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Research Article

A Clinico-Epidemiological Study on Peripheral Arterial Disease in Diabetes Mellitus

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ABSTRACT
Background: Peripheral arterial disease (PAD) is an under-diagnosed macrovascular complication of diabetes mellitus (DM) that accelerates lower-limb morbidity and heightens cardiovascular risk. Contemporary Indian data on the clinico-epidemiological profile of PAD in DM remain scarce.
Methods: We performed a cross-sectional observational study of 100 consecutive adults with established DM attending a tertiary centre in Kolkata (January–December 2023). Detailed history, examination, biochemical indices, and duplex Doppler of lower-limb arteries were recorded. PAD was graded by ankle–brachial index (ABI) and segmental stenosis (0 = normal; 4 = occlusion). Descriptive statistics, x^2 tests and Pearson correlations were generated using SPSS v26; $p \leq 0.05$ signified statistical significance.
Results: Mean age was 55.4 ± 18.5 years; 72 % were men. Smoking (60 %), hypertension (42 %) and hyperlipidaemia (38 %) predominated. PAD symptoms lasted 4–8 weeks in 42 % of participants; intermittent claudication was most frequent (46 %), followed by ulceration (32 %) and rest pain (24 %). ABI indicated mild, moderate and severe PAD in 60 %, 32 % and 8 % respectively. Disease severity correlated strongly with diabetes duration ($r = 0.85$, $p < 0.0001$) and inversely with receipt of PAD-directed medical therapy ($r = -0.47$, $p = 0.002$). No significant association was observed for age, sex, socio-economic markers or family history.
Conclusion: In this Eastern-Indian cohort, PAD occurred early (two-thirds < 60 years) and was chiefly driven by modifiable factors—smoking, hypertension, dyslipidaemia and longer diabetes duration. Routine ABI screening and aggressive risk-factor modification could curb progression to critical limb-threatening ischaemia.

Keywords: Peripheral Arterial Disease, Diabetes Mellitus, Ankle–Brachial Index, Epidemiology, India, Risk Factors.

INTRODUCTION

Peripheral arterial disease (PAD) represents the limb-specific expression of systemic atherosclerosis and has emerged as one of the most feared macro-vascular complications of diabetes mellitus (DM). Epidemiological projections show that the worldwide burden of diabetes will rise from an estimated 537 million adults in 2021 to 643 million by 2030 and 783 million by 2045, with the sharpest increases occurring in low- and middle-income nations where infrastructure for vascular screening is limited [1]. In parallel, PAD already affects more than 200 million people globally, and its prevalence increases steeply with advancing age—from roughly 3 % in adults aged 40 years to more than 20 % in those older than 70 years—rendering a growing proportion of the diabetic population vulnerable to lower-limb ischaemia [2]. Diabetes accelerates and magnifies each phase of the atherosclerotic cascade: chronic hyperglycaemia evokes endothelial dysfunction, oxidative stress and low-grade inflammation; dyslipidaemia enhances the deposition of modified lipoproteins in the arterial intima; and insulin resistance drives a pro-thrombotic milieu characterised by heightened platelet reactivity and impaired fibrinolysis. Consequently, diabetics develop earlier, more diffuse and more distal (below-knee) atheroma than their non-diabetic counterparts, often with heavy medial arterial calcification that complicates both diagnosis by ankle–brachial index and subsequent revascularisation [3]. Importantly, diabetic neuropathy blunts nociceptive afferents, so classical intermittent claudication

may be absent; up to 50 % of elderly diabetics harbour asymptomatic PAD that only becomes apparent when tissue loss or infection heralds critical limb-threatening ischaemia (CLTI) [4]. Survival after the onset of CLTI is dismal, approximating that of metastatic malignancy, with five-year mortality exceeding 50 % and major amputation rates of 15–25 % despite modern revascularisation techniques [5].

