

# Prevalence and Determinants of Subclinical Atherosclerosis in Asymptomatic Adults in the United States

Yousaf Saeed<sup>1\*</sup>

<sup>1</sup>Department of Internal Medicine, University at Buffalo, Buffalo, New York, United States.

\*Corresponding Author: Yousaf Saeed, email: [drsaeedyou786@gmail.com](mailto:drsaeedyou786@gmail.com)

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## ABSTRACT

**Background:** Subclinical atherosclerosis is an early asymptomatic stage of cardiovascular disease characterized by silent vascular abnormalities that may progress to major cardiovascular events such as myocardial infarction and stroke. These vascular changes, therefore, should be detected early for timely preventive intervention and cardiovascular risk reduction.

**Objective:** To ascertain the prevalence and determinants of subclinical atherosclerosis in asymptomatic adults in the United States.

**Methods:** This cross-sectional observational study was conducted at the Department of Internal Medicine at the University at Buffalo, Buffalo, New York, USA, from June 2024 to May 2025. The research used a successive non-probability sampling strategy to enroll 250 asymptomatic people aged 35 to 70. Subclinical atherosclerosis was assessed using carotid intima-media thickness (CIMT) and coronary artery calcium (CAC) scores. All individuals had their clinical and demographic information documented thoroughly, including smoking behaviors, hypertension, diabetes mellitus, obesity status, lipid profile values, and a family history of cardiovascular disease. The acquired data was statistically analyzed using SPSS version 26.0.

**Results:** Subclinical atherosclerosis was identified in 92 (36.8%) participants. There was an increase in prevalence with age, and this was a highly significant difference. Male participants demonstrated higher prevalence compared to females. Subclinical vascular disease showed significant association with hypertension, smoking, diabetes mellitus, obesity and high LDL cholesterol ( $p < 0.05$ ). The multivariate logistic regression analysis revealed age  $> 50$  years, hypertension, smoking, diabetes mellitus and high LDL cholesterol as independent risk factors for subclinical atherosclerosis.

**Conclusion:** There was a significant proportion of asymptomatic adults who had evidence of subclinical atherosclerosis. Early vascular abnormalities were strongly associated with traditional cardiovascular risk factors. The early identification and management of cardiovascular risk factors could limit the incidence of future cardiovascular complications.

**Keywords:** Subclinical atherosclerosis, Coronary artery calcium, Carotid intima-media thickness, Cardiovascular risk factors, Asymptomatic adults, United States

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## INTRODUCTION

Cardiovascular disease remains the leading cause of morbidity and mortality worldwide and continues to impose a major burden on healthcare systems despite advancements in preventive medicine and therapeutic interventions [1]. Atherosclerosis is the main pathological mechanism involved in most cardiovascular diseases, such as coronary artery disease, cerebrovascular disease and peripheral arterial disease. It is a progressive inflammatory disease in which the endothelium is damaged, lipids build up, the walls of the arteries become inflamed, smooth muscle grows and plaques develop. Importantly, the development of atherosclerosis often begins many years before the appearance of clinical symptoms, making early detection essential for reducing future cardiovascular complications [2].

Subclinical atherosclerosis is the early stage of arterial disease in which structural or functional abnormalities of the arteries are present but there are no clinical symptoms like angina, myocardial infarction, transient ischemic attack or stroke [3]. In the asymptomatic stage, pathological changes silently continue and can advance greatly before clinical changes occur. The identification of subclinical vascular disease has therefore become more and more a focus in preventive cardiology, because it could offer the chance for early intervention and risk modification, before irreversible cardiac damage occurs [4].

During the last few years, noninvasive imaging techniques including carotid intima-media thickness (CIMT) and coronary artery calcium (CAC) scoring have been shown to be good tools for the identification of early atherosclerotic changes [5]. CIMT measures the thickening of the artery wall, indicative of

increased CIMT or early vascular remodeling, while CAC scoring measures the presence of calcified plaque in the coronary arteries. Both methods have been shown to be highly predictive of future cardiovascular events and cardiovascular risk stratification. The imaging tools are now being used more and more in the assessment of cardiovascular risk and are being used for preventive cardiac screening, especially in people who would otherwise be classified as low or intermediate risk based on traditional clinical scoring systems [6].

