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Original Article

Prevalence of Peripheral Arterial Disease Using the Ankle-Brachial Index in Indian Population: A Scoping Review

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ABSTRACT

Background: Peripheral Arterial Disease (PAD) is a major manifestation of systemic atherosclerosis and is associated with a markedly increased risk of cardiovascular and cerebrovascular events. The Ankle–Brachial Index (ABI) is a simple, reliable, and non-invasive tool for the detection of PAD. However, evidence on the prevalence of ABI-based PAD in the Indian population remains fragmented and highly variable.

Aim: To systematically map and summarize existing literature on the prevalence of PAD assessed using the Ankle–Brachial Index in the Indian population.

Methods: In this scoping review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines were followed. Comprehensive searches were carried out in PubMed, Scopus, Medline, and Google Scholar for studies published from 2010 to 2024. Studies conducted among Indians reporting PAD prevalence using ABI were included. Data items comprising study characteristics, sample size, ABI method, cutoff used, prevalence, and associated risk factors were charted using a predefined extraction framework. No critical appraisal or meta-analysis was performed.

Results: Fifty-two studies fulfilled the inclusion criteria. Most of these were hospital-based, cross-sectional in design (65.4%), with sample sizes ≤300 (73%), and conducted predominantly in South India (50%). Most of them used a standard ABI cut off of ≤0.90 (84.6%) and handheld Doppler devices (48%). The prevalence of PAD ranged widely from 7% to 62%, with a pooled mean of approximately 31%. Hospital-based studies demonstrated a higher prevalence, with a mean of approximately 34%, when compared to community-based studies (~18%). Most patients with PAD had mild-to-moderate disease, and severe PAD (ABI <0.4) was relatively rare. The consistent risk factors included diabetes mellitus (≈85% of studies), hypertension (≈73%), dyslipidemia (≈56%), tobacco use (≈48%), and obesity (≈35%).

Conclusion: PAD is an important, yet largely undiagnosed vascular condition in India. Amidst the heterogeneity in study design and ABI methodologies, a consistent use of ABI ≤ 0.90 speaks to its reliability for the detection of PAD. There is an obvious need for nationally representative, community-based studies along with standardized measurement protocols of ABI to further strengthen the early identification and prevention strategies in high-risk populations.

Keywords: *Peripheral Arterial Disease; Ankle–Brachial Index; India; Prevalence; Diabetes Mellitus; Hypertension; Scoping Review.*

INTRODUCTION

Peripheral Arterial Disease, also commonly known as Peripheral Vascular Occlusive Disease or Lower Extremity Artery Disease (LEAD), is characterized by atherosclerotic occlusive changes that lead to the narrowing or obstruction of major arteries in the lower limbs, typically found distal to the aortic bifurcation[1]. Because the predominant underlying

pathology is atherosclerosis, PAD is an absolute marker for systemic atherosclerosis in all parts of the body[1]. Patients with PAD, even when asymptomatic, are at an increased and independent risk of subsequent fatal and non-fatal cardiovascular (CVD) events such as stroke and myocardial infarction[1]. Since most PAD cases are clinically asymptomatic, presymptomatic screening is very necessary for early identification and timely management of associated risk factors that can slow the disease process[6]. The current international standard non-invasive method used for initial evaluation and mass screening is the Ankle Brachial Index, which is described as the ratio between the resting ankle systolic blood pressure and the highest brachial systolic blood pressure, conventionally using a cut point of < 0.90 to indicate the presence of PAD[11].

The global burden of lower extremity arterial diseases, LEAD continues to rise steadily, with a remarkable increase in Low and middle income countries, where an estimated 70% of all LEAD patients reside[4]. Despite its profound clinical significance, Peripheral Arterial Disease remains markedly underdiagnosed and undertreated, particularly across developing nations and resource-limited settings[4]. A very important reason for early diagnosis and the prompt institution of treatment is that even asymptomatic PAD is associated with a 4-fold increased risk of a MACCE-a predictor of significant morbidity, disability, and mortality[20]. Thus, broad, accessible screening is one way to ensure effective secondary prevention of devastating future coronary and cerebrovascular events[28].