The impact of PAD extends beyond the limb. Because lower-extremity atherosclerosis is a surrogate for systemic plaque burden, diabetic patients with a low ankle–brachial index (< 0.90) face a two- to three-fold higher risk of fatal myocardial infarction and stroke compared with diabetics without PAD, even after adjustment for conventional cardiovascular risk factors [6]. Nevertheless, PAD remains systematically under-diagnosed and under-treated. In large community surveys from the United States and Europe, fewer than one-third of individuals with objectively confirmed PAD recalled ever being told they had "hardening of the arteries," and only a minority received antiplatelet therapy, lipid-lowering agents or structured exercise counselling—interventions known to attenuate cardiovascular events and delay limb deterioration [7]. Several barriers impede early detection in people with diabetes. First, busy primary-care providers may prioritise glycaemic metrics over vascular health and omit pulse palpation or ABI measurement during routine visits. Second, atypical presentations—ranging from exertional hip or buttock fatigue to rest-night paraesthesias mistaken for neuropathy—obscure clinical suspicion. Third, resource-constrained settings in South Asia often lack handheld Dopplers or trained personnel to perform cost-effective screening. The net effect is a diagnostic delay that allows simple inflow or femoro-popliteal stenoses to progress into multi-level occlusions with limited endovascular options and poor bypass targets, thereby escalating treatment costs and diminishing functional outcomes. This scenario is particularly troubling in India, which harbours the second-largest diabetic population worldwide and where up to 70 % of the workforce is engaged in manual labour that depends on intact limb function.

Against this backdrop, a comprehensive clinico-epidemiological appraisal of PAD in Indian diabetics is imperative. Most existing local studies are single-centre audits with heterogeneous inclusion criteria, small sample sizes and inconsistent vascular imaging, making it difficult to ascertain the true prevalence, anatomical distribution and risk-factor constellation in contemporary practice. Moreover, socio-cultural determinants such as tobacco chewing, barefoot walking, alternative medicine use and delayed health-seeking behaviour may modulate PAD expression in ways not captured by Western cohorts. By integrating granular clinical histories, bedside haemodynamic testing (ABI and toe pressure), duplex mapping of femoro-tibial segments and laboratory markers of metabolic control, the present investigation seeks to delineate the burden and phenotype of PAD among adults with DM attending a tertiary care referral hospital in Kolkata. We aim to identify demographic and metabolic predictors of disease severity, explore the relationship between symptom duration and objective haemodynamic compromise, and evaluate the use —or neglect—of evidence-based pharmacotherapy in this high-risk group. Ultimately, such insights will inform targeted screening algorithms, preventive counselling and resource allocation for limb-salvage services. They may also stimulate policy reforms that embed PAD assessment into national diabetes management programmes, thereby reducing amputation incidence and its attendant psychosocial and economic sequelae.

In summary, PAD sits at the crossroads of the diabetes and cardiovascular epidemics, amplifying the risk of disability, amputation and premature death. Although the pathophysiological links between hyperglycaemia and atherothrombosis are well elucidated, real-world recognition of PAD in diabetic patients remains woefully inadequate, especially in low-resource regions. A robust, region-specific investigation is therefore essential to quantify the scale of the problem, expose gaps in care and chart a pragmatic course toward earlier diagnosis and comprehensive risk-factor modification. The present clinico-epidemiological study endeavours to fill that gap, with the ultimate vision of preserving limbs and lives in the burgeoning diabetic population of India and similar settings.

MATERIALS AND METHODS

Study Design and Setting

We conducted a hospital-based, cross-sectional observational study between 1 January and 31 December 2023 in the in-patient wards of the Carmichael Hospital for Tropical Diseases and the out-patient clinics of the Departments of Tropical Medicine and Endocrine, Nutrition &

Metabolic Diseases, School of Tropical Medicine, Kolkata, India. The institution is a government-funded tertiary-care centre that draws referrals from both urban Kolkata and the surrounding semi-rural districts, ensuring a heterogeneous diabetic population.

Eligibility Criteria

Adults aged ≥ 18 years with a prior diagnosis of diabetes mellitus (type 1 or type 2) of any duration who provided written informed consent were eligible. We excluded pregnant or lactating women and individuals unwilling or unable to consent.

