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"CORONARY ARTERY DIAMETER ON CT CORONARY ANGIOGRAPHY, IN NORMAL ADULT POPULATION OF PAKISTAN, RELEVANCE WITH AGE AND GENDER"

Dr Hira Ahmed[1], Dr Asma Aijaz[2], Dr Shazia Fahmi[3], Dr Talat Samreen[4], Dr Sarwath Fatimee[5], Dr Nadeem Baig[6], Syeda Anza Husnain[7]

[1]Assistant Professor Anatomy Department, Karachi Medical And Dental College (KMDC)
[2]MBBS, Mphil Assistant Professor Anatomy Department KMDC
[3]Assistant Professor Anatomy Department KMDC
[4]Assistant Professor Anatomy Department KMDC
[5]Associate Professor Department of Anatomy Fatima Jinnah Dental College, JSMU, Karachi
[6]HOD Anatomy Department KMDC
[7]Mphil, Research Scientist, School of Biochemistry and Biotechnology, The University of The Punjab, Lahor

ABSTRACT:

Background: Coronary artery diameters are decisive for interventional radiologists and cardiologists. This helps them in choosing the stent size appropriately, based on the need and diameter of the vessel. An important factor affecting the diagnostic, therapeutic and prognostic purposes for patients is gender. Angiography has been the gold standard in establishing the accurate size of coronary artery, but it has certain limitations. On the other hand, Computed Tomography (CT) coronary angiography is better in terms of evaluating the size of vessel, mural thickness as well as calcified and non-calcified plaques.

Objective: Our purpose of study is to establish data for normal coronary artery diameters using multi-detector CT as our tool, in individuals without prevailing heart disease. Coronary artery diameters are decisive for interventional radiologists and cardiologists. This helps them in choosing the stent size appropriately, based on the need and diameter of the vessel. An important factor affecting the diagnostic, therapeutic and prognostic purposes for patients is gender. For reference, a vessel

Material and Methods: We randomly selected 180 consecutive patients without any underlying disease who underwent CT coronary angiography for evaluation of Coronary Artery Disease, between August 2020 and August 2021. CT coronary angiography based vessel diameters were analyzed on Vitrea on 64 slice. Patient's demographics and data were obtained from our hospital record system Radiology Information System (RIS).

Results: In our study we found that the mean indexed diameter to BSA among males and females for LM 3.96mm with SD 0.585, LAD 3.62mm with SD 0.515 , LCX 2.99mm with SD 0.629 and RCA 3.13mm with SD 0.532. These values are comparable to other studies.

Conclusion: In a normal adult Pakistani population, the normative data for coronary artery are this is similar to that reported in Indian and western population

KEYWORDS: CT coronary angiography (CTA), coronary artery disease CAD, Multi-detector CT (MDCT).

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About the authors：Dr Hira Ahmed

Email:

INTRODUCTION:

There have been very few reports on the diameters of normal (un-diseased) coronary arteries during life in the Pakistani population. It is frequently necessary to know the coronary dimensions, particularly during operations such as stenting, in order to select the right balloon, stent, or requirement for stenting. Luminal angiography is the most frequently used technique in practise for determining the coronary artery diameter. However, luminal angiography is insufficiently accurate in determining the epicardial coronary artery size since it does not account for the arterial wall mural thickness. Until yet, evidence has been limited to eye estimations or electronic caliper measures taken from cine-angiographic images [1-4].

It is unknown whether the diameters of coronary arteries o Pakistani population are comparable to those of the western population. There is a widespread belief that Pakistanis have smaller epicardial coronary arteries than westerners, based on measurements of diseased coronary arteries in patients undergoing Coronary Artery Bypass Grafting (CABG) or autopsy specimens [5]. Thus, we used 64-slice quantitative Multi Detector Computed Tomography (MDCT) coronary angiography to produce normative data for normal epicardial coronary arteries in a subpopulation of Pakistanis without structural heart disease.

Coronary CT angiography has emerged as a helping tool in establishing coronary artery disease and cardiovascular disease management [1, 2]. In American literature, a certain decline has been reported in mortality rate associated with heart disease due to the useful application of CT coronary angiography as an adjunct tool [2, 3]. It is read from literature, that Caucasian males have larger diameter of coronary vessels, while women have smaller coronary artery diameters [5, 6,7]. Smaller coronary arteries hamper challenges during bypass graft and interventional procedures such as angioplasties where limitations ensue in choosing the diameter of stents [8]

Coronary artery disease was previously considered to be first world country's disease, but now along with Tuberculosis, it is equally prevalent in Indo-Asian countries. According to WHO, it is now more prevalent in developing countries, also carrying a high risk for morbidity and mortality [9, 10].