India presents a particularly complex epidemiological landscape, rapidly becoming characterized as the "Diabetic Capital of the World[13]. Since PAD is identified as one of the significant macro vascular complications of Type 2 Diabetes Mellitus (T2DM), studying its prevalence in the Indian population is critical[1]. Established risk factors mirroring systemic atherosclerosis, such as diabetes, advanced age, smoking, hypertension, and dyslipidemia, are prevalent in the Indian population[1]. Current data concerning PAD prevalence in India is limited, often consisting of studies with small sample sizes and exhibiting high variability across different regions and cohorts, necessitating a comprehensive review[21]. The major variation in the reported prevalence rates is tremendous: from 3.2% in an urban South Indian population[57] to 18% in high-risk inpatients[31], 26.7% among the elderly in Kerala[34], and up to 56.25% in specialized diabetic cohorts[46]. Existing literature also suggests that data from rural Eastern India is scarce[38].

The Ankle Brachial Index remains the most viable and universally applied initial screening modality in resource-limited or primary care contexts due to its inherent advantages[12]. It is characterized as a simple, reproducible, rapid, and low-cost test using easily available tools such as Doppler ultrasound or oscillometric devices[12]. The ABI is essential for screening asymptomatic individuals, classifying the severity of PAD, and determining the overall vascular risk[36]. By mapping and synthesizing heterogeneous prevalence and risk factor data derived from ABI measurements conducted across the Indian population through a scoping review, this project consequently intends to clarify the documented burden of PAD, identify the critical regional gaps in knowledge, and strengthen the evidence base required for the deployment of targeted, cost-effective primary preventive strategies that address this growing public health threat[29].

A scoping review was, therefore, carried out to map the available evidence on the prevalence of Peripheral Arterial Disease, as diagnosed using the Ankle–Brachial Index, in the Indian population. This review hence aims at summarizing the reported prevalence estimates, examining the settings, populations, and methodological characteristics of the existing studies, and exploring regional variations to guide future research priorities and strengthen early cardiovascular risk detection efforts in India.

METHODS

This scoping review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. A review protocol detailing objectives, eligibility criteria, search strategy, and data-charting framework was developed a priori and approved by the Institutional Research Committee, although it was not registered in PROSPERO or OSF as the review formed part of an on-going academic research project.

Eligibility Criteria

The studies included in this scoping review were those conducted within India and reported the prevalence of PAD by using ABI. To be eligible for inclusion, the studies had to be population-based or hospital-based, published in a peer-reviewed journal, and written in English. The studies that did not use ABI as the diagnostic tool for PAD, case reports, reviews, editorials, conference abstracts that lacked full data, were conducted outside India, or involved animal or laboratory-based experimental designs were excluded.

Information Sources

A total of four electronic databases—PubMed, Scopus, Medline, and Google Scholar—were used to undertake the comprehensive search for eligible studies published between 2010 and 2024. The search was updated to December 2024. The reference lists of all the included studies were screened manually for additional articles. Only peer-reviewed studies published in the English language were considered, and no attempts were made to obtain unpublished data from study authors.

Search Strategy

The search strategy included MeSH terms and the use of Boolean operators. Following are the keywords and their combinations used."Ankle Brachial Index" OR "ABI"; "Peripheral Arterial Disease" OR "PAD" OR "Arterial Disease"; "Prevalence" OR "Epidemiology"; "India" OR "Indian population." Database-specific adjustments were designed based on variations in syntax used for searching. A fully elaborated PubMed search strategy was drafted to ensure replicability, and similar strategies have been used across other databases.

