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The Effect of Age on Cardiothoracic Ratio (CTR) of Non-hypertensive and Hypertensive Berom Adults in Jos-North

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ABSTRACT

Cardiothoracic ratio (CTR) is a simple, affordable, and non-invasive radiographic measure used to estimate the heart size, particularly useful in settings with limited access to advanced diagnostic tools. Ethnic and age-related factors can influence thoracic and cardiac morphology, yet data on CTR variations among specific Nigerian ethnic groups like the Berom are limited. This study aimed to evaluate the effect of age on CTR among non-hypertensive and hypertensive Berom adults in Jos North Local Government Area, Plateau State, Nigeria. A comparative cross-sectional study was conducted involving 120 third-generation Berom adults aged 22–70 years, with equal representation of non-hypertensive and hypertensive males and females. Participants were recruited through consecutive sampling in the Kabong district of Jos North local government area. Posterior-anterior (PA) chest radiographs were taken, and CTR was computed as the ratio of transverse cardiac to transverse thoracic diameter. Statistical analysis was performed using SPSS version 20. The results showed a progressive increase in mean CTR with age in both the non-hypertensive and hypertensive groups. However, the hypertensive participants consistently exhibited significantly higher CTR values across all age categories ($p < 0.01$). Pearson correlation revealed a strong positive relationship between CTR and age among hypertensives ($r = 0.62$, $p < 0.001$), while no significant correlation was found among non-hypertensives. These findings suggest that CTR increases with age, particularly in hypertensive individuals. Incorporating age-specific CTR evaluation may improve cardiovascular risk assessment and early diagnosis of cardiomegaly in this population using basic chest radiography.

Keywords: age, Berom, cardiothoracic ratio, chest radiography, hypertension

INTRODUCTION

The cardiothoracic ratio (CTR) is a critical radiological parameter used in the evaluation of cardiac size on chest radiographs. It serves as a non-invasive, cost-effective tool for detecting cardiomegaly and monitoring cardiovascular health, especially in resource-limited settings such as Nigeria[1, 2]. Defined as the ratio of the transverse cardiac diameter to the transverse thoracic diameter, CTR values exceeding 0.50 in adults are generally considered abnormal and indicative of potential cardiac pathology[3].

Hypertension remains a leading modifiable risk factor for cardiovascular diseases (CVD) both globally and within Sub-Saharan Africa, where rates of awareness, treatment, and control remain suboptimal[4, 5]. In Nigeria, the prevalence of hypertension is rising, driven by urbanization, aging populations, and changing lifestyles[6]. Structural cardiac changes such as left ventricular hypertrophy and cardiomegaly often accompany long-standing hypertension and can be identified by changes in the CTR[7]. Thus, evaluating CTR among non-hypertensive and hypertensive individuals provides valuable insight into the cardiovascular impact of elevated blood pressure.

Age is a well-recognized factor influencing cardiac morphology and function. With advancing age, cardiac dimensions may increase due to both physiological remodeling and age-related pathology, an effect that may be amplified in individuals with hypertension[8, 9]. However, limited studies have examined the age-related variations in CTR within indigenous Nigerian populations, particularly among the Berom ethnic group, an indigenous ethnic group in Plateau State[10].

Considering the interplay of ethnogenetic and environmental factors on cardiovascular anatomy, there is a pressing need for localized studies exploring how age and hypertension affect cardiothoracic indices. This study aimed to evaluate the effect of age on CTR among non-hypertensive and hypertensive Berom adults in Jos-North Local Government Area of Plateau State. By delineating age-related CTR trends across different blood pressure statuses, this study seeks to enhance understanding of cardiovascular aging and provide context-specific reference values for chest radiograph interpretation in this population.

MATERIALS AND METHODS

This comparative cross-sectional observational study was conducted at the Radiology Unit of the University of Jos Health Services Centre. Ethical approval was obtained from the University of Jos Health Services Centre Ethical Research Committee, and informed consent was obtained from all participants prior to enrolment.

The study population comprised third-generation Berom males and females aged 22 to 70 years, residing in the Kabong district of Jos-North Local Government Area, Plateau State, Nigeria. Participants were either normotensive or diagnosed hypertensives with controlled blood pressure. Exclusion criteria included individuals who were non-Berom by ethnicity, hypertensive participants with complications or comorbidities, and pregnant women.

Sample size was determined using the Altman formula for comparing two means: $N = (2 \times Cp_1power) / d^2$, where Cp_1power is a constant defined by the selected significance level and power. Therefore, at a significance level of 0.05 and a power of 90%, Cp_1power was set at 10.5[11]. Based on prior studies, the expected CTR difference between non-hypertensives and hypertensives was 0.06, with a standard deviation of 0.07. This yielded a standardized difference (d) of 0.857 [12]. Accordingly, a minimum of 30 males and 30 females per group (non-hypertensive and hypertensive) were required, totaling 120 participants.