It is assumed that hormones play a major role in gender based differentiation of coronary artery diameters [11,12]. Coronary artery disease is more frequently observed in men as compared to women, size alone is not a single risk factor [13]. On the other hand, poorer prognosis for coronary artery disease was seen in females with small coronary artery diameters compared to men [14].

Zia et. Al concluded that Pakistanis and Caucasians have not significant difference in diameters of coronary arteries, while increased rate of morbidity and mortality in South Asian people can be because of other factor(s) like malnutrition, infections and lower socio-economic status [4].

Smaller coronary artery diameters provide therapeutic challenges such as difficulties for choosing percutaneous transluminal coronary angioplasty, atherectomy or even stenting. A plaque in a smaller coronary artery will create a perception of severe disease although not really present in comparison to a plaque located in a larger calibre vessel. [15]

Purpose of our study is to establish data for normal coronary artery diameters, using multi-detector CT as adjunct tool, in individuals at low risk for coronary artery disease. Many factors like age, gender, ethnicity, height and weight influence the anatomy of coronary arteries. We will learn about the

difference in coronary artery diameters based on age and gender in our study. The coronary artery diameter is considered to be inversely associated with prevalence of coronary artery disease (CAD). For example, a vessel with diameter of 2.5 mm would be at higher risk of moderate atherosclerotic disease as compared to a vessel with luminal diameter of 3.5 mm [15]. Also, for diagnostic purpose if the lumen diameter is measured accurately, it helps interventional radiologists and cardiologists to choose the stents and balloons appropriately, based on the need and diameter of the vessel. Coronary angiography has been the gold standard in establishing the accurate size of coronary artery, but it has certain limitations. On the other hand, Computed Tomography (CT) coronary angiography is better in terms of evaluating the normal and variant anatomy, size of vessel, mural thickness as well as calcified and non-calcified plaques.

METHODOLOGY:

Retrospectively, we analyzed 200 patients at Dow University of Health Sciences, Karachi, whose coronary CT angiography was normal. The patients were analyzed by cardiologist and also underwent thorough clinical history, routine blood tests, ECHO and 12 lead ECG. CT coronary angiography was performed to rule out coronary artery disease in low-risk patients. The patients mostly presented with atypical chest pain and few of them were hypertensive, smokers and had positive family history of heart disease. The inclusion criteria were patients above 18 years of age, normal ECHO and ETT and a normal clinical examination. The CT-CAG was carried out on 64 slice CT scan. CONTRAST MEDIUM was introduced. ECG-gated MDCT was done with a controlled heart rate between 60-75 bpm. The diameter of vessels included was based on the following parameters:

1. Left Main Artery (LM): in case of short LM (< 1 cm), measurement was taken just before its bifurcation. It its more than 1 cm, then measurement was taken in true axial dimension, almost 1 cm to its origin.
2. Left Anterior Descending Artery (LAD): Approximately 1 cm after origin and before giving off Diagonal branch (D1).
3. Left Circumflex Artery (LCx): Within 2 cm of its origin.
4. Right Coronary Artery (RCA): Within 2 cm of its origin.

True axial images were selected to calibrate the vessel diameter. Anatomical variants like Ramus Intermedius were also observed. Exclusion criteria were Agstaton score > 0 or any patient with high risk coronary artery disease. Any vessel with luminal irregularity, ectasia, dissection or of anamulous origin was excluded from study.

STATISTICAL ANALYSIS:

