Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Munir et al - 2026

DOI: http://doi.org/10.5281/zenodo.20285442

SONOGRAPHIC ASSESSMENT OF INTIMA MEDIA THICKNESS IN POSTMENOPAUSAL DIABETIC FEMALES

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Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Munir et al - 2026

DOI: http://doi.org/10.5281/zenodo.20285442

Author Details

Keywords:

Received on 25 Mar 2026

Accepted on 30 Apr 2026

Published on 19 May 2026

Corresponding E-mails & Authors*:

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Abstract

ABSTRACT

Due to hormonal and metabolic changes, postmenopausal women are more susceptible to cardiovascular illnesses. Diabetes mellitus increases atherosclerosis even more. Non-invasive ultrasound measurements of carotid intima-media thickness (IMT) are a trustworthy indicator for the early identification of subclinical atherosclerosis. The aim of the current study was to assess the intima media thickness by sonographic method in postmenopausal women suffering from diabetes and correlate it with age, duration of disease and other associated risk factors. The study is based on a cross-sectional design, where participants are recruited from a tertiary care hospital radiology department among postmenopausal diabetic women. The carotid intima media thickness was estimated using high resolution B mode ultrasound scan. Data were analyzed using IBM SPSS Statistics. Inferential analysis including the sample t-test and correlation analysis was performed, along with descriptive statistics. Statistical significance was accepted when $p \leq 0.05$. Among postmenopausal diabetic females, the study showed a substantial rise in carotid IMT. Longer duration of diabetes and increasing age were positively correlated with IMT levels. Increased cardiovascular risk was indicated by higher IMT levels in participants with a higher body mass index and poor glycemic management. According to assessment of patients and observed variables in this study, age, obesity, and the length of diabetes are all potentially found correlated with elevated IMT, underscoring the significance of early screening and preventative measures to lower cardiovascular morbidity in this high-risk population.

CHAPTER 1
INTRODUCTION

A non-invasive marker that reflects the structural integrity of arterial walls and the early development of cardiovascular disease is carotid intima media thickness (CIMT). It measures the combined thickness of the carotid artery including media (middle smooth muscle layer) and intima (innermost endothelial layer) at the level of the common carotid artery just prior to its division into the internal and external carotid arteries. The intima, media, and adventitia are the three layers that make up the artery wall anatomically [1]. One layer of endothelial cells makes up the intima. Smooth muscle cells and elastic fibers, which give structural strength and control vessel diameter

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through contraction and relaxation, are found in the media, which is located underneath the intima. Connective tissue, nerves, and tiny blood vessels that support the arterial wall are found in the outermost adventitia [2].

Carotid intima media thickness (CIMT) is a marker of subclinical atherosclerosis and a predictor of cardiovascular risk. Studies show higher CIMT values in postmenopausal diabetic women compared with premenopausal women, independent of age. High-resolution ultrasonography based research further confirms a marked increase in CIMT after menopause. Additionally, poor glycemic control strongly correlates with increased CIMT, indicating a synergistic effect of hyperglycemia and hormonal decline [3]. Regression analyses identify postmenopausal status and blood glucose levels as key independent predictors of CIMT. Hormonal changes, especially estrogen deficiency, are linked to menopause and speed up atherosclerotic processes. These alterations considerably raise the risk of subclinical and cardiovascular disease when paired with diabetes. In order to detect early atherosclerotic changes, preventive measures, and clinical management in this high-risk population.

Diabetes Mellitus is a chronic disease that is increasingly common throughout the globe. Atherosclerosis is one of the widely known independent risk factors for ischemic as well as hemorrhagic strokes and remains the most common cause of death and disabilities in patients with diabetes, especially with type 2 diabetes. The disease leads to thickening of the carotid intima-media layer; hence, it is regarded as an early marker of atherosclerosis [4]. An increase in the CIMT is used as a predictive index of future cardiovascular and cerebrovascular events and is regarded as a marker of atherosclerosis in other vascular beds. It is suggested that it is an adaptive response in cases such as diabetes and hypertension in order to relieve cardiovascular stress. The study was observed to evaluate the impact of diabetes by comparing its effect in the test subjects with the control group who have not been diagnosed with diabetes. Over 50% of deaths resulting from diabetes are caused by CVD, and they are up to six times more prevalent in T2DM compared to healthy patients. Cardiovascular disease (CVD), which accounts for over 50% of diabetes-related mortality, is two to six times more common in patients with type 2 diabetes mellitus (T2DM) than in non-diabetics. It has been established that carotid intima-media thickness (CIMT), as determined by ultrasonography, is a separate risk factor for CVD. Additionally, CIMT has been used in clinical trials to assess the effectiveness of anti-hypertensive, anti-diabetic, and anti-hyperlipidemia medications [5].

An independent risk factor for atherosclerosis and its consequences is diabetes mellitus. Chronic hyperglycemia causes oxidative stress, inflammation, and endothelial damage, all of which contribute to the thickening of artery walls. Diabetes significantly aggravates arterial damage in postmenopausal women, making them more vulnerable to both overt and subclinical

Vol. 5 No. 2 (2026)

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Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

cardiovascular disease. Therefore, it is crucial to identify these vascular alterations early in order to stop the development of dangerous consequences like myocardial infarction and stroke. In women with diabetes mellitus, menopausal status and metabolic changes significantly affect vascular health [6].

Currently, 48% and 3.5% of deaths from CVD are caused by hypertension and diabetes, respectively. Chronic hyperglycemia speeds up the development of atherosclerosis by causing endothelial dysfunction, arterial stiffness, and systemic inflammation. According to studies, people with diabetes have far higher CIMT than people without the disease. Menopause, or the change from reproductive to post-reproductive life, is a crucial time for female cardiovascular health. Women who are not yet menopausal have a decreased risk of cardiovascular disease. Following menopause, estrogen insufficiency increases arterial stiffness, lipid abnormalities, and endothelial dysfunction, which increases cardiovascular risk and causes CIMT thickening [7].

An accurate surrogate diagnostic for early atherosclerosis is carotid intima-media thickness (IMT). It may be assessed non-invasively using high-resolution B-mode ultrasonography and indicates the total thickness of the intimal and medial layers of the artery wall. Increased IMT is strongly associated with future cardiovascular events and is widely used in both clinical practice and research as an indicator of vascular health. Before symptoms appear, subclinical atherosclerotic alterations can be found with sonographic assessment of carotid IMT. It becomes particularly important in cases of postmenopausal diabetic patients because normal risk assessment models would not be able to indicate the extent of injury suffered by arteries. Early detection of structural changes in carotid arteries makes it possible to apply appropriate treatments aimed at decreasing the risk of heart diseases and achieving better outcomes [8]. One of the physiological stages of the female body is characterized by menopause when women experience a whole range of physiological alterations such as endocrine disorder and nervous regulation imbalance. If they remain unnoticed, then these alterations can affect the health of women, their quality of life, as well as their working capacity. The appearance of CAD differs substantially in premenopausal women [9].

Regardless of gender, it has been demonstrated that endogenous estrogens may have a preventive effect on the incidence of CAD. Hormones may influence lipid levels, coagulation, and other physiological systems, such as the central nervous system, the cardiovascular system, and the adipose/metabolic system. For both premenopausal and postmenopausal women, carotid intima-media thickness (CIMT) is a reliable indicator of CAD. Postmenopausal women with diabetes face a markedly increased cardiovascular risk. Elevated CIMT in this group reflects more advanced subclinical atherosclerosis, closely associated with postmenopausal metabolic disturbances, particularly hyperglycemia [10]. These findings highlight the importance of early vascular screening and strict glycemic control to reduce cardiovascular complications. Carotid intima–media

Vol. 5 No. 2 (2026)

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Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

thickness (CCA-IMT) is a reliable marker of subclinical atherosclerosis and an early indicator of cardiovascular and cerebrovascular risk. Increased CCA-IMT has been consistently associated with major risk factors including age, obesity, diabetes mellitus, and hypertension, making sonographic assessment valuable for early vascular evaluation [11].

