

## ORA- Observational study



### Retrospective observational study of morphometric assessment of Aortic Knob Dimensions and Cardiothoracic Diameter: Insights in relation to age and gender.

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#### ABSTRACT:

**Aim of the study:** To evaluate the morphometric characteristics of the aortic knob and examine its potential relationship with cardio-thoracic diameter. Additionally, to investigate any correlation between aortic knob measurements and age, and to compare these dimensions between male and female subjects. **Material and methods:** Retrospective study was conducted in the Department of Radiology, MVJMC & RH where in following parameters were analysed in the Chest X Ray in DICOM format using Radiant software. Aortic Knob Width, length of Aortic Knob, Curved length of Aortic Knob followed by calculation of Aortic Knob Index. Additionally, Transverse Thoracic Diameter, Cardiac Diameter were measured and Cardio Thoracic Ratio calculated. **Results** All parameters, except for the Transverse Thoracic Diameter and Cardio-Thoracic Ratio, were found to be higher in females compared to males; however, these differences were not statistically significant. Cardiothoracic Ratio was more in males than in females and the difference was statistically significant. Aortic Knob width, straight length of aortic knob, curved length of the aortic knob, transverse thoracic diameter and cardiac diameter showed an increase with age which was statistically significant. Maximum values of the Aortic Knob Width and Aortic Knob Index were observed in the age group of 60-69 years. Cardiothoracic Ratio values showed significant decrease with age. The Aortic Knob Width showed strong positive correlation with all parameters except Aortic Knob Index and Cardio Thoracic Ratio. **Conclusion:** This study provides normative reference values of Aortic knob dimensions in Indian Population and is the first study in Indian population to compare knob width with other chest parameters.

**KEYWORDS:** Aortic Knuckle, Association, Cardio thoracic ratio, Dimensions, PA Chest X-ray.

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## 1. INTRODUCTION

Cardiovascular diseases are responsible for nearly three-quarters of all estimated global deaths. In India, cardiovascular diseases are a leading cause of death, contributing significantly to the national mortality burden, in line with global estimates by the World Health Organization (WHO), which reports 17.9 million CVD-related deaths worldwide annually, comprising 31% of all global deaths. [1] One of the most commonly used imaging techniques for evaluating heart and lung conditions is the posteroanterior (PA) chest radiograph. This method is widely available, cost-effective, and simple to perform, making it a valuable tool in diagnosing and managing cardiovascular diseases. The aortic knob (AK), referred to as the aortic knuckle, is visualized on a PA chest radiograph as the topmost convex contour on the left cardiac border. [2]

It is the outermost part of the aortic arch before it curves downward to form the descending aorta, the medial portion of the arch becomes obscure as it blends with the mediastinal shadow whereas the lateral portion is visible as a localized bulge against the left lung. [2] Several pathological conditions including hypertension, cardiac dysfunction, altered aortic wall elasticity and elevated aortic pressure may alter the dimensions of the arch. This prominence is also observed in cases of aortic stenosis, coarctation, and aneurysms. Aortic knob enlargement is most frequently seen in individuals with systemic hypertension. Less frequent associations include metabolic syndrome, obstructive sleep apnoea, and atherosclerosis. [3]

While a PA chest radiograph is a primary method for assessing the aortic knob, other imaging techniques such as computed tomography (CT), echocardiography, magnetic resonance imaging (MRI), and radionuclide imaging provide additional diagnostic insights. The size and prominence of the aortic knob can also vary based on factors such as body type, age, and gender. [3, 4]

The purpose of the current study was –

1. To assess the dimensions of Aortic knob and to investigate the correlation between the Aortic knob dimensions and the cardio-thoracic diameter.
2. To determine correlation between the Aortic knob measurements and age.
3. To compare the values of Aortic knob measurements in males and females.

## 2. MATERIALS AND METHODS

Using PA chest radiographs, an observational retrospective study was carried out in the Radiology and Imaging Department of MVJMC & RH Bangalore. This study was approved by the Institutional Ethics Committee of MVJ Medical College & Research Hospital, (MVJMC & RH /IEC-44/2024). Using a random sampling method, 150 chest radiographs were selected for examination, comprising 79 from female subjects and 71 from male subjects. The data was collected from February 2025 to March 2025.

**Inclusion Criteria**

Males and Females above the age of 20 and below the age of 80 years were included in the study.

**Exclusion Criteria**

Subjects with connective tissue disorders, aortic aneurysms, aortic ectasia, congenital malformations,

variations in position /number of aortic arches were excluded from the study.

The PA chest radiographs were analysed using DICOM software for the below mention measurements from the Department of Radiology.

**Measurements:** [5] The parameters measured were (Figure 1)

**Aortic Knob Width (AKW):** It is a horizontal straight line drawn from midline of body to lateral most point of aortic knob represented by EF in Fig1

**Straight length of Aortic Knob (AKS):** It refers to the vertical straight line drawn from upper part of aortic knob to the lower part of aortic knob represented by GH in Fig1.