A number of traditional cardiovascular risk factors have been implicated in the onset and progression of subclinical atherosclerosis [7]. Older age, male sex, hypertension, diabetes mellitus, dyslipidemia, obesity, smoking, sedentary lifestyle and family history of cardiovascular disease are all known to cause endothelial damage and plaque development. Over time, these risk factors increase vascular inflammation and cause progressive hardening and narrowing of the arteries. However, many asymptomatic individuals with significant vascular abnormalities remain undiagnosed because routine screening for subclinical disease is not universally performed [8].

The presence of subclinical atherosclerosis in the asymptomatic adult population in the United States is an important public health issue [9]. Silent cardiovascular disease continues to grow, with the rise of obesity, metabolic syndrome, diabetes mellitus and sedentary lifestyles [10]. Thus, early detection of high-risk asymptomatic individuals could help in the timely lifestyle modification and pharmacological intervention as well as individual preventive measures to reduce cardiovascular morbidity and mortality [11]. Therefore, this study was conducted to determine the prevalence and determinants of subclinical atherosclerosis among asymptomatic adults in the United States using carotid intima-media thickness assessment and coronary artery calcium scoring. The study also aimed to evaluate the association between traditional cardiovascular risk factors and early vascular abnormalities in an apparently healthy adult population [12].

## MATERIALS AND METHODS

This cross-sectional observational research was conducted at the Department of Internal Medicine at the University at Buffalo, Buffalo, New York, USA, from June 2024 to May 2025. The Institutional Review Board provided ethical permission for the study prior to participant recruitment, and the whole research process followed the ethical criteria established in the Declaration of Helsinki. All enrolled people provided written informed permission prior to the start of data collecting activities.

A total of 250 asymptomatic adults were recruited through consecutive non-probability sampling

techniques. Those patients who were 35 to 70 years old, who presented to internal medicine out patient department with routine preventive medical check-up were included. People with known history of coronary artery disease, myocardial infarction, cerebrovascular accident, peripheral arterial disease, congestive heart failure, chronic inflammatory disease, malignancy, chronic hepatic disease or advanced renal impairment and pregnancy were excluded. Furthermore, subjects who were undergoing treatment for known pre-existing cardiovascular disease were excluded to minimize for possible confounding effects on vascular imaging results.

Using a predesigned structured assessment form, comprehensive demographic and clinical information were obtained. Age, sex, smoking status, alcohol intake, body mass index (BMI), hypertension, diabetes mellitus, dyslipidaemia, physical activity level, and family history of cardiovascular disease were recorded as variables. Blood pressure was taken following adequate resting period by the standardized sphygmomanometer techniques. Body weight and height were measured and used for BMI calculations. Venous blood samples were obtained following an overnight fast of about 8-12 hours. Biochemical parameters measured were: serum total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides, fasting blood glucose and glycated hemoglobin (HbA1c). Standardised automated analytical techniques were used for all laboratory analyses carried out in the institution's central laboratory.

Coronary artery calcium (CAC) scoring and carotid intima-media thickness (CIMT) measurement were used for assessment of subclinical atherosclerosis. High-resolution B-mode carotid ultrasonography was performed to evaluate bilateral CIMT by experienced radiologists. A CIMT value greater than 0.9 mm or the presence of carotid plaque was considered suggestive of subclinical atherosclerotic disease. The coronary artery calcium scoring was performed with multidetector computed tomography (MDCT), with a CAC score > 0 considered positive coronary artery calcification.

Based on vascular imaging results, two study groups were created. Group B participants had abnormal CIMT values or carotid plaque formation and/or a positive CAC indicating early vascular disease; whereas Group A participants had no evidence of subclinical atherosclerosis.