According to the World Health Organization, CVD causes around 17.9 million deaths each year, or almost 31% of all fatalities worldwide. Atherosclerosis, a condition characterized by cholesterol buildup and arterial inflammation that can result in myocardial infarction and stroke, is one of the many conditions that fall under the category of cardiovascular disease (CVD).

Cardiovascular disease continues to be the world's leading cause of death despite advancements in cardiovascular treatment and prevention depend on early identification of atherosclerotic alterations. Low-density lipoprotein is the most common factor in atherosclerosis [12]. Residual risk refers to the rest of the cardiovascular risk factors causing atherosclerosis in instances where LDL levels are normal or pharmacologically controlled. The increase in IMT can be attributed to the substantial increase in TG and HbA1c levels and the decrease in HDL-C level in DMt2 patients. There is notable variation in cardiovascular risk because of the existence or nonexistence of the various elements within the cardiovascular risk individually. It was observed that there was an increased risk of 50-90% to exhibit very high intima-media thickness (determined by ultrasound examination of the carotid arteries) in certain combinations of MetS elements: high TG or low HDL-C, hypertension, abdominal obesity, or high glucose. Other research demonstrated an increase in the number of MetS elements [13].

Chronic low-grade inflammation is a significant cause of elevated IMT. Inflammatory indicators like C-reactive protein (CRP) and interleukins are frequently high in postmenopausal diabetic females, which exacerbates endothelial damage and plaque development. Furthermore, cholesterol accumulation in the artery walls is exacerbated by changes in lipid metabolism, such as elevated low-density lipoprotein (LDL) and decreased high-density lipoprotein (HDL). In postmenopausal women, carotid atherosclerosis is linked to additional lipid variables beyond those found in metabolic syndrome. Researchers showed a link between the prevalence of carotid plaques and the cholesterol in VLDL [13]. Since the intima and media are predominantly engaged in early pathological alterations, CIMT only concentrates on the layers. Because of the malfunction, lipids especially LDL cholesterol can build up inside the intima, causing inflammation and immune cell recruitment. Smooth muscle cells from the media move and multiply into the intima throughout time, creating extracellular matrix and thickening the wall [14].

The necessity for localized research on vascular risk in postmenopausal women was highlighted by a study carried out in Lahore, Pakistan, which showed that diabetic and hypertensive people had considerably higher CIMT values than health controls. This study uses sonographic imaging to

Vol. 5 No. 2 (2026)

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Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

assess and compare CIMT in premenopausal and postmenopausal diabetic females in Pakistan. It also aims to evaluate the effects of metabolic variables on CIMT, such as age, body mass index (BMI), blood pressure, and blood glucose levels. Additionally, by combining geographical findings and population-specific risk factors, this study fills a significant vacuum in Pakistani data, helping to improve cardiovascular complications prevention efforts for postmenopausal diabetes females [15].

CIMT is a sign of "subclinical" illness since this thickening may happen even before distinct atherosclerotic plaques form. CIMT, which is often expressed in millimeters. CIMT is a measurement of the separation between these lines. A thickness of less than 0.6 mm is generally regarded as normal in young adults, but values exceeding 0.9 mm or increases over time signal greater cardiovascular risk. Normal values differ depending on age and gender. Elevated CIMT is associated with an increase in cardiovascular morbidity and mortality including myocardial infarction and stroke. Carotid IMT measurement using carotid ultrasonography is considered the most studied parameter used in the non-invasive assessment of atherosclerosis [4]. CIMT was assessed by bilateral ultrasonography at four sites at two centimeters proximal and distal from the bulb of the common carotid artery. Lower serum magnesium concentration was associated with higher intima-media thickness. Adequate nutrition status of a usual high intake of marginal magnesium can be beneficial in preventing the detrimental effects of cardiovascular disease. Therefore, people with low serum magnesium concentration would be more prone to CIMT elevation [16].

This study uses sonography to measure carotid intima media thickness in postmenopausal diabetic females. The research study aims to evaluate and compare mean CIMT in postmenopausal females with diabetes which assess the associations between CIMT and metabolic/clinical factors including age, BMI, duration of diabetes, glycemic control (HbA1c), blood pressure, and lipid profile. Findings will help to identify the strongest predictors of increased CIMT in this population. Increased carotid intima-media thickness (IMT) in postmenopausal female diabetics is caused by a complicated interplay between vascular dysfunction, metabolic imbalance, and hormone insufficiency.

Assessing IMT in postmenopausal female diabetics is clinically significant since it can help with early detection. Personalized patient care can also be improved by integrating IMT assessment into regular clinical practice. Therefore, sonographic assessment of carotid IMT is essential for guiding clinical decision-making and enhancing long-term health outcomes in addition to increasing early diagnosis of subclinical atherosclerosis. Grayscale Sonography is a two-dimensional method that enables the viewing of the anatomy in real-time through the use of variations in the brightness of ultrasound wave echoes. The sum of thickness between the lumen intima to media adventitia

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Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

interfaces can be determined by B-mode ultrasound where high-resolution longitudinal pictures of the walls of the arterial system like the common carotid artery can be achieved [3]. Doppler Sonography is a method that enables a quantitative analysis of the velocity, direction, and waveform characteristics of blood flow in a vessel by graphical representation of shifts in frequency of ultrasound waves. The spectral Doppler technique measures the peak systolic velocity (PSV), end-diastolic velocity (EDV), and resistive indices in evaluating arteries like the common and internal carotid arteries in relation to intima media thickness measurement [10].

A Doppler imaging method that allows real-time visualization of blood flow presence, direction, and relative velocity within a vessel by superimposing color-coded blood flow information onto a two-dimensional B-mode grayscale image. Color Doppler is used to locate and map arterial blood flow, distinguish the vascular lumen from the vessel wall and luminal narrowing linked to early atherosclerotic changes in the sonographic evaluation of intima media thickness. Ultrasound and magnetic resonance imaging can detect lesions better. Thus, obesity modifies breast tissue composition, which may improve lesion appearance, but it also presents technical and diagnostic obstacles that can lower imaging accuracy [2].

The purpose of the study is to detect any significant increase in carotid intima media thickness in postmenopausal diabetic females that is assessed by sonography and to assess the relationship between duration of diabetes and carotid intima media thickness in postmenopausal females. The sonographic measurement of carotid intima media thickness serve as an effective tool for early detection of subclinical atherosclerosis in postmenopausal diabetic females. Different groups may experience atherosclerosis differently due to differences in lifestyle, genetic susceptibility, and access to healthcare. The main goal of this study is to use sonography to measure the carotid intima-media thickness in postmenopausal diabetic females and investigate its relationship to a number of risk factors, including body mass index, age, and the length of diabetes. It is anticipated that the results will aid in early diagnosis, better risk assessment, and the creation of preventative measures specific to this high-risk group.

AIMS AND OBJECTIVES

- To measure the thickness of the carotid intima-media in postmenopausal women with diabetes using sonography.
- To assess the relationship between postmenopausal females' carotid intima-media thickness and the length of their diabetes.
- To determine whether sonographic measurements of carotid intima-media thickness are helpful in identifying early atherosclerotic changes in females with postmenopausal diabetes.

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Pakistan Journal of Medical & Cardiological Review

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Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

CHAPTER 2
LITERATURE REVIEW

Overall, the non-HDL-C/HDL-C ratio emerges as a practical and reliable marker for cardiovascular risk assessment in postmenopausal women. Lipid abnormalities, particularly elevated atherogenic lipoproteins such as VLDL, play a key role in subclinical atherosclerosis. Carotid intima–media thickness (CIMT) is a well-established surrogate marker of early atherosclerotic change, and routinely measured lipid indices are increasingly recognized for their predictive value, especially in postmenopausal women who are prone to adverse metabolic shifts [10].

