Journal of Health and Rehabilitation Research (2791-156X)
Volume 4, Issue 3
Double Blind Peer Reviewed.
https://jhrlmc.com/
DOI: https://doi.org/10.61919/jhrr.v4i3.1504
www.lmi.education/

Comparative Study of Sonographic Evaluation of Common Carotid Intima-Media Thickness Among Obese and Non-Obese Type II Diabetic Patients

Tehreem Zahra[1], Mehwish Bibi[1], Naba Naseer[1], Muhammad Shahzad Hanif[2], Zainab Naseer[1], Ume Samia[1], Ahmad Mukhtar[1]

Correspondence
Tehreem Zahra
Lecturer, tehreemzahra608@gmail.com
Affiliations
1 School of Health Sciences, University of Management and Technology, Lahore, Pakistan.
2 Medical Officer, Hunan University of Traditional Chinese Medicine, Changsha, China.

Keywords
Carotid Intima-Media Thickness, Type II Diabetes, Obesity, Cardiovascular Risk, Ultrasound, Atherosclerosis, Body Mass Index.
Disclaimers

Authors' Contributions	All authors contributed equally to the work of this study.
Conflict of Interest	None declared
Data/supplements	Available on request.
Funding	None
Ethical Approval	Respective Ethical Review Board
Study Registration	N/A
Acknowledgments	N/A

ABSTRACT

Background: Intima-media thickness (IMT) is a marker of cardiovascular risk and is influenced by factors such as obesity and type II diabetes. Assessing IMT in diabetic patients provides insights into their cardiovascular health.

Objective: To compare the common carotid intima-media thickness between obese and non-obese type II diabetic patients.

Methods: This case-control study was conducted at the Department of Radiology, Services Hospital, Lahore, over three months. A total of 86 type II diabetic patients aged 30-75 years were included, with 43 obese and 43 non-obese participants. Carotid IMT was measured using gray-scale B-mode ultrasound. Participants were positioned supine with the neck extended, and the common carotid arteries were scanned. Data analysis was performed using SPSS version 25.0, with independent t-tests to compare IMT between groups and Pearson correlation to assess the association with diabetes duration.

Results: The mean IMT for obese patients was 0.842 mm (SD = 0.152) for the left CCA and 0.858 mm (SD = 0.119) for the right CCA. In non-obese patients, mean IMT was 0.592 mm (SD = 0.134) for the left CCA and 0.616 mm (SD = 0.127) for the right CCA. Significant differences were observed between groups ($p < 0.001$).

Conclusion: Obese type II diabetic patients have significantly higher carotid IMT compared to non-obese patients, emphasizing the impact of obesity on cardiovascular risk.

INTRODUCTION

Intima-media thickness (IMT) is defined as the distance between the lumen-intima interface and the media-adventitia interface of the arterial wall, and it serves as a significant marker for cardiovascular diseases and associated risk factors (1). The thickening of the intimal layer, often visualized as focal atherosclerotic plaques, is indicative of early atherosclerosis and reflects the cumulative burden of risk factors over time (2). A wide range of variables are implicated in influencing IMT, including lifestyle factors such as smoking and alcohol use, as well as intrinsic factors like ethnic origin, gender, metabolic abnormalities, and specific genotypic indices. Additional contributors include systemic conditions such as diabetes mellitus, high body mass index (BMI), and inflammatory conditions, all of which are known to exacerbate the thickening of the arterial walls (3). Among these, diabetes mellitus plays a particularly pivotal role, directly affecting the stiffness and thickness of the carotid intima-media, alterations which are detectable through non-invasive imaging modalities like B-mode ultrasound (4). Diabetes is associated with impaired endothelial function, reduced fibrinolysis, increased platelet aggregation, and a prothrombotic state, which collectively contribute to vascular changes that heighten the risk of cardiovascular events (4).

The impact of obesity on IMT is another critical area of concern, particularly in individuals with type II diabetes, where excess body weight further accelerates the process of atherosclerosis. Obesity is associated with chronic inflammation, oxidative stress, and dysregulation of lipid metabolism, all of which can intensify the adverse effects of diabetes on the vascular system (6). Smoking, a well-documented cardiovascular risk factor, compounds these effects by promoting endothelial dysfunction, elevating inflammatory markers, and accelerating the atherosclerotic process (6). Notably, the role of ultrasonography in the assessment of IMT has evolved, with high-frequency B-mode ultrasound emerging as a preferred method due to its accuracy and non-invasiveness. This technique allows for the detailed visualization of the arterial wall and measurement of IMT, particularly in the distal common carotid artery, thereby providing valuable insights into the extent of atherosclerosis and cardiovascular risk (10). Studies have demonstrated that IMT values exceeding normative ranges are predictive of increased risk for cardiovascular events, including stroke and myocardial infarction (10).