The Statistical Package for Social Sciences (SPSS) version 26.0 was used to input and analyze all of the data that had been gathered. Categorical data were presented as frequencies and percentages, whereas continuous variables were presented as mean  $\pm$

standard deviation. The independent sample t-test and, where necessary, the chi-square test were used for comparative comparisons between study groups. To find independent factors linked to subclinical atherosclerosis, multivariate logistic regression analysis was also used. A p value of < 0.05 was considered statistically significant.

**RESULTS**

The research included 250 asymptomatic individuals. The research group's average age was 52.1 ± 9.4 years, with a range of 35 to 70 years. Of those who enlisted, 146 (58.4%) were men and 104 (41.6%) were women. Vascular abnormalities were present in 92 (36.8%) participants as evidence of subclinical atherosclerosis (either abnormal carotid intima-media thickness (CIMT), carotid plaque formation, or a positive coronary artery calcium (CAC) score), while 158 (63.2%) participants had no vascular abnormalities.

Table 1 displays the demographic and clinical characteristics of the participants at baseline. Participants with subclinical atherosclerosis were substantially older than those without vascular abnormalities (58.4 ± 7.6 vs. 48.5 ± 8.1 years, p<0.001). Male participants exhibited considerably greater rates of subclinical atherosclerosis than females. Subclinical vascular disease was also linked to hypertension, diabetes, smoking, obesity, high LDL cholesterol levels, and a family history of cardiovascular disease.

**Table 1: Baseline Characteristics of Study Participants**

Variables	No Subclinical Atherosclerosis (n=158)	Subclinical Atherosclerosis (n=92)	p-value
Mean age (years)	48.5 ± 8.1	58.4 ± 7.6	<0.001
Male gender	82 (51.9%)	64 (69.6%)	0.006
Female gender	76 (48.1%)	28 (30.4%)	0.006
Smokers	31 (19.6%)	42 (45.7%)	<0.001
Hypertension	48 (30.4%)	63 (68.5%)	<0.001
Diabetes mellitus	27 (17.1%)	39 (42.4%)	<0.001
BMI ≥30 kg/m <sup>2</sup>	46 (29.1%)	41 (44.6%)	0.015
Elevated LDL-C	52 (32.9%)	61 (66.3%)	<0.001
Positive family history	38 (24.1%)	35 (38.0%)	0.021

As illustrated in Table 1, hypertension and elevated LDL cholesterol were among the most prevalent cardiovascular risk factors observed in participants with subclinical atherosclerosis. There were also strong associations with early vascular abnormalities with smoking and diabetes mellitus.

The age-wise distribution of subclinical atherosclerosis is given in Table 2. The incidence of vascular abnormalities rose gradually with age. The prevalence rates were much higher in the 55 years old and older age groups. The prevalence was the highest in the age group 65-70 years.

**Table 2: Age-Wise Distribution of Subclinical Atherosclerosis**

Age Group (Years)	Total Participants	Participants with Subclinical Atherosclerosis	Prevalence
35-44	52	8	15.4%
45-54	86	24	27.9%
55-64	74	39	52.7%
65-70	38	21	55.3%

The findings shown in Table 2 demonstrate a clear age-related increase in subclinical atherosclerosis prevalence, suggesting that advancing age remains one of the strongest contributors to silent vascular disease among asymptomatic adults.

Carotid ultrasonography and coronary artery calcium scoring results are given in Table 3. Increased carotid intima-media thickness without coronary calcification was identified in 34 (13.6%) participants, while isolated positive CAC scores were observed in 20 (8.0%) participants. Both abnormal CIMT and positive CAC scores were simultaneously present in 38 (15.2%) participants.