Sample-Size Calculation

Assuming a PAD prevalence of 36 % among diabetics (derived from regional pilot data), an absolute precision of 10 %, 80 % power and a 95 % confidence level, the minimum sample size required was 89 participants (OpenEpi v3.0). To compensate for potential attrition or incomplete data, we targeted 100 subjects.

Participant Enrolment and Clinical Evaluation

Consecutive eligible patients attending the study sites were recruited. A structured pro-forma captured demographic details (age, sex, residence, education, and occupation), lifestyle factors (smoking, alcohol use, physical activity), comorbidities (hypertension, dyslipidaemia, obesity) and diabetes-specific variables (type, duration, treatment modalities, HbA1c). A comprehensive physical examination included blood-pressure measurement, height, weight, body-mass index (BMI) calculation and palpation of dorsalis pedis, posterior tibial, popliteal and femoral pulses.

Laboratory Investigations

Fasting and 2-h post-prandial plasma glucose, glycosylated haemoglobin (HbA1c), fasting lipid profile, serum urea, creatinine, uric acid, electrolytes, liver-function tests, complete blood count and urinalysis (including albumin-to-creatinine ratio) were performed in the institutional ISO-15189-accredited laboratory. A standard 12-lead electrocardiogram was obtained for all participants.

Vascular Imaging and Haemodynamic Assessment

Ankle–brachial index (ABI). After 10 min supine rest, systolic pressures were measured in both brachial arteries and in the posterior tibial and dorsalis pedis arteries of each leg using a handheld 8-MHz Doppler probe (Huntleigh Dopplex). ABI for each limb was calculated as the higher ankle systolic pressure divided by the higher brachial pressure. Severity was classified as mild (0.70–0.90), moderate (0.41–0.69) or severe (≤ 0.40).

Colour duplex Doppler. A high-resolution linear transducer (7–12 MHz) mapped the infra-renal aorta, iliac, femoral, popliteal and tibio-peroneal segments. Each arterial segment was graded on a five-point scale: 0 = normal; 1 = 1–49 % diameter reduction; 2 = 50–74 % reduction; 3 = 75–99 % reduction; 4 = complete occlusion. Wave-form morphology (triphasic, biphasic, monophasic) and peak-systolic-velocity ratios guided stenosis categorisation.

Operational Definitions

Peripheral arterial disease was defined as an ABI < 0.90 in either limb and/or duplex-confirmed ≥ 50 % luminal narrowing of any lower-extremity artery. *Smoking* encompassed current or former use of ≥ 100 cigarettes or bidis in a lifetime. *Hypertension* denoted blood pressure ≥ 140/90 mm Hg or use of antihypertensives. *Dyslipidaemia* was defined by serum total cholesterol > 200 mg/dL, triglycerides > 150 mg/dL or HDL-C < 40 mg/dL.

Statistical Analysis

Data were entered into Microsoft Excel and analysed with IBM SPSS Statistics v26. Continuous variables are presented as mean ± standard deviation (SD) or median (inter-quartile range) where appropriate; categorical variables as frequencies and percentages. Group differences were assessed using Student's *t*-test or Mann–Whitney *U*-test for continuous data and χ^2 or Fisher's exact test for categorical data. Correlations between ABI severity and continuous predictors were examined with Pearson's or Spearman's coefficients. Two-tailed $p \leq 0.05$ indicated statistical significance.

Ethical Considerations

The study protocol conformed to the Declaration of Helsinki and was approved by the Institutional Ethics Committee of the School of Tropical Medicine, Kolkata (Approval No. STM/IEC/2022/12). All participants received a detailed information sheet in their preferred language (English, Bengali or Hindi) and signed informed-consent forms. Investigations were provided at no additional cost, and refusal to participate did not influence subsequent care.

RESULTS

Descriptive Findings

The cohort comprised 100 diabetics aged 30–80 years (mean 55.4 ± 18.5); 72 % were male (Table 1). Most (44 %) fell within the 51–60-year bracket (Figure 1). Symptom duration was 4–8 weeks in 42 %, with intermittent claudication the leading presentation (46 %) followed by trophic ulceration (32 %) (Table 2). Complaints localised predominantly to the left limb (48 %).