Study Selection, Data Charting and Synthesis of Results

All identified records from PubMed, Scopus, Medline, and Google Scholar were exported to Zotero for organization and duplicate removal. Titles and abstracts were screened based on the predefined eligibility criteria, and full-text assessment was conducted for all potentially relevant studies. A total of 52 studies fulfilled the final inclusion criteria and were included in this scoping review, as outlined in the PRISMA-ScR flow diagram. A standardized data-charting form was developed to chart key information from each included study in a systematic way. This form was initially tested on five studies to optimize clarity, consistency, and completeness, and revisions were done before commencing full charting. Extraction was independently performed to minimize errors; thereafter, discrepancies were resolved through comparisons and consensus. Extracted variables included author details, year of publication, study region, study design and setting, sample size, participant characteristics, ABI measurement method, ABI cut-off value, PAD prevalence, severity categories, and associated risk factors**.** No authors were contacted for additional information; however, data were cross-checked using tables, supplementary files, and figures when required. The data extracted were compiled into an Excel spread sheet and analysed descriptively. Frequencies, proportions, and simple descriptive summaries were used to present the characteristics of included studies. No meta-analysis was conducted because of significant methodological variation across studies, including variation in ABI measurement techniques, sampling approaches, and population profiles. Instead, patterns, trends in methods, regional variations, and gaps in the existing evidence on the prevalence of PAD using ABI in the Indian population were summarized using a narrative synthesis.