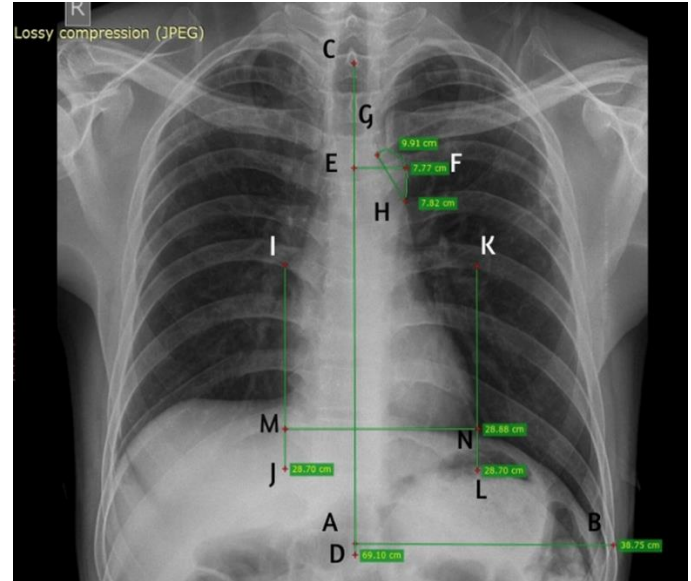
**Curved length of Aortic Knob (AKC):** It is the curved length from the superior point to the inferior margin on the lateral aspect of Aortic knob represented by GFH in Fig1.

**Aortic knob Index (AKI):** Aortic Knob Index: ratio of curved length of aortic knob to straight length of aortic knob. (AKC/AKS)

**Transverse Thoracic Diameter (TTD):** It is the greatest lateral thoracic diameter from the most outer contour on the right to the most outer contour on the left thorax.

**Cardiac Diameter (CD):** Cardiac diameters is traced between the outermost right and left margins of the heart represented by line MN in Fig1.

**Cardio Thoracic Ratio (CTR):** Cardio thoracic ratio is the relationship of cardiac diameter to the transverse thoracic diameter (CD/TTD).



**Figure 1: Chest radiograph showing measurements done using measuring tools in DICOM software.**

AB= Half of maximum transverse thoracic diameter. CD= Midline.

EF= Maximum distance of the left edge of the aortic knob (AK) from the midline. GH= Straight length of aortic knob. GFH= Curved length of aortic knob. IJ= Vertical line drawn through maximum right extension of cardiac silhouette. KL= Vertical line drawn through maximum left extension of cardiac silhouette. MN= Maximum cardiac diameter.

**Statistical analysis:**

The statistical analysis was performed using IBM-SPSS software version 19 and Microsoft Excel Version 2023. Normality of the data was assessed using the Shapiro–Wilk test, and all parameters were found to follow a normal distribution. The mean and standard deviation (SD) were calculated for AKW, AKS, AKC, AKI, TTD, CD, CTR. The data was also analyzed via Students t test, chi square test, Anova and Bonferroni (Post-hoc) tests. Pearson's coefficient was used to test correlation of

AKW with other parameters.  $P < 0.05$ , statistically significant

**RESULTS:**

The mean age of the study population was  $49.63 \pm 16.29$ , mean age of males being  $49.71 \pm 16.93$  and females being  $49.54 \pm 15.81$  (Table1). No statistical difference was observed between the two sexes. As shown in Table 1, all parameters exhibited higher mean values in females compared to males, except for TTD

and CTR, which were greater in males. However, the gender-based differences in these parameters were not statistically significant ( $P > 0.05$ ), indicating similar morphometric characteristics across sexes for most variables. Notably, the CTR was significantly higher in females ( $0.47 \pm 0.05$ ) than in males ( $0.45 \pm 0.04$ ), and this difference was statistically significant ( $P = 0.001$ ), suggesting a distinct sexual dimorphism in this specific anatomical proportion.

**Table 1-Mean and standard deviation of different parameters based on gender.**

VARIABLES	FEMALE	MALE	Total	P value
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Age	$49.54 \pm 15.81$	$49.71 \pm 16.93$	$49.62 \pm 16.29$	0.948
AKW	$2.42 \pm 0.38$	$2.36 \pm 0.42$	$2.39 \pm 0.40$	0.409
AKS	$2.68 \pm 0.48$	$2.66 \pm 0.51$	$2.67 \pm 0.49$	0.819
AKC	$3.12 \pm 0.56$	$3.06 \pm 0.63$	$3.09 \pm 0.59$	0.578
AKI	$1.16 \pm 0.09$	$1.15 \pm 0.10$	$1.15 \pm 0.10$	0.374
TTD	$19.53 \pm 1.87$	$20.01 \pm 1.64$	$19.75 \pm 1.78$	0.102
CD	$9.16 \pm 1.11$	$8.91 \pm 1.09$	$9.04 \pm 1.11$	0.175
CTR	$0.47 \pm 0.048$	$0.45 \pm 0.04$	$0.46 \pm .045$	<b>0.001 (SIG)</b>

As shown in Table 2, a total of 150 X-rays were analyzed retrospectively, comprising 79 females and 71 males. The majority of female patients were in the 30–39-year age group, followed by the 40–49-year group. In contrast, most male patients were in the 60–69-year age group, followed by the 30–39-year group. A Chi-square test was performed to assess the association between age distribution and gender, which was found to be statistically non-significant ( $P = 0.503$ ).