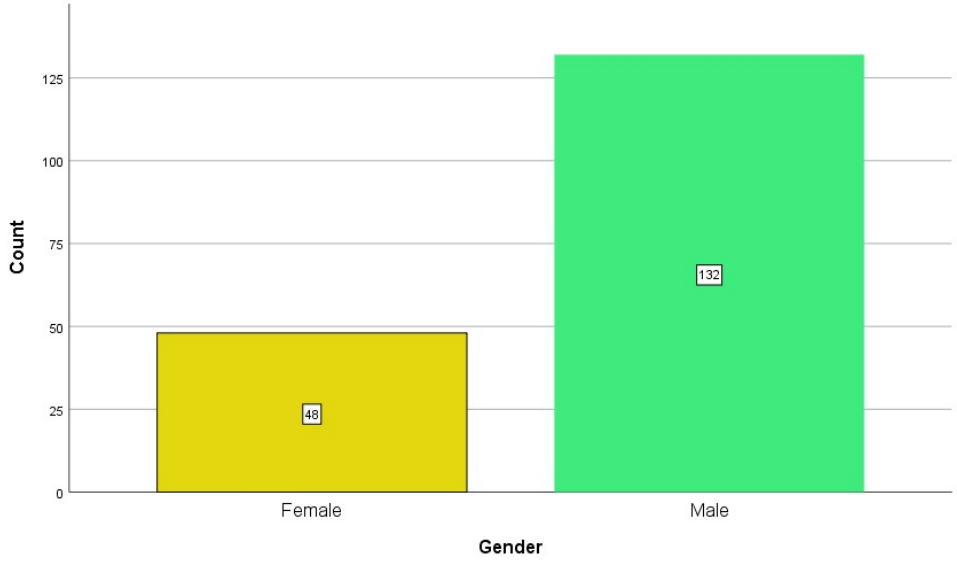
We analyzed data using 25.0 SPSS. The descriptive statistics of the variables age, gender, LM, LAD, LCX, RCA is evaluated statistically with mean, median mode, range, standard deviation, interquartile range, skewness and kurtosis. The frequency of LM, LAD, LCX, RCA is plotted with histogram chart with a normal curvature. The confidence interval considered is 95% with p-value less than 0.05.

RESULTS:

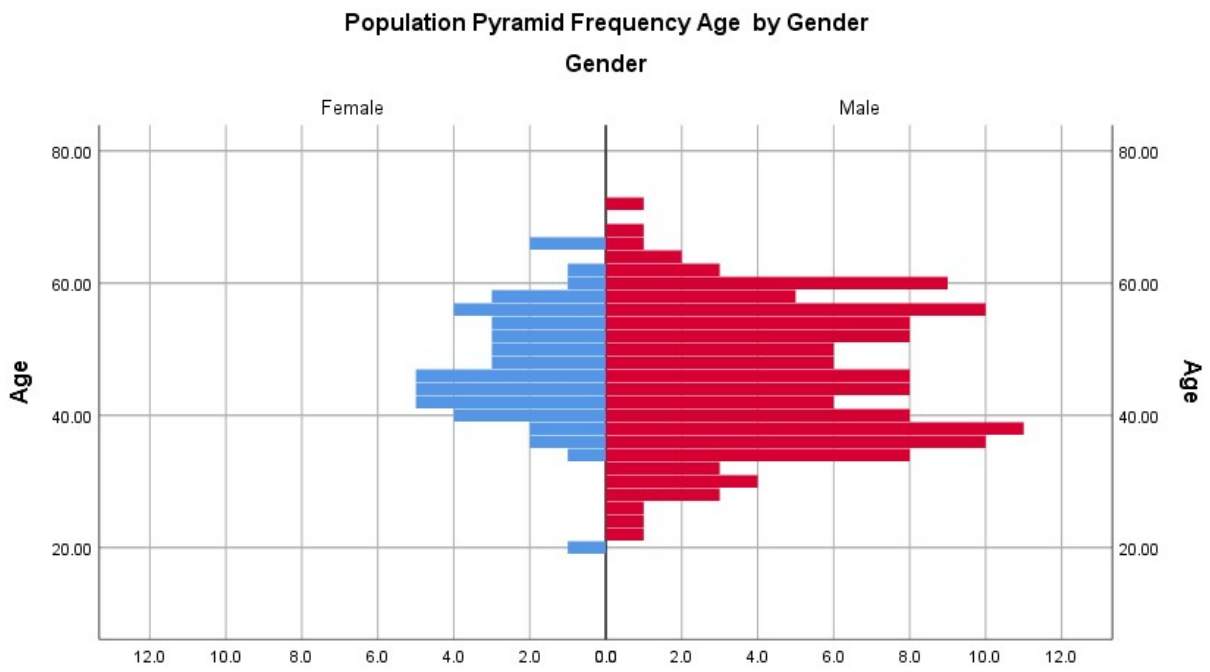
The descriptive analysis through SPSS is evaluated with mean, median, mode frequencies and the standard deviation for both variable age and gender is calculated accordingly.