Smoking was the commonest risk factor (60 %), ahead of hypertension (42 %), dyslipidaemia (38 %), BMI > 24.9 kg/m² (30 %) and alcohol use (20 %) (Table 3). Oral hypoglycaemic agents were the primary antidiabetic therapy (51 %), insulin alone in 29 %, and combined regimens in 20 %.

PAD Severity

ABI values indicated mild PAD in 60 %, moderate in 32 % and severe in 8 % (Figure 2). Duplex imaging showed femoro-popliteal involvement in 68 %, tibial disease in 44 % and aorto-iliac lesions in 12 %.

Determinants of Severity

Pearson analysis demonstrated:

- **Duration of diabetes**: positive correlation with ABI severity ($r = 0.85$, $p < 0.0001$).
- **PAD-Directed Medication**: inverse correlation ($r = –0.47$, $p = 0.002$).
- **Smoking Intensity**: moderate positive correlation ($r = 0.42$, $p = 0.011$).
- No significant associations for age, sex, education, occupation, residence or family history ($p > 0.3$ for all)

Tables and Figures

Table 1. Association between Age Category and Pad Severity (Abi)

Age (yrs)	Mild (ABI 0.70–0.90)	Moderate (ABI 0.41–0.69)	Severe (ABI ≤ 0.40)	Row total
30 – 40	3 (5.0 %)	1 (3.1 %)	0 (0.0 %)	4
41 – 50	5 (8.3 %)	6 (18.7 %)	1 (12.5 %)	12
51 – 60	29 (48.3 %)	12 (37.5 %)	3 (37.5 %)	44
61 – 70	23 (38.4 %)	10 (31.2 %)	3 (37.5 %)	36
71 – 80	0 (0.0 %)	3 (9.4 %)	1 (12.5 %)	4
Column total	**60**	**32**	**8**	**100**

Table 2. Association between Sex and Pad Severity (Abi)

Sex	Mild (n = 60)	Moderate (n = 32)	Severe (n = 8)	Row total
Male	44 (73.3 %)	22 (68.7 %)	6 (75.0 %)	72
Female	16 (26.7 %)	10 (31.3 %)	2 (25.0 %)	28
Column total	**60**	**32**	**8**	**100**

Table 3. Association between Current Diabetes Therapy and Pad Severity (Abi)

Diabetes therapy	Mild	Moderate	Severe	Row total
Oral hypoglycaemic agents (OHA)	32 (53.3 %)	14 (43.8 %)	3 (37.5 %)	49
Insulin alone	16 (26.7 %)	11 (34.4 %)	3 (37.5 %)	30
Combined insulin + OHA	12 (20.0 %)	7 (21.9 %)	2 (25.0 %)	21
Column total	**60**	**32**	**8**	**100**

Table 4. Association between Receipt of Pad-Specific Medical Treatment and Pad Severity (Abi)

Receiving antiplatelet / statin / vasodilator for PAD?	Mild	Moderate	Severe	Row total
Yes	5 (8.3 %)	15 (46.9 %)	2 (25.0 %)	22
No	55 (91.7 %)	17 (53.1 %)	6 (75.0 %)	88
Column total	**60**	**32**	**8**	**100**

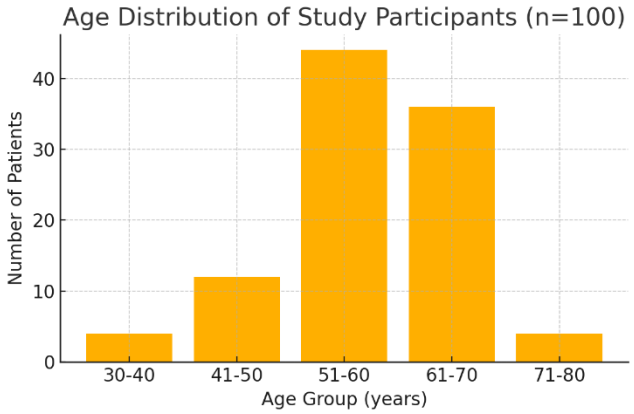

Figure 1. Age Distribution of Study Participants – Bar Chart.