Manuscript Submitted under JHRR ID 1504: August 27/2024 | Accepted: September 04/2024

The carotid arteries, which supply oxygenated blood to the head and neck, are key sites for evaluating IMT due to their superficial location and ease of access with ultrasound imaging. The common carotid arteries originate differently on each side of the body—the right CCA arises from the brachiocephalic artery bifurcation, while the left CCA emerges directly from the aortic arch, reflecting variations in vascular anatomy (12). Despite these anatomical differences, both arteries exhibit similar courses in the neck, ascending within the lateral carotid fascial sheath alongside the internal jugular vein and vagus nerve. This anatomical consistency facilitates the standardized measurement of IMT across populations and enables comparative studies that explore the impact of various risk factors on arterial health.

Diabetes mellitus, a global health burden, significantly contributes to the progression of cardiovascular disease, with the prevalence of type II diabetes projected to reach 300 million worldwide by 2025 (13). In Pakistan, the prevalence of type II diabetes is alarmingly high, with regional variations observed across different provinces and between urban and rural settings (14). This high burden underscores the importance of early detection and monitoring of cardiovascular risk factors such as IMT in diabetic populations. Understanding the relationship between obesity and IMT in diabetic patients is critical, as it provides insight into the compounded risks these individuals face and highlights the need for targeted interventions to mitigate cardiovascular complications. This study aims to compare the common carotid IMT in obese versus non-obese individuals with type II diabetes, thereby elucidating the additional impact of obesity on vascular health in this high-risk population.

MATERIAL AND METHODS

The study was designed as a case-control investigation conducted at the Department of Radiology, Services Hospital, Lahore, Pakistan, over a period of three months. A total of 86 participants aged between 30 and 75 years, all diagnosed with type II diabetes mellitus, were included. The sample size was calculated using the formula for two means, considering carotid intima-media thickness values of non-obese and obese diabetic patients (2). Participants were recruited using a non-probability convenience sampling technique, with 43 individuals allocated to the obese group and 43 to the non-obese group. Inclusion criteria specified patients diagnosed with diabetes, as defined by HbA1c criteria, and within the specified age range. Exclusion criteria included individuals with a history of cardiovascular diseases, stroke, or pregnancy, to eliminate confounding factors that could influence carotid intima-media thickness.

Data collection involved performing gray-scale B-mode ultrasound using a LOGIQ machine equipped with a 7-10 MHz linear probe and a 3-5 MHz curvilinear probe. Each participant was positioned supine with a cushion beneath the lower neck, allowing the neck to be slightly extended. Ultrasound scanning was conducted on the lateral side of the thyroid gland lobes to visualize the common carotid arteries (CCA) using both gray-scale and color Doppler imaging techniques. The intima-media thickness (IMT) was measured at the mid-level of each CCA, ensuring that the ultrasound probe remained perpendicular to the vessel wall to provide accurate measurements. The presence of artifacts was minimized by applying an adequate amount of acoustic gel and avoiding excessive pressure with the probe.

Body mass index (BMI) was calculated using the Quetelet index formula: BMI = weight (kg) / height (m^2) (15). Measurements of uncompressed subcutaneous fat were also taken at the suprapubic region in three separate trials to provide additional data on adiposity. Data collected included demographic information, diabetes duration, BMI, and carotid IMT values. All participants provided written informed consent before undergoing ultrasound examination, and the study adhered to the ethical principles outlined in the Declaration of Helsinki. The study protocol was approved by the institutional review board of Services Hospital, Lahore.

Data analysis was conducted using SPSS version 25.0. Quantitative variables, including age, IMT, and BMI, were presented as mean ± standard deviation. Qualitative variables, such as the duration of diabetes and gender, were reported as frequencies and percentages. To compare IMT between obese and non-obese groups, independent sample t-tests were performed, with a p-value of less than 0.05 considered statistically significant. Pearson correlation analysis was utilized to explore associations between the duration of diabetes and IMT values in both the left and right carotid arteries. The analysis aimed to determine whether the duration of diabetes had any significant effect on carotid intima-media wall thickness, independent of obesity status.

The results of the data analysis provided insights into the differences in carotid IMT between obese and non-obese diabetic patients, with a particular focus on the impact of obesity on arterial health in the context of type II diabetes. The findings were interpreted in light of existing literature, with implications for clinical practice and potential recommendations for the management of cardiovascular risk in diabetic populations.