**Table 2: Age distribution based on gender.**

Age distribution	Female n(%)	Male n(%)	Total n(%)
20-29 Years	7(8.9%)	12(16.9%)	19(12.7%)

30-39 Years	18(22.8%)	13(18.3%)	31(20.7%)
40-49 Years	17(21.5%)	10(14.1%)	27(18.0%)
50-59 Years	12(15.2%)	11(15.5%)	23(15.3%)
60-69 Years	14(17.7%)	17(23.9%)	31(20.7%)
>70 Years	11(13.9%)	8(11.3%)	19(12.7%)
Total	79(100.0%)	71(100.0%)	150(100.0%)

As shown in Table 3 and table 4, the results of the ANOVA and Bonferroni analysis revealed significant age-related differences in several aortic knob parameters. Aortic knob width (AKW) showed significant enlargement in individuals aged 60 years and above

compared to younger adults, reflecting vascular remodeling. Similarly, the straight length (AKS) and curved length (AKC) of the aortic knob increased significantly with age, particularly beyond 60 years, with the curved length showing the most pronounced differences. In contrast, the aortic knob index (AKI) remained stable across age groups, suggesting proportional consistency despite dimensional increases. The transverse thoracic diameter (TTD) showed a mid-life peak, being significantly greater in the 50–59 year group compared to 40–49 years. The CD demonstrated consistent enlargement with age, being significantly higher in those >40 years, with the greatest differences observed in the >70 years group ( $p \leq 0.007$ ). Similarly, the CTR was significantly elevated in elderly individuals,

especially >70 years, compared with younger groups, indicating progressive structural remodeling of the heart and great vessels with advancing age.

This post-hoc analysis was performed in an exploratory context to examine potential pairwise differences across age groups for each measured parameter. To maintain stringent control of the family-wise error rate given the extensive number of comparisons, Bonferroni adjustment was applied. Consequently, the corrected P-values presented in the table reflect a conservative approach that prioritizes minimizing type I error; therefore, non-significant findings should be interpreted with consideration of reduced statistical power inherent to this correction method.

**Table 3: Mean and standard deviation of different parameters based on age distribution.**

VARIABLES	Age Distribution						P value
	20-29 Years	30-39 Years	40-49 Years	50-59 Years	60-69 Years	>70 Years	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
AKW	2.14 ± 0.23	2.21 ± 0.25	2.38 ± 0.45	2.27 ± 0.39	2.72 ± 0.38	2.60 ± 0.30	<b>0.000</b>
AKS	2.35 ± 0.40	2.55 ± 0.50	2.60 ± 0.46	2.55 ± 0.42	2.89 ± 0.39	3.10 ± 0.47	<b>0.000</b>
AKC	2.68 ± 0.42	2.91 ± 0.54	2.96 ± 0.53	3.00 ± 0.53	3.43 ± 0.47	3.62 ± 0.57	<b>0.000</b>
AKI	1.12 ± 0.07	1.14 ± 0.06	1.13 ± 0.08	1.17 ± 0.12	1.19 ± 0.12	1.17 ± 0.10	0.080
TTD	19.40 ± 1.92	19.92 ± 1.89	20.18 ± 1.49	18.62 ± 2.20	20.03 ± 1.46	20.17 ± 1.17	<b>0.015</b>
CD	8.43 ± 0.710	8.78 ± 1.16	9.50 ± 1.07	8.25 ± 1.01	9.39 ± 0.91	9.80 ± 0.80	<b>0.000</b>
CTR	0.44 ± 0.03	0.44 ± 0.04	0.47 ± 0.05	0.45 ± 0.04	0.47 ± 0.04	0.49 ± 0.04	<b>0.000</b>

**Table 4: The Bonferroni post-hoc analysis showing age-related variations across several aortic parameters**

Dependent Variable		Mean Difference (I-J)	Std. Error	P-value	95% Confidence Interval		Cohen's D Effect Size	
					Lower Bound	Upper Bound		
AKW	20-29 Years	30-39 Years	-0.07076	0.103	1.000	-.3768	.2353	-0.284
		40-49 Years	-.24281	0.105	0.339	-.5573	.0717	-0.642
		50-59 Years	-.12947	0.109	1.000	-.4551	.1961	-0.392