Takahashi et al., in 2004 stated thatIMT levels are greater in DMt2 patients. It is linked to endothelial dysfunction (ED), a well-known significant risk factor for the emergence of diabetic cardiovascular problems, and insulin resistance (IR). Larsen's team conducted an 18-year follow-up of individuals with diabetes and measured glycated hemoglobin to show the correlation between the degree of glycemic control and the severity of atherosclerotic lesions. Numerous biochemical and cellular processes are impacted by hyperglycemia, which results in altered lipid metabolism and increased oxidative stress. As DMt2 lasts longer, the carotid IMT rises. Studies have demonstrated that carotid atherosclerosis characteristics enhanced risk stratification in DMt2 patients and predict unfavorable cardiovascular outcomes [17].

According to a study by Pleskovic et al, elevated blood pressure damages the arterial walls and encourages atherosclerosis, and hypertension is linked to elevated CIMT in T2DM. Therefore, in order to reduce related secondary complications, there are primary measures to control hypertension in T2DM must be implemented. Increased blood sugar damages the inner layer of the endothelium, increasing its susceptibility to lipids and foam cells and accelerating the formation of atherosclerotic plaques. The current plagues cause the intima to thicken. Another way that DM linked to CIMT thickening is because individuals with DM have higher insulin levels, which encourage the development of smooth muscle cells in the arterial wall [7].

According to the previous study by Haung et al., in 2019, twenty postmenopausal women with type 2 diabetes and twenty postmenopausal women without type 2 diabetes who did not have a history of coronary heart disease had carotid IMT, a noninvasive measure of cardiovascular risk, measured using high-resolution ultrasound. They were also evaluated for their known role in coronary heart disease. Women with type 2 diabetes had a mean carotid IMT of 88 mm, while those without the disease had a mean of 74 mm. Age, race, cholesterol, and perceived level of physical activity did not differ between the groups. However, women with type 2 diabetes reported lower use of hormone replacement therapy (P =.027), higher body mass index (P =.026), and more hypertension (P =.004). [18]

T2DM patients had far lower serum osteocalcin levels than controls (63.73± 27.20 vs. 136.16±

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https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Munir et al - 2026

DOI: http://doi.org/10.5281/zenodo.20285442

21.96 pg/mL, P<0.001). Patients with osteoporosis had significantly lower levels of osteocalcin than those with normal BMD. In T2DM patients, there was a strong negative correlation between serum osteocalcin and CIMT. Compared to women without diabetes, postmenopausal women with diabetes had significantly lower osteocalcin levels. Despite a negative connection between serum osteocalcin and CIMT, multivariate regression analysis revealed that osteocalcin levels were only independently linked to worse glycemic parameters in postmenopausal women with type 2 diabetes [17].

The overall evidence from the study by Spence JD., indicates that patients with T2DM have an elevated CIMT when compared to those without T2DM, despite the contradictory results from individual studies. In addition, there was a noticeable rise in TG, TLC, and LDL-C in T2DM patients. Additionally, a notable decrease in HDL-C was noted. The study emphasized that individuals with type 2 diabetes have dyslipidemia. Patients with type 2 diabetes who have dyslipidemia are more likely than people without the disease to develop secondary CVD. The higher CIMT found in the T2DM participants compared to those without T2DM in this study supports this risk. The data compiled in this study indicates that people with type 2 diabetes have a high risk of dyslipidemia and subclinical atherosclerosis [19].

Only the younger population (mean age: 35 years) exhibits a gender difference in CIMT; the older population (age range: 55–72 years) does not. One explanation could be that postmenopausal women had lower levels of estrogen, which inhibited the development of arteriosclerosis. The gender difference in CIMT was less pronounced in the older group. But the individuals in our study had diabetes, a significant and separate risk factor for CVD. Gender differences in CIMT may result from gender differences in CVD risk variables. Furthermore, compared to women, men are more vulnerable to CVD risk factors. Because of the diabetes status, the gender difference in CIMT was considerable [20].

The research by Doom et al., on the functions of glucose metabolism in normal physiological situations and in cardiovascular-related pathogeneses can be used to guess about the processes underlying the connection of vitamin D with C-IMT in a study. It has been demonstrated that glucose and vitamin D has cardio-protective effects by preventing the uptake of cholesterol and the production of foam cells. Furthermore, it has been demonstrated that vitamin D inhibits endoplasmic reticulum stress and cholesterol uptake, hence preventing the onset of atherogenesis. A lack of vitamin D may raise serum levels of parathyroid hormone (PTH), lower levels of insulin-like growth factor 1 (IGF-1), and activate the renin-angiotensin system. Thus, a lack of vitamin D increases the risk of cardiovascular disease [2].

Studies demonstrate that CCA-IMT increases with advancing age due to progressive vascular remodeling and endothelial dysfunction. Obesity and higher BMI contribute through metabolic

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Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

and inflammatory mechanisms, while hypertension and diabetes are linked to significantly higher IMT compared with healthy populations. Overall, the evidence supports routine CCA-IMT assessment, particularly in high-risk groups, for early detection and prevention of cardiovascular disease [21].

Studies show that diabetic patients have significantly higher CIMT values than non-diabetic controls, often exceeding normal reference ranges. CIMT also increases with age, reflecting the cumulative effects of chronic hyperglycemia and vascular inflammation. Some research suggests that female diabetic patients may have slightly higher CIMT than males, potentially due to hormonal and metabolic differences. Overall, the evidence supports routine CIMT assessment in type II diabetes for early detection of subclinical atherosclerosis and prevention of cardiovascular events. Carotid intima–media thickness (CIMT) is a widely used, noninvasive sonographic marker for early atherosclerosis, particularly in individuals with type II diabetes mellitus. Diabetes accelerates vascular remodeling and endothelial dysfunction, making CIMT a practical tool for assessing cardiovascular and cerebrovascular risk [22].

Additionally findings revealed a strong inverse relationship between CIMT in diabetic individuals, a biomarker for bone growth. Numerous processes, including inflammatory factors, various adipokines like resistin and adiponectin, and variables related to bone metabolism, are involved in the pathophysiologic connection between osteoporosis and atherosclerosis. Additionally, serum OCN revealed an independent link with the severity of coronary atherosclerosis and considerably decreased in patients with coronary artery disease compared to those without in a sample of metabolic syndrome patients with adequate glucose tolerance. In patients with metabolic syndrome who do not have type 2 diabetes, found an inverse connection between OCN levels and cardiovascular risk [23].

Study by *Wajid et al.*, in 2026 revealed considerably higher cIMT in a group of obese people compared to people of normal weight in the same CVRS group for the first and second CVRS groups. This could be partially explained by the fact that cIMT is linked to both cardiovascular risk and obesity. The multiple linear regression analysis did not retain the link between cIMT and CVRS, which may be partially due to the study's small sample size. To the best of our knowledge, this is the first study to look at the relationship between cIMT and CVD risk in young females who are free of disease. A recent study that included older patients of both genders found only a minor connection between CVD risk score and cIMT [24].