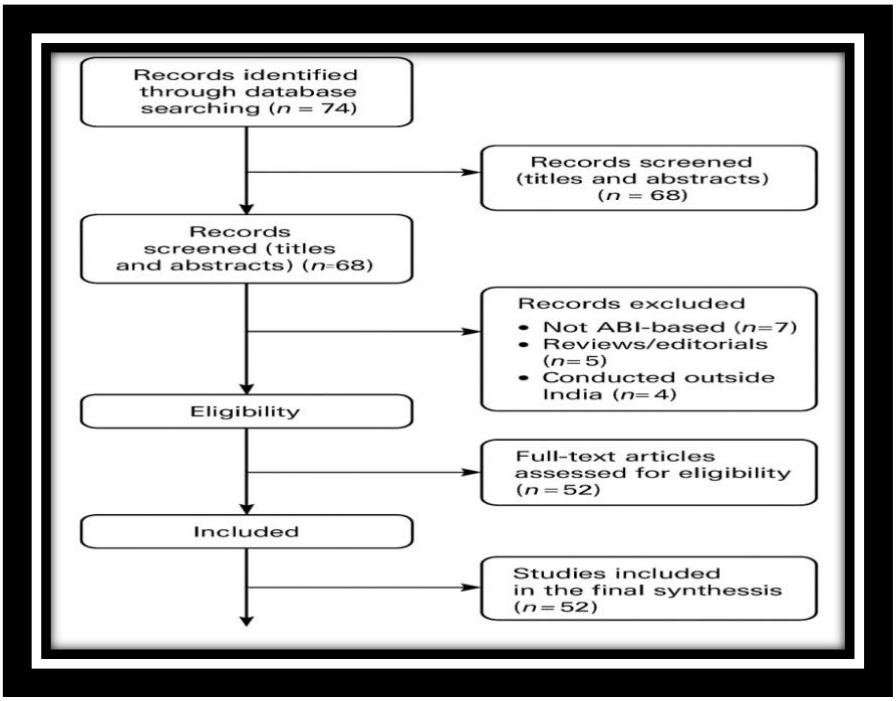


Figure: 1 – Final study selection flow diagram

RESULTS

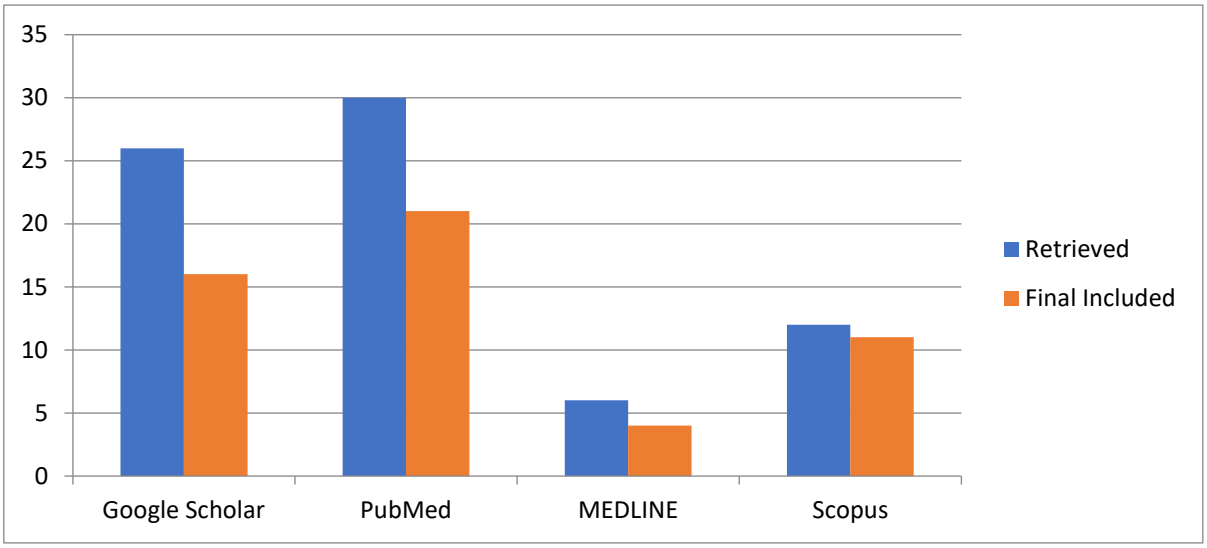
The 52 included studies showed significant heterogeneity in design, methodology, sample characteristics, and geographic coverage. Most studies, about two-thirds of all the evidence, were conducted in a hospital setting. A smaller proportion consisted of community-based surveys conducted in rural, semi-urban, or mixed populations. South India had the highest number of publications, while many regions, particularly North-East and central India, were under-represented.

Study Characteristics

Most of the studies had a cross-sectional design and included adult populations with different cardiovascular risk profiles. Sample sizes varied greatly, ranging from less than 100 to over 1,000 participants. A considerable number of studies targeted high-risk groups, with the majority of these involving patients with diabetes mellitus, hypertension, or multiple

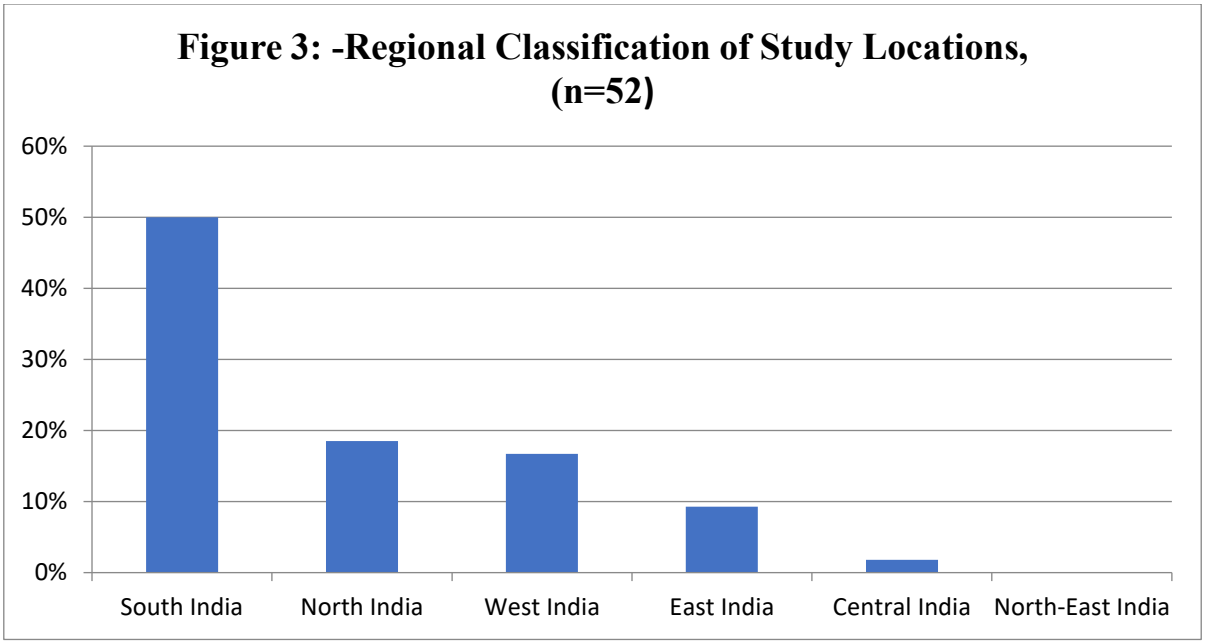
metabolic risk factors. The mean age of participants generally ranged between 45 and 70 years, with a marked predominance of males in several cohorts**.**