**Table 3: Imaging Findings of Subclinical Atherosclerosis**

Imaging Findings	Frequency (n)	Percentage
Increased CIMT only	34	13.6%
Positive CAC score only	20	8.0%
Both abnormal CIMT and CAC	38	15.2%
No vascular abnormalities	158	63.2%

Combined abnormalities (both CIMT and CAC) were detected in a significant number of participants as shown in Table 3, and therefore, both carotid and coronary subclinical vascular disease coexisted among asymptomatic individuals.

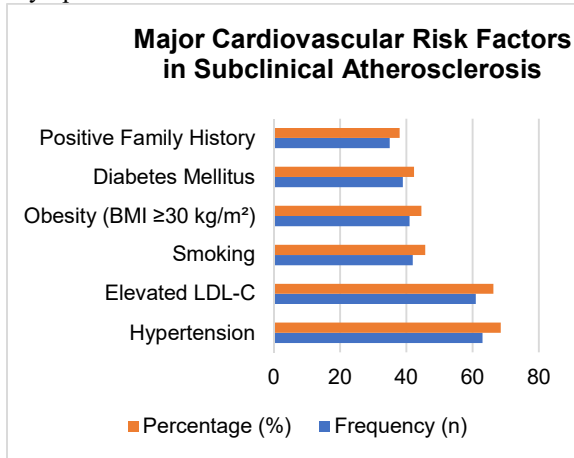
Multivariate logistic regression analysis was done to determine independent determinants associated with subclinical atherosclerosis. Table 4 revealed that age,

hypertension, smoking, diabetes mellitus and elevated LDL cholesterol are statistically significant independent predictors.

**Table 4: Multivariate Logistic Regression Analysis for Determinants of Subclinical Atherosclerosis**

Variables	Odds Ratio (OR)	95% Confidence Interval	p-value
Age >50 years	3.58	2.01–6.12	<0.001
Smoking	2.69	1.47–4.89	0.001
Hypertension	3.31	1.88–5.84	<0.001
Diabetes mellitus	2.42	1.29–4.53	0.004
Elevated LDL-C	2.95	1.64–5.30	<0.001

The regression analysis showed that hypertension and age > 50 years were the most powerful predictors of subclinical atherosclerosis in this study population. Other risk factors for early vascular disease included elevated levels of LDL cholesterol, smoking and diabetes mellitus. Among those with subclinical atherosclerosis, hypertension and elevated LDL cholesterol were the strongest cardiovascular risk factor associations as illustrated in Figure 1. Smoking, obesity, and diabetes mellitus also showed substantial associations with silent vascular abnormalities in asymptomatic adults.



**Figure 1: Prevalence of Subclinical Atherosclerosis According to Major Cardiovascular Risk Factors**

The study overall showed that subclinical atherosclerosis is widespread among U.S. adults who are not experiencing any symptoms. Older age, hypertension, higher LDL cholesterol, smoking and diabetes mellitus were found to be the most powerful determinants linked to early vascular abnormalities. These results emphasize the need of early cardiovascular screening and prevention of the risk factors in asymptomatic people.

