East African Medical Journal Vol. 93 No. 2 February 2016
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A. E. Oguntoyinbo, Department of Radiology, P. O. Adeoye, Department of Surgery, J. A. Ogunmodede, Department of Medicine, O. A. Bolarinwa, Department of Epidemiology and Community Health, H. T. Ahmed, Department of Radiology University of Ilorin, Teaching Hospital, Ilorin and A. A. Adewara, Department of Statistics, University of Ilorin, PMB 1515 Ilorin, Nigeria

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ABSTRACT

***Background*: Cardio-vascular disease (CVD) is now on the increase. The precise diagnosis of CVD is of immense clinical importance to the cardiac surgeons, pathologist and also for cardiologists. However, information on normal values for various cardio-vascular structures in Nigeria, a country with the highest population of blacks in the world is sparse. In this regard the age-related radiographic sizes of a Nigerian cohort of patients with non-cardiogenic complaints or consultations were therefore assessed.**
***Objectives*: To evaluate the limits of normal cardiac size in our environment , determine if there was a relationship between the age and size of the heart and to evaluate the relationship between sex and cardiac size and cardio-thoracic ratio.**
***Design*: A cross-sectional study.**
***Setting*: The Radiology department of University of Ilorin Teaching Hospital, Ilorin, North Central Nigeria between January to June 2012.**
***Subjects*: One Hundred patients were consecutively recruited and their chest radiographs examined after fulfilling the inclusion criteria.**
***Results*: Males accounted for 55% of the study population. The age range was 1 month to 73 years, (Mean = 29.3, SD =2.41668). The mean cardiac size was 11.7cm. The average cardiac size for adult males and females, were 11.6cm and 11.5cm respectively while that of thoracic size was 29.0cm and 26.8cm respectively. Correlation between age and cardiac size was 0.66; age and thoracic size was 0.64 and between cardiac size and thoracic size was 0.89. The paired sample t-test for age and cardiac size was less than 0.05 (p value <0.05).**
***Conclusion*: knowing the average values of cardiac size for adult males and females (11.6cm and 11.5cm) and thoracic size (29.0cm and 26.8cm) respectively from this study presents a base line for early detection of variation from normal cardiac measurements in this environment.**

INTRODUCTION

The age of an individual has a lot to do with his or her physiological, anatomical and biochemical attributes. These attributes themselves have a bearing on the responses to sicknesses or manifestations observed in disease states. Until very recently, the main causes of death in Nigeria were infectious diseases, such as tuberculosis (TB), but in recent years, the population affected by infectious diseases is decreasing (except in cases of epidemic) and the average life span is increasing in our society (1, 2, 3).

Cardio-vascular diseases (CVD) are now on the increase. From World Health Organisation (WHO) reports, an estimated 17.3 million people died from CVDs in 2008, representing 30% of all global deaths (4). Of these deaths, an estimated 7.3 million were due to coronary heart disease and 6.2 million were due to stroke (5).

Sagall emphasised that the exact diagnosis of CVD is clinically important for cardiac surgeons, pathologists and also for cardiologists (6). However, information on normal values for various cardiovascular structures in Nigeria, a country with the highest population of blacks in the world is sparse, similar study being presented by Obikili E. N. *et al* from the eastern part of the country (7, 8).

In this regard the age-related radiographic sizes

of a Nigerian cohort of patients with non-cardiac complaints or consultations were therefore assessed and the results compared with reported values of other races.

MATERIALS AND METHODS

The study was conducted at the Radiology department of University of Ilorin Teaching Hospital, Ilorin, Nigeria. Ilorin is a major city located in the North-Central region of the country. Chest radiographs of patients who presented for routine medical examinations and those with non-cardiac complaints were prospectively assessed for cardiac size and the cardio-thoracic ratio over a period of six months, from January to June 2012. The evaluations were performed either by a senior registrar or consultant radiologist. The transverse cardiac diameter (the horizontal distance between the most rightward and leftward borders of the heart seen on a postero-anterior (PA) chest radiograph was measured and this was divided by the transverse chest diameter (measured from the inside rib margin at the widest point above the costo-phrenic angles on a PA chest film) to give the cardiothoracic ratio (CTR). A cardio-thoracic ratio of more than 50%, is considered abnormal in an adult; more than 66% in a neonate[9, 10].