RESULTS

The study involved 86 participants, with a predominance of females (59.3%, n=51) compared to males (40.7%, n=35). The age of participants ranged from 30 to 60 years, with a mean age of 51 years (SD = 9.3). This demographic distribution provides a balanced representation of both genders, with a slightly higher number of female participants, and covers a broad age range relevant to the assessment of carotid intima-media thickness in diabetic patients.

The participants were equally divided into two groups based on obesity status: 43 individuals (50%) were classified as obese, and 43 individuals (50%) as non-obese. The analysis

of carotid intima-media thickness (IMT) revealed notable differences between the obese and non-obese groups. For the left common carotid artery (CCA), the mean IMT among obese participants was 0.842 mm (SD = 0.152), while in non-obese participants, the mean IMT was significantly lower at 0.592 mm (SD = 0.134). Similarly, for the right CCA, obese participants exhibited a mean IMT of 0.858 mm (SD = 0.119), compared to 0.616 mm (SD = 0.127) in the non-obese group. These differences in IMT between obese and non-obese participants were statistically significant, with p-values of 0.000 for both the left and right CCA, indicating that obesity is associated with a marked increase in carotid artery thickness in type II diabetic patients.

Further analysis using Pearson correlation explored the relationship between the duration of diabetes and carotid IMT. The results indicated no significant correlation between the duration of diabetes and IMT in both the left CCA (p = 0.108) and the right CCA (p = 0.083). These findings suggest that while obesity significantly affects carotid artery thickness, the duration of diabetes alone does not appear to influence IMT in this study population.

Table 1 Demographics

Variable	Frequency/N	Percentage	Minimum Age	Maximum Age	Mean	Std. Deviation
Female	51	59.3	-	-	-	-
Male	35	40.7	-	-	-	-
Total	86	100.0	-	-	-	-
Age	86	-	30	60	51	9.3

Table 2 Carotid Artery Side

Carotid Artery Side	Group	N	Mean (mm)	Std. Deviation	P-Value
Left CCA IMT	Obese	43	0.842	0.152	0.000
Left CCA IMT	Non-obese	43	0.592	0.134	0.000
Right CCA IMT	Obese	43	0.858	0.119	0.000
Right CCA IMT	Non-obese	43	0.616	0.127	0.000

The figures illustrate B-mode and colour Doppler ultrasound scans of the common carotid arteries (CCA) in different patients. Image A highlights a comparison of IMT between the right and left CCAs, demonstrating a thicker intima-media layer in the right artery (0.8 mm) compared to the left (0.5 mm). In Image B, both CCAs are evaluated with color Doppler imaging, showing IMT measurements of 0.5 mm for the right CCA and 0.7 mm for the left CCA. These images underscore the variability in IMT among different CCAs, which is a critical marker for assessing cardiovascular risk, particularly in obese and non-obese diabetic patients.

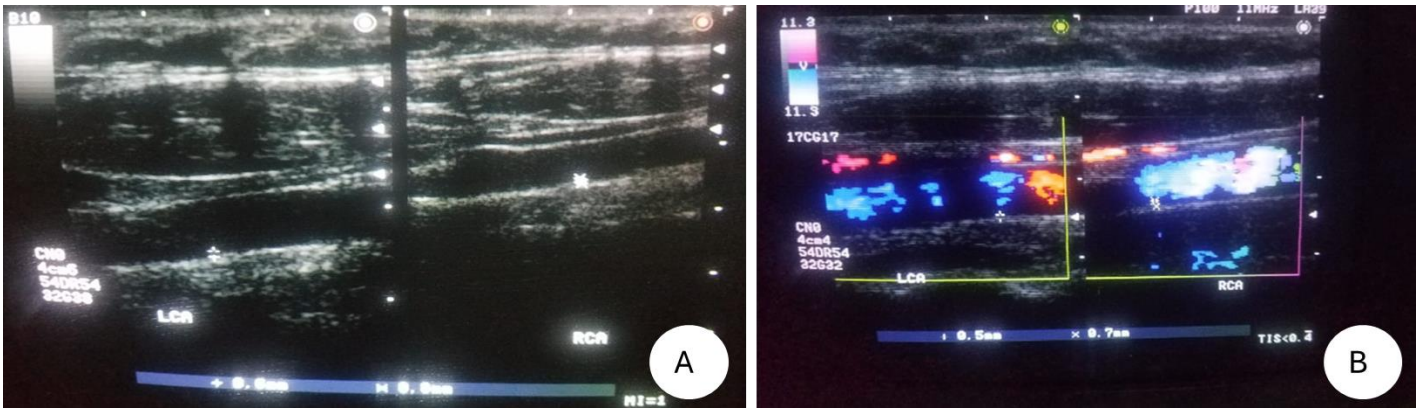

Figure 1 Ultrasound images of common carotid arteries: Image A shows right and left IMT at 0.8 mm and 0.5 mm; Image B shows right and left IMT at 0.5 mm and 0.7 mm.