Participants were recruited using consecutive sampling with equal sex representation until the required sample size was achieved. Each participant underwent a standard posteroanterior (PA) chest radiograph using a Philips Practix mobile X-ray unit operated at 100 kV and 20 mA, with a focal-film distance of 150 cm. Radiographs were reviewed on a standard viewing box, and measurements were taken using a meter rule. The transverse cardiac diameter (TCD) and transverse thoracic diameter (TTD) were recorded, and the CTR calculated as CTR = TCD / TTD.

Anthropometric data, including height and weight, were obtained using an RGZ-160 stadiometer. Body mass index (BMI) was computed as weight (kg)/height² (m²). Blood pressure was measured using a mercury sphygmomanometer and a Littmann stethoscope, with the participant seated and rested for at least five minutes prior to measurement. A structured proforma was administered to capture demographic and clinical data, including biodata, social history (e.g., alcohol and tobacco use), medical history (e.g., hypertension diagnosis, medications), and clinical follow-up frequency.

Data were analyzed using IBM SPSS Statistics version 20. Descriptive statistics (means, standard deviations, and frequencies/percent) were used to summarize demographic, clinical, and radiographic data. Independent samples t-test was used to compare the mean CTR between non-hypertensive and hypertensive groups, and between sexes within each group. Pearson correlation analysis was done to find the association between age and CTR. Statistical significance was set at $p < 0.05$.

RESULTS

The demographic and anthropometric characteristics of the study participants, stratified by sex and hypertension status, are presented table 1. With each subgroup consisting of 30 males and 30 females, accounting for 25% each of the total study population in both the non-hypertensive and hypertensive groups, indicating equal representation by sex across both categories.

Table 1: Demographic and anthropometric characteristics of study participants

Characteristics	**Study Groups**		**Statistics**	**P value**
	Non-Hypertensives	Hypertensives		
Sex (Frequency/percent)			X^2	
Males	30(25.0)	30(25.0)	-	-
Females	30(25.0)	30(25.0)	-	-
Age (Mean±SD) Years			F test	
Male	42.40±10.74	55.30±7.84	1.379	0.247
Female	36.37±8.46	51.80±7.05	0.037	0.848
Height (Mean±SD) m				
Male	1.63±0.07	1.56±0.07	1.229	0.259
Female	1.53±0.06	1.51±0.06	0.013	0.909
Weight (Mean±SD) Kg				
Male	66.20±8.88	68.77±6.38	2.209	0.143
Female	63.07±10.58	65.38±14.72	0.409	0.525
BMI (Mean±SD) Kg/m²				
Male	24.89±2.96	28.13±2.09	3.757	0.057
Female	26.91±3.60	29.76±2.61	0.282	0.597

The mean age for non-hypertensive males was less than that of hypertensive males. Non-hypertensive females were also younger than their hypertensive counterparts. Statistical analysis using the F-test showed no significant difference in age between the groups for both sexes ($p > 0.05$ for both males and females).

With respect to height, non-hypertensive males had a mean height slightly higher than hypertensive males. Among females, non-hypertensive participants also measured on average, heights slightly higher than their hypertensive counterparts. However, these differences were not statistically significant ($p > 0.05$ for both males and females).

In terms of weight, hypertensive males weighed slightly more than non-hypertensive males. Similarly, hypertensive females had a higher mean weight than non-hypertensive females, but the differences were not statistically significant ($p > 0.05$ for both males and females).

Regarding body mass index (BMI), non-hypertensive males had a mean BMI that was lower than that of hypertensive males. Among females, BMI values were also higher in the hypertensive group compared to the non-hypertensive group. The difference approached statistical significance in males ($p = 0.057$), but not in females ($p = 0.597$). These findings suggest a trend toward higher BMI in hypertensive participants, particularly among males.

Table 2 presents the correlation analysis between age and cardiothoracic ratio (CTR) among the non-hypertensive study population. Pearson correlation coefficient revealed a weak negative correlation between age and CTR, which was not statistically significant ($p > 0.05$).

Table 2: Correlation between age and cardiothoracic ratio

Parameters	**Values (Mean±SD)**	**Pearson Correlation Coefficient**	**p-value**
Among Berom Non-Hypertensive Males			
Age (Years)	42.40±10.74	-0.125	0.509
CTR	0.48±0.03		
Among Berom Non-Hypertensive Females			
Age (Years)	36.37±8.46	0.385	0.036
CTR	0.45±0.04		

Among the hypertensive males (Figure 1), there was a statistically significant moderate positive correlation between age and CTR ($r = 0.492$, $p < 0.05$). In the hypertensive females (Figure 2), the Pearson correlation coefficient was also positive but weak and not statistically significant ($r = 0.201$, $p > 0.05$). These findings provide a descriptive overview of the relationship between age and cardiothoracic ratio across sex and hypertensive status in the study population.