The value of the cardiac diameter itself was also measured and documented as well as the age and sex of the patients for 100 patients that met the exclusion criteria listed as follows:

1. Obvious gross lesion or defect of the heart or pericardium
2. Cardiac malformation or past history of heart disease
3. Past history of hypertension
4. Abnormal curvature of vertebral column or chest wall deformity
5. Signs of dehydration, presence of ascites, oedema, urinary retention, large cysts and tumor, pregnancy or defect in a part of the body
6. Functional thyroid disease
7. Clinical findings suggestive of gross nutritional deficiencies.

Data obtained were collated and checked for inconsistencies. Statistical Package for the Social Sciences (SPSS), version 18 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Descriptive statistics and correlations of variables associations were presented in tabular forms while means were compared using student t-test. P values of <0.05 were taken as significant.

RESULTS

Males accounted for 55% of the study population. Age range was from one month to seventy-three years (Mean = 29.3, SD = 2.41668). The mean cardiac size was 11.7cm. The average cardiac size for adult males and females, were 11.6cmand 11.5cm respectively while that of thoracic size was 29.0cm and 26.8cm respectively. Correlation between age and cardiac size was 0.66; age and thoracic size was 0.64 and between cardiac size and thoracic size was 0.89. The paired sample t-test for age and cardiac size was less than 0.05 (p value < 0.05). Other statistics obtained are shown in the Tables and figures, below including the averages (means) stated above.

The age-related change in heart size shows a progressive increase in cardiac size amongst males from birth to earlier fourth decade, after which it gradually decreased or tailed- off (figure 1): whereas amongst females, heart size progressively increased from birth to the early fifth decade, after which it gradually decreased or tailed-off (figure 2). P-value 0.001. At age 10 and below there were more patients (46.7%) with Cardio-thoracic ratio (CTR) of more than 50% while the reverse was observed in higher age groups. This observation was statistically significant (P=0.018), bearing in mind that in children CTR up to 60% is still taken as normal.

Table 1a
Socio-demographic profile

Socio-demography (N=100)	Frequency (%)
Age group	
<10	15.(15)
11 – 20	12 (12)
21-30	25 (25)
31-40	12 (12)
41-50	18 (18)
51-60	9 (9)
61-70	9 (9)
Mean 33.4 ± 2	
Sex	
Male	55 (55)
Female	45 (45)

Mean Cardiac size = 11.7cm ± 2.2cm
Median CTR = 46%
Male mean =47.1%
Female mean = 46.9%

AS shown in the table, those Patients within age group 21-30 years of constitute one-quarter of the total patients used for this study with a mean age of 33 years and variability of two years (Table 1). Male (55%) are slightly more than the female (45%) (Table 1).
The mean cardiac size is 11.7cm $\pm$ 2.2cm while the median CTR is 46% as shown.

Table 1b
Cardiac size and Age-group (YRS)

Cardiac size (cm) -	AGE- GROUP (YRS) 0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	Total
6	2	-	-	-	-	-	-	-	2
6.5	2	-	-	-	-	-	-	-	2
7	1	-	-	-	-	-	-	-	0
7.5	3	-	-	-	-	-	-	-	3
8	3	-	-	-	-	-	-	-	3
8.5	2	-	-	-	-	-	-	-	2
9	3	-	-	1	-	-	-	-	4
9.5	2	-	-	-	-	-	-	-	2
9.7	1	-	-	-	-	-	-	-	1
9.8	1	-	-	-	-	-	-	-	1
10	1	1	-	-	-	-	-	-	2
10.5	-	1	1	1	-	1	1	0	5
10.8	-	-	1	-	-	-	-	-	1
11	-	3	2	1	-	-	-	-	6
11.2	-	-	1	-	-	-	-	-	1
11.5	-	-	2	-	1	-	2	-	5
11.6	-	-	-	-	-	1	-	-	1
12	-	1	5	3	2	3	-	-	14
12.5	-	1	1	4	1	-	-	2	9
12.8	-	-	-	-	-	1	-	-	1
13	-	1	1	-	6	2	1	1	12
13.5	-	-	-	3	-	1	1	-	5
14	-	1	2	1	5	-	-	-	8
15	-	-	1	1	2	1	-	-	5
16	-	-	-	-	-	1	-	-	1
Total	21	9	17	16	17	11	5	3	100

