.54	18.00	90.00	72.00
TAD(cm)	167	4.95±0.91	2.00	7.00	5.00
TCD(cm)	167	10.88±1.55	7.00	14.60	7.60
WITD(cm)	167	26.06±3.25	17.10	30.00	12.90

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

Variables	Total count	Mean±SD	Minimum	Maximum	Range
AGE(yrs)	169	40.93±20.22	18.00	91.00	73.00
TAD(cm)	169	5.11±0.69	3.10	7.50	4.40
TCD(cm)	169	10.82±1.50	7.00	15.40	8.40
WITD(cm)	169	26.05±2.98	17.10	30.00	12.70

Table 3: Regression Equations for some of the measured parameters for male subjects

Variable	Regression Equation
Transverse Cardiac Diameter* Thoracic Diameter (cm)	Transverse Cardiac Diameter= 0.723 + 0.391x (Widest Internal Thoracic diameter)
Transverse Aortic Diameter*Transverse Cardiac Diameter (cm)	Transverse Aortic Diameter = 1.26 + 0.336x (Transverse Cardiac Diameter)

Table 4: Regression Equations for some of the measured parameters

Variable	Regression Equation
Transverse Cardiac Diameter*Thoracic Diameter (cm)	Transverse Cardiac Diameter = 0.024 + 0.414x (Widest Internal Thoracic Diameter)
Transverse Aortic Diameter*Transverse Cardiac Diameter (cm)	Transverse Aortic Diameter =1.98 + 0.287x (Transverse Cardiac Diameter)

The table below shows a comparison of mean values of the measured parameter for transverse aortic diameter (TAD) of present study to past study. It compares the mean value of the measured TAD obtained from past study carried out on other human populations with that of the present study. The mean values of the measured parameter were observed to be higher in the males than in females when compared with the exception of the present study.

Table 5: A comparison of mean values of measured TAD of present study to past study

Author	Ethnic Group	Age Group	Males TAD Mean±SD	Females TAD Mean±SD
Yousef *et al.*, [8]	Sudanese	19-57	5.313±0.541	5.85±0.672
Present study	Rivers	18-91	4.95±0.91	5.11±0.69

Key* TAD= Transverse Aortic Diameter

Table 6: Showing a comparison of mean values of measured TCD of present study to past studies

Author	Age Group	Males TCD Mean±SD	Females TCD Mean±SD
Lauder and Milne [9]	62-69 70-79 80-90	13.60±1.51 13.85±1.45 14.43±1.26	12.81±1.42 13.16±1.36 13.39±1.53
Yousef *et al.*, [8]	19-57	12.667±1.57	11.292±1.593
Present Study	62-69 70-79 80-90	10.64±1.01 10.65±1.79 19.46±1.32	10.03±1.67 9.32±2.03 11.45±1.22

Key* TCD= Transverse Cardiac Diameter

Table 7: A comparison of mean values of measured WITD of present study to past studies

Author	Ethnic Group/Country	Age Group	Males WITD Mean±SD	Females WITD Mean±SD
Obikili *et al*., [10]		20-29 40-59 60+	29.6±1.9 29.0±1.7 27.8±2.7	26.3±1.5 27.1±1.6 25.1±1.7
Potter *et al*., [11]	Americans	32-50 60-69	31.6±31.8	
Ashcroft and Miali [12]	Jamaicans	35-44 55-64	31.4±1.8 30.8±2.0	27.9±1.7 26.1±2.0
Yousef *et al.*, [8]	Sudanese	19-57	28.941±2.474	26.753±3.112
Present study	Rivers	18-91	26.06±3.25	26.05±2.98

Key* WITD= Widest Internal Thoracic

The table below shows a comparison of mean values of the measured parameter for Transverse Cardiac Diameter (TCD) of present study to past study. It compares the mean value of the measured TCD obtained from past study carried out on other human populations with that of the present study. The mean values of the measured parameter were observed to be higher in the males than in females when compared. It was observed that, there were ethnic differences.