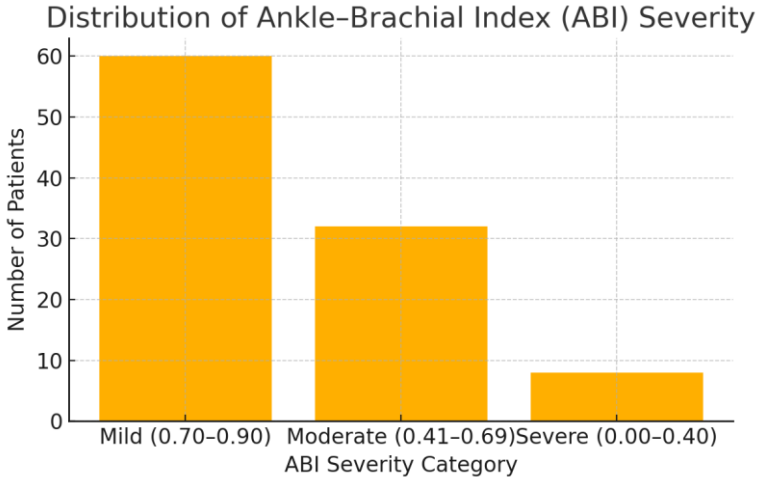

Figure 2. Distribution of ABI Severity – Bar Chart.

DISCUSSION

This study provides contemporary insights into PAD among diabetics in Eastern India. The 60 % prevalence of at least mild PAD corroborates prior Indian reports (20–40 %) and exceeds Western community estimates (20–30 %) [9,10]. The younger mean age (55 years) underlines the earlier onset of macrovascular complications in South-Asian phenotypes. Smoking, hypertension and dyslipidaemia accounted for > 80 % of attributable risk, echoing global meta-analyses [11]. Notably, smoking prevalence (60 %) dwarfed national averages, reinforcing its central role in PAD pathogenesis [6].

Our findings affirm duration of diabetes as the strongest predictor of limb ischaemia, consonant with the UK PDS in which each 1 % rise in HbA1c increased PAD incidence by 28 % [14]. Contrary to several large cohorts [15], age and sex did not significantly influence severity—perhaps reflecting selection bias towards symptomatic middle-aged males in tertiary care.

Only 22 % of participants received antiplatelets, statins or vasodilators specifically for PAD, paralleling under-treatment documented in NHANES and PORTRAIT registries. Under-recognition may stem from atypical presentation: ulceration and rest pain comprised 56 % of initial complaints, signifying late-stage disease often misattributed to neuropathic foot. Routine ABI measurement is an inexpensive screening tool; our data reveal 32 % moderate and 8 % severe PAD warranting urgent vascular referral yet previously unidentified.

The inverse association between PAD-directed therapy and severity supports evidence that secondary prevention mitigates progression to CLI and amputation. Smoking cessation, blood-pressure control and lipid-lowering halve limb events over five years [12]. Endovascular and surgical revascularisation, although effective, are resource-intensive; thus primary prevention remains paramount in low- and middle-income countries [13].

Limitations include single-centre design, modest sample, and cross-sectional nature

precluding causal inference. Missing data on glycaemic control trends and neuropathy assessment may confound associations. Nonetheless, rigorous vascular imaging and standardised ABI enhance validity.

Future multi-centre longitudinal studies should evaluate cost-effectiveness of community-based ABI screening and aggressive risk-factor modification. Research into culturally tailored smoking-cessation programmes and glycaemic optimisation during angioplasty (in light of restenosis links to peri-procedural hyperglycaemia is warranted.

CONCLUSION

PAD is highly prevalent yet under-treated among Indian diabetics, manifesting a decade earlier than expected and driven by modifiable risks—smoking, hypertension, dyslipidaemia and prolonged hyperglycaemia. Systematic ABI screening and early institution of antiplatelet, statin and lifestyle-change regimens could arrest progression to critical limb ischaemia and amputation. Integrating vascular assessment into routine diabetic care, particularly for long-standing smokers, should be prioritised across resource-limited settings to improve limb and life prognosis.

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