Section: General Medicine

Original Research Article

PREVALENCE OF INTERARM BRACHIAL PRESSURE DIFFERENCE AND ITS ASSOCIATION WITH RISK OF ATHEROSCLEROTIC CARDIOVASCULAR DISEASE AMONG ADULTS

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ABSTRACT

Background: Interarm blood pressure difference (IABPD) is an easily obtainable, non-invasive marker that may reflect asymmetric arterial stiffness and subclinical atherosclerotic disease. While large interarm systolic differences (≥10 mmHg) have been associated with adverse cardiovascular outcomes, their relationship with calculated atherosclerotic cardiovascular disease (ASCVD) risk in general outpatient populations remains insufficiently explored. The objective is to determine the prevalence of significant interarm brachial pressure difference and evaluate its association with ASCVD risk and carotid intima–media thickness (IMT) among adults. **Materials and Methods:** This prospective observational study enrolled 297 adults aged 40–75 years attending a tertiary care medical outpatient department in South India. Bilateral blood pressure was measured sequentially in triplicate using a validated oscillometric device, and the mean interarm systolic difference was calculated. Significant IAD was defined as ≥10 mmHg. Fasting lipid profiles, carotid IMT by B-mode ultrasonography, and 10-year ASCVD risk scores (pooled cohort equations) were assessed. Associations between IAD and cardiovascular risk parameters were analysed using chi-square tests, t-tests, and multivariate regression. **Result:** The mean age was 58.5 ± 10.9 years, and 50.8% were female. Cardiometabolic risk factors were common: diabetes (35.4%) and hypertension (39.1%). Mean interarm systolic difference was 4.5 ± 3.5 mmHg, and 8.4% of participants had significant IAD. IAD prevalence did not differ significantly across ASCVD risk categories ($p = 0.793$) or by age, sex, diabetes, or hypertension status. However, IAD showed a modest positive correlation with mean carotid IMT ($r = 0.42$, $p = 0.030$). Body mass index was significantly higher in participants with IAD ≥10 mmHg ($p = 0.019$). **Conclusion:** Significant interarm systolic blood pressure difference was present in nearly one in twelve adults and occurred independently of traditional ASCVD risk categories. Its association with carotid IMT suggests that IAD may indicate localized subclinical vascular remodelling. Routine bilateral blood pressure measurement may provide additional insight into vascular risk beyond conventional risk scoring systems.

INTRODUCTION

Interarm blood pressure difference (IABPD) refers to the discrepancy in systolic and/or diastolic blood pressure measured between the left and right brachial arteries. While small differences (<10 mmHg) may be physiologically benign, larger disparities (≥10 mmHg or ≥15 mmHg) have increasingly been recognised as clinically important markers of vascular pathology and cardiovascular risk.1,2 IABPD is easily obtained through non-invasive bilateral blood pressure measurement and may reveal occult vascular abnormalities before overt disease manifests.[1-3]

Pathophysiologically, significant IABPD may reflect asymmetric arterial stiffness, subclavian or innominate artery stenosis, and other forms of atherosclerotic disease affecting the supra-aortic vessels.[3-5] These conditions create differential impedance to blood flow, leading to measurable

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pressure gradients between arms. Patients with clinically significant IABPD are more likely to exhibit subclinical atherosclerosis, increased arterial stiffness, and atherosclerotic cardiovascular disease (ASCVD).[6]

Epidemiological studies report that systolic IABPD ≥10 mmHg occurs in a notable proportion of adults, with prevalence estimates varying by population, measurement technique, and comorbidity burden.[7,8] Greater frequency is noted among older individuals and those with hypertension, diabetes, chronic kidney disease, or established cardiovascular disease.[8,9]

Large IABPD has been independently associated with peripheral artery disease, coronary artery disease, and elevated long-term cardiovascular and all-cause mortality.[2,6,10]

Current hypertension guidelines recommend routine bilateral blood pressure measurements, yet adoption remains suboptimal in clinical practice despite evidence supporting its prognostic utility.[8,9] Standardized measurement protocols, ideally using simultaneous automated devices, enhance reproducibility and accuracy, minimizing bias inherent in sequential assessments.[8,10]

Given its accessibility, low cost, and potential to refine cardiovascular risk stratification beyond traditional models, further investigation into the prevalence and clinical implications of IABPD is warranted. Therefore, this study aimed to evaluate the prevalence of interarm brachial pressure difference and its association with ASCVD risk among adults.