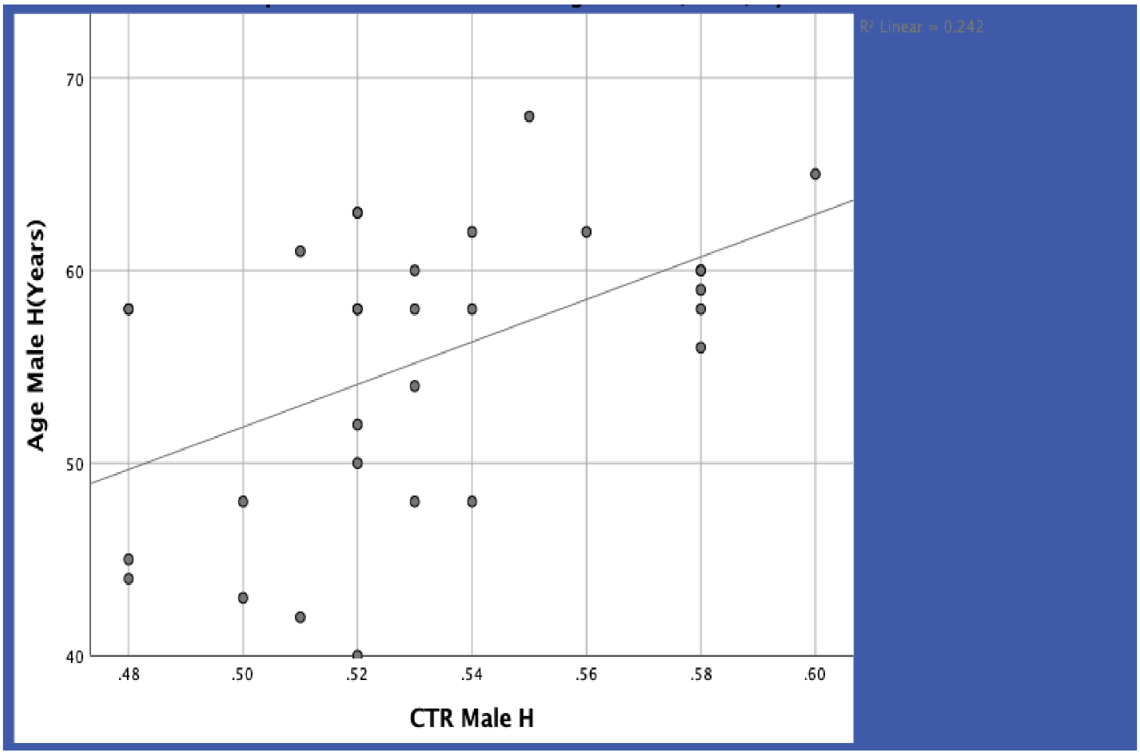

Figure 1: Correlation between Age and CTR among Berom Hypertensive Males

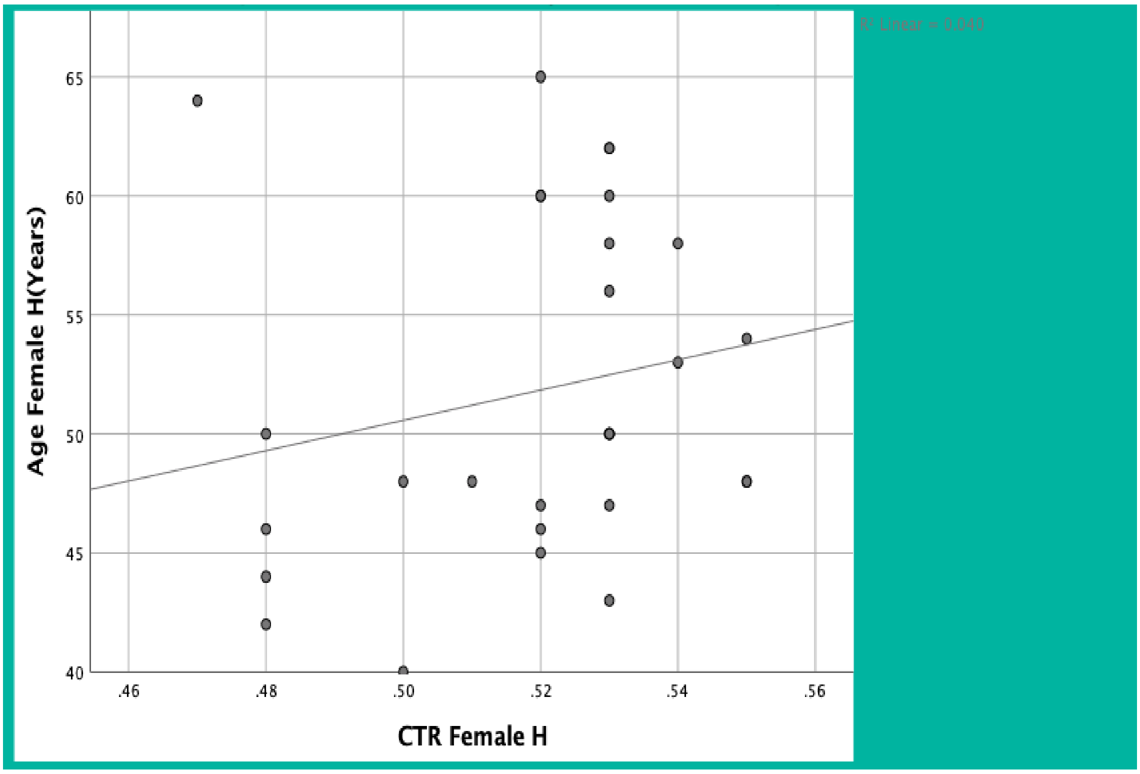

Figure 2: Correlation between Age and CTR among Berom Hypertensive Females

DISCUSSION

This study examined the effect of age on cardiothoracic ratio among non-hypertensive and hypertensive Berom males and females in Jos-North, Plateau State. The results revealed varying patterns of association between age and CTR across sex and blood pressure status, with a significant positive correlation observed among hypertensive males.

The moderate, statistically significant positive correlation between age and CTR among hypertensive males in this study is indicative of progressive cardiac structural changes that often accompany aging in the presence of elevated blood pressure. Longstanding hypertension contributes to increased afterload, leading to compensatory left ventricular hypertrophy and cardiac dilation, which can manifest as an increased cardiothoracic ratio on chest radiographs[13-15]. These age-related and pressure-mediated changes are well-documented and align with the principles of cardiac remodeling due to hemodynamic stress over time[16].

In contrast, the weak negative correlation observed among non-hypertensive males was not statistically significant, suggesting a less pronounced or potentially protective effect of normotension on age-related changes in cardiac size. This observation is consistent with findings from studies that show relatively stable CTR in healthy adults without cardiovascular comorbidities[16].

Among non-hypertensive females, a weak positive correlation was noted, albeit statistically insignificant. This pattern may reflect minor age-associated cardiac changes, modulated by hormonal influences and possibly by lower average levels of physical stress on the myocardium in this subgroup[18]. Notably, estrogen has been shown to confer cardioprotective effects in premenopausal females, potentially mitigating age-related cardiac enlargement[19].

Hypertensive females also demonstrated a weak, non-significant positive correlation between age and CTR. Although consistent with a trend toward cardiac enlargement with age, the association was less marked than in hypertensive males. This difference might be attributed to sex-specific responses to hypertension. Females tend to exhibit more concentric patterns of left ventricular hypertrophy with preserved systolic function, whereas males more commonly develop eccentric hypertrophy and chamber dilation[20]. These distinctions may influence the degree to which CTR increases with age in either sex.

