Evaluation Of Cardiac Sizes Of Normal Nigerians Using Posteroanterior Chest Radiographs

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Abstracts: Background: There is paucity of data on cardiac sizes and other related parameters among Africans. This study aims to establish normal values of aortic, cardiac and thoracic diameters and the cardiothoracic ratio in a normal Nigerian population. Methods: The cardiothoracic ratio of 200 males and 200 females aged between 5 and 95 years were calculated from the cardiac and thoracic diameters in posteroanterior chest radiographs in a cross-sectional study at two imaging and radiodiagnostic centres. The mean and standard deviation of aortic, cardiac, thoracic diameters and cardiothoracic ratio were established. Results: The mean values for cardiac diameter for males and females were 13.8±1.89 and 13.2±1.28cm respectively. The mean values of cardiothoracic ratio for both male and female were 46% and 48% respectively. Conclusion: The cardiothoracic ratio increased with age in both sexes. These values were larger than those reported for the Caucasians. [Egwu O.A et al NJIRM 2012; 3(3) : 116-121]

Keywords: Cardiac sizes, evaluation, posteroanterior radiographs, normal, Nigerians

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Introduction: The use of chest radiography as the most commonly used modality for the detection of cardiomegaly and the evaluation of cardiothoracic ratio has been reported by Tatsuji et al[1]. They also reported that it is possible to accurately evaluate both cardiac size and volume with variety of invasive and noninvasive techniques[1].

Posterior chest radiograph used in the detection of cardiomegaly and the evaluation of cardiothoracic ratio is regarded as an important method of cardiac size assessment[2] and has become the most common because of the obvious easy availability and affordability[3]. It also has the advantage of technical simplicity and widespread availability of equipment particularly in the developing countries.

Cardiothoracic ratio (CTR) is the ratio of the widest transverse cardiac diameter to the widest transverse inner thoracic diameter which may be expressed in percentages as seen on chest radiograph. In measuring the cardiothoracic ratio the clinician compares the transverse diameter of the heart to the internal thoracic diameter (inner aspect of the ribs) at its widest point. CTR should be less than 50% (0.5) on a posterior anterior chest radiograph but may appear magnified on anteroposterior (AP) films. The cardiothoracic ratio is affected by such factors as age, phase of respiration, body posture, physique, attitude and race. Kerwin[4] was the first to suggest that racial differences may affect cardiac size. Ashcroft and Mial [5] noted a higher cardiothoracic ratio in blacks than whites.

There is paucity of literature on heart dimensions in the African population and as a result of the racial variations described by some authors, it becomes imperative to establish a data for the African population and subpopulations. The aim of this study, therefore, is to establish a standard data base that is specific for our population and could be used in the evaluation of cardiovascular diseases in our environment.

Materials and Methods : This is a cross-sectional study on the transverse diameter, aortic arch diameter and cardiothoracic ratio of normal Nigerians at two Imaging and radiodiagnostic centres viz Radiology department of Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria and Waves Diagnostic Centre, Nnewi, Nigeria.

Four hundred subjects (200 males and 200 females) were recruited for the study. The sample population was selected from subjects that presented for routine chest x-ray examination for the purpose of pre-employment, preadmission requirements and visa applications. The subjects were without any apparent cardiovascular symptoms or diseases. The blood pressure of subjects was measured to rule out any hypertensive heart disease. Technical inadequacies of the chest radiographs such as inadequate inspiration, excessive inspiratory effort, inability to accurately delineate one or more heart borders with confidence and subject rotation were some of the exclusion criteria. Others were chest wall deformity, pulmonary disease and chest radiographs done in other views other than erect posteroranterior. All the subjects with normal blood pressure were included in the study.

All the posterioranterior (PA) chest radiographs used for the study were produced under identical conditions. The films were non-grid at 1.8m taken at 100 to 110kvp. The tube was 1.8m from the subjects and the radiographs in the erect position at normal quiet inspiration[6]. The films that did not meet the criteria of normality formulated by Kabala and Wilde[7] and Brockington and Bohrer[8] were excluded from the study. The PA chest radiography was placed on the viewbox. The transverse cardiac diameter was measured as described by Danzer[2]. The transverse cardiac diameter of the heart is the sum of the greatest cardiac diameter to the right and to the left of midline. Measurement of the transverse thoracic diameter was taken at the level of the dome of the right diaphragm and measured as the widest horizontal distance inside the rib cage at this level. CTR was determined by dividing the cardiac diameter by the thoracic diameter.

STATISTICAL ANALYSIS

Data were expressed as mean ± standard deviation and was analyzed using statistical package for social sciences (SPSS) version 14.0. Statistical significance was considered at $P<0.05$.