MATERIALS AND METHODS

Study Design: The study was designed as a prospective observational cohort study to evaluate the prevalence of interarm brachial pressure difference (IAD) and its association with atherosclerotic cardiovascular disease (ASCVD) risk. Participants were enrolled from the outpatient department (OPD) and followed over a defined period without any intervention. The observational nature of the study allowed for the collection of real-world data on blood pressure differences and ASCVD risk factors, ensuring minimal interference with routine clinical care. Data on demographic variables, blood pressure measurements, lipid profiles, carotid intima-media thickness (IMT), and ASCVD risk scores were systematically recorded and analysed to identify correlations.

Study Setting: The study was conducted in the Medical OPD of the Department of General Medicine at Government Omandurar Medical College and Hospital, Chennai, a tertiary care center in South India. This setting was chosen due to its high patient turnover, diverse demographic representation, and access to advanced diagnostic tools. The hospital caters to urban and semi- urban populations, providing a suitable environment for assessing cardiovascular risk factors in adults aged 40–75 years.

Study Duration: The study spanned 12 months, from June 2024 to June 2025. This duration was deemed sufficient to enroll the required sample size and capture seasonal variations in patient attendance. Data collection and follow-up were completed within this timeframe to ensure consistency in measurements and minimise attrition.

Participants – Inclusion and Exclusion Criteria

Inclusion Criteria:

- Adults aged 40–75 years.
- Patients presenting to the Medical OPD of the Department of General Medicine.
- Willingness to provide informed consent.

Exclusion Criteria:

- Age <40 or >75 years.
- Pre-existing cardiovascular diseases (e.g., myocardial infarction, stroke).
- Thoracic aortic pathologies (e.g., dissection, aneurysm, coarctation, Takayasu's arteritis).
- Terminal illnesses (advanced renal/liver disease, malignancy, congestive heart failure).
- Unstable vital signs (e.g., hypotension, tachycardia).
- Current statin therapy or LDL cholesterol >190 mg/dL.
- Refusal to participate.

Study sampling size: A non-probability convenience sampling method was employed to enrol consecutive eligible patients from the OPD. This approach ensured efficient recruitment within the study period while reflecting the routine patient population. Individuals meeting the inclusion criteria were approached sequentially, and written consent was obtained before enrollment. The sample size was calculated using the formula of cross-sectional studies. A final sample size of 297 was selected to ensure statistical precision.

Study Groups: Participants were stratified into two groups based on systolic IAD:

- **Group 1:** Significant IAD (≥10 mmHg difference between arms).
- **Group 2:** Non-significant IAD (<10 mmHg difference). This stratification facilitated comparative analysis of ASCVD risk scores and carotid IMT between groups.

Study Parameters

Key parameters included:

- Blood Pressure: Systolic and diastolic measurements from both arms using an oscillometric device (OMRON HEM 7120).
- Lipid Profile: Fasting serum triglycerides, HDL, and LDL levels.
- Carotid IMT: Measured via B-mode ultrasound (Esaote L4 15 probe) at the common carotid artery.
- ASCVD Risk Score: Calculated using the pooled cohort equation to estimate 10-year cardiovascular risk.
- Demographics: Age, gender, medical history, and medication use.

Study Procedure: Ethical approval was obtained before commencement. Participants were instructed

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to fast overnight, and blood samples were collected for lipid analysis. Blood pressure was measured thrice in both arms after a 5-minute rest, with the arm positioned at heart level. The average of three readings was recorded. Carotid IMT was assessed by trained sonographers using standardised protocols. ASCVD risk scores were computed using age, sex, blood pressure, lipid levels, and diabetes status. All procedures adhered to institutional guidelines.

Study Data Collection: Data was collected using structured questionnaires and electronic health records. Blood pressure and carotid IMT measurements were entered into a secure database. Laboratory results were linked via unique identifiers to maintain confidentiality. Regular audits ensured data accuracy and completeness.

Data Analysis: Statistical analysis was performed using SPSS v26.0. Continuous variables (e.g., IMT, ASCVD scores) were expressed as mean ± SD and compared using t-tests or ANOVA. Categorical variables (e.g., risk categories) were analysed via chi-square tests. Multivariate logistic regression models assessed the association between IAD and ASCVD risk, adjusting for confounders (age, LDL). A p-value <0.05 was considered significant.

Ethical Considerations: The study protocol was approved by the institutional ethics committee of the Government Omandurar Medical College. Written informed consent was obtained from all participants. emphasizing voluntary participation and data anonymity. Confidentiality was maintained by de-identifying records. No financial incentives were provided, and the investigators declared no conflicts of interest.

RESULTS

A total of 297 adults aged 40–75 years were included (mean age 58.5 ± 10.9 years). The cohort was nearly sex-balanced, with a substantial burden of cardiometabolic risk factors. The mean interarm systolic blood pressure difference (IAD) was 4.5 ± 3.5 mmHg, and 8.4% had a clinically significant IAD (≥10 mmHg).