Database Sources



The majority of the final included studies were sourced from **PubMed (26)** and **Google Scholar (16)**, indicating these databases were the most productive and comprehensive for the review. Overall, reliance on multiple databases enhanced coverage, with PubMed and Google Scholar forming the primary evidence base.

Regional Variation



Geographical distribution of these studies revealed that South India itself accounted for almost half the literature included, while very few studies were from Northern, Eastern, and Northeastern parts of the country. Such uneven distribution clearly establishes the importance of having more geographically diverse research being conducted so that country-wise representative prevalence rates for PAD could be obtained.

ABI Measurement Methods

ABI measurement methodology varied significantly. About half the studies employed a handheld Doppler device, which reflects the accepted standard method, but others used either oscillometric devices or palpatory techniques. Most studies used an ABI cut-point of ≤0.90, consistent with international guidelines, to define the presence of PAD. A few studies used thresholds at ≤0.91 or <1.0, which has contributed to variation in the reported prevalence. Several studies conducted among people with diabetes mentioned some problems regarding falsely elevated ABI levels because of arterial calcification.

Study settings

Table: 1 Classification of Studies by Setting **(N = 52)**

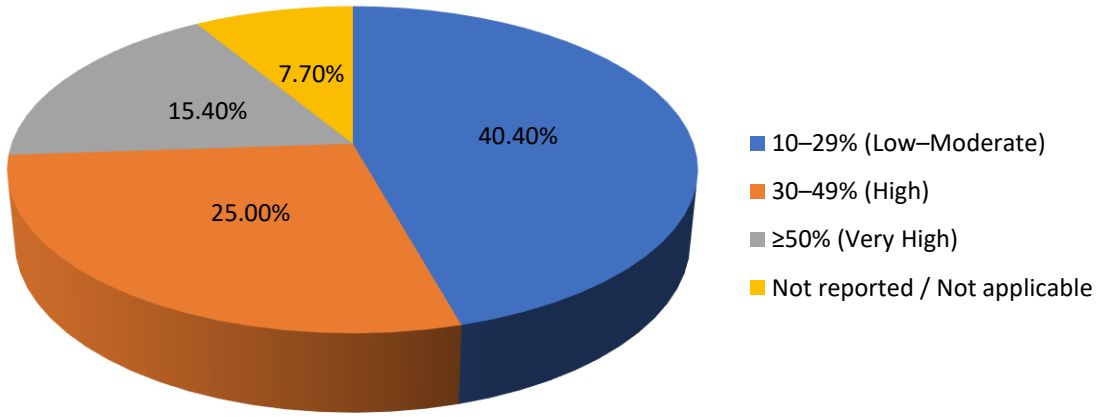
Setting Type	Frequency (n)	Percentage (%)
Hospital-based (Tertiary / Secondary Care)	**38**	**73.1%**
Community-based (Population surveys, camps, field-based)	**8**	**15.4%**

Most of the included studies were hospital-based (73.1%), indicating a strong focus on tertiary and secondary care settings. In contrast, community-based studies constituted only 15.4%, reflecting limited population-level and field-based research.

