Sex Dimorphism of the Heart Diameters and Cardiothoracic Ratios in a Normal Nigerian Population.

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SUMMARY

Objective: To determine gender associated differences in the cardiothoracic ratio (CTR) and heart diameters in a normal Nigerian population.

Subject and Method: The normal heart diameters and cardiothoracic ratios were measured from posteroanterior (PA) chest radiographs of healthy 510 male and 508 female Nigerians of age range 4 - 80 years.

Results: Mean heart diameter of 13.0+ 1.5cm, 12.3+1.3cm and 12.6+1.5cm for males, females and both respectively and mean CTR values of 46.2 + 4.1, 47.2 + 4.4 and 46.7 + 4.3 of males, females and both respectively were noted in the studied population. . The study reports a consistent sex difference in heart diameter of 0.5 to 1.2cm and 1.0 to 3.1cm in chest diameter. It apportions a difference of up to 37% in heart size ratio to gender difference.

Discussion/Conclusion: The study established statistically significant differences in the heart diameter and CTR of the studied population, which is based on gender.

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KEYWORDS: **Sex dimorphism, cardiothoracic ratio, heart diameter.**

INTRODUCTION

Cardiovascular disease has been noted to be the commonest cause of death and disabilities at all ages and in all countries[1]. With the exception of exercise induced cardiac enlargement, all forms of heart enlargements are evidences of heart disease and dysfunction. The postero-anterior chest radiograph provides a simple, and clear evidence of cardiac enlargement and other cardiac parameters. Several works have been done on the establishment of normal values of heart diameters in Nigeria[2, 3.] and outside Nigeria[4 - 7.] Various researches also have established significant differences between various cardiac parameters of males and females[8 – 11] but to the best of our knowledge and information available to us, no such studies have been done amongst Nigerians within the South east.

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This work uses the postero-anterior chest radiograph to establish the differences between normal heart and chest diameters and CTR of male and female Nigerians within the South East.

SUBJECTS AND METHODS

From a total number of 1885 Nigerians physically examined and enrolled into this research, only 1018 postero-anterior chest radiographs of the subjects that met the standards set by Kabala and Wide[7] were admitted for this study. These samples included both sexes from ages 4 years and above. The study was carried out in the University of Nigeria Teaching Hospital (UNTH) Enugu, Nigeria, and Hansa, Special Diagnostic Centre, Enugu, Nigeria. This sample population was selected from candidates that came for chest X-ray examination as a result of requirements such as pre-employment, pre-admission, visa application and volunteer candidates without signs of any cardiovascular disease symptoms. The PA chest radiographs of all the candidates were taken in the erect position with a film focus distance of 1.8m. The exposures were made at normal quiet inspiration.

Subject's name, sex, age and medical history were noted. Also, the candidate's blood pressures were taken, and the values accepted to be normal for this research were cases where the systolic blood pressure fell between 110 and 145mmHg and the diastolic pressure between 60 and 100mmHg.

The transverse cardiac diameter was measured in the usual way described by Danzer[12.] Measurements were done to the nearest 0.1cm. No corrections were done for magnification[13]. The transverse cardiac diameter of the heart is the sum of the greatest cardiac distance to the right and to the left of the 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 values were calculated as ratios of the heart diameter with the thoracic diameter expressed in percentage.

RESULTS

Five hundred and ten (510) of the samples used for this study were males while the rest five hundred and eight (508) samples were females. Age ranged from 4 to 80 years with a mean of 32.8+15 years. Age was broken into intervals of 10 years.

The result in table 1 gives the relationship of age with heart diameters of both sexes. The mean heart diameter for both sexes is 12.6+1.5. Males showed larger values of heart diameters for all the age groups of females except age group 4–10. The largest degree of standard deviation was also noted in the males.

The range of values of heart diameters for the males gave 9.8 to 13.6 while for the females it gave 10.1 to 12.9. The mean heart diameter for the males gave 13.0+1.5 while for the females it gave 12.3+1.3. Age correlated positively and significantly with the female heart diameters at $p<0.01$, $r=0.43$ and $p<0.01$, $r=0.37$ for the males, and for both sexes at $p<0.01$, $r=0.41$(Pearson correlation).

Table 2 gives the relationship between the chest diameters and age of both sexes. The mean chest diameter for both sexes is 27.2+4.6. Men showed larger values of chest diameters and larger degrees of standard deviation in each of the age groups. The range of heart diameter for male gave 21.0 to 29.4, with a mean value of 28.3+4.9 while the females showed a range of 20.5 to 26.9, with a mean value of 26.0+4.5. Age correlated with female chest diameter at $p<0.01$, $r=0.32$, for males, at $p<0.01$, $r=0.27$, and for both at $p<0.01$, $r=0.31$, (Using Pearson correlation).

Table 3 gives the result of the relationship of age with CTR. Females showed larger CTR values in all the age groups. The male CTR values ranged from 45.4 to 49.0, with a modal value of 45.4, while the female values ranged from 45.5 to 49.7, with a modal value as 45.9. The mean CTR value for the females gave 47.2 ± 4.4 and 46.2 ± 4.1 for the males. Larger degree of standard deviation was noted for the females. Age correlated with CTR for males, females, and both sexes at $p<0.01$, $r=0.2$ (Using Pearson correlation).

