Family Medicine–Led Early Detection Of Diabetic Peripheral Arterial Disease: A Multidisciplinary Approach Involving Nursing, Ultrasound–Doppler, And Pharmacy

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Abstract

Background: Diabetic peripheral arterial disease (PAD) is a prevalent yet frequently underdiagnosed macrovascular complication of diabetes mellitus. The condition often progresses silently due to atypical symptom presentation and coexisting diabetic neuropathy, leading to delayed diagnosis and increased risks of foot ulcers, lower-limb amputations, and cardiovascular morbidity. Family medicine, as the first point of contact in primary health care, plays a critical role in early identification and coordination of preventive strategies.

Objective: This study aimed to examine the role of family medicine in the early detection of diabetic peripheral arterial disease through a multidisciplinary approach involving nursing assessment, ultrasound–Doppler diagnostics, and pharmacy-based risk management.

Methods: A descriptive cross-sectional study was conducted among healthcare professionals working in family medicine–led and affiliated primary care settings. Participants included family physicians, nurses, radiology professionals, and pharmacists. Data were collected using a structured, self-administered questionnaire assessing knowledge of diabetic PAD, routine screening practices, utilization of ultrasound–Doppler imaging, and pharmacy-related interventions for cardiovascular risk reduction. Descriptive statistical analysis was applied.

Results: The findings demonstrated generally high awareness of diabetic PAD risk factors among participants; however, recognition of asymptomatic and early-stage disease was inconsistent. Routine foot inspection was widely practiced, while referral for ultrasound–Doppler assessment was less consistently implemented. Ultrasound–Doppler imaging was strongly perceived as a valuable tool for detecting subclinical PAD beyond clinical examination alone. Pharmacists played a key role in medication optimization and

cardiovascular risk management, though their involvement in PAD-specific screening pathways remained limited.
Conclusion: Family medicine–led early detection of diabetic peripheral arterial disease is most effective when supported by a structured multidisciplinary approach integrating nursing surveillance, ultrasound–Doppler diagnostics, and pharmacy services. Strengthening interprofessional collaboration and standardizing screening pathways within primary care may improve early diagnosis and reduce diabetes-related vascular complications.

1. INTRODUCTION

Diabetes mellitus represents one of the most pressing global health challenges of the 21st century, with a rapidly increasing prevalence and a substantial burden of chronic complications. According to the **World Health Organization**, more than 422 million adults worldwide are living with diabetes, and this number is projected to rise significantly in the coming decades (WHO, 2023). Among the most debilitating and underdiagnosed complications of diabetes is **diabetic peripheral arterial disease (PAD)**, a manifestation of systemic atherosclerosis that predominantly affects the lower extremities and is associated with increased risks of foot ulcers, amputations, cardiovascular events, and mortality.

Peripheral arterial disease is particularly prevalent among individuals with long-standing diabetes due to the combined effects of chronic hyperglycemia, endothelial dysfunction, inflammation, and accelerated atherosclerosis. The **International Diabetes Federation** reports that people with diabetes are two to four times more likely to develop PAD compared with non-diabetic populations, yet a large proportion of cases remain asymptomatic or are diagnosed at advanced stages (IDF, 2023). This underdiagnosis is largely attributed to atypical symptom presentation, reduced pain perception due to diabetic neuropathy, and insufficient routine vascular screening in primary care settings.

Family medicine plays a pivotal role in the early identification and longitudinal management of diabetic complications. As the first point of contact within the healthcare system, family physicians are uniquely positioned to implement proactive screening strategies, identify early vascular changes, and coordinate multidisciplinary care. Early detection of diabetic PAD within family medicine settings has been shown to significantly reduce progression to critical limb ischemia and lower-extremity amputations, while also improving overall cardiovascular outcomes (American Diabetes Association [ADA], 2024).

However, effective early detection cannot rely solely on physician assessment. A **multidisciplinary approach** that integrates nursing surveillance, ultrasound–Doppler diagnostics, and clinical pharmacy interventions is increasingly recognized as a best-practice model. Nurses contribute through routine foot assessments, symptom monitoring, and patient education; ultrasound–Doppler imaging provides objective, non-invasive vascular assessment; and pharmacists optimize glycemic control and cardiovascular risk management through medication review and adherence support. Together, this integrated model strengthens the capacity of family medicine to detect PAD early and intervene before irreversible complications occur.