The figure below shows the correlation between transverse aortic diameter and the transverse cardiac diameter for female subjects. It was observed that, there was a positive correlation between the transverse aortic diameter and the transverse cardiac diameter P<0.05.

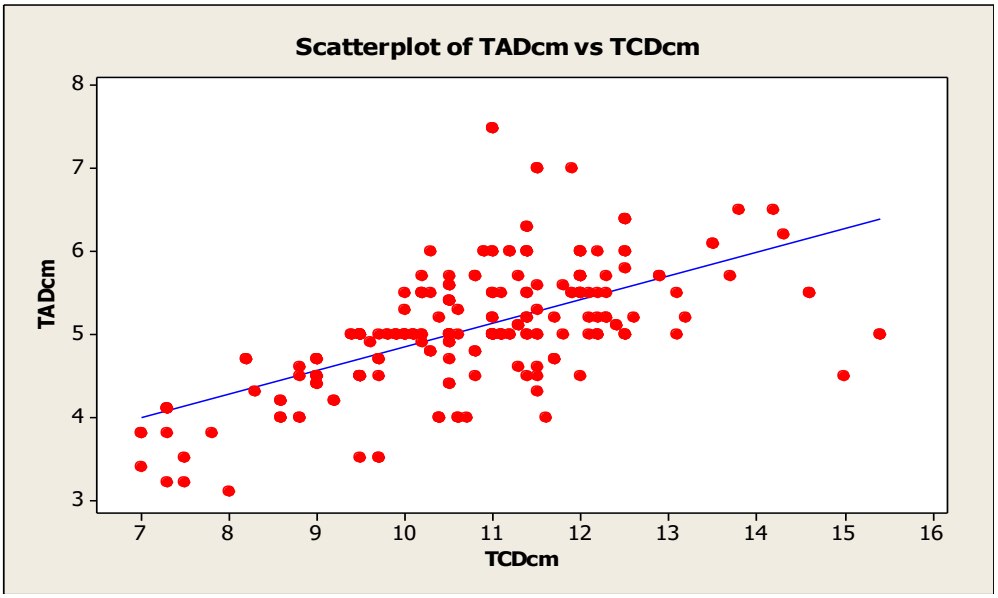

Figure 4: Pearson correlation of Transverse Aortic Diameter (TADcm) and Transverse Cardiac Diameter (TCDcm) of female subjects' r = 0.611

The figure below shows the correlation between the transverse aortic diameter and the transverse cardiac diameter for male subjects. It was observed that there was a strong positive correlation between the transverse aortic diameter and the transverse cardiac diameter P<0.05.