Prevalence of PAD

PAD prevalence varied largely among studies, from 7% to 62%, based on population characteristics, setting, and measurement technique used. Hospital-based studies, particularly those with diabetic or multi-morbid populations, were more likely to present higher estimates of prevalence (mean ~34%). On the contrary, community-based studies presented lower but significant prevalence levels (average ~18%), reflecting the underlying burden in the general population. In the case of studies reporting severity classification, mild-to-moderate PAD predominated and severe PAD (ABI <0.4) was relatively rare **.**

Figure:4-Prevalence of Peripheral Arterial Disease (PAD) (N = 52)



Risk Factors

Table : 2- Distribution of Associated Risk Factors **(N = 52)**

Risk Factors	Percentage (%)
Diabetes mellitus, Hypertension, Dyslipidemia, Obesity/High BMI	**58%**
Smoking/Tobacco use, Alcohol, Sedentary lifestyle	**20%**
Advanced age, Gender (male/female predisposition)	**10%**
CAD, Stroke, High CRP, CKD	**8%**
Neuropathy, Retinopathy, Nephropathy	**4%**

Diabetes, hypertension, dyslipidemia, obesity constitute the **major contributors (≈58%)** to peripheral arterial disease in the Indian population. Lifestyle habits such as smoking and sedentary behaviour contribute to nearly **one-fifth (20%)** of cases.

Table: 3- Severity of Peripheral Arterial Diseases as per ankle brachial Index (N=52)

PAD Severity Category	Frequency (n)	Percentage (%)
Mild PAD	15	28.8%
Moderate PAD	8	15.4%
Severe PAD	4	7.7%

PAD Severity Category	Frequency (n)	Percentage (%)
Borderline / Abnormal (ABI 0.91–0.99)	6	11.5%
Combined (Mild–Moderate)	5	9.6%
Not Reported / Not Stratified	14	27.0%

Table 3 shows that Mild peripheral arterial disease was the most frequently reported severity category (28.8%), while severe PAD was least common (7.7%). However, over one-fourth (27.0%) of the studies did not report severity stratification.

Methodological Variation

There existed a great degree of variability regarding the methods adopted for sample collection, measurement procedures for ABI, and criteria adopted for determining the severity associated with PAD. While some research papers followed set guidelines, there existed variability and an unorganized manner of describing procedures

Table:4- Ankle-Brachial Index (ABI) Assessment Methods Used in Indian Studies (N = 52)

Method Used for ABI Measurement	Frequency (n)	Percentage (%)
Handheld Doppler + Sphygmomanometer	25	48.1%
Oscillometric Device (Automated ABI machines like VP-1000, WatchBP, Diapodo Care)	10	19.2%
Doppler Ultrasound / Duplex / Color Doppler (for confirmation or comparison)	7	13.5%
Palpatory / Manual Method (without Doppler)	4	7.7%
Combined / Comparative (Doppler + Oscillometric / Post-exercise ABI)	3	5.8%
Not Specified / Not Applicable (no ABI or non-vascular tool used)	3	5.8%

The handheld Doppler with sphygmomanometer remains the predominant method for ABI measurement in Indian research — accounting for nearly half (48%) of all studies

DISCUSSION

This scoping review provides a comprehensive synthesis of published evidence on the prevalence of Peripheral Arterial Disease, as measured by the Ankle–Brachial Index, across diverse populations in India. Fifty-two studies were selected that reflect the substantial but uneven body of literature extending between a range of clinical and community settings. The findings show a wide variability in the reported prevalence of PAD, methodological approaches, and geographical distribution, underlining the fragmented nature of the existing evidence and calling for more standardized epidemiological research in India.

Prevalence Patterns and Interpretation

In the included studies, the overall prevalence of PAD ranged from 7% to 62%, with significant heterogeneity. Generally, prevalence was higher in hospital-based studies among populations with high risk, such as diabetes, hypertension, dyslipidemia, or multiple cardiovascular risk factors. By contrast, community-based studies often reported lower prevalence, although still significant enough to indicate a substantial underlying burden in the general population. These findings agree with global evidence that PAD is usually underdiagnosed outside clinical settings and more often found among people who already have metabolic or vascular comorbidities.