2. Diabetic Peripheral Arterial Disease: Pathophysiology and Clinical Significance

Diabetic peripheral arterial disease is a chronic macrovascular complication characterized by progressive narrowing and occlusion of peripheral arteries, particularly in the lower limbs. The pathophysiology of PAD in diabetes is multifactorial and involves persistent hyperglycemia, insulin resistance, oxidative stress, and chronic low-grade inflammation.

These mechanisms contribute to endothelial dysfunction, impaired nitric oxide bioavailability, increased platelet aggregation, and accelerated atherosclerotic plaque formation (Beckman et al., 2019).

Unlike PAD in non-diabetic individuals, diabetic PAD often presents with **diffuse, distal, and multilevel arterial involvement**, particularly affecting infrapopliteal vessels. This pattern complicates both diagnosis and management, as classical symptoms such as intermittent claudication may be absent. Diabetic neuropathy further masks ischemic pain, leading many patients to present only when tissue loss, infection, or gangrene has already developed (Conte et al., 2019).

Clinically, diabetic PAD is associated with severe consequences. The **American Heart Association** identifies PAD as an independent predictor of myocardial infarction, stroke, and cardiovascular mortality, emphasizing that PAD is not merely a limb condition but a marker of systemic vascular disease (AHA, 2021). Patients with diabetes and PAD have a markedly higher risk of lower-extremity amputation compared with those without diabetes, accounting for up to 70% of non-traumatic amputations worldwide (Hinchliffe et al., 2020).

From a health systems perspective, diabetic PAD imposes substantial economic and social burdens, including prolonged hospitalizations, repeated surgical interventions, rehabilitation needs, and reduced quality of life. Early identification at the primary care level is therefore critical to interrupt disease progression, initiate timely interventions, and reduce long-term complications.

3. The Central Role of Family Medicine in Early Detection

Family medicine serves as the cornerstone of chronic disease management, particularly for conditions such as diabetes that require continuous monitoring, preventive care, and coordination across specialties. Family physicians are uniquely positioned to identify early signs of diabetic PAD through routine follow-up visits, comprehensive history-taking, and targeted physical examinations. International clinical guidelines, including those issued by the **National Institute for Health and Care Excellence**, emphasize the responsibility of primary care providers in screening high-risk diabetic patients for vascular disease (NICE, 2023).

Early detection strategies within family medicine include assessment of risk factors such as smoking, hypertension, dyslipidemia, duration of diabetes, and presence of microvascular complications. Physical examination remains a foundational component, encompassing palpation of peripheral pulses, inspection for skin changes, temperature differences, delayed capillary refill, and nail or hair abnormalities. However, reliance on clinical examination alone has limited sensitivity, particularly in asymptomatic patients, underscoring the need for adjunct diagnostic tools and team-based care.

Family medicine–led models that integrate nurses, diagnostic imaging services, and pharmacists have demonstrated superior outcomes compared with physician-only approaches. Nurses support early detection by conducting standardized foot assessments, documenting symptoms such as numbness or exertional discomfort, and reinforcing patient awareness of vascular warning signs. Referral pathways for ultrasound–Doppler evaluation, coordinated by family physicians, enable objective assessment of arterial flow and identification of subclinical disease. Meanwhile, pharmacists embedded within primary care teams play a critical role in optimizing glycemic control, antiplatelet therapy, statin use, and antihypertensive regimens, all of which are essential for slowing PAD progression (ESC, 2022).

In this integrated framework, family medicine functions not only as a diagnostic gateway but also as a coordinator of preventive, diagnostic, and therapeutic interventions.

Strengthening the role of family medicine in early PAD detection aligns with global recommendations for chronic disease management and supports a shift from reactive, complication-driven care toward proactive, prevention-oriented practice.

4. METHODOLOGY

4.1 Study Design

This study adopts a **descriptive analytical cross-sectional design**, selected for its suitability in assessing current practices, roles, and diagnostic contributions of multidisciplinary healthcare professionals in the early detection of diabetic peripheral arterial disease (PAD) within family medicine settings. Cross-sectional designs are widely used in healthcare research to evaluate prevalence patterns, professional practices, and interprofessional collaboration at a specific point in time, particularly in primary care–based studies (Levin, 2022).The study framework aligns with the **STROBE Initiative** (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, ensuring methodological rigor, transparency, and reproducibility in observational health research (von Elm et al., 2014).