Table 2
Correlation between Age and Sex with Cardiothoracic Ratio

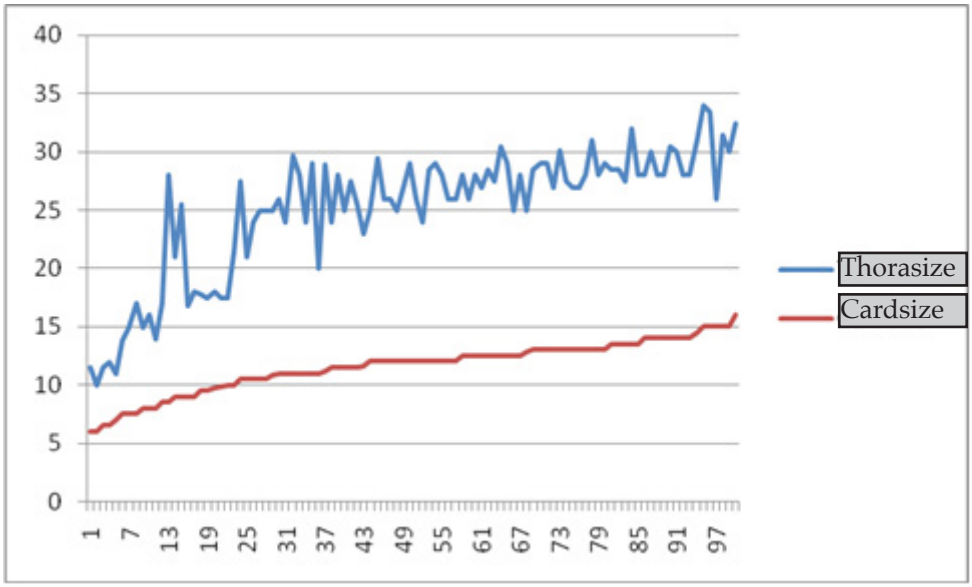
Variable	CTR ≤ 50%	> 50%	Total (100%)
Age (years)			
≤ 10	8 (53.3)	7 (46.7)	15
11 – 20	10 (83.3)	2 (16.7)	12
21 – 30	24 (96)	1 (4)	25
31 – 40	11 (91.7)	1 (8.3)	12
41 – 50	16 (88.9)	2 (11.1)	18
51 – 60	8 (88.9)	1 (11.1)	9
≥ 60	6 (66.7)	3 (33.3)	9
X^2 = 15.356 (Yates corrected) df =6, p=0.018			
	Sex		
Male	44 (80)	11 (20)	55
Female	39 (86.7)	6 (13.3)	45
X^2 = 0.780, df=1, p=0.377			
Variable	CTR < 50%	> 50%	Total (100%)
Age (years)			
< 10	8 (53.3)	7 (46.7)	15
11 – 20	10 (83.3)	2 (16.7)	12
21 – 30	24 (96)	1 (4)	25
31 – 40	11 (91.7)	1 (8.3)	12
41 – 50	16 (88.9)	2 (11.1)	18
51 – 60	8 (88.9)	1 (11.1)	9
> 60	6 (66.7)	3 (33.3)	9
X^2 = 15.356 (Yates corrected) df =6, p=0.018			
Sex			
Male	44 (80)	11 (20)	55
Female	39 (86.7)	6 (13.3)	45
X^2 = 0.780, df=1, p=0.377			

Table 3
Correlation between Age and Cardiac indices

	Variable	Cardiac size	Cardiothoracic Ratio
Age	Pearson Correlation	.310**	-.007
	Sig. (2-tailed)	.002	.948
	N	100	100