These results underscore the significant impact of obesity on carotid intima-media thickness among type II diabetic patients, highlighting the need for targeted management strategies to address cardiovascular risks associated with increased arterial thickness in this population.

DISCUSSION

The findings of this study indicated that obesity significantly increased carotid intima-media thickness (IMT) among type II diabetic patients, independent of the duration of diabetes. The results demonstrated that obese participants had markedly higher IMT values in both the left and right common carotid arteries compared to non-obese participants, aligning with previous research that identified obesity as a critical factor in the progression of atherosclerosis and cardiovascular risk (18). This is consistent with the study by Elshorbagy et al. (2016), which also reported a significant difference in IMT between obese and non-obese individuals, emphasizing the role of adiposity in vascular alterations (19). Moreover, Alizadeh et

al. (2012) found that type II diabetic patients had greater IMT compared to non-diabetic individuals, supporting the association between metabolic abnormalities and increased arterial thickness (18). These findings reinforce the importance of obesity management in diabetic populations to mitigate cardiovascular risks.

The absence of a significant correlation between the duration of diabetes and IMT suggests that factors beyond glycemic control, such as obesity, may have a more pronounced impact on arterial health. This aligns with studies that have highlighted the multifactorial nature of atherosclerosis, where metabolic syndrome components, including high BMI, play a pivotal role in vascular changes (20). However, the lack of association between diabetes duration and IMT contrasts with findings from other studies, such as those by Mohan et al. (2000), which reported that longer diabetes duration correlated with increased carotid thickness, particularly in older adults (17). This discrepancy may be attributed to differences in study populations, the age range of participants, or the duration of diabetes considered significant in influencing IMT.

One strength of this study was the use of high-resolution B-mode ultrasound, which is recognized as a reliable method for assessing IMT and has been validated in numerous studies, including those by Hollander et al. (2002) (16). The standardization of ultrasound measurements and the careful control of confounding variables, such as cardiovascular disease history and smoking, added robustness to the findings. However, the study also had limitations, including the use of a convenience sampling method, which may limit the generalizability of the results. The relatively short study duration and the cross-sectional design also restricted the ability to infer causality or observe longitudinal changes in IMT related to diabetes progression or obesity interventions.

Further research with larger sample sizes and longitudinal designs is recommended to explore the interplay between diabetes duration, glycemic control, and obesity on IMT. Additionally, incorporating more diverse populations and examining the effects of targeted obesity interventions on IMT could provide deeper insights into managing cardiovascular risks in diabetic patients. Given the significant association found between obesity and increased IMT, this study underscores the importance of weight management as a crucial component of cardiovascular disease prevention strategies in individuals with type II diabetes. By addressing obesity, healthcare providers may be able to more effectively reduce the burden of atherosclerosis and its associated complications in this high-risk group.

CONCLUSION

The study concluded that obesity is significantly associated with increased carotid intima-media thickness among type II diabetic patients, highlighting the critical role of obesity as a modifiable risk factor for cardiovascular disease in this population. The lack of association between the duration of diabetes and IMT suggests that managing obesity may be more impactful in reducing arterial thickening than focusing solely on glycemic control. These findings underscore the importance of integrating weight management strategies into the clinical care of diabetic patients to mitigate cardiovascular risks. Addressing obesity through lifestyle interventions, pharmacotherapy, or surgical options could have substantial implications for improving vascular health and overall outcomes in individuals with type II diabetes, ultimately enhancing the quality of care and reducing the long-term burden of cardiovascular complications.