A study included 128 diabetic women 40 years of age and older who were equally divided into premenopausal and postmenopausal groups. A sampling strategy was used to choose the participants. CIMT was measured using high-resolution ultrasonography, and clinical data including blood pressure, blood glucose, age, and BMI were recorded. Effect sizes (Cohen's d, R2),

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Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

95% confidence intervals, and ANOVA inside regression were shown; $p < 0.05$ was considered statistically significant. There were 64 premenopausal and 64 postmenopausal female diabetics among the total of 128 participants. In comparison to premenopausal females (0.666 ± 0.17 mm), postmenopausal ladies had a considerably larger mean carotid intima-media thickness (CIMT) (1.013 ± 0.17 mm). Regression analysis revealed that blood glucose levels ($B = 0.001$, $p < 0.001$) and postmenopausal status ($B = 0.709$, $p < 0.001$) together explained 58.6% of the variation in CIMT. According to the study's findings, postmenopausal diabetes women are considerably more vulnerable than premenopausal women because of their higher blood glucose levels and greater carotid intima-media thickness (CIMT) [25].

A combination of characteristics linked to a higher risk of atherosclerosis and cardiovascular diseases is known as metabolic syndrome, and it is becoming more and more common in Poland. A study's objective was to assess carotid artery atherosclerotic lesions in MetS patients. 335 people with MetS were included in the study; 211 of them were female (65%) and 124 were male (37%) and ranged in age from 37 to 82. The International Diabetes Federation (IDF) criteria were used to make the MetS diagnosis. Two subgroups of patients with and without DMt2 were created. In comparison to other groups, they found that patients with DMt2 had the highest IMT measurement. In comparison to the grouping without DMt2, it was observed that females in the first subgroup had a higher level of IMT. Additionally, it was found that patients with DMt2 had considerably higher levels of TG and HbA1c and lower levels of HDL-C, which may account for the elevated IMT. The number of MetS components increased gradually in subsequent research [26].

In a study by Han et al., 2025, fifty patients each from the diabetes and non-diabetic groups made up the total of 100 patients chosen. Inclusion Standards Individuals with type 2 diabetes mellitus who are older than thirty. Based on their body mass index (BMI), patients were classified as either non-obese or obese. Obesity is indicated in persons with a BMI of 27.3 kg/m^2 or more. For continuous data, statistical analysis data are displayed as means; for frequency data, they are displayed as n (%). For statistical significance, a P value of less than 0.05 was used. Therefore, in the 40–50 age range, CIMT is 0.08±0.03 in cases and 0.07±0.01 in controls. CIMT in the 51–60 age range is 0.11±0.04 in cases and 0.074±0.01 in controls. CIMT in the 61–70 age range is 0.13±0.021 in cases and 0.07±0.02 in controls. The age group of 61 to 70 years old has a higher mean CIMT (0.13±0.021), and the number of CIMT cases increases with age [27].

Data from 800 postmenopausal women between the ages of 50 and 81 from the population-based KORA F4 project, which was carried out in Southern Germany between 2006 and 2008, were examined in a cross-sectional research. That research revealed that carotid plaques in the common carotid artery, but not IMT, may be independently associated with the reproductive parameters age

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Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

of menarche and ever use of hormone replacement treatment [20]. It is uncertain if menopause and carotid intima-media thickness, as well as the prevalence and stability of carotid plaque, are related in the Chinese female population. They recruited 2,131 adults over 40 from northeastern China to participate in a population-based, cross-sectional study. It was discovered that 1,133 (53.2%) of the participants were postmenopausal. After adjusting for potential confounding variables, carotid plaque and its unstable status were found to be highly associated with the postmenopausal status ($P < 0.001$) when CIMT was present at the 50th–75th and ≥75th percentiles. In conclusion, vascular risk factors increase when menopausal status changes. Compared to premenopausal level, postmenopausal status is associated with higher morbidity of CIMT, carotid plaque, and its unstable state [28].

To investigate the connection between premenopausal and postmenopausal women's carotid intima-media thickness and fasting blood glucose, a study by *Buckley et al.*, was conducted in which 2,959 women who were seen at the Maanshan People's Hospital. The association between blood glucose level and carotid IMT in the premenopausal and postmenopausal groups was examined. The mean IMT (mIMT; 0.81 ± 0.23 mm versus 0.70 ± 0.14 mm, respectively, $p < 0.001$) and maximum IMT (maxIMT; 0.86 ± 0.35 mm versus 0.74 ± 0.16 mm, respectively, $p < 0.001$) values were greater in postmenopausal women than in premenopausal women. In the stratification study, mIMT and maxIMT both rose with increasing FBG when FBG was > 10 mmol/L in the postmenopausal group, whereas maxIMT increased with increasing FBG when FBG was < 7 mmol/L in the premenopausal group [29].

At the Lahore Imaging Center, 337 individuals over 30 participated in a case-control stratified study. Four groups of participants were created: control (96), diabetes mellitus (DM) (69), hypertension (95), and both DM and hypertensive (77). There were 184 men and 153 women among the total participants. With a mean of roughly 0.52 mm, the control group had the lowest carotid intima-media thickness. The DM group, on the other hand, had elevated cIMT values, up to roughly 0.98 mm. With mean values between 0.67 and 0.68 mm, the hypertensive group's cIMT increased moderately. The group with both DM and hypertension had the highest cIMT readings, with mean values of about 1.0 mm and maximum values as high as 1.6 mm. These results imply that increased arterial thickness is a result of both diabetes and hypertension. This study demonstrates how metabolic and hemodynamic variables contribute to vascular injury. Additionally, the findings highlight that diabetes significantly affects cIMT, especially when it is linked to hypertension [30].

CHAPTER 3
METHODOLOGY

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https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

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DOI: http://doi.org/10.5281/zenodo.20285442

3.1. Material and methods

3.2. Study Design:

This study was hospital-based cross-sectional analytical study conducted in the radiology department. It included postmenopausal females aged 45–70 years with DM. The study was allowed to assess carotid intima-media thickness using B-mode ultrasonography and determined its association with clinical and biochemical parameters.

3.3. Study Duration:

The study was conducted over a period of 5 to 6 months after synopsis approval and defense.

3.4. Sample Size:

An estimated sample size of approximately 50 patients ensured adequate statistical power for detecting associations between intima media thickness in post-menopausal diabetic females.

3.5. Sample Collection:

Sample collection was carried out using a non-probability consecutive sampling technique. Sample was collected from different hospitals in Sargodha such as Novocare hospital Sargodha. All postmenopausal females had aged 45–70 years diagnosed with Type 2 Diabetes Mellitus. Patients fulfilled the inclusion criteria invited to participate in the study. A structured Proforma was used to record demographic details (age), clinical history, and relevant physical examination findings (blood pressure, height, weight, and body mass index). Venous blood samples will be collected under aseptic conditions for laboratory investigations including fasting blood glucose, HbA1c, and lipid profile, following standard hospital protocols. Carotid intima-media thickness was measured using high-resolution B-mode ultrasonography.

3.6. Selection Criteria Inclusion Criteria:

- Female patients who were postmenopausal, not had menstruation for at least 12 months used as inclusion criteria.
- Female patients having at least 45 years old used as inclusion criteria.
- Female patients who had been diagnosed with Type 2 diabetes mellitus used as inclusion criteria.
- Female patients who were willing to have carotid ultrasonography for CIMT measurement were included.

Exclusion Criteria:

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- Females with a history of stroke, transient ischemic attack (TIA), or cardiovascular events were excluded.
- Patients with known carotid artery disease (e.g., stenosis >50%, plaque causing hemodynamic changes) were excluded.
- Individuals with poorly controlled hypertension or other comorbidities that could independently affect IMT.
- Postmenopausal females who were not diabetic or whose diabetes is newly diagnosed (<1 year).
- Pregnant or lactating females.

3.7. Data collection:

It includes:

- Identification of the study variables
- No. of patients in control and diseased groups
- Demographical parameters (age, gender, BMI, family history)

Methods for Collection of Data

- Clinical history
- Relevant medical records
- Physical examination and symptoms

3.8. Data Collection Tools (Proforma/Questionnaire)

- Patient consent form
- Questionnaire

Selection of imaging modality:

Ultrasound is a safe, non-invasive, and successful imaging technique for identifying early vascular alterations. It is recommended for evaluating carotid intima media thickness (CIMT) in postmenopausal diabetic females. It was appropriate for repeated follow-up exams, which are frequently required in high-risk patients, because it employed sound waves rather than ionizing radiation.