Statistics			
		Age	Gender
N	Valid	180	180
	Missing	0	0
Mean		45.8500	
Median		45.0000	
Mode		55.00	
Std. Deviation		10.12684	
Variance		102.553	
Skewness		-.021	
Std. Error of Skewness		.181	
Kurtosis		-.521	
Std. Error of Kurtosis		.360	
Range		52.00	
Minimum		20.00	
Maximum		72.00	
Percentiles	25	38.0000	
	50	45.0000	
	75	54.0000	

While the distribution of males and females is assessed through a bar chart builder as shown below:



The relationship of females and males with respect to their age is demonstrated below:

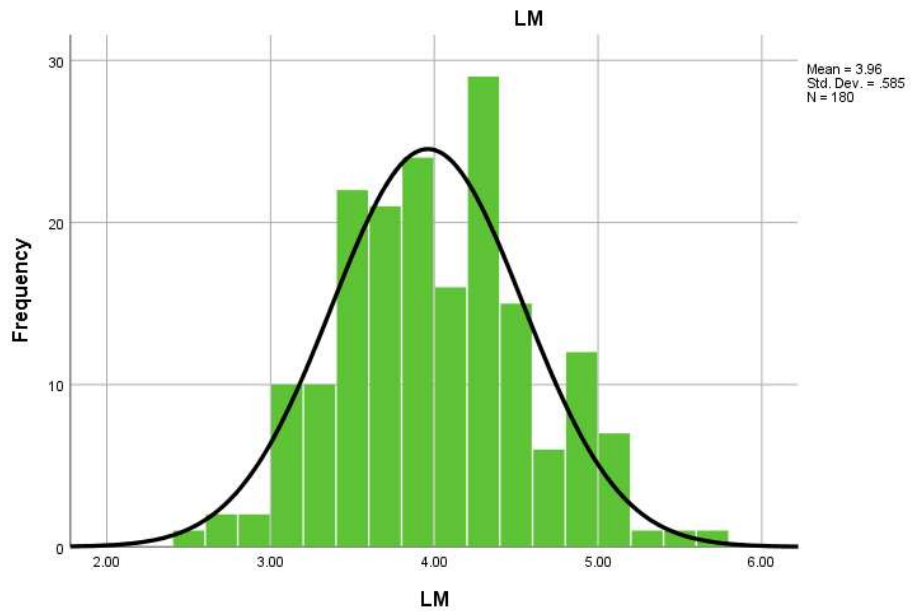


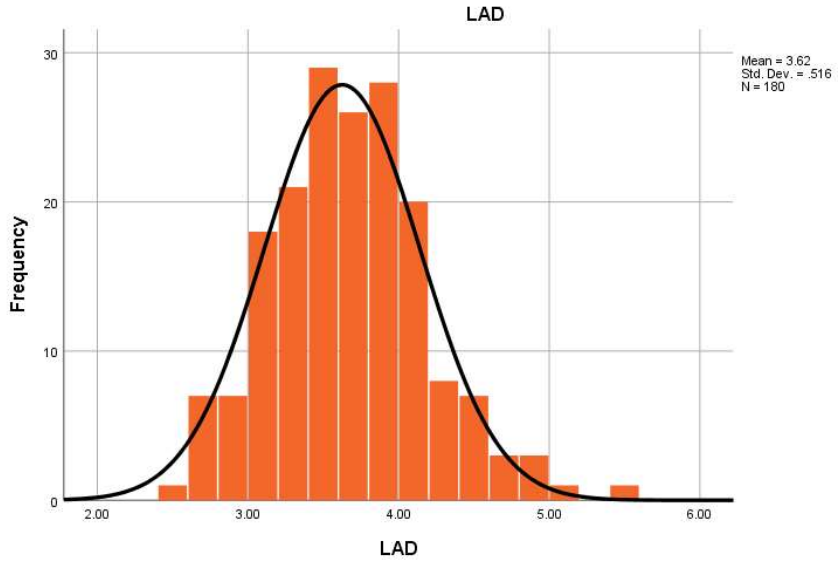
The descriptive analysis through SPSS is evaluated with mean, median, mode frequencies and the standard deviation of LM, LAD, LCX, RCA is calculated accordingly