		60-69 Years	-.58205*	0.103	<0.001	-.8881	-.2760	-1.710
		>70 Years	-.46158*	0.114	0.001	-.8023	-.1208	-1.949
30-39 Years		20-29 Years	.07076	0.103	1.000	-.2353	.3768	.2353
		40-49 Years	-.17204	0.093	0.979	-.4485	.1044	-0.479
		50-59 Years	-.05871	0.097	1.000	-.3478	.2303	-0.184
		60-69 Years	-.51129*	0.089	<0.001	-.7781	-.2445	-1.552
		>70 Years	-.39081*	0.103	0.003	-.6968	-.0848	-1.419
40-49 Years		20-29 Years	.24281	0.105	0.339	-.0717	.5573	-0.642
		30-39 Years	.17204	0.093	0.979	-.1044	.4485	-0.479
		50-59 Years	.11333	0.100	1.000	-.1847	.4114	0.267
		60-69 Years	-.33925*	0.093	0.005	-.6157	-.0628	-0.810
		>70 Years	-.21877	0.105	0.595	-.5333	.0957	-0.551
50-59 Years		20-29 Years	.12947	0.109	1.000	-.1961	.4551	-0.392
		30-39 Years	.05871	0.097	1.000	-.2303	.3478	-0.184
		40-49 Years	-.11333	0.100	1.000	-.4114	.1847	0.267
		60-69 Years	-.45258*	0.097	<0.001	-.7416	-.1635	-1.161
		>70 Years	-.33211*	0.109	0.042	-.6577	-.0065	-0.936
60-69 Years		20-29 Years	.58205*	0.103	<0.001	.2760	.8881	-1.710
		30-39 Years	.51129*	0.089	<0.001	.2445	.7781	-1.552
		40-49 Years	.33925*	0.093	0.005	.0628	.6157	-0.810
		50-59 Years	.45258*	0.097	<0.001	.1635	.7416	-1.161
		>70 Years	.12048	0.103	1.000	-.1855	.4265	0.335
>70 Years		20-29 Years	.46158*	0.114	0.001	.1208	.8023	-1.949
		30-39 Years	.39081*	0.103	0.003	.0848	.6968	-1.419
		40-49 Years	.21877	0.105	0.595	-.0957	.5333	-0.551
		50-59 Years	.33211*	0.109	0.042	.0065	.6577	-0.936
		60-69 Years	-.12048	0.103	1.000	-.4265	.1855	0.335
AKS	20-29 Years	30-39 Years	-.20455	0.130	1.000	-.5938	.1847	-0.436
		40-49 Years	-.25768	0.134	0.848	-.6578	.1424	-0.586
		50-59 Years	-.20538	0.139	1.000	-.6196	.2088	-0.495
		60-69 Years	-.53874*	0.130	0.001	-.9280	-.1495	-1.355
		>70 Years	-.75737*	0.145	<0.001	-1.1909	-.3239	-1.981
	30-39 Years	20-29 Years	.20455	0.130	1.000	-.1847	.5938	-0.436
		40-49 Years	-.05313	0.118	1.000	-.4048	.2986	-0.109

		50-59 Years	-.00083	0.123	1.000	-.3685	.3669	-0.002
		60-69 Years	-.33419	0.114	0.057	-.6736	.0052	-0.738
		>70 Years	-.55282*	0.130	0.001	-.9421	-.1635	-1.119
	40-49 Years	20-29 Years	.25768	0.134	0.848	-.1424	.6578	-0.586
		30-39 Years	.05313	0.118	1.000	-.2986	.4048	-0.109
		50-59 Years	.05230	0.127	1.000	-.3268	.4314	0.117
		60-69 Years	-.28106	0.118	0.275	-.6328	.0706	-0.657
		>70 Years	-.49969*	0.134	0.004	-.8998	-.0996	-1.065
	50-59 Years	20-29 Years	.20538	0.139	1.000	-.2088	.6196	-0.495
		30-39 Years	.00083	0.123	1.000	-.3669	.3685	-0.002
		40-49 Years	-.05230	0.127	1.000	-.4314	.3268	0.117
		60-69 Years	-.33337	0.123	0.114	-.7011	.0343	-0.819
		>70 Years	-.55199*	0.139	0.002	-.9662	-.1378	-1.231
	60-69 Years	20-29 Years	.53874*	0.130	0.001	.1495	.9280	-1.355
		30-39 Years	.33419	0.114	0.057	-.0052	.6736	-0.738
		40-49 Years	.28106	0.118	0.275	-.0706	.6328	-0.657
		50-59 Years	.33337	0.123	0.114	-.0343	.7011	-0.819
		>70 Years	-.21862	0.130	1.000	-.6079	.1707	-0.512
	>70 Years	20-29 Years	.75737*	0.145	<0.001	.3239	1.1909	-1.981
		30-39 Years	.55282*	0.130	0.001	.1635	.9421	-1.119
		40-49 Years	.49969*	0.134	0.004	.0996	.8998	-1.065
		50-59 Years	.55199*	0.139	0.002	.1378	.9662	-1.231
		60-69 Years	.21862	0.130	1.000	-.1707	.6079	-0.512
AKC	20-29 Years	30-39 Years	-.28744	0.151	0.882	-.7378	.1630	-0.570
		40-49 Years	-.33495	0.155	0.487	-.7979	.1279	-0.682
		50-59 Years	-.37899	0.161	0.294	-.8582	.1002	-0.781
		60-69 Years	-.81195*	0.151	<0.001	-1.2623	-.3616	-1.768
		>70 Years	-1.00158*	0.168	<0.001	-1.5031	-.5000	-2.295
	30-39 Years	20-29 Years	.28744	0.151	0.882	-.1630	.7378	0.570
		40-49 Years	-.04751	0.136	1.000	-.4544	.3594	-0.088
		50-59 Years	-.09156	0.143	1.000	-.5170	.3339	-0.169
		60-69 Years	-.52452*	0.132	0.002	-.9172	-.1319	-1.019
		>70 Years	-.71414*	0.151	<0.001	-1.1645	-.2637	-1.282
	40-49	20-29 Years	.33495	0.155	0.487	-.1279	.7979	-0.682