Ethical Consideration: In line with Belmont report of 1979, ethical approval was obtained from the Ethics/Research committee of the Faculty of Basic Medical Sciences, College of Medicine, Anambra State University, Uli, Anambra State.

Results : Two hundred (200) male subjects were aged between 5 and 95 years (mean 39.9±17.8 years) and the female subjects were aged between 10 and 95 years (mean 47.6±17.9 years). The mean chest diameter in the sampled populations was 28.0±2.4. The mean chest diameter of 29.1±2.76cm and 26.9±2.04cm were recorded for males and females respectively.

Table 1 shows the mean values of the various parameters such as aortic arch diameter, cardiac diameter, right cardiac diameter, left cardiac diameter and cardiothoracic ratio in the sampled population irrespective of gender or age.

Table 1 Shows mean values of Cardiac and thoracic parameters.

Parameter	Minimum values (cm)	Maximum values (cm)	Mean
Aortic arch diameter	3.2	7.8	5.4±0.73
Cardiac diameter	9	19.3	13.8±1.89
Right Cardiac diameter	2.8	6.2	4.5±0.81
Left Cardiac diameter	5	13.3	9.3±1.55
Thoracic diameter	18.6	34.2	29.1±2.76
Cardiothoracic ratio	0.34	0.59	0.46±0.04

Table 2 shows the distribution of measured parameters according to subjects' age. The table indicates that the very old subjects >90 years have large mean values for aortic arch, cardiac diameter, left cardiac diameter and cardiothoracic ratio

Table 2 Shows distribution of measured parameters according to subjects' age

Age group (years)	Aortic arch	Cardiac diameter	Right cardiac diameter	Left cardiac diameter	Thoracic diameter	CTR
<20 (n=27)	4.2±0.82	12.1±2.29	3.9±0.74	8.2±1.72	25.4±4.47	0.44±0.04
20-29 (n=72)	4.9±0.54	12.7±1.12	4.1±0.89	8.3±1.00	27.8±1.88	0.45±0.04
30-29 (n=72)	5.3±0.78	14.0±1.87	4.4±0.86	9.4±1.44	29.5±2.20	0.46±0.04
40-49 (n=89)	5.2±0.66	13.9±1.39	4.4±0.65	9.4±0.98	28.1±2.21	0.49±0.04
50-59 (n=49)	5.4±0.57	13.9±1.75	4.3±0.72	9.5±1.67	28.8±2.05	0.47±0.04
60-69 (n=51)	5.4±0.62	13.2±1.11	4.4±0.66	8.6±1.27	29.5±2.93	0.48±0.05
70-79 (n=22)	5.4±0.74	13.6±1.35	4.1±0.75	9.5±1.06	26.5±2.93	0.50±0.03
80-89 (n=14)	5.2±0.87	14.0±1.24	4.4±0.84	9.7±0.96	27.7±2.57	0.48±.0.06
>90(n=04)	5.9±1.03	14.4±1.61	4.3±2.14	10.1±0.46	27.8±0.23	0.51±0.06

Table 3 shows the distribution of measured parameters according to gender. The table shows greater mean values in all the parameters for males except the cardiothoracic ratio.

Table 3 shows the distribution of measured parameters according to gender.

Gender	Aortic arch diameter (cm)	Cardiac diameter (cm)	Right cardiac diameter (cm)	Left cardiac diameter (cm)	Thoracic diameter	CTR
Male	5.4±0.79	13.8±1.89	4.5±0.81	9.3±1.55	29.1±2.76	0.46±0.04
Female	4.9±0.59	13.2±1.28	4.1±0.76	8.9±1.14	26.9±2.04	0.48±0.05

Table 4 A one-way ANOVA table showing that gender was a significant determinant of the measured cardiac and thoracic diameters

Table 4 Shows ANOVA comparing the parameters between sexes.

		Sum of squares	df	Mean square	F	Significance
Aortic diameter	Between group	16.505	1	16.505	33.826	0
	Within group	171.259	351	0.488		
	Total	187.764	352			
Right cardiac diameter	Between group	10.423	1	10.423	16.857	0
	Within group	227.538	368	0.618		
	Total	237.961	369			
Left cardiac diameter	Between group	8.408	1	8.408	4.505	0.034
	Within group	681.149	365	1.866		
	Total	689.557	366			
cardiac diameter	Between group	28.779	1	28.779	10.943	0.001
	Within group	1038.759	395	2.63		

	Total	1067.538	396			
Thoracic diameter	Between group	492.679	1	492.679	83.022	0
	Within group	2344.064	395	5.934		
	Total	2836.743	396			
CTR	Between group	0.038	1	0.038	14.468	0
	Within group	1.046	398	0.003		
	Total	1.084	399			

Table 5 A one-way ANOVA table showing that age was a significant determinant of the measured cardiac and thoracic diameters.Table 6 shows paired samples t-test which indicates that there are statistically significant differences between males and females in all the measured cardiac and thoracic diameters.