The carotid arteries are superficial, ultrasound can produce real-time, high-resolution pictures that allow for accurate intima-media thickness measurement and early detection of atherosclerosis before plaque formation. Furthermore, it doesn't need contrast chemicals, which was crucial for diabetic patients who could have compromised renal function. Ultrasound was preferred for routine screening and monitoring of cardiovascular risk in postmenopausal women with diabetes until it is affordable, widely accessible, and well tolerated.

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DOI: http://doi.org/10.5281/zenodo.20285442

3.9. Survey conduction:

- Ethical approval were obtained from patients
- Informed consent was filled and signed by participants
- Use of questionnaire and ultrasound report
- On the basis of questionnaire, assess the symptoms and examined the patient physically.

3.10. Ethical considerations:

- Personal and medical information of patients was kept confidential.
- Data was coded to protect identity.
- Care was taken to prevent discomfort or prolonged pressure on the neck.
- Participants was treated with dignity and respect throughout the study.
- Any medical history or personal information was gathered in a private setting.
- Ultrasound was safe and non-ionizing, posing minimal risk to participants.
- Ensured gentle handling of the transducer to avoid discomfort or strain on the neck.
- Observed participants for any signs of discomfort or anxiety during the procedure.
- Any abnormal findings or adverse events was managed appropriately and participants referred for further care if needed.
- Used sterile gel and clean equipment to maintain hygiene.

3.11. Equipment and techniques used

- **Ultrasound Machine**

High-resolution B-mode imaging was used.

- **Transducer (Probe)**

Linear array transducer was used with high frequency transducer 7–15 MHz.

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Color and Spectral Doppler:

- Color Doppler was used to assess blood flow patterns and detect turbulence or stenosis.
- Spectral Doppler was used for quantitative flow velocity measurements.

3.12.Scanning techniques:

- Patient rested at 10–15 minutes before scan.
- Patient lied in supine position, neck slightly extended, head turned opposite to scanning side.
- Removed all type of neck jewelry and clothing that may interfere.
- High-resolution B-mode ultrasound was used.
- Linear array transducer (7–15 MHz) was used to assess the structure.
- Sonographer adjusted Gain, focus and depth for optimal wall visualization
- Both carotid arteries was assessed during scanning like CCA, carotid bulb, ICA.
- Longitudinal plane used for IMT measurement.
- Measure far wall of the carotid artery by sonographer.
- Sonographer took 3–5 measurements per segment and average.
- Sonographer avoided the areas with plaques.
- Sonographer measured IMT = distance between lumen-intima and media adventitia interfaces.
- Sonographer measured typically 1–2 cm proximal to carotid bulb.
- Sonographer used color or spectral Doppler to assess blood flow and detect hemodynamic abnormalities.

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3.13. Data analysis:

Carotid intima-media thickness (CIMT) analyzed directly on the ultrasound system using a high-resolution B-mode ultrasonography machine. The intima-media complex was visualized as a double-line echo pattern, representing the lumen intima and media adventitia interfaces. The reported variables collected from survey and data were collected and analyzed by using appropriate data software and results were computed. For standardization, three measurements were taken at each site (right and left common carotid artery), and the mean value was automatically calculated or manually averaged.

3.14. Statistical analysis

All collected data was entered and analyzed using statistical software such as SPSS. Continuous variables such as age, duration of menopause, duration of DM, HbA1c levels, lipid profile, and carotid intima-media thickness (CIMT) was presented as mean ± standard deviation (SD), while categorical variables (e.g., presence of hypertension) was expressed as frequencies and percentages. Carotid intima media thickness (CIMT) was assessed in postmenopausal diabetic females began with descriptive statistics.

For comparisons, an independent t-test was used to compare CIMT between groups (e.g., diabetic vs. non-diabetic or premenopausal vs. postmenopausal), while ANOVA was applied for multiple group comparisons. Correlation analysis, such as Pearson correlation was performed to assess relationships between CIMT and variables like HbA1c, duration of diabetes, and lipid profile. Multiple linear regression analysis was often used to identify independent predictors of increased CIMT. A p-value of ≤0.05 considered statistically significant, and results were presented in the form of tables, graphs, and charts where appropriate.

CHAPTER 4
RESULTS

Sample size= 50 Observed variables;

Age, BMI, CIMT, Duration of menopause, diabetes, presence of plaque, hypertension, FBG

Age and Frequency distribution in observed patients

The largest percentage (38%) of responders are between the ages of 50 and 55. At 36% of the sample, the 40–50 age group is the second largest. At 26%, those in the 55–60 age range are the smallest group. With a minor concentration in the 50–55 range, the distribution is generally

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DOI: http://doi.org/10.5281/zenodo.20285442

reasonably balanced. The bar chart represent age as shown in figure 4.1.

Age					
		Frequency	Perce nt	Valid Percent	Cumulative Percent
Valid	40-50	18	36.0	36.0	36.0
	50-55	19	38.0	38.0	74.0
	55-60	13	26.0	26.0	100.0
	Total	50	100.0	100.0	

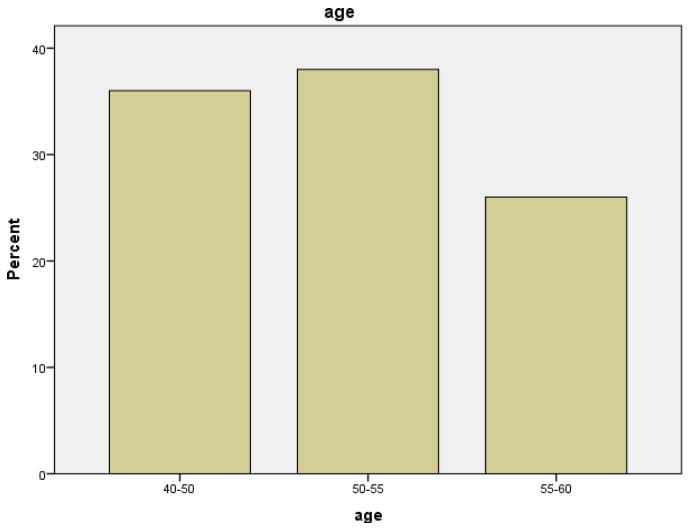

Figure 4.1: Age and frequency distribution in observed patients

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BMI and frequency distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.5-24.9=normal	28	56.0	56.0	56.0
	25-29.9=overweight	10	20.0	20.0	76.0
	>30=obese	12	24.0	24.0	100.0
	Total	50	100.0	100.0	

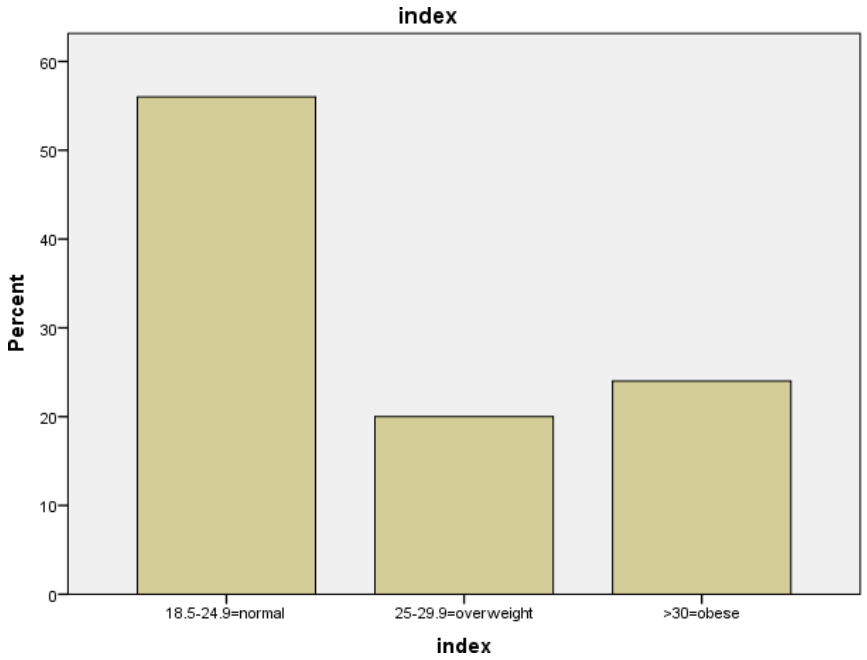

Figure 4.2: BMI and frequency distribution in patients Duration of menopause in diabetic patients