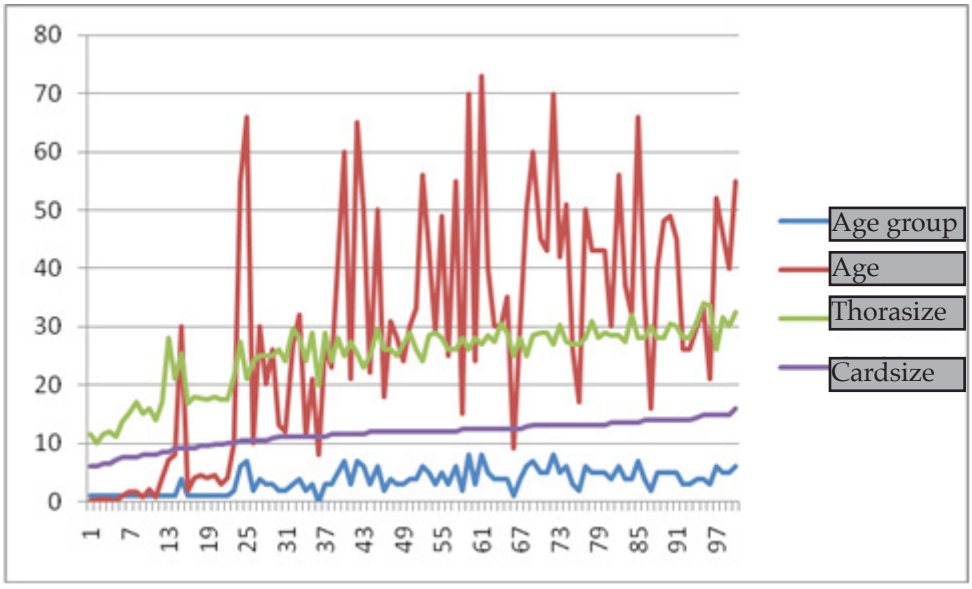
There was a statistically significant positive correlation between Age and Cardiac size as shown in this table.

Figure 1a
Chart of Cardiac size, and Thoracic size versus age versus age



Keys : Thorasize=Thoracic Diameter; Cardsize= Cardiac Diameter.

Figure 1b
Chart of age, age-group, cardiac size and Thoracic size



Keys : Cardsize=cardsize or Diameter; Thorasize = Thorasize or diameter.

DISCUSSION

Cardio-vascular disease, (CVD), is the number one cause of death globally, claiming 17.3 million lives each year, even in the developing countries, including Nigeria. Cases of hypertension are on the increase in Central, Southern and Western Africa, Nigeria inclusive (1, 3)

In Nigeria today, executives are dying suddenly as a result of heart attack (11). There is need to prevent this scourge and so this study focuses on establishing a normal limit or value for the apparently healthy individual in our setting, in-order to identify early departure from the normal. From our study the heart size was greater in males than in females; particularly it was significantly different after birth to age 39yrs, which is similar to the findings in the studies of Gray (12) or Kitz man, *et al* (13).

In addition in this study, the mean heart size of adults over 20 years were in male 11.6cm and 11.5cm in female respectively, being approximately 0.0497cm greater in men than women and it is especially different between the age of 20 years and 39 years.

Our findings are in agreement with the findings of authors in United Kingdom (14), except for differences in values of their own cardiac measurements which were greater than the values recorded in this study; the gender and age differences in cardiac measurements are similar to our own report.

Most of the adult cardiac sizes in this study ranged between 11cm and 13cm, so it can be inferred that any heart size that is outside this range, in whose age falls within the age-bracket of 18-55 years in this environment, will require closer clinical and radiological attention.

In a similar study to ours, it was shown that a change in cardiac diameter of greater than 1.5cm between 2 X-rays of an individual is significant (14). They found out that in their own setting, in normal individuals, cardiac diameter was less than 15.5 cm in males, and less than 14.5 cm in females. These measurements are higher than what we found here, which means a Nigerian with a heart dimension of that range falling within the same age bracket and same sex group as in our study can be regarded as being abnormal, and it is a confirmation that there is racial difference in cardiac size.