The significantly higher mean age among hypertensive participants compared to non-hypertensive ones further supports the epidemiological relationship between advancing age and the development of hypertension[21, 22]. Arterial stiffening and decreased vascular compliance, which occur naturally with age, contribute significantly to increased systolic blood pressure and the pathogenesis of hypertensive heart disease[23].

The cardiothoracic ratio, although a relatively crude measurement, remains a valuable and accessible index for evaluating cardiac enlargement in clinical settings, especially in low-resource environments[24]. It provides an early indicator of cardiac stress or failure, but must be interpreted alongside demographic and clinical parameters such as age, sex, body habitus, and comorbidities[25]. Nevertheless, it should be noted that CTR does not offer specificity regarding the type or severity of underlying cardiac pathology and is less sensitive than echocardiography or cardiac MRI in detecting subtle myocardial changes[25].

Limitations of the current study include its modest sample size and ethnic homogeneity, which may limit generalizability beyond the Berom population. Additionally, the use of plain radiographic CTR measurements does not account for dynamic functional parameters or distinguish between different hypertrophy patterns. Future studies incorporating echocardiographic or magnetic resonance imaging would provide more detailed insights into structural and functional cardiac changes associated with age and hypertension.

CONCLUSION

Cardiothoracic ratio increases with age among Berom adults, particularly in hypertensive individuals. Age-specific CTR evaluation can enhance cardiovascular risk assessment and monitoring in this population.

Conflict of interests

The authors have no conflict of interests to declare.

Authors' contribution

PBN: Conceptualization, study design, data acquisition, radiographic measurements, statistical analysis, interpretation of results, manuscript drafting, and revision; EOE, YMU, NZN, YMU, MAW, CNE: Drafting and revising the manuscript.

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