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https://pakjmcr.com/index.php/1/about

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Majority of respondents, have gone through menopause for one to five years account for 48% of sample Thirty percent of participants had been menopausal for five to eight years, and the smallest group, twenty-two percent, had been menopausal for eight to twelve years. Overall, the results showed that about half of the participants were in the early stages of menopause, with a progressive decline in frequency as the duration lengthens. The bar chart represented the duration of menopause as shown in figure 4.3.

Duration of Menopause					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	24	48.0	48.0	48.0
	5-8	15	30.0	30.0	78.0
	8-12	11	22.0	22.0	100.0
	Tot al	50	100.0	100.0	

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Figure 4.3: Duration of menopause and frequency distribution Presence of plaque and frequency distribution analysis

Sixty-eight percent of the sample contained plaque, while thirty-two percent did not. This suggests that over two-thirds of the participants have plaque. The bar chart represented the plaque as shown in figure 4.4.

plaque					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	present	28	56.0	56.0	56.0
	absent	22	44.0	44.0	100.0
	Total	50	100.0	100.0	

Figure 4.4: plaque and frequency distribution Descriptive statistics

Association of of CIMT, density, plaque and duration

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All variables were tested across 50 participants, according to the descriptive statistics. A moderate level within the measured range (1–2) is indicated by the CIMT mean value of 1.56 (SD = 0.50). Plaque exhibits a similar pattern with a mean of 1.44 (SD = 0.50), indicating comparatively similar distributions, while lipoprotein density has a mean of 1.40 (SD = 0.49). With a mean of 1.66 and a standard deviation of 0.75, duration has somewhat greater variability, indicating greater dispersion among its categories. The variables show a moderate degree of variation overall, with duration of diabetes exhibiting the most dispersion among respondents.

Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
CIMT	50	1.00	2.00	1.5600	.07091	.50143
Lipoprotein density	50	1.00	2.00	1.4000	.06999	.49487
Plaque	50	1.00	2.00	1.4400	.07091	.50143
Duration of diabetes	50	1.00	3.00	1.6600	.10540	.74533
Valid N (list wise)	50					

Descriptive statistics of duration, presence, menopause and BMI:

All variables were tested on tiny ordinal ranges, with values between 1 and 3 (presence ranging from 1 to 2), according to the descriptive statistics. Menopause duration (M = 1.74) and BMI (M = 1.68) have somewhat higher mean scores than length (M = 1.66) and hypertension presence (M = 1.32), indicating typically low-to-moderate levels across categories. The standard deviations, which range from 0.47 to 0.84, indicate a moderate degree of response variability, with hypertension presence exhibiting the least fluctuation. Overall, there doesn't seem to be any extreme dispersion

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DOI: http://doi.org/10.5281/zenodo.20285442

in the data from 50 valid cases.

Descriptive Statistics						
	N	Minimu m	Maximu m	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Duration of diabetes	50	1.00	3.00	1.6600	.10540	.74533
Hypertension presence	50	1.00	2.00	1.3200	.06664	.47121
Menopause duration	50	1.00	3.00	1.7400	.11361	.80331
BMI	50	1.00	3.00	1.6800	.11932	.84370
Valid N	50	-	-			

All variables were measured on a comparable scale among 50 participants, according to the descriptive statistics. Menopause duration has the greatest mean (1.74) and hypertension presence has the lowest mean (1.32), with mean values ranging from 1.32 to 1.74. Overall, the results point to distributions that are largely stable and do not exhibit significant variance among factors.

Descriptive Statistics			
	Mean	Std. Deviation	N
Menopause duration	1.7400	.80331	50

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BMI	1.6800	.84370	50

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Lipoprotein density	1.4000	.49487	50
Duration of diabetes	1.6600	.74533	50
Hypertension presence	1.3200	.47121	50

Cross tab

Side of CIMT side involved with age

Increased CIMT (>0.8) is more prevalent overall (28 cases) than normal CIMT (22 cases) across all age categories, according to the cross-tabulation. Age-related increases in CIMT are most common in the 50–55 age group (13 instances), followed by the 55–60 age group (9 cases). The most common pattern in both normal and enlarged CIMT categories is bilateral participation, particularly in normal CIMT (12 instances). Although left-side involvement somewhat outnumbers right-side involvement in increasing CIMT cases, both are quite uncommon. Overall, the findings indicate that bilateral side involvement is the most typical manifestation and that rising age is linked to greater CIMT levels.

Crosstab						
Count						
Age			side involved			Total
			right side	left side	bilater al	
40-50	CIMT	<0.8=normal	3	1	8	12
		>0.8=increase ed	1	2	3	6
	Total		4	3	11	18
50-55	CIMT	<0.8=normal	1	2	3	6

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		>0.8=increas ed	4	5	4	13
	Total		5	7	7	19
55-60	CIMT	<0.8=normal	1	2	1	4
		>0.8=increas ed	2	3	4	9
	Total		3	5	5	13
Total	CIMT	<0.8=normal	5	5	12	22
		>0.8=increas ed	7	10	11	28
	Total		12	15	23	50

Chi-Square analysis

Since all p-values are higher than 0.05, the chi-square analysis reveals no statistically significant relationship between age group and side involved. The Pearson Chi-Square test results for the three age groups (40–50, 50–55, and 55–60) are not significant (p =.405,.687, and.786, respectively). Likewise, there is no significant correlation between the variables in the entire sample, as indicated by the overall connection (χ^2 = 1.343, df = 2, p =.511). The lack of a significant trend across age groups is further supported by the linear-by-linear association tests (all p >.05). The bar chart represented the CIMT thickness at which age as shown in figure 4.5 and 4.6.

Chi-Square Tests			
age	Value	df	Asymp. Sig. (2-sided)

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40-50	Pearson Chi-Square	1.807[b]	2	.405
	Likelihood Ratio	1.706	2	.426
	Linear-by-Linear Association	.038	1	.845
	N of Valid Cases	18		
50-55	Pearson Chi-Square	.752[c]	2	.687
	Likelihood Ratio	.758	2	.684
	Linear-by-Linear Association	.696	1	.404
	N of Valid Cases	19		
55-60	Pearson Chi-Square	.481[d]	2	.786
	Likelihood Ratio	.495	2	.781
	Linear-by-Linear Association	.213	1	.644
	N of Valid Cases	13		
Total	Pearson Chi-Square	1.343[a]	2	.511
	Likelihood Ratio	1.356	2	.508
	Linear-by-Linear Association	.570	1	.450