	Years	30-39 Years	.04751	0.136	1.000	-.3594	.4544	-0.088
		50-59 Years	-.04404	0.147	1.000	-.4827	.3946	-0.083
		60-69 Years	-.47700*	0.136	0.009	-.8839	-.0701	-0.944
		>70 Years	-.66663*	0.155	<0.001	-1.1295	-.2037	-1.212
	50-59 Years	20-29 Years	.37899	0.161	0.294	-.1002	.8582	-0.781
		30-39 Years	.09156	0.143	1.000	-.3339	.5170	-0.169
		40-49 Years	.04404	0.147	1.000	-.3946	.4827	-0.083
		60-69 Years	-.43296*	0.143	0.042	-.8584	-.0075	-0.863
		>70 Years	-.62259*	0.161	0.002	-1.1018	-.1433	-1.132
	60-69 Years	20-29 Years	.81195*	0.151	<0.001	.3616	1.2623	-1.768
		30-39 Years	.52452*	0.132	0.002	.1319	.9172	-1.019
		40-49 Years	.47700*	0.136	0.009	.0701	.8839	-0.944
		50-59 Years	.43296*	0.143	0.042	.0075	.8584	-0.863
		>70 Years	-.18963	0.151	1.000	-.6400	.2608	-0.367
	>70 Years	20-29 Years	1.00158*	0.168	<0.001	.5000	1.5031	-2.295
		30-39 Years	.71414*	0.151	<0.001	.2637	1.1645	-1.282
		40-49 Years	.66663*	0.155	<0.001	.2037	1.1295	-1.212
		50-59 Years	.62259*	0.161	0.002	.1433	1.1018	-1.132
		60-69 Years	.18963	0.151	1.000	-.2608	.6400	-0.367
	AKI	20-29 Years	30-39 Years	-.02282	0.029	1.000	-.1105	.0648
40-49 Years			-.01487	0.030	1.000	-.1050	.0752	-0.182
50-59 Years			-.05851	0.031	0.947	-.1518	.0347	-0.539
60-69 Years			-.07443	0.029	0.185	-.1621	.0132	-0.686
>70 Years			-.04895	0.033	1.000	-.1465	.0486	-0.609
30-39 Years		20-29 Years	.02282	0.029	1.000	-.0648	.1105	-0.315
		40-49 Years	.00795	0.027	1.000	-.0712	.0871	0.103
		50-59 Years	-.03569	0.028	1.000	-.1185	.0471	-0.361
		60-69 Years	-.05161	0.026	0.684	-.1280	.0248	-0.515
		>70 Years	-.02613	0.029	1.000	-.1138	.0615	-0.307
40-49 Years		20-29 Years	.01487	0.030	1.000	-.0752	.1050	-0.182
		30-39 Years	-.00795	0.027	1.000	-.0871	.0712	0.103
		50-59 Years	-.04364	0.029	1.000	-.1290	.0417	-0.408
		60-69 Years	-.05956	0.027	0.394	-.1387	.0196	-0.555
		>70 Years	-.03407	0.030	1.000	-.1242	.0560	-0.362