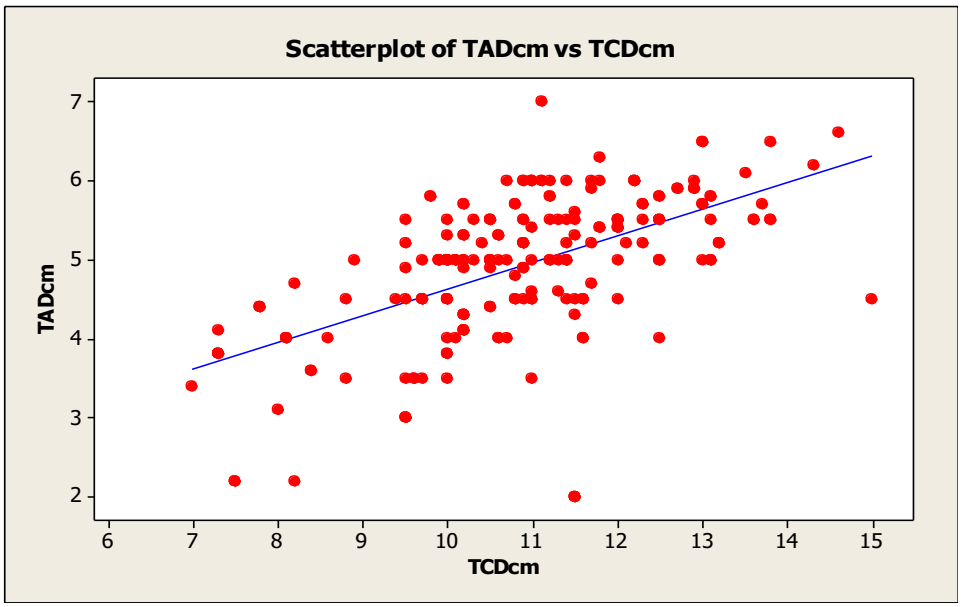

Figure 5: Pearson correlation of Transverse Aortic Diameter (TADcm) and Transverse Cardiac Diameter (TCDcm) of male subjects' r = 0.566

The figure below shows the correlation between Transverse cardiac diameter and the widest internal thoracic diameter. It was observed that, there was a strong positive correlation between the Transverse cardiac diameter and the widest internal thoracic P<0.05.

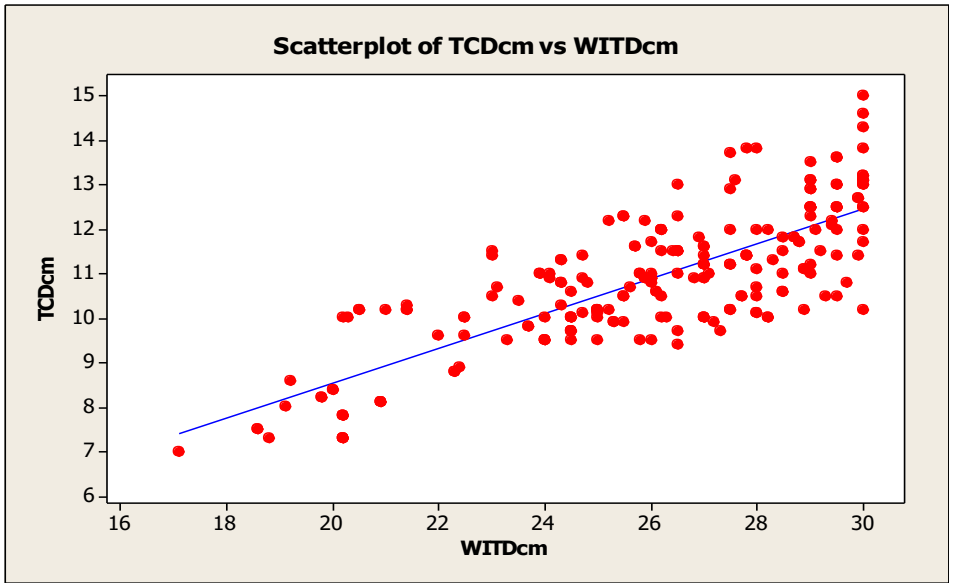

Figure 6: Pearson correlation of Transverse Cardiac Diameter (TCDcm) and Widest Internal Thoracic Diameter (WITDcm) of male subjects' r = 0.787

The figure below shows the correlation between Transverse cardiac diameter and the widest internal thoracic diameter. It was observed that, there was a strong positive correlation between the Transverse cardiac diameter and the widest internal thoracic P<0.05.