The differences in prevalence estimates may also be partly attributed to the variation in age composition, sex distribution, and the clustering of risk factors in the study populations. Most of the studies included had adults aged 45 years and above, a demographic in which atherosclerotic burden naturally increases. Male predominance was seen in most of the studies, although international evidence suggests that PAD may be underrecognized among women. These findings together underscores that demography and clinical variables interact complexly to influence the pattern of PAD seen in India.

Variability in ABI Measurement and Cut-off Values

One large source of heterogeneity among studies was the methodological variability in the measurement of ABI. Though roughly half the studies employed handheld Doppler devices, which is generally considered the gold standard, others used oscillometric devices or palpatory methods. Other potential factors affecting ABI accuracy include variation in cuff placement, patient positioning, rest period before measurement, and investigator training.

The cut-off value of ABI≤0.90, as recommended internationally, was used for the diagnosis of PAD in most of the reviewed studies. However, a few studies applied different thresholds, such as ≤0.91 or <1.0, which may overestimate the prevalence. Furthermore, diabetic-related populations noted that medial arterial calcification can result in falsely high ABI values and, consequently, lead to underdiagnosis. These methodological discrepancies indicate that there is an urgent need to standardize measurement protocols within Indian research and clinical settings.

Risk Factor Associations

Among these included studies, diabetes mellitus and hypertension stood out as the most common risk factors for PAD, followed by dyslipidemia, smoking, obesity, and older age. The co-existence of cardiometabolic risk factors was evident, and it was more prominent among hospital-based populations. It should be remembered that there is no doubt about the pathophysiologic association linking atherosclerosis and PAD. As Non-Communicable Diseases continue to proliferate at an alarming rate within India, it should be noted that PAD will emerge as an increasingly common contributor within the country's burden of cardiovascular disease.

Regional and Population-Level Gaps

Geographical distribution and representation: A very important finding made from this review is the imbalance that prevails with regards to geographical distribution. It is noticed that more than half a century, at least as far as these studies are concerned, South India alone contributes significantly. Compared to the South, very meager progress as yet has been made in the northern, central, and Northeast regions of India. Not very many studies were done on rural populations, who have a considerable burden of risk factors for cardiovascular diseases. These gaps highlight the need for more inclusive and geographically representative epidemiological studies

Implications for Screening and Public Health Practice

The result of the current review poses considerable implications for practice within community health settings across India. PAD continues being grossly underdiagnosed, specially among asymptomatic patients and rural populations. Because of its simplicity and low cost, incorporating ABI testing into existing clinics for non-communicable diseases, foot checks for diabetes, and community health projects today would greatly improve detection rates. By emphasizing PAD screens, specially among diabetics, smokers, older people, and patients with multiple risk factors for cardiometabolic disease, public health authorities can make an impact. Improving the skills and competence of CHWs within ABI measurement and interpretation could help.

Methodological Limitations within Current Evidence

The review pointed out some methodological inadequacies associated with previous research on ABI, including having small sample populations, inconsistent reporting, unstandardized procedures among centers regarding ABI, selecting samples from specific populations, and an absence of data gathered from a community setting. Many research papers failed to stratify participants based on PAD severity or control variables.

Recommendations for Future Research

Future research should employ standardized ABI testing procedures and incorporate larger and more varied samples from across India. Studies should also focus on longitudinal research about PAD and its CVS complications. Adding more advanced testing methods, like toe-brachial index (TBI), may also enable more precise burden measurement among diabetic and calcified patients. Also, incorporating PAD testing within nation-wide NCD surveillance would enable more accurate estimation and definition of burden.

PAD is an often-overlooked but common atherosclerotic disease with an average prevalence rate of 31% among Indians. Diabetes and hypertension are recognized as risk factors, and it usually presents as mild to moderate disease. Despite there being variability in research methodology and imbalance within regions, Ankle Brachial Index continues to be a low-cost and valid method for diagnosing PAD early. Improvement in Ankle Brachial Index diagnosis and its implementation with primary healthcare services needs the focus of everyone..

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