**DISCUSSION**

The present study examined the prevalence and determinants of subclinical atherosclerosis in the U.S. adult population in the absence of clinical symptoms with the use of carotid intima-media thickness assessment and coronary artery calcium scoring [6]. Results showed that over 33% of the studied population were found to have some degree of silent vascular disease without any clinical cardiovascular signs or symptoms. This shows that the amount of hidden burden of early atherosclerotic changes in apparently healthy adults is not negligible and preventive cardiovascular screening is important [7]. One of the most important factors associated with subclinical atherosclerosis in the current study was age. Participants older than 50 years demonstrated significantly higher prevalence of abnormal vascular findings compared to younger individuals [8]. There is an association with ageing and endothelial dysfunction, increase in arterial stiffness, chronic vascular inflammation, oxidative stress, and progressive deposition of lipids in arterial walls, which leads to the progression of atherosclerosis. The higher prevalence of vascular abnormalities found in the older age groups in the present study confirms the results of previous epidemiological studies that assessed asymptomatic cardiovascular risk [9]. Male participants had significantly higher prevalence of subclinical atherosclerosis than did female participants [10]. The low prevalence found among females may be partly attributed to hormonal protection in premenopausal women, differences in lipid metabolism and variations in vascular inflammatory responses. But the risk of cardiovascular disease rises with age continually, especially in women after menopause, when their estrogen-mediated vascular protective effects are reduced [11]. Hypertension proved to be the most important cardiovascular risk factor linked to subclinical atherosclerosis [12]. Abnormal CAC scores and CIMT were significantly higher in participants with hypertension. Hypertension leads to endothelial damage, vascular remodeling, shear stress and activation of inflammatory processes, leading to thickening of the arterial wall and the formation of plaques. The results are consistent with the available evidence on the key role of hypertension in the initiation of atherosclerotic processes [13]. Subclinical vascular disease was also highly related to smoking in the current study. Increased oxidative stress, endothelial dysfunction, platelet activation, and chronic inflammatory responses from tobacco exposure can also promote the formation of a plaque and the calcification of blood vessels. The smokers were significantly more likely to exhibit early vascular abnormalities, reflecting the need for smoking

cessation in cardiovascular prevention campaigns [14,15].

An additional independent predictor of subclinical atherosclerosis was diabetes mellitus and high LDL cholesterol levels [16]. Persistent hyperglycemia leads to endothelial dysfunction, glycation of vascular proteins, oxidative damage and activation of inflammatory cytokines, which accelerate vascular damage. In a similar way, high LDL cholesterol is directly linked to the deposition of lipids in the wall of the arteries and the development of the atherosclerotic plaques. This study reinforces the strong relationship between dyslipidaemia and subclinical atherosclerosis and the need for an aggressive approach to the lipid profile in high-risk asymptomatic people [17].

In this study, the use of the CIMT evaluation in conjunction with the coronary artery calcium scoring enhanced the identification of silent vascular disease [18]. CIMT assessment can offer valuable information about early thickening of the artery walls and development of plaques, and CAC scoring can detect coronary artery calcification and subclinical coronary artery disease. Abnormal CIMT and CAC results were present in several of the participants, suggesting that there may be a parallel progression of carotid and coronary vascular abnormalities in early atherosclerotic disease [19].

The findings of this study have important clinical implications for preventive cardiology. Asymptomatic patients with serious vascular disorders may only be diagnosed after having suffered a major cardiovascular event like myocardial infarction or stroke [20]. Noninvasive vascular imaging to identify high-risk individuals may help to make timely lifestyle changes, quit smoking, control blood pressure, manage lipids, and provide individualized preventive interventions to reduce long-term cardiovascular morbidity and mortality [14,15].

This study has certain limitations. A cross-sectional study design has the disadvantage of not being able to make causal inferences between cardiovascular risk factors and subclinical atherosclerosis [16,17]. The study was carried out in one tertiary care academic hospital and may not be applicable to other populations. Moreover, long-term follow-up data on cardiovascular outcomes were not available. However, the study offers valuable information regarding the burden and determinants of subclinical vascular disease in the asymptomatic adult population in the United States [18-20].

## CONCLUSION

Subclinical atherosclerosis is common among asymptomatic adults in the United States, as more than one-third of participants had early vascular abnormalities. The major determinants identified included advancing age, hypertension, smoking,

diabetes mellitus, obesity and increased LDL cholesterol. Carotid intima-media thickness and coronary artery calcium scoring are noninvasive vascular imaging techniques that could prove useful in early cardiovascular risk detection in the asymptomatic population. Timely preventive intervention can decrease future cardiovascular morbidity and mortality by aggressively managing modifiable cardiovascular risk factors early in life.

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## Conflict of Interest

The author declare that they have no conflict of interest.

## Authors' Contributions

Y.S. contributed substantially to the conception and design of the study, data collection, statistical analysis, interpretation of results, manuscript drafting, and final approval of the manuscript.

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