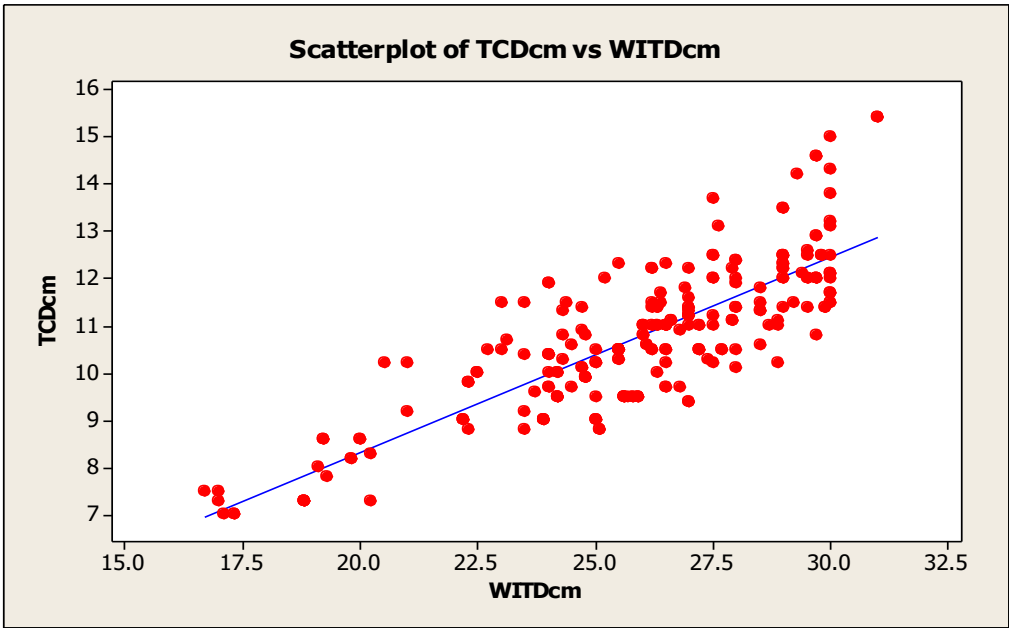

Figure 7: Pearson correlation of Transverse Cardiac Diameter (TCDcm) and Widest Internal Thoracic Diameter (WITDcm) of female subjects' r = 0.822

DISCUSSIONS

Summary of results

The mean values of all measured parameters for adult males aged 18 and above: TAD(cm) 44.15±21.54, TCD(cm) 10.88±1.55, WITD(cm) 26.06±3.25, mean age (yrs) 44.15±21.54. (Table 1) In females: TAD(cm) 5.11±0.69, TCD(cm) 10.82±1.50, WITD(cm) 26.05±2.98, mean age (yrs) 40.93±20.22 (Table 2).

The correlation between the transverse aortic diameter and the transverse cardiac diameter for female subjects, the correlation between the transverse aortic diameter and the transverse cardiac diameter for male subjects, and the correlation between the transverse cardiac diameter and the widest internal thoracic diameter were all positively correlated (r = 0.611, r = 0.566, r = 0.822, P 0.05).

Implications

The mean values for the transverse aortic diameter (TAD) for both males and females were 4.93±0.90 and 5.06± 0.74, and it was observed that there was no significant difference between males and females in our study. In contrast to a study done by Obikili and Okoye [10], a different observation was made, where they recorded larger values of transverse aortic diameter in males than in females.

In our study, the transverse cardiac diameter (TCD) increased gradually with age, which is in agreement with a study done by Mensah *et al*., [13] on the Ghanaian population. This trend was also noted in other studies done on Caucasians and Asians [14-16]. There was an increase with age in the widest internal thoracic diameter mean values for both males and females in the present study, which correlates with a study done by Mihara *et al*., [17]. In a study done by Obikili and Okoye [10], they made a different observation in that there was a decrease with advancing age in males. He concluded that Nigerians' larger cardiothoracic ratio is likely due to their smaller widest internal thoracic diameter when compared to Caucasians and Asians.

There was a strong positive correlation between transverse aortic diameter and transverse cardiac diameter for female subjects (r = 0.611), making it significant, while the male subjects had a weak positive correlation (r = 0.566), but it was still significant (Figs 4 and 5). There was a strong positive correlation between transverse cardiac diameter and cardiothoracic ratio (CTR) for male subjects, making it clinically significant (r = 0.787).

The current study found a positive sexual dimorphism in men's measured and calculated parameters, with men getting older and having a higher mean value than women.

CONCLUSIONS

There was a strong positive correlation between transverse aortic diameter and transverse cardiac diameter for female subjects (r = 0.611), while the male subjects had a weak positive correlation (r = 0.566). The present study showed a positive sexual dimorphism in the variables, with the males having higher values than the females.

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