	50-59 Years	20-29 Years	.05851	0.031	0.947	-.0347	.1518	-0.539
		30-39 Years	.03569	0.028	1.000	-.0471	.1185	-0.361
		40-49 Years	.04364	0.029	1.000	-.0417	.1290	-0.408
		60-69 Years	-.01592	0.028	1.000	-.0987	.0669	-0.127
		>70 Years	.00957	0.031	1.000	-.0837	.1028	0.080
	60-69 Years	20-29 Years	.07443	0.029	0.185	-.0132	.1621	-0.686
		30-39 Years	.05161	0.026	0.684	-.0248	.1280	-0.515
		40-49 Years	.05956	0.027	0.394	-.0196	.1387	-0.555
		50-59 Years	.01592	0.028	1.000	-.0669	.0987	-0.127
		>70 Years	.02548	0.029	1.000	-.0622	.1131	0.217
	>70 Years	20-29 Years	.04895	0.033	1.000	-.0486	.1465	-0.609
		30-39 Years	.02613	0.029	1.000	-.0615	.1138	-0.307
		40-49 Years	.03407	0.030	1.000	-.0560	.1242	-0.362
		50-59 Years	-.00957	0.031	1.000	-.1028	.0837	0.080
		60-69 Years	-.02548	0.029	1.000	-.1131	.0622	0.217
TTD	20-29 Years	30-39 Years	-.52197	0.503	1.000	-2.0237	.9798	-0.273
		40-49 Years	-.78212	0.517	1.000	-2.3256	.7613	-0.464
		50-59 Years	.78027	0.535	1.000	-.8177	2.3782	0.374
		60-69 Years	-.63487	0.503	1.000	-2.1366	.8669	-0.385
		>70 Years	-.76895	0.560	1.000	-2.4412	.9033	-0.556
	30-39 Years	20-29 Years	.52197	0.503	1.000	-.9798	2.0237	-0.273
		40-49 Years	-.26016	0.455	1.000	-1.6170	1.0967	-0.151
		50-59 Years	1.30224	0.475	0.104	-.1162	2.7207	0.639
		60-69 Years	-.11290	0.439	1.000	-1.4221	1.1963	-0.067
		>70 Years	-.24698	0.503	1.000	-1.7487	1.2548	-0.148
	40-49 Years	20-29 Years	.78212	0.517	1.000	-.7613	2.3256	-0.464
		30-39 Years	.26016	0.455	1.000	-1.0967	1.6170	-0.151
		50-59 Years	1.56240*	0.490	0.026	.0998	3.0250	0.842
		60-69 Years	.14725	0.455	1.000	-1.2096	1.5041	0.100
		>70 Years	.01318	0.517	1.000	-1.5303	1.5566	0.010
	50-59 Years	20-29 Years	-.78027	0.535	1.000	-2.3782	.8177	0.374
		30-39 Years	-1.30224	0.475	0.104	-2.7207	.1162	0.639
		40-49 Years	-1.56240*	0.490	0.026	-3.0250	-.0998	0.842
		60-69 Years	-1.41515	0.475	0.051	-2.8336	.0033	-0.779

		>70 Years	-1.54922	0.535	0.066	-3.1472	.0487	-0.852
	60-69 Years	20-29 Years	.63487	0.503	1.000	-.8669	2.1366	-0.385
		30-39 Years	.11290	0.439	1.000	-1.1963	1.4221	-0.067
		40-49 Years	-.14725	0.455	1.000	-1.5041	1.2096	0.100
		50-59 Years	1.41515	0.475	0.051	-.0033	2.8336	-0.779
		>70 Years	-.13407	0.503	1.000	-1.6358	1.3677	-0.099
	>70 Years	20-29 Years	.76895	0.560	1.000	-.9033	2.4412	-0.556
		30-39 Years	.24698	0.503	1.000	-1.2548	1.7487	-0.148
		40-49 Years	-.01318	0.517	1.000	-1.5566	1.5303	0.010
		50-59 Years	1.54922	0.535	0.066	-.0487	3.1472	-0.852
		60-69 Years	.13407	0.503	1.000	-1.3677	1.6358	-0.099
CD	20-29 Years	30-39 Years	-.34898	0.287	1.000	-1.2052	.5072	-0.344
		40-49 Years	-1.07255*	0.295	0.006	-1.9525	-.1926	-1.133
		50-59 Years	.17915	0.305	1.000	-.7318	1.0902	0.200
		60-69 Years	-.96672*	0.287	0.014	-1.8229	-.1105	-1.144
		>70 Years	-1.37105*	0.319	<0.001	-2.3244	-.4177	-2.083
	30-39 Years	20-29 Years	.34898	0.287	1.000	-.5072	1.2052	-0.344
		40-49 Years	-.72357	0.259	0.089	-1.4971	.0500	-0.644
		50-59 Years	.52813	0.271	0.798	-.2806	1.3368	0.479
		60-69 Years	-.61774	0.250	0.220	-1.3641	.1287	-0.591
		>70 Years	-1.02207*	0.287	0.007	-1.8782	-.1659	-0.981
	40-49 Years	20-29 Years	1.07255*	0.295	0.006	.1926	1.9525	-1.133
		30-39 Years	.72357	0.259	0.089	-.0500	1.4971	-0.644
		50-59 Years	1.25171*	0.279	<0.001	.4179	2.0855	1.189
		60-69 Years	.10583	0.259	1.000	-.6677	.8794	0.106
		>70 Years	-.29850	0.295	1.000	-1.1784	.5814	-0.305
	50-59 Years	20-29 Years	-.17915	0.305	1.000	-1.0902	.7318	0.200
		30-39 Years	-.52813	0.271	0.798	-1.3368	.2806	0.479
		40-49 Years	-1.25171*	0.279	<0.001	-2.0855	-.4179	1.189
		60-69 Years	-1.14588*	0.271	0.001	-1.9546	-.3372	-1.192
		>70 Years	-1.55021*	0.305	<0.001	-2.4612	-.6392	-1.668
	60-69 Years	20-29 Years	.96672*	0.287	0.014	.1105	1.8229	-1.144
		30-39 Years	.61774	0.250	0.220	-.1287	1.3641	-0.591
		40-49 Years	-.10583	0.259	1.000	-.8794	.6677	0.106

