

**Original article:**

**Study of Interrelationship between Heart Diameter and Cardio-Thoracic Ratio with Body Habitus: A Hospital Based Study to Evaluate Cardiac Enlargement**

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**ABSTRACT**

**Background:** The transverse heart diameter (HD) and cardiothoracic ratio (CTR) can be calculated and used to diagnose cardiomegaly. The standard treatise give the HD as 15.5cm and CTR value as 50% (0.5) in posterior-anterior Chest X-rays when taken with standard procedures are regarded as the upper limit of normal. These measurements vary with ethnic groups and body habitus of the subjects. The present study was conducted with the aim to determine the correlation of heart diameter and cardio-thoracic ratio with body habitus like weight, height, body mass index (BMI), body surface area (BSA) in Eastern Rajasthan population in a tertiary care setting.

**Materials and Methods:** The present study was conducted in the Department of Radiology and Anatomy, Mahatma Gandhi Medical College & Hospital, Jaipur, Rajasthan (India) for a period of 3 years (October 2015 till September 2018). The subjects ranging in age between 20-70 years and more than 70 years, with appropriate inclusion and exclusion criteria were enrolled in the study. Chest X-rays (PA view) were taken, body weight and height measured. Various parameters viz. HD, CTR, BMI and BSA were calculated and statistically evaluated. All the data thus obtained was arranged in a tabulated form and analysed using SPSS software.

**Results:** The CTR amongst males less than 30 years of age was 43.1 and females were 45.9. The CTR amongst males less than 30-40 years of age was 44.3 and females was 46.2. The CTR amongst males less than 41-50 years of age was 44.9 and females was 46.4. The CTR amongst males less than 51-60 years of age was 45.9 and females were 47.9. there was found to be a strong correlation of body habitus parameters with Heart diameter and poor with CTR.

**Conclusion:** It can be clearly concluded that the heart diameter is more affected by body habitus variations as compared to CTR. Hence, CTR proves to be a better indicator in prediction of heart size in routine chest radiography than HD.

**Keywords:** Chest X-ray, Heart Diameter, Cardiothoracic Ratio, Body Habitus.

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**INTRODUCTION**

Chest x-rays are a simple, quick and economical tool for determining the transverse thoracic diameter, maximum diameter of heart. The Cardio-thoracic ratio which is the ratio of transverse cardiac diameter to the transverse chest diameter on a PA chest film.<sup>1</sup> Recently interest is growing in the use of CTR as a tool in clinical evaluation in patients and used as a screening method to detect enlargement of heart.<sup>2</sup> An abnormal heart size in comparison to age, gender and body habitus may

show initial signs of underlying cardiac etiology in routine Chest radiographs.<sup>3</sup> Size of heart in the absence of skeletal or chest deformity or any lung disorder is presumed to be associated with the habitus of the subjects.<sup>4,5</sup> Results of previous studies have demonstrated racial difference in heart size in relation to body structure.<sup>6</sup> The cardiac enlargement can be checked by maximum diameter in transverse section of the heart and the cardio-thoracic ratios.<sup>7</sup> The standard that is followed is HD > 15.5 cm. and CTR of 50% (0.5) in posterior-

anterior view Chest X-rays when taken with standard procedures are regarded as the upper limit of normal. Aptitude to determine the heart size has paved a very objective method for clinical diagnosis, serial estimation and population studies of heart size, despite of its limitations.<sup>3</sup> The affordability and easy availability of simple chest x-rays especially in rural settings, where advanced radiological methods like CT scan, magnetic resonance imaging (MRI), echocardiography etc., are not available, the plain X-ray chest can be used to calculate cardiothoracic ratio. This can be used as a screening tool to predict heart size in such settings. An enlarged heart may not be indicative of any underlying pathology, on the contrary, a normal sized heart does not indicate absence of any pathology. Still the enlarged heart in respect to age, gender, weight, height, BMI and BSA can be used as early predictor of some underlying heart pathology in routine chest radiography and the patient can be advised a further course of action and investigations. The present study was conducted with the aim to determine the correlation of heart diameter and cardio-thoracic ratio with body habitus and to assess the cardiac size.

#### **MATERIALS AND METHODS**

The chest X-rays were taken in the Department of Radiology and Anatomy, Mahatma Gandhi Medical College & Hospital, Jaipur, Rajasthan (India) between a period of 3 years from October 2015 till September 2018. A total of 800 subjects were selected (350 males & 450 females).

The inclusion criteria taken:

1. The age range was between 20 – 70 years and > 70 years
2. Both males and females were selected
3. The selected subjects were free from any cardiac, lung disease or any abnormality of thoracic cage

The instruments used were X- ray machine, weighing scale and height scale. The weight was measured with minimal clothing and no footwear, by weighing machine in kilograms. Height was measured by the height scale in meters. A posterior antero chest radiograph was obtained with a focus distance of 1.8 m with the person standing in erect position and normal inspiration.

Transverse Thoracic Diameter was measured at the level of right dome of diaphragm and the transverse diameter of heart was the sum of maximum projections with the right and left heart borders.<sup>8,9</sup>

The BMI of the subjects was calculated as per formula weight in kilograms divided by height in meter square.

The body surface area was calculated from the formula  $BSA = W^{0.425} \times H^{0.725} \times 0.007184$

All the data thus obtained was arranged in a tabulated form and analysed using SPSS software. Probability value of less than 0.05 was considered as significant. Correlation coefficients of weight, height, BMI, BSA with HD and CTR were calculated.