In table 4, an age group from 20 years and above was carved out of the general sample distribution. This was to have a clear knowledge of the result of the core adult population

Table 1a: Relationship of Age (years) with Heart Diameter (centimeters).

Sex	Age	Mean	N	S. D.
Male	4-10	9.8	20	1.8
	11-20	12.1	81	1.8
	21-30	13.2	146	1.2
	31-40	13.4	100	1.5
	41-50	13.6	70	1.2
	51-60	13.5	62	1.0
	61-70	13.6	20	1.5
	71-80	13.2	11	1.2
	Mean	13.0	510	1.5
Female	4-10	10.1	25	1.2
	11-20	11.6	79	1.1
	21-30	12.0	186	1.1
	31-40	12.8	100	1.1
	41-50	13.1	69	1.3
	51-60	12.7	33	1.0

Table 2: Relationships of Age and Chest Diameter (centimeters) by Sex

Sex	Age	Mean	N	S. D.	Range
Male	4-10	21.0	20	3.57	0.83
	11-20	26.6	81	4.48	0.30
	21-30	29.1	146	4.84	0.15
	31-40	29.4	100	4.97	0.21
	41-50	28.9	70	5.06	0.20
	51-60	28.5	62	5.10	0.22
	61-70	27.8	20	5.52	0.46
	71-80	28.1	11	5.07	0.48
	Total	28.3	510	4.91	0.12
Female	4-10	20.49	25	3.33	0.50
	11-20	25.59	79	4.26	0.22
	21-30	26.26	186	4.48	0.12
	31-40	26.85	100	4.57	0.17
	41-50	26.54	69	4.82	0.27

Table 3: Relationship of Age (years) with CTR (percentage).

Sex	Age	Mean	N	S. D.
Male	4-10	46.8	20	2.6
	11-20	45.5	81	3.7
	21-30	45.4	146	3.6
	31-40	45.6	100	5.0
	41-50	47.4	70	4.2
	51-60	47.3	62	3.6
	61-70	49.0	20	4.4
	71-80	46.9	11	4.2
	Mean	46.2	510	4.1
Female	4-10	49.7	25	3.6
	11-20	45.5	79	3.4
	21-30	45.9	186	3.8
	31-40	47.9	100	3.9
	41-50	49.6	69	6.1

within the distribution it also gives the values of 80% central tendency in the CTR and heart diameter values of the sampled population. Observations on the differences in the heart diameter of both sexes expressed in percentage have been documented in table 5.

Table 4: The values of the 80% central tendency in the CTR and heart diameter values of the sampled population.

Sex	Values for all the sampled age		Values for ages 20 & above	
	CTR (%)	Heart D (cm)	CTR (%)	Heart D (cm)
Male	40 – 50	10.9 – 14. 6	40 – 49	11.4 – 14.7
Female	41 – 51	10.6 – 14.2	41 – 51	10.8 – 13.7
Both	40 – 50	10.6 – 14.5	40 – 50	11.0 – 14.4

Table 5: A sex differential observation in the chest and heart diameters (cm) and CTR (percentage) values.

Age group	Difference in heart diameter	Difference in chest diameter	Ratio of difference in %
11 – 20	0.5	1	50
21 – 30	1.2	2.8	43
31 – 40	0.6	2.5	24
41 – 50	0.5	2.4	21
51 – 60	0.8	2.1	38
61 – 70	0.7	1.4	50
71 – 80	1.1	3.1	35

DISCUSSION

The most recurrent factors associated with most sex dimorphism have been morphological and physiological factors. Males have larger, longer and thicker bones than females and are also involved in more muscular activities, which increase their musculature and weight. Females of the same age groups showed slightly smaller chest and heart diameters than the males. Through all the age groups, females showed larger CTR values with an overall mean value of 47.2% than men, that showed the value of 46.2%. A central 80 percent ranges of the distribution of the studied population within which the ranges are certainly normal also showed the same pattern of higher heart and chest diameters and lower CTR in the males for all entire population and also with the population above 20 years (i.e. population of core adults)

Other authors have observed and commented on the variability of heart diameter and CTR with sex[9,10] Oberman[7] apportions a difference of 20% in heart size to sexual difference. Most views attribute this sex difference to the fact that "Males work harder physically and their skeletal Muscles are more developed than those of woman". Brainton[11] in an orthodiographic study of transverse heart diameter reduced the transverse heart diameter of men by 0.8cm to obtain the standard for women. The findings of this study reveal a consistent sex difference in heart diameter of 0.5 to 1.2cm with an average of 0.8cm against 0.5 to 1.0cm observed by Oberman[7] and also exactly equal with the average of 0.8cm observed by Bainton[14]. This study also shows a consistent sex differential in chest diameter of 1.0 to 3.1 cm.

This study apportions a difference of up to 37% of heart size ratio to sexual difference as against 20% given by Oberman[7] which he noted in the Caucasians. The inconsistency of sexual variation in the age group 4-10 could be attributed to the non-functionality of the male and female secondary hormones. As a result, the male and female morphology and physiology were alike.

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