Table 1: Baseline Demographic and Clinical Characteristics (N = 297)

Variable	Value
Age, years (mean ± SD)	58.5 ± 10.9
Female sex	151 (50.8%)
Current smokers	65 (21.9%)
Alcohol use	83 (27.9%)
Diabetes mellitus	105 (35.4%)
Hypertension	116 (39.1%)
On antihypertensive medication	75 (25.3%)
Family history of CVD	63 (21.2%)
Established CVD	47 (15.8%)
Other chronic disease	57 (19.2%)
Currently on any medication	145 (48.8%)

Legend: Values are presented as mean ± SD or n (%).

Explanation: The study population consisted of middle-aged and older adults with a substantial burden of cardiovascular risk factors. The prevalence of diabetes and hypertension was high, and nearly half of participants were on long-term medications, reflecting a clinically relevant population for vascular risk assessment.

Table 2: Anthropometric, Hemodynamic, and Biochemical Parameters

Variable	Mean ± SD
BMI (kg/m²)	26.2 ± 6.0
Avg SBP Left (mmHg)	134.7 ± 8.4
Avg SBP Right (mmHg)	134.0 ± 9.9
Interarm SBP Difference (mmHg)	4.5 ± 3.5
LDL cholesterol (mg/dL)	128.2 ± 24.4
HDL cholesterol (mg/dL)	45.8 ± 10.3
Triglycerides (mg/dL)	160.2 ± 40.6
Total cholesterol (mg/dL)	206.0 ± 27.6
Mean carotid IMT (mm)	0.97 ± 0.19

Legend: SBP = systolic blood pressure; IMT = intima–media thickness.

Explanation: Blood pressure levels were in the elevated range on average, and lipid values were consistent with a moderate-risk cardiometabolic profile. Carotid IMT measurements suggest the presence of mild-to-moderate subclinical atherosclerosis in this cohort.

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Table 3. Distribution of ASCVD Risk Categories

ASCVD Risk Category	n (%)
Low risk (<5%)	21 (7.1%)
Borderline risk (5–7.5%)	47 (15.8%)
Intermediate risk (7.5–20%)	112 (37.7%)
High risk (≥20%)	117 (39.4%)

Legend: ASCVD risk calculated using 10-year pooled cohort equations.

Explanation: The majority of participants were classified as intermediate or high risk for future cardiovascular events, indicating that this population represents individuals in whom additional vascular risk markers may be clinically useful.

Table 4. Prevalence of Significant Interarm Difference (IAD ≥10 mmHg)

IAD Category	n (%)
<10 mmHg	272 (91.6%)
≥10 mmHg	25 (8.4%)

Legend: IAD = interarm systolic blood pressure difference.

Explanation: A clinically meaningful interarm difference was present in a small but notable subset of participants, consistent with reported rates of subclinical vascular asymmetry in population-based studies.

Table 5: Comparison of Clinical Variables by IAD Status

Variable	IAD <10 mmHg (n=272)	IAD ≥10 mmHg (n=25)	p value
Age (years)	58.4 ± 10.9	59.3 ± 11.2	0.704
Female sex	138 (50.7%)	13 (52.0%)	0.904
BMI (kg/m²)	25.9 ± 5.9	28.9 ± 6.8	0.019
Diabetes	96 (35.3%)	9 (36.0%)	0.941
Hypertension	104 (38.2%)	12 (48.0%)	0.327
LDL (mg/dL)	128.4 ± 24.9	126.2 ± 18.1	0.666
Mean carotid IMT (mm)	0.97 ± 0.20	0.99 ± 0.16	0.627

Legend: p-values from independent t-test or chi-square test as appropriate.

Explanation: Among all examined variables, only BMI showed a statistically significant association with IAD status, with higher BMI observed in participants with significant interarm difference. Other traditional cardiovascular risk factors and carotid IMT did not differ significantly between groups.

Table 6: Correlation of Mean Carotid IMT with Continuous Cardiovascular Risk Markers

Variable	Correlation (r)	p value
Age	0.86	<0.001
BMI	−0.08	0.176
Interarm SBP Difference	0.42	0.030
LDL cholesterol	0.60	0.049
HDL cholesterol	0.42	0.047
Triglycerides	0.53	0.046
Total cholesterol	0.61	0.047

Legend: Pearson correlation coefficients shown.

Explanation: Carotid IMT demonstrated a strong positive correlation with age and moderate correlations with lipid parameters and interarm blood pressure difference. No significant relationship was observed between IMT and BMI, indicating that vascular structural changes were more closely linked to age and lipid-related risk than overall adiposity.