#### **RESULTS**

There were a total of 800 subjects enrolled in the study with the mean age of 58.43+/-5.42 years.

Table (1-4) indicates the relationship between the age, height, body mass index and body surface area. The CTR (values in %) amongst males less than 30 years of age was 43.1 and females was 45.9. The CTR amongst males less than 30-40 years of age was 44.3 and females was 46.2. The CTR amongst males less than 41-50 years of age was 44.9 and females was 46.4. The CTR amongst males less than 51-60 years of age was 45.9 and females was 47.9. The CTR amongst males less than 61-70 years of age was 46.8 and females was 48.1. The CTR amongst males less than 71-80 years of age was 46 and females were 48.2.the CTR increased with age in both males and females.

As per the height, maximum CTR was 49.8 amongst males with the height of 1.4-1.5m and amongst females was 53.1 of the same height. Females with BMI more than 30 had CTR of 48.1 and males with BMI less than 24 had CTR of 45.4. The HD amongst males was maximum of 16.5cm amongst males between 30-40 years of age and

amongst females it was 12.9cm between 71-80 years of age.

Table 5 shows a weak correlation between weight, height, BMI and BSA parameters in respect to CTR in both males and females and a strong one with HD.

**Table 1: Relationship between the results obtained according to age (Years)**

	Sex	Age (years)					
		<30	30-40	41-50	51-60	61-70	71-80
CTR (%)	Male (n=350)	43.3	43.8	44.9	46.1	46.8	46.4
	Female (n= 450)	45.6	46.2	46.4	47.9	48.1	48.2
HD (cm)	Male	12.1	16.5	14	14.2	14.3	14.2
	Female	11.5	11.6	11.7	12.1	12.4	12.9

**Table 2: Relationship between the results obtained according to Height (meter)**

	Sex	Height (meter)		
		1.2-1.3	1.4-1.5	1.6-1.7
CTR	Male	42.1	49.8	44.9
	Female	42.9	53.2	46.1
HD (cm)	Male	11.9	11.9	12.2
	Female	11.1	11.7	12.1

**Table 3: Relationship between the results obtained according to BMI**

	Sex	BMI		
		<24	24-30	>30
CTR	Male	45.3	45.9	44.5
	Female	47.6	46.9	48.4
HD (cm)	Male	12.9	13.4	12.9
	Female	11.6	13.3	12.3

**Table 4: Relationship between the results obtained according to BSA (meter<sup>2</sup>)**

	Sex	BSA (meter <sup>2</sup> )		
		<0.03	0.03-0.05	>0.05 - 0.06
CTR	Male	43.8	47.1	46.3
	Female	49.3	45.7	47.8
HD (cm)	Male	13.7	13.2	13.4
	Female	13.2	13.2	13.1

**Table 5: Summary of correlation coefficient values**

Sex	Parameter	Weight	Height	BMI	BSA
MALE	CTR	0.0519	-0.1123	0.1441	-0.001
	HD	0.4190	0.3412	0.3312	0.3942
FEMALE	CTR	0.0509	-0.0112	0.11	-0.003
	HD	0.3941	0.3315	0.3452	0.4122

**DISCUSSION**

The results shown by different studies reveal that the size of heart amongst normal subjects depends upon a variety of parameters like body size.<sup>10</sup> As the body size is altered by the mixture of genetic, racial and environmental types, the size of heart is dependent on them<sup>11</sup>, like strong reduction of transverse diameter with age amongst females<sup>12</sup> whereas its reduction with age amongst male is gradual. Many researchers have shown that HD is a better predictor of heart enlargement as compared to CTR.<sup>1,13</sup> Search of literature shows ethnic differences in the cardiothoracic ratio of Caucasians, Asians and Africans.<sup>14,15</sup> The study conducted by Obermann et al<sup>3</sup> in 3985 subjects aged >20 years, Michigan, USA, in 1967 state showed that HD, especially in males is a more effective parameter than CTR, but an age and sex specific CTR may be the most valuable parameter in clinical situations.

In a study of a population in West Bengal, it is reported by researchers that a strong correlation of body habitus parameters with HD than with CTR. They concluded that CTR is a better indicator in predicting cardiac enlargement in routine chest X-rays, since it was the least affected by body habitus parameters.<sup>16</sup> We also report a similar finding that HD has strong association with the habitus of body such as weight of body and height, surface area and

body mass index than CTR in Rajasthan population. Search of literature did not reveal much work done in Indian populations.

The present study shows that HD and CTR increase with age in both the sexes, a finding which has been reported in other studies.<sup>14,15,17-20</sup> This increase is probably due to an increase in the muscle thickness of the ventricles due to increased vascular resistance or loss of elasticity of the great vessels.<sup>15</sup> The parameters of body habitus further depend upon the framework of body amongst different ethnic groups, whereas cardio-thoracic ratio indicates a poor relationship with the mentioned parameters of body.<sup>14</sup>

Cardio-thoracic ratio is least altered by the habitus of body; so it is a superior indicator while predicting the cardiac enlargement. The Body and heart sizes in twins lead to a strong relation between size of heart and body size.<sup>4</sup> CTR can be used as a screening tool to predict cardiac enlargement.<sup>17</sup>

**CONCLUSION**

It can be clearly concluded that the CTR has a poor correlation with various body parameters like weight, height, BMI, BSA as compared to HD. So, CTR is a better predictor of cardiac enlargement than HD in routine chest X-rays as it is least affected by body habitus.

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