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Print ISSN 3007-2379

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	N of Valid Cases	50		

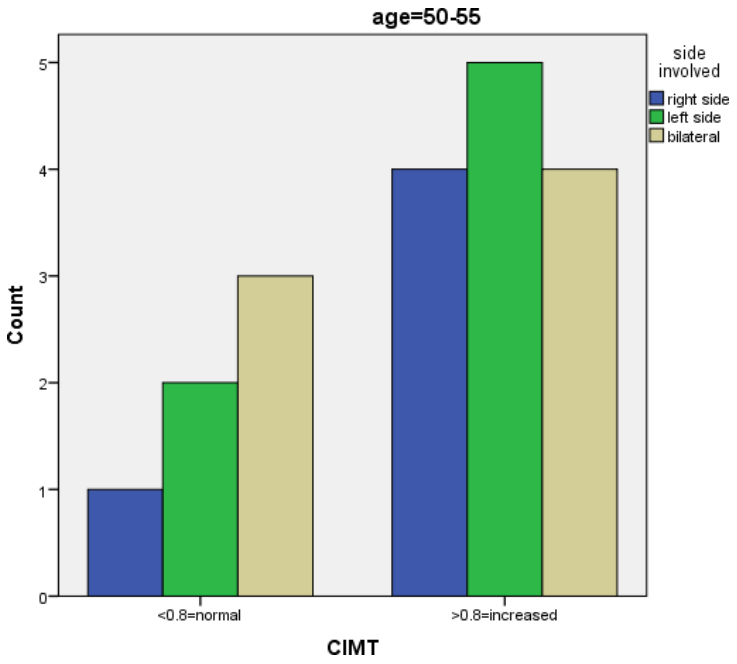

Figure 4.5: CIMT and age distribution in participants

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DOI: http://doi.org/10.5281/zenodo.20285442

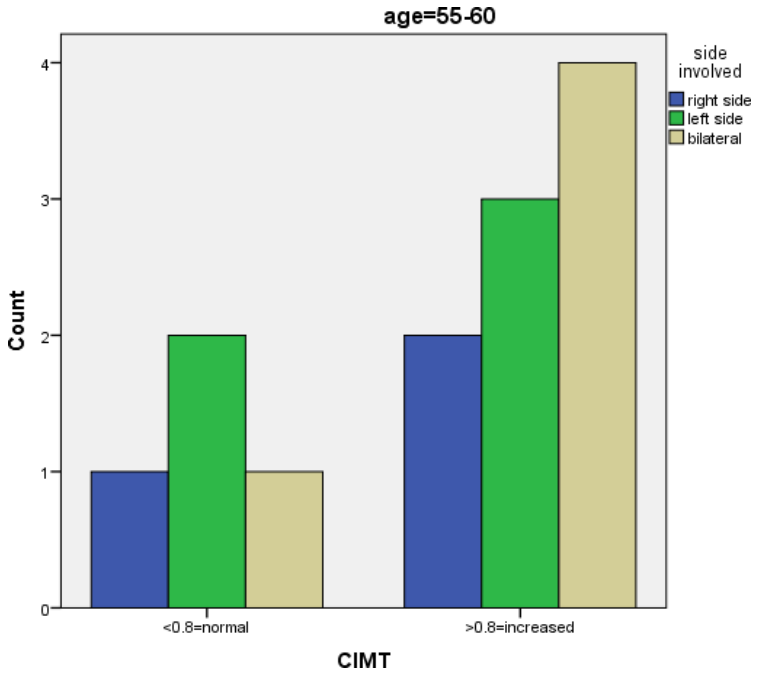

Figure 4.6: CIMT and age distribution in participants

Post Hoc Tests

Since some of the p-values are less than 0.05, the Tukey HSD multiple comparisons demonstrate that there are some statistically significant differences between the normal, overweight, and obese BMI groups for any of the variables. Similar levels across BMI categories are indicated by the minor significant mean differences between groups for FBG, hypertension presence, duration of diabetes, menopause duration, and plaque. Even if some comparisons like the duration between normal and overweight. Overall, the findings imply that these clinical factors in our dataset are significantly impacted by BMI categories

Multiple Comparisons
Tukey HSD

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Dependent Variable	(I) index	(J) index	Mean Difference (I-J)	Std. Error	Sig.
FBG	18.5-24.9=normal	25-29.9=overweight	.02143	.17922	.992
		>30=obese	-.26190	.16786	.0273
	25-29.9=overweight	18.5-24.9=normal	-.02143	.17922	.992
		>30=obese	-.28333	.20830	.0370
	>30=obese	18.5-24.9=normal	.26190	.16786	.273
		25-29.9=overweight	.28333	.20830	.0370
hypertension presence	18.5-24.9=normal	25-29.9=overweight	.12143	.17515	.769
		>30=obese	-.09524	.16404	.831
	25-29.9=overweight	18.5-24.9=normal	-.12143	.17515	.769
		>30=obese	-.21667	.20357	.0541
	>30=obese	18.5-24.9=normal	.09524	.16404	.831
		25-29.9=overweight	.21667	.20357	.0541

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Duration of diabetes	18.5-24.9=normal	25-29.9=overweight	.55000	.26607	.108
		>30=obese	-.08333	.24920	.940
	25-29.9=overweight	18.5-24.9=normal	-.55000	.26607	.108
		>30=obese	-.63333	.30924	.0112
	>30=obese	18.5-24.9=normal	.08333	.24920	.940
		25-29.9=overweight	.63333	.30924	.112
Menopause duration	18.5-24.9=normal	25-29.9=overweight	-.45714	.29430	.276
		>30=obese	-.02381	.27564	.996
	25-29.9=overweight	18.5-24.9=normal	.45714	.29430	.276
		>30=obese	.43333	.34206	.421
	>30=obese	18.5-24.9=normal	.02381	.27564	.996
		25-29.9=overweight	-.43333	.34206	.0421
Plaque	18.5-24.9=normal	25-29.9=overweight	-.14286	.18494	.722
		>30=obese	-.22619	.17321	.0399

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	25-29.9=overweight	18.5-24.9=normal	.14286	.18494	.722
		>30=obese	-.08333	.21495	.921
	>30=obese	18.5-24.9=normal	.22619	.17321	.0399
		25-29.9=overweight	.08333	.21495	.921

Correlations

Results from 50 participants across five variables are displayed in the descriptive statistics. Menopause (M = 1.74) and duration (M = 1.66) have comparatively higher mean values than hypertension presence (M = 1.32), with mean values ranging from 1.32 to 1.74. With the index exhibiting the greatest dispersion (SD = 0.84) and presence the lowest (SD = 0.47), standard deviations reveal moderate variability. Overall, the results point to distributions that are generally stable across factors and do not exhibit excessive variation.

Correlations

		Duration of Menopause	BMI	Lipoprotein density	Duration of diabetes	Hypertension presence
Duration of Menopause	Pearson Correlation	1	.055	.113	-.014	-.045
	Sig. (2-tailed)		.702	.435	.921	.755
	N	50	50	50	50	50

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https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

BMI	Pearson Correlation	.055	1	-.225	-.014	.057
	Sig. (2-tailed)	.702		.116	.922	.692
	N	50	50	50	50	50
Lipoprotein density	Pearson Correlation	.113	-.225	1	-.122	.140
	Sig. (2-tailed)	.435	.116		.400	.332
	N	50	50	50	50	50
Diabetes duration	Pearson Correlation	-.014	-.014	-.122	1	.026
	Sig. (2-tailed)	.921	.922	.400		.860
	N	50	50	50	50	50
hypertension presence	Pearson Correlation	-.045	.057	.140	.026	1
	Sig. (2-tailed)	.755	.692	.332	.860	
	N	50	50	50	50	50

ANOVA Test:

There is slight statistically significant difference in length between FBG groups, according to the one-way ANOVA results. Variations in FBG do not significantly alter duration, as indicated by the minor between-group effect ($F = 1.862$, $p > 0.05$ suggested). The lack of a meaningful link is further supported by the fact that the within-group variation (SS = 26.204) is much greater than the between-group variation (SS = 1.016). Overall, there are no appreciable differences in length

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between the various FBG groups in this sample.