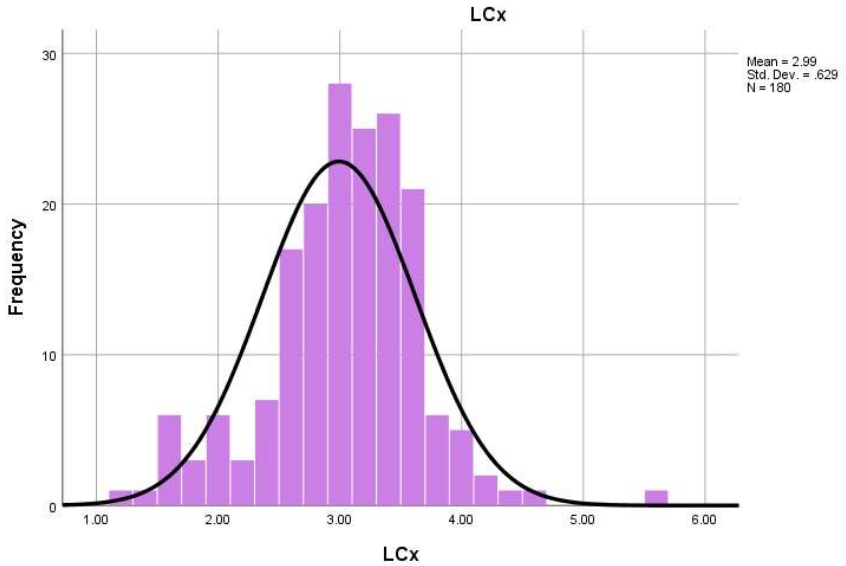
Statistics					
		LM	LAD	LCx	RCA
N	Valid	180	180	180	180
	Missing	0	0	0	0
Mean		3.9606	3.6250	2.9922	3.1311
Median		3.9000	3.6000	3.0000	3.1000
Mode		4.20	3.50	3.20	3.50
Std. Deviation		.58544	.51566	.62904	.53213
Variance		.343	.266	.396	.283
Skewness		.177	.471	-.238	.246
Std. Error of Skewness		.181	.181	.181	.181
Kurtosis		-.182	.613	1.578	1.039
Std. Error of Kurtosis		.360	.360	.360	.360
Range		3.10	3.00	4.30	3.10
Minimum		2.50	2.50	1.20	1.70
Maximum		5.60	5.50	5.50	4.80

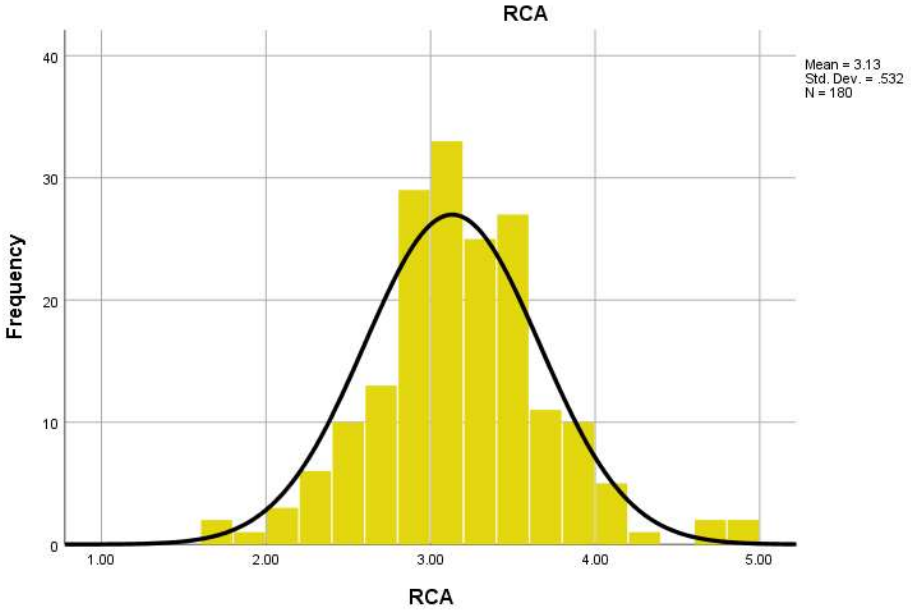
Percentiles	25	3.5000	3.3000	2.7000	2.8000
	50	3.9000	3.6000	3.0000	3.1000
	75	4.3000	3.9000	3.4000	3.5000

The histogram chart builder is used to depict the frequencies of LM, LAD, LCX, and RCA as shown below:









DISCUSSION:

Coronary artery diameters are highly varied in the general population [1,13,14]. Numerous investigations have found correlations between coronary artery anatomy and genetic variables, age, sex, body weight, body surface area, cardiac mass, and ethnic or racial factors [4,12,13,15-18]. Numerous these research involved either injections into autopsy specimens or dissections. The fundamental invalidity of these investigations is due to the numerous parameters involved in procuring, preserving, fixating, and analysing the epicardial coronary arteries. As a result, the efficacy of these measures for calculating the true diameter of coronary arteries is under doubt. Coronary angiography interpretation is inherently inaccurate and observer dependant [19,20].