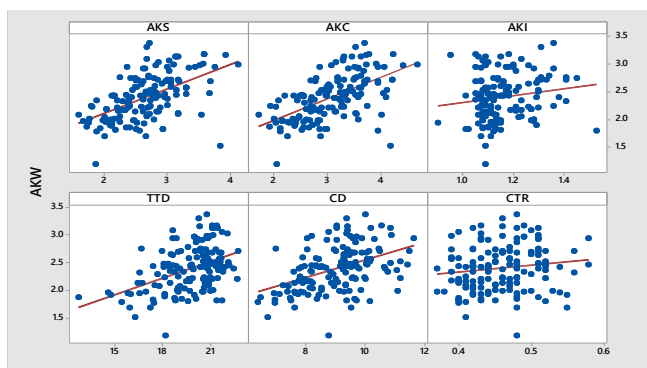
		50-59 Years	1.14588*	0.271	0.001	.3372	1.9546	-1.192
		>70 Years	-.40433	0.287	1.000	-1.2605	.4518	-0.461
	>70 Years	20-29 Years	1.37105*	0.319	<0.001	.4177	2.3244	-2.083
		30-39 Years	1.02207*	0.287	0.007	.1659	1.8782	-0.981
		40-49 Years	.29850	0.295	1.000	-.5814	1.1784	-0.305
		50-59 Years	1.55021*	0.305	<0.001	.6392	2.4612	-1.668
		60-69 Years	.40433	0.287	1.000	-.4518	1.2605	-0.461
CTR	20-29 Years	30-39 Years	-.00498	0.012	1.000	-.0415	.0316	-0.137
		40-49 Years	-.03546	0.013	0.083	-.0730	.0021	-0.885
		50-59 Years	-.00920	0.013	1.000	-.0481	.0297	-0.247
		60-69 Years	-.03409	0.012	0.091	-.0706	.0025	-0.898
		>70 Years	-.05098*	0.014	0.004	-.0917	-.0103	-1.688
	30-39 Years	20-29 Years	.00498	0.012	1.000	-.0316	.0415	-0.137
		40-49 Years	-.03048	0.011	0.099	-.0635	.0025	-0.688
		50-59 Years	-.00422	0.012	1.000	-.0387	.0303	-0.099
		60-69 Years	-.02911	0.011	0.108	-.0610	.0028	-0.685
		>70 Years	-.04600*	0.012	0.004	-.0825	-.0095	-1.106
	40-49 Years	20-29 Years	.03546	0.013	0.083	-.0021	.0730	-0.885
		30-39 Years	.03048	0.011	0.099	-.0025	.0635	-0.688
		50-59 Years	.02626	0.012	0.438	-.0093	.0619	0.570
		60-69 Years	.00138	0.011	1.000	-.0316	.0344	0.030
		>70 Years	-.01551	0.013	1.000	-.0531	.0220	-0.343
	50-59 Years	20-29 Years	.00920	0.013	1.000	-.0297	.0481	-0.247
		30-39 Years	.00422	0.012	1.000	-.0303	.0387	-0.099
		40-49 Years	-.02626	0.012	0.438	-.0619	.0093	0.570
		60-69 Years	-.02489	0.012	0.496	-.0594	.0096	-0.566
		>70 Years	-.04178*	0.013	0.025	-.0807	-.0029	-0.963
	60-69 Years	20-29 Years	.03409	0.012	0.091	-.0025	.0706	-0.898
		30-39 Years	.02911	0.011	0.108	-.0028	.0610	-0.685
		40-49 Years	-.00138	0.011	1.000	-.0344	.0316	0.030
		50-59 Years	.02489	0.012	0.496	-.0096	.0594	-0.566
		>70 Years	-.01689	0.012	1.000	-.0534	.0197	-0.393
	>70 Years	20-29 Years	.05098*	0.014	0.004	.0103	.0917	-1.688
		30-39 Years	.04600*	0.012	0.004	.0095	.0825	-1.106

	40-49 Years	.01551	0.013	1.000	-.0220	.0531	-0.343
	50-59 Years	.04178*	0.013	0.025	.0029	.0807	-0.963
	60-69 Years	.01689	0.012	1.000	-.0197	.0534	-0.393

The correlation analysis showed that AKW had significant moderate positive correlations with AKS, AKC, TTD, and CD, indicating that increases in these parameters are moderately associated with increases in AKW. In contrast, AKI and CTR demonstrated very weak and statistically non-significant correlations with AKW, as their confidence intervals included zero and P-values exceeded 0.05, indicating no meaningful relationship with AKW (Table 5). Scatter plot representation shown in figure 2

**Table 5: showing the correlation between AKW and other parameters**

Variable	Correlation	95.0% C.I		P-value
		LB	UB	
AKS	0.54	0.41	0.68	<0.001
AKC	0.58	0.44	0.71	<0.001
AKI	0.16	-0.01	0.32	0.058
TTD	0.45	0.30	0.59	<0.001
CD	0.44	0.30	0.59	<0.001
CTR	0.14	-0.02	0.30	0.090



**Figure 2: Scatter plot representation of AKW in correlation with other parameters**

### 3. DISCUSSION

Aortic knob variations are not given much importance in clinical side practice. In this study attempt was made to find out if there was any association between the AK dimensions & cardio-thoracic diameter with age and gender. This was done by collecting random samples of chest X-Rays done in the recent past (after the covid era) from the radiology department.