ANOVA Table						
			Sum of Squares	df	Mean Square	F
Duration of diabetes * FBG	Between Groups	(Combine d)	1.016	1	1.016	1.862
	Within Groups		26.204	48	.546	
	Total		27.220	49		

The length and FBG groups had no statistically significant link, according to the ANOVA results (p = 0.0179). There is no indication of a significant variation in length between the various FBG groups because the p-value is higher than 0.05. In this sample, length generally seems to be unrelated to FBG levels.

ANOVA Table			
			Sig.
Duration of diabetes * FBG	Between Groups	(Combined)	.0179
	Within Groups		
	Total		

Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

According to the ANOVA data, there is no statistically significant correlation between length and menopause. The within-group variation (SS = 25.494, df = 47) is significantly greater than the between-group variation (SS = 1.726, df = 2). There is no discernible linear trend since the linearity component is nearly nil (SS = 0.006) and the majority of the variation results from deviation from linearity (SS = 1.720). In this population, duration does not generally differ considerably between menopausal types.

CHAPTER 5
DISCUSSION

This current research was centered on carotid intima-media thickness (IMT) assessment using ultrasonography in postmenopausal diabetic women, emphasizing the importance of such an assessment in terms of being a noninvasive indicator of subclinical atherosclerosis. The results have revealed that the IMT in postmenopausal diabetic women is higher compared to normal values. This finding can be explained by the combination of both menopause and diabetes, where the former refers to the absence of estrogen hormone, which has a pivotal protective effect in the vessels. Its decreased production leads to the progression of endothelial dysfunction, accumulation of lipids, and thickening of the arterial walls.

Mostly participants have gone through menopause for one to five years account for 48% of sample Thirty percent of participants had been menopausal for five to eight years, and the smallest group, twenty-two percent, had been menopausal for eight to twelve years. The variables show a moderate degree of variation overall, with duration of diabetes exhibiting the most dispersion among respondents. Increased CIMT (>0.8) is more prevalent overall (28 cases) than normal CIMT (22 cases) across all age categories, according to the cross-tabulation. Age-related increases in CIMT are most common in the 50–55 age group.

From this research, ultrasound was confirmed to be a powerful and accurate imaging technique used in measuring IMT. Ultrasound presents various advantages like non-invasiveness, low cost, and accessibility making it ideal for the screening process in high-risk groups. The increased level of IMT in postmenopausal diabetic women agrees with several reports indicating that carotid IMT is a good indicator for future morbidity and mortality among people at high cardiovascular risk. It is essential to measure IMT in diabetic women after menopause since this parameter is an accurate reflection of early vascular changes without any clinical symptoms [19]. This observational study carried out on surveyed patients is yet another piece of evidence supporting the value of carotid intima-media thickness (IMT) in evaluating vascular conditions in postmenopausal diabetic females. Being implemented using the cross-sectional method, this research allowed gathering data without any external interference, which helped measure the naturally varying IMT in participants.

Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

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DOI: http://doi.org/10.5281/zenodo.20285442

The survey methodology also helped introduce demographics and medical/lifestyle details into the analysis, giving more insight into the meaning of the results of ultrasound examination [15].

Tukey HSD multiple comparisons in our study demonstrate that there are somehow statistically significant differences between the normal, overweight, and obese BMI groups for any of the variables. Similar levels across BMI categories are indicated by the minor significant mean differences between groups for FBG, hypertension presence, duration of diabetes, menopause duration, and plaque.

Results from 50 participants across five variables are displayed in the descriptive statistics. Menopause (M = 1.74) and duration (M = 1.66) have comparatively higher mean values than hypertension presence (M = 1.32), with mean values ranging from

1.32 to 1.74. The higher IMT measured in the observed patients indicates the combined effect of metabolic and hormonal conditions typical for this group of people. The within-group variation (SS = 25.494, df = 47) is significantly greater than the between-group variation (SS = 1.726, df = 2). There is no discernible linear trend since the linearity component is nearly nil (SS = 0.006) and the majority of the variation results from deviation from linearity (SS = 1.720) as observed from statistically analysis in our study.

Variation in the measurements of the IMT values in the surveyed participants illustrates the diversity of progression in terms of disease, despite the fact that these people share many similar characteristics. Based on the data gathered within this observational dataset, it can be stated that IMT increased significantly in patients having a longer time of suffering from diabetes and poorly controlled blood glucose levels [22]. According to survey responses, many of them did not have enough knowledge about the cardiovascular risks linked to their condition and menopause [24].

Generally, from the outcomes of the observational survey, the association between the increase in IMT and the risk factors can be modified using the data from the patient's surveys, there is a need for preventive health care. Moreover, a clear connection between the increased IMT and clinical indices like age, length of diabetes presence, and BMI has been established. A higher level of BMI has a connection with some metabolic disorders, such as dyslipidemia and insulin resistance that cause further arterial thickness increase [12].

For both premenopausal and postmenopausal women, carotid intima-media thickness (CIMT) is a reliable indicator of CAD. Postmenopausal women with diabetes face a markedly increased cardiovascular risk. Elevated CIMT in this group reflects more advanced subclinical atherosclerosis, closely associated with postmenopausal metabolic disturbances, particularly hyperglycemia [10]. These findings highlight the importance of early vascular screening and strict glycemic control to reduce cardiovascular complications. Carotid intima–media thickness (CCA-IMT) is a reliable marker of subclinical atherosclerosis and an early indicator of cardiovascular and

Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

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DOI: http://doi.org/10.5281/zenodo.20285442

cerebrovascular risk. Increased CCA-IMT has been consistently associated with major risk factors including age, obesity, diabetes mellitus, and hypertension, making sonographic assessment valuable for early vascular evaluation [11].

In conclusion, the significance of this study lies in the potential clinical importance of the ultrasonic evaluation of IMT to assist in the early detection and prediction of cardiovascular risk. The elevated IMT seen among post-menopausal women who have diabetes underscores the importance of prompt action, in terms of modifying their lifestyles and controlling blood sugar levels. Early detection by screening for IMT may help identify people at a higher risk of developing cardiovascular diseases.

CHAPTER 6
CONCLUSIONS / RECOMMENDATIONS

The current study shows that a useful, non-invasive, and trustworthy technique for identifying early atherosclerosis alterations in postmenopausal diabetic females is sonographic evaluation of carotid intima-media thickness (IMT). The results show that IMT is markedly elevated in this high-risk cohort, suggesting the combined impact of persistent hyperglycemia and hormonal changes associated with menopause. IMT was found to be positively correlated with body mass index, age, and the length of diabetes, suggesting that these variables are important in hastening vascular alterations. According to the study, postmenopausal diabetic women are especially susceptible to subclinical cardiovascular disease, which may go undiagnosed in the absence of suitable screening instruments. Thus, prompt intervention and prevention of major cardiovascular problems including stroke and coronary artery disease can be facilitated by early detection with ultrasound. These results suggest that routine carotid ultrasonography screening be included in the clinical assessment of postmenopausal diabetic patients, particularly those with long-term diabetes or other isk factors such as obesity and hypertension. To lower cardiovascular risk, medical providers should stress stringent glycemic control, weight management, and lifestyle changes like consistent exercise and a balanced diet. It is advised that bigger sample numbers and longitudinal follow-up be used in future studies to confirm these results and provide standardized IMT threshold values for risk assessment. In general, early diagnosis and preventative care can be greatly enhanced by incorporating sonographic IMT assessment into standard clinical practice, which will ultimately lower the morbidity and mortality linked to cardiovascular illnesses in this susceptible group.

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Pakistan Journal of Medical & Cardiological Review
https://pakjmcr.com/index.php/1/about
Online ISSN 3007-2387
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