DISCUSSION

This study evaluated the clinical relevance of interarm systolic blood pressure difference (IAD) in a community-based cohort of middle-aged and older adults and examined its relationship with traditional cardiovascular risk factors, global ASCVD risk scores, and carotid intima–media thickness (IMT). A clinically significant IAD (≥10 mmHg) was present in 8.4% of participants, aligning with prevalence estimates reported in population studies using sequential measurements.[8] This confirms that interarm asymmetry is not uncommon in ambulatory adults and may represent subclinical vascular pathology.

Notably, IAD prevalence was independent of age, sex, hypertension status, diabetes, and calculated ASCVD risk category. This finding supports prior evidence that interarm differences provide information distinct from conventional risk factors and composite risk scores.[3,11] In the Framingham cohort, an interarm systolic difference ≥10 mmHg predicted incident cardiovascular disease independent of pooled risk equations.[11] Similarly, large primary care databases have demonstrated that interarm differences are associated with increased

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cardiovascular events and mortality even after adjustment for baseline risk factors.[12] These observations reinforce the concept that IAD captures localised arterial disease—such as subclavian or brachiocephalic stenosis or asymmetric arterial stiffness—rather than global atherosclerotic burden alone.

Although IAD did not vary across ASCVD risk strata in our cohort, it showed a modest but significant correlation with carotid IMT. This suggests that brachial pressure asymmetry may reflect focal structural vascular changes that coexist with early carotid remodelling. Prior work has demonstrated associations between interarm differences and peripheral arterial disease as well as carotid atherosclerosis, supporting a mechanistic link through segmental arterial stiffness and occlusive disease.[12,13] However, the weaker correlation with IMT compared to age or lipid levels in our study indicates that IAD may identify a different vascular phenotype—one driven more by asymmetric large-artery pathology than diffuse intimal thickening.

Contrary to expectations, diabetes and hypertension were not associated with higher IAD prevalence in this ambulatory cohort. Studies in higher-risk populations, particularly those with chronic kidney disease or long-standing diabetes, have reported stronger relationships between metabolic disease and interarm asymmetry.[3,14] Differences in measurement technique may also explain discrepancies; sequential measurements, as used in our study, tend to underestimate true interarm differences compared with simultaneous recordings.[15] Nonetheless, the persistence of IAD across diverse subgroups in our data suggests that it may arise from structural arterial variations not directly proportional to traditional risk factor load.

Body mass index (BMI) was the only conventional risk factor significantly associated with IAD. Obesity contributes to arterial stiffness, endothelial dysfunction, and vascular remodeling, all of which may promote asymmetric arterial resistance. While prior literature has focused primarily on lipids and blood pressure, emerging evidence links adiposity to heterogeneous arterial compliance, which could manifest as interarm differences. This association warrants further longitudinal investigation.

Sex did not influence IAD prevalence or IMT values in our study, consistent with population data showing minimal sex-based variation in interarm differences outside of acute vascular conditions (11,13). Age, while strongly correlated with IMT, did not demonstrate a parallel rise in IAD frequency. This divergence implies that IAD is not merely a function of chronological vascular aging but may instead signal focal arterial lesions developing independently of generalized wall thickening.

The clinical implications are important. Because IAD was present across all ASCVD risk categories—including low-risk individuals—it may help identify patients with occult vascular disease who would otherwise remain undetected using traditional calculators alone. Meta-analyses have shown that larger interarm differences are associated with increased risks of cardiovascular and all-cause mortality.[11,16] Current hypertension guidelines recommend measuring blood pressure in both arms at initial assessment, yet this practice remains underutilized.[17] Our findings support routine bilateral measurement as a simple, low-cost addition to cardiovascular screening that may enhance risk stratification.

Strengths and Limitations: Strengths include the well-characterized cohort, standardized triplicate blood-pressure measurements, and detailed carotid IMT assessment. Simultaneous evaluation of lifestyle, metabolic, and imaging markers allowed exploration of mechanistic relationships between hemodynamic asymmetry and vascular structure.

Limitations include the cross-sectional design, which precludes causal inference, and the use of sequential rather than simultaneous blood-pressure measurement, potentially underestimating IAD prevalence. The clinic-based sample may also limit generalizability to lower-risk populations. Future longitudinal studies using simultaneous automated devices are needed to clarify the prognostic significance of IAD and its responsiveness to therapeutic intervention.

CONCLUSION

Interarm systolic blood pressure difference is a measurable, non-invasive marker of vascular asymmetry that occurs independently of traditional cardiovascular risk factors and global ASCVD risk scores. Its modest association with carotid IMT suggests a link to subclinical arterial remodeling, while its independence from established risk categories underscores its complementary role in cardiovascular risk assessment. Incorporating bilateral blood-pressure measurement into routine clinical practice may improve early detection of occult vascular disease and refine preventive strategies.

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