REFERENCES

1. American Diabetes Association. Classification and diagnosis of diabetes: standards of medical care in diabetes—2019. Diabetes Care. 2019;42(Supplement_1).
2. Bulut A, Avci B. Carotid Intima-Media Thickness Values Are Significantly Higher in Patients with Prediabetes Compared to Normal Glucose Metabolism. Medicine. 2019;98(44).
3. Casella IB, Presti C, Porta RMP, Sabbag CRD, Bosch MA, Yamazaki Y. A Practical Protocol to Measure Common Carotid Artery Intima-Media Thickness. Clinics. 2008;63:515-520.
4. Corti R, Fuster V, Badimon JJ. Pathogenetic Concepts of Acute Coronary Syndromes. J Am Coll Cardiol. 2003;41(4S).
5. Homma S, Hirose N, Ishida H, Ishii T, Araki G. Carotid Plaque and Intima-Media Thickness Assessed by B-Mode Ultrasonography in Subjects Ranging from Young Adults to Centenarians. Stroke. 2001;32(4):830-835.
6. Hong SB, Lee JJ, Kim SH, Suh YJ, Han JY, Kim YS, et al. The Effects of Adiponectin and Inflammatory Cytokines on Diabetic Vascular Complications in Obese and Non-Obese Patients with Type 2 Diabetes Mellitus. Diabetes Res Clin Pract. 2016;111:58-65.
7. Kronenberg HM, Melmed S, Polonsky KS, Wilson JD, Foster DW. Williams Textbook of Endocrinology. 2002.
8. Liu KH, Chan YL, Chan JCN, Chan WB. Association of Carotid Intima-Media Thickness with Mesenteric, Preperitoneal and Subcutaneous Fat Thickness. Atherosclerosis. 2005;179(2):299-304.
9. Meijers A, Seller Oria C, Free J, Langendijk JA, Knopf AC, Both S. First Report on an In Vivo Range Probing Quality Control Procedure for Scanned Proton Beam Therapy in Head and Neck Cancer Patients. Med Phys. 2021;48(3):1372-1380.
10. Meo SA, Zia I, Bukhari IA, Arain SA. Type 2 Diabetes Mellitus in Pakistan: Current Prevalence and Future Forecast. J Pak Med Assoc. 2016;66(12):1637-1642.
11. Mendonça JA, de Andrade BB, de Aquino JLB, Leandro-Merhi VA, Damian GB. Spectral Doppler and Automated Software-Guided Ultrasound Assessment of Bilateral Common Carotid Intima-Media Thickness in Spondyloarthritis: Is There a Correlation with Clinical Findings?. Drugs Context. 2018;7.
12. Tranquart F, Bergès O, Koskas P, Arsene S, Rossazza C, Pisella PJ, et al. Color Doppler Imaging of Orbital

Vessels: Personal Experience and Literature Review. J Clin Ultrasound. 2003;31(5):258-273.
13. Wang S, Sun Q, Zhai L, Bai Y, Wei W, Jia L. The Prevalence of Depression and Anxiety Symptoms among Overweight/Obese and Non-Overweight/Non-Obese Children/Adolescents in China: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2019;16(3):340.
14. Poredos P. Intima-Media Thickness: Indicator of Cardiovascular Risk and Measure of the Extent of Atherosclerosis. Vasc Med. 2004;9(1):46-54.
15. Nadeem B, Bacha R, Gilani SA. Correlation of Subcutaneous Fat Measured on Ultrasound with Body Mass Index. J Med Ultrasound. 2018;26(4):205.
16. Hollander M, Bots ML, Del Sol AI, Koudstaal PJ, Witteman JC, Grobbee DE, et al. Carotid Plaques Increase the Risk of Stroke and Subtypes of Cerebral Infarction in Asymptomatic Elderly: The Rotterdam Study. Circulation. 2002;105(24):2872-2877.
17. Mohan V, Ravikumar R, Shanthi Rani S, Deepa R. Intimal Medial Thickness of the Carotid Artery in South Indian Diabetic and Non-Diabetic Subjects: The Chennai Urban Population Study (CUPS). Diabetologia. 2000;43:494-499.
18. Alizadeh A, Roudbari A, Heidarzadeh A, Jandaghi AB, Jamali MB. Ultrasonic Measurement of Common Carotid Intima-Media Thickness in Type 2 Diabetic and Non-Diabetic Patients. Iran J Radiol. 2012;9(2):79.
19. Elshorbagy HH, Fouda ER, Kamal NM, Bassiouny MM, Fathi WM. Evaluation of Epicardial Fat and Carotid Intima-Media Thickness in Obese Children. Iran J Pediatr. 2016;26(1).
20. Reinehr T, Wunsch R. Intima Media Thickness – Related Risk Factors in Childhood Obesity. Int J Pediatr Obes. 2011;6(1):46-52.
21. Garcia MJ, McNamara PM, Gordon T, Kannell WB. Morbidity and Mortality in Diabetics in the Framingham Population: Sixteen-Year Follow-Up Study. Diabetes. 2008;23(2):105-111.