Heart sizes of Japanese were found to exceed those of American subjects. The sex difference in the HS (Heart size) can be explained by the fact the men usually involved in more physically demanding activities than women, apart from influence of hormones in both sexes. This can be as much as 20% (6).

In our study the influence of age on cardiac is further demonstrated by the fact that there was gradual rise of HS with age to about 55 after which HS was stable. It is because at this stage of life, occult CVS disease, in addition to myocardia and vascular changes as a result of age, interact with the persistent cohort phenomenon to confound the change of heard size with age

Cardio-thoracic ratio (CTR) can be used in determining the severity and prognosis of heart disease, so having a record of normal range in this environment is important. The racial difference observed in HS, will affect the CTR, so to use 50% as normal values for all human races will be incorrect. The average CTR in our study was 0.46.

For instance, in the UK, clinically it is assumed that when CTR = 50% it may be due to Cardiac failure, pericardial effusion, left or right ventricular hypertrophy (14).

Heart size increases in obese subject because of hypertrophy of the muscle due to increased work load on the heart and so an increased or decreased HS in a normal individual may indicate onset of overweight or loss of weight, when other causative factors have been excluded. It means that we need to match heart size with the patient's age, gender and weight! There is evidence of association between obesity and many CVD in literature (15-17).

CVD is preventable and so a better understanding of the most effective interventions for reducing this large and costly disease burden is vital. A study like ours can allow for early recognition of changes in the heart, before permanent anatomical changes set in (14, 15-19).

This study may provide a model to predict tendency for CVD based on the relationship we found between age, sex and cardiac size in this environment, similar to other clinical parameters such as blood pressure and blood glucose level readings which give indications or departure from the average means in a particular group or setting. It will minimise the future CVD in an individual if early evaluation is done once there is disparity between patient's age and cardiac arithmetic limits or parameters.

As matter of fact, the reason why the transverse diameter of the heart of an individual is normally half of the dimension of the thoracic diameter is not known. However it is evident that a normal CTR of 50% may not be a true reflection of the condition of the heart because of the sex, racial differences in mean cardiac dimensions.

For instance in a similar study, a significant relationship was found between the cardiac measurements and age, which differed within ethnic groups. It was a prospective survey of applicants for employment undertaken by some authors in London hospital Medical College, to investigate the relationship between heart diameter and cardio-thoracic ratio (measured in 100 mm chest radiographs), age and ethnic group. It involved 1432 male applicants, aged between 17 and 64 years, of whom 861 were Caucasians, 295 Asians and

172 Africans/West Indians. The median values of their cardio-thoracic ratio were: 43% in Caucasians, 44% in Asians, and 46% in Africans. The upper extreme observations in each regression (2.5% of the population) were delimited by confidence limits plotted on the regressions against age for both cardiac diameter and cardiothoracic ratio. It was concluded that a single upper limit (for example 50%) for cardio-thoracic ratio was unsatisfactory. If all their subjects with values of cardio-thoracic ratio greater than 50% in the sample had been recalled for more detailed cardiological investigation, it would have affected 2.2% of Caucasians, 4.1% of Asians, and 9.3% of Africans. Limits of 50% in Caucasians, 52% in Asians and 53% in Africans, would exclude 2.2, 2.4 and 2.6% of subjects in each of these racial groups in their sample. Age accounted for relatively little of the variation observed (20, 21).

It was postulated that the smaller transverse diameter in Nigerians (and by extension subjects of African descent) was likely responsible for their higher CTRs values in comparison with Caucasians or Asians (7,8, 20, 21).

In conclusions, the burden of CVD is large, costly and increasing. Unless major changes are implemented, the CVD burden is likely to grow bigger in the next decade. Premature CVD is very preventable. However, the most effective work to develop and compare methodologies for predicting the future CVD affliction should therefore be commissioned. Our study presents a base line for early detection of variation from normal cardiac measurements, based on the age of subjects. It established a correlation: between Age and Cardiac size as 0.66 in the population studied, as well as gender differences in heart measurements.

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