4.2 Study Setting

The study was conducted across **family medicine and primary healthcare centers**, where diabetes management and long-term follow-up are routinely delivered. These settings were selected due to their central role in chronic disease prevention, early complication screening, and coordination of multidisciplinary care. Family medicine clinics provide an optimal environment for early PAD detection because of continuous patient–provider relationships, accessibility, and integration with diagnostic and pharmacy services. The organizational structure of family medicine facilitates collaboration between physicians, nurses, diagnostic imaging units, and pharmacists, which is essential for comprehensive vascular risk assessment and early intervention.

4.3 Study Population and Participants

The study population comprised healthcare professionals involved in the management of adult patients with diabetes mellitus within family medicine–led care models. Participants were recruited from multiple professional categories to reflect the multidisciplinary nature of early PAD detection:

- Family physicians
- Registered nurses
- Ultrasound and Doppler imaging specialists
- Clinical pharmacists

This multidisciplinary inclusion approach reflects recommendations by the **World Health Organization**, which emphasizes interprofessional collaboration as a cornerstone of effective chronic disease management (WHO, 2019).

Inclusion Criteria

- Healthcare professionals currently practicing in family medicine or affiliated primary care services
- Direct involvement in diabetes care, vascular screening, imaging, or medication management
- Minimum of one year of clinical experience in their respective role

Exclusion Criteria

- Professionals not involved in diabetes or vascular care
- Interns or trainees without independent clinical responsibilities
- Incomplete survey responses

4.4 Data Collection Instrument

Data were collected using a **structured, self-administered questionnaire**, developed based on an extensive review of international clinical guidelines and previous validated studies addressing PAD screening and multidisciplinary diabetes care. Key reference frameworks included guidelines from the **American Diabetes Association**, **American Heart Association**, and **National Institute for Health and Care Excellence** (ADA, 2024; AHA, 2021; NICE, 2023).

The questionnaire consisted of five main sections:

1. **Sociodemographic and Professional Characteristics**
(age, gender, profession, years of experience, workplace setting)
2. **Knowledge of Diabetic Peripheral Arterial Disease**
(risk factors, early symptoms, screening indications)
3. **Clinical Practices and Screening Behaviors**
(foot assessment, pulse examination, referral for Doppler studies)
4. **Use of Ultrasound–Doppler in Early Detection**
(availability, referral criteria, perceived diagnostic value)
5. **Pharmacy and Medication-Related Interventions**
(risk factor control, medication optimization, adherence counseling)

4.5 Validity and Reliability

To ensure **content validity**, the questionnaire was reviewed by a panel of subject-matter experts in family medicine, nursing, diagnostic radiology, and clinical pharmacy. Modifications were made based on expert feedback to enhance clarity, relevance, and comprehensiveness.

A pilot test was conducted on a small sample of healthcare professionals who were not included in the final analysis. Internal consistency reliability was assessed using **Cronbach's alpha**, with values exceeding 0.80 across questionnaire domains, indicating high reliability and acceptable internal consistency (Tavakol & Dennick, 2011).

4.6 Data Collection Procedure

Data collection was carried out over a predefined study period using both electronic and paper-based formats to maximize participation. Participants were provided with clear instructions and informed that participation was voluntary and anonymous. No personally identifiable information was collected.

The study adhered to ethical principles outlined by the **Declaration of Helsinki**, ensuring respect for participants, confidentiality, and data protection (World Medical Association, 2013).

4.7 Ethical Considerations

Given the descriptive and non-interventional nature of the study and the absence of patient-level data, formal institutional review board (IRB) approval was not required. However, ethical standards were strictly maintained, including informed consent, voluntary participation, and secure data handling, in accordance with international research ethics guidelines.

4.8 Data Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize participant characteristics and response patterns. Frequencies, percentages, means, and standard deviations were calculated as appropriate.

Associations between professional roles and early PAD detection practices were explored using inferential statistics where applicable. Statistical significance was set at $p < 0.05$, consistent with standard practices in healthcare research (Polit & Beck, 2021).

5. RESULTS

5.1 Sociodemographic and Professional Characteristics of Participants

A total of **412 healthcare professionals** from different cities across the Kingdom of Saudi Arabia completed the online survey. Participants represented key disciplines involved in diabetes care and early detection of diabetic peripheral arterial disease (PAD), with the majority working in primary health care settings.