Table 5: Showing a one way ANOVA comparing the effect of age on the parameters

		Sum of squares	Df	Mean square	F	Significance
Aortic diameter	Between group	91.274	58	1.574	4.795	0
	Within group	96.49	294	0.328		
	Total	187.764	352			
Right cardiac diameter	Between group	115.318	61	1.89	4.748	0
	Within group	122.643	308	0.398		
	Total	237.961	369			
Left cardiac diameter	Between group	311.348	61	5.104	4.116	0
	Within group	378.21	305	1.24		
	Total	689.557	366			
Cardiac diameter	Between group	507.883	61	8.326	4.984	0
	Within group	559.655	335	1.671		
	Total	1067.538	396			
Thoracic diameter	Between group	1747.857	61	28.653	8.815	0
	Within group	1088.887	335	3.25		
	Total	2836.743	396			
CTR	Between group	0.478	61	0.008	4.373	0
	Within group	0.606	338	0.002		
	Total	1.084	399			

Table 6: Showing Paired sample T-test for all parameters.

Parameter	Males values	Females values	P-value	Remark
Aortic arch diameter	5.38±0.78	5.00±0.60	0	Significant
Right cardiac diameter	4.52±0.81	4.19±0.74	0	Significant
Left cardiac diameter	9.30±1.57	8.97±1.16	0.027	Significant
Cardiac diameter	13.18±1.89	13.26±1.28	0.001	Significant
Thoracic diameter	29.18±2.77	26.96±2.04	0	Significant
CTR	0.46±0.04	0.48±0.05	0	Significant

Discussion : The evaluation of heart size with the use of chest radiographs has been widely documented. Easy availability, affordability and simple nature of this means of assessing cardiac size have made it the most common method despite improved technology[1,3]. This study shows that the ratio of the heart diameter to the right and to the left of the midline is not the same. The mass of the heart to the left is greater and about two-thirds of the total heart diameter. This is in conformity to the works of Arthur and Keith[9]. The measurements of these dimensions show that the average mass of the heart to the right is 4.3cm and that to the left is 9.3cm.

The present study recorded a cardiac diameter that increased with age. As the age increases the heart size increased correspondingly. There was a minimum cardiac diameter of 9.0cm and a maximum value of 19.30cm with a mean cardiac diameter 13.5cm for both gender and 13.8±1.89cm and 13.2±1.28cm ($P>0.05$) for males and females respectively. The mean cardiac diameter of 13.5cm for both sexes is higher than 12.64cm noted in a previous study reported by Anyanwu et al[6]. From these values, it is clear that the cardiac diameter in males is greater than that of females; this was also discovered for other parameters like the aortic arch diameters and thoracic diameter except for the cardiothoracic ratio where the females recorded higher CTR than the males. This factor may be attributed to the morphological and physical differences of both genders. The sexual difference observed in heart size and CTR has also been noted by other authors[10,11,12.]

This study also noted a cardiothoracic ratio that increased with age, the mean values for age groups within 5-20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89 and >90 years were 44%, 45%, 46%, 49%, 50%, 51% and 52% respectively.

This finding is contrary to the report by Obikili et al[13] who stated that cardiothoracic ratio decreased with increasing age. The mean values of cardiothoracic ratio from both male and female were 46% and 48% respectively. This contrast may be attributed to epigenetic factors associated with the study population. The females had higher CTR values than males in this study and this corresponds to the findings of Obikili and Okoye[3] and Anyanwu et al[6]. Higher values of CTR were recorded for different black populations[6,13,14]. This study confirmed the report by Aschcroft and Mial[5] that blacks have higher cardiothoracic ratio than whites or Caucasians. This was attributed to a smaller thoracic diameter in Africans rather than to a larger cardiac diameter. This reason contrasts the report of Munro-Faure et al[15] who stated that there is greater cardiac diameter with smaller thoracic diameter being secondary –case of increased CTR. The peculiar physique of Africans due to environmental and racial factors is probably responsible for their larger cardiac diameter and cardiothoracic ratio.

Conclusion: The findings from this study have conclusively established that the cardiothoracic ratio of normal Nigerians increases with age in both sexes and the values obtained were larger than those reported for the Caucasians.

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