Numerous investigations have been conducted in various populations using QCA (Quantitative Coronary Angiography). Coronary angiograms are luminograms, and because coronary atherosclerosis begins as an abluminal process, many of the patients studied in these studies may have had early coronary atherosclerosis and were mislabeled as normal. Due to the fact that CT-CAG can evaluate both the coronary wall and the lumen, it looks to be a more accurate method of determining the coronary diameters in truly normal coronary arteries. While numerous research have used QCA to estimate coronary artery diameters in diverse populations, there are currently no published findings using MDCT coronary angiography to estimate coronary diameters in the south Indian population. We used a 64-slice MDCT angiography to attempt to determine typical coronary widths in south Indians. Indians have been found to have much smaller coronary arteries than the western population [18,19,21].

This has been related to the bodily habitus, build, and surface area of the body. Lip reported that while the unadjusted mean diameters of various coronary artery segments in the western population were larger in Caucasians than in Asians, there was no statistically significant difference when these were indexed to body surface area, leading them to conclude that the smaller size of the coronaries in Asians is due to their relative small size. As expected, we discovered that diameters are slightly larger in our study than those reported in the literature by luminal angiography. This could be because MDCT also shows the mural thickness of coronary arteries in addition to the luminogram.

Due to previous publications indicating an age-related shift in coronary dimensions [12], we split our patients into two groups for analysis: those aged less than or equal to 40 years and those aged >40 years. Between the two age groups, there was no significant difference in coronary diameters between males and females. Coronary artery diameters, on the other hand, were shown to be positively linked with height, weight, BMI, and BSA. This is also consistent with prior results indicating a favorable connection between coronary diameters and body surface area [18,21]. Male patients had larger coronary arteries on average than female patients in both the left and right coronary systems. However, when diameters were linked to BSA, this difference vanished, indicating that it is more BSA dependent than sex dependent.

Others have reported an increase in CABG mortality in patients with narrow coronary arteries. The CASS study discovered that operating mortality dropped as average vessel diameter increased in men and women, and that both vessel size and body size had additional predictive power once clinical indicators of operative mortality were controlled for. Additionally, our findings corroborate prior work by Dodge et al, who revealed that narrower coronary arteries are associated with a significantly increased risk of in-hospital death [24].

A small mid-LAD diameter is associated with a significantly higher risk of CABG-related in-hospital mortality. Although coronary artery diameter is a significant factor in determining body size inequalities. These data provide additional support for the concept that smaller coronary arteries contribute to increased perioperative mortality with CABG and poor outcomes with alternative therapies for coronary disease in women and smaller people [24].

Asians have been shown to have an early and aggressive form of coronary artery disease [22]. Normal coronary artery diameters can be used to guide stent size selection, particularly in diffusely damaged

coronaries. As under- or over-sized, under- or over-expanded stents are well-documented risk factors for stent thrombosis, re-stenos, and procedure-related problems, these normative data can help limit these risks.

LIMITATION:

The study was conducted at a tertiary referral centre and hence may have been influenced by referral bias. Additionally, we analysed normal CT coronary angiograms in patients who underwent the study for a variety of causes, including typical or atypical chest discomfort, and these individuals may not accurately represent the 'normal' community[20].

Unlike previous studies that used luminal angiography, MDCT assesses total arterial diameter, including coronary artery mural thickness, which may exaggerate coronary artery lumen size.

CONCLUSION:

The purpose of this study was to produce normative data for normal proximal coronary artery diameters in a Pakistani subpopulation. Coronary artery diameters (indexed to BSA) are comparable between Pakistanis and western population. The diameters of the coronary arteries as estimated by CT are slightly greater than those determined by luminogram or catheter angiography. Arteriosclerosis has no discernible effect on vessel size reduction. When the widths of the right and left coronary systems are normalised to body surface area, there is no discernible gender difference[23].

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