The current study showed that the mean AKW and AKI values were greater in females than in males but not significantly so. The AKS values did not differ much between males and females. The TTD was higher in males than in females and the CD was found to be higher in females than in males but the values were not significant. Significant differences in AKW were observed between younger (20–39 years) and older age groups (60–69 years and >70 years). Suggesting progressive enlargement of the aortic knob with advancing age, likely due to vascular remodeling and atherosclerotic changes. AKW showed strong positive correlation with CD, TTD, AKS and AKC

Shankar et al attempted to find the variations in aortic knob in a study population of 108 normal, healthy adult subjects in relation to gender and age. They used three parameters in the study which were AKW, AKS, AKI. They found that the mean value of AKW was significantly higher in males as compared to females in contrast to present study where females showed higher values than males, though not significant. [3] The mean

AKS although greater in males was not significantly so similar to the current study where not much difference was observed between the two sexes, the mean AKI was greater in females though this was not significant similar to what we observed in our study. AKW showed significant positive correlations with age, BMI, and the CD. In the present study also AKW showed a significant correlation with age and CD.

Kayastha et al. conducted a study to investigate variations in the measurements of the AK on chest radiographs among normal and hypertensive Nepalese individuals, focusing on three parameters: AKW, AKS, and AKI. [4] The results indicated that AKW values were elevated in hypertensive patients compared to the normal population. Although AKS values were marginally higher in hypertensive patients than in the normal group, the difference was not statistically significant. Furthermore, AKW, AKS, and AKI values were found to be greater in males than in females, although this difference was also not statistically significant. Notably, AKI was significantly higher than that observed in the normal population, and the overall AKI in males was significantly greater than in females, which contrasts with findings from previous studies as well as our own.

Elzaki M performed a study on biometric data of adult's Aortic knob diameter in PA chest radiograph of Sudanese population, correlating to age and normative heart diameter. Four parameters were used BMI, AKD (Aortic knob diameter), HD (heart diameter), CTR. AKD and HD values were observed to be larger in males than in females, and a strong positive correlation existed

between them. Furthermore, AKD exhibited a significant age-related association, aligning with our results. [5]

Eun-ji Lee and colleagues conducted a study examining the association between AKW and metabolic syndrome within a Korean demographic. The research revealed that AKW exhibited significant correlations with various factors including age, BMI, waist circumference, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, fasting glucose, insulin, hemoglobin A1c (HbA1c), and uric acid levels. Notably, all variables demonstrated significant correlations with AKW, with the exception of total cholesterol and uric acid levels in males, as well as insulin levels in females. Additionally, Lifestyle factors such as physical activity, smoking, and alcohol use also influenced AKW. [6] Although our study did not assess metabolic or lifestyle variables, the observed correlation between AKW and age in our dataset reinforces the importance of considering systemic and demographic factors when interpreting aortic knob measurements.

Ray et al., in their study of the West Bengal population, reported that AKW, TTD, and CD values were higher in males, with AKW increasing with age across both sexes. They also observed a positive correlation between AKW and TTD, CD, and age, consistent with our findings. [7]

Anyanwu et al. studied 1,018 chest radiographs from a Nigerian cohort and found that aortic diameter (AD), chest diameter, and heart diameter were all greater in males, while CTR was higher in females. This aligns with our findings, where CTR was also significantly greater among females. They also found a significant correlation

between AD, age, and heart diameter, and a positive correlation between AD and CTR, whereas in our study, AK dimensions and CTR did not show a strong association. [8]

In another comparative study by Rayner et al., hypertensive patients were shown to have significantly higher AKW and CTR values than normotensive controls, with a strong positive correlation between the two. [9] These findings support the idea that aortic knob width may serve as an indirect radiographic marker for cardiovascular risk, particularly hypertension

Korkmaz et al measured cardio ankle vascular index in hypertensive patients and correlated it with Aortic knob width. They found a positive correlation between the two parameters. They concluded that the diameter of aortic knob can predict subclinical atherosclerosis. [10]

Aortic knob dimensions have been studied previously in other populations like Nigerian, American, Saudi Arabian, Nepalese. Compared to these populations the Indian population showed relatively smaller dimensions of the aortic knob. Maximum dimensions of the knob were observed in Nigerians followed by Americans. This could be attributed to racial difference and also the methodology adopted to measure the aortic knob. [4, 6, 9]

#### 4. CONCLUSION

The present study provides valuable normative data on aortic knob dimensions and their relationship with cardiothoracic parameters in the Indian population. It demonstrates that while most aortic knob dimensions were slightly higher in females, only the cardiothoracic ratio (CTR) showed a statistically significant difference

between genders, being higher in males. Aortic knob width correlated positively with age and most thoracic parameters, suggesting its potential utility as a supplementary indicator in cardiovascular risk assessment. These findings highlight the importance of age- and sex-specific reference values when interpreting chest radiographs and underscore the relevance of the aortic knob as a morphometric marker in routine radiological evaluations.

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Approval of final manuscript: All authors

#### Declaration of Generative AI

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