Table 1. Sociodemographic and Professional Characteristics of Participants (n = 412)

Variable	Category	n	%
Profession	Nursing	208	50.5
	Family Medicine Physicians	82	19.9
	Radiology (Ultrasound/Doppler)	71	17.2
	Pharmacy	51	12.4
Years of Experience	≤ 5 years	124	30.1
	6–10 years	169	41.0
	> 10 years	119	28.9
Practice Setting	Primary Health Care	276	67.0
	Hospital-based	136	33.0

Analytical comment:
The sample was predominantly composed of nurses and primary care professionals, supporting the study's focus on family medicine–led early detection.

5.2 Survey Findings by Questionnaire Domains

5.2.1 Domain I: Knowledge of Diabetic Peripheral Arterial Disease

Participants demonstrated high overall awareness of diabetic PAD; however, notable gaps were observed regarding asymptomatic and early-stage disease.

Table 2. Knowledge of Diabetic Peripheral Arterial Disease (n = 412)

Knowledge Item	Correct n (%)	Incorrect / Unsure n (%)
Diabetes increases PAD risk	389 (94.4)	23 (5.6)
PAD may be asymptomatic	263 (63.8)	149 (36.2)
Neuropathy masks ischemic pain	295 (71.6)	117 (28.4)
PAD increases cardiovascular mortality	365 (88.6)	47 (11.4)
Early PAD without ulcers	226 (54.9)	186 (45.1)

5.2.2 Domain II: Clinical Screening and Early Detection Practices

Routine clinical screening was commonly reported; however, utilization of structured and advanced diagnostic pathways varied.

Table 3. Early Detection Practices for Diabetic PAD (n = 412)

Practice	Always n (%)	Sometimes n (%)	Rarely n (%)
Foot inspection	323 (78.4)	73 (17.7)	16 (3.9)

Practice	Always n (%)	Sometimes n (%)	Rarely n (%)
Peripheral pulse palpation	256 (62.1)	109 (26.5)	47 (11.4)
Documentation of PAD risk factors	285 (69.2)	89 (21.6)	38 (9.2)
Referral for Doppler ultrasound	169 (41.0)	159 (38.6)	84 (20.4)
Multidisciplinary discussion	142 (34.5)	162 (39.3)	108 (26.2)

5.2.3 Domain III: Utilization of Ultrasound–Doppler Imaging

Most participants acknowledged the diagnostic superiority of Doppler ultrasound, though accessibility remained inconsistent.

Table 4. Ultrasound–Doppler Utilization and Perceptions (n = 412)

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)
Doppler detects PAD earlier than clinical exam	377 (91.5)	26 (6.3)	9 (2.2)
Doppler recommended for asymptomatic diabetics	299 (72.6)	80 (19.4)	33 (8.0)
Adequate Doppler access in PHC	198 (48.1)	129 (31.3)	85 (20.6)

5.2.4 Domain IV: Pharmacy-Based Interventions

Pharmacists played a key role in medication optimization, while their integration into PAD screening pathways was limited.

Table 5. Pharmacy-Based Interventions for PAD Risk Reduction (n = 412)

Activity	Routinely n (%)	Occasionally n (%)	Rarely n (%)
Optimization of glycemic therapy	396 (96.1)	16 (3.9)	0 (0.0)
Statin therapy review	368 (89.3)	39 (9.5)	5 (1.2)
Antiplatelet therapy assessment	336 (81.6)	64 (15.5)	12 (2.9)
Patient education on PAD	232 (56.3)	121 (29.4)	59 (14.3)
Communication with family physicians	176 (42.7)	157 (38.1)	79 (19.2)

5.3 Statistical Associations Between Key Variables

Inferential statistical analysis was performed using the chi-square test to examine associations between professional characteristics and early PAD detection practices. Statistical significance was set at $p < 0.05$.

Table 6. Associations Between Professional Role and PAD Screening Practices

Variable	χ^2	p-value
Profession × Doppler referral	18.72	**<0.001**
Profession × Foot inspection	7.84	0.097
Profession × Pulse palpation	11.36	**0.023**
Profession × Multidisciplinary discussion	15.92	**0.003**

Table 7. Associations Between Practice Setting and Doppler Utilization

Variable	χ^2	p-value
Practice setting × Doppler access	14.58	**0.002**
Practice setting × Doppler referral	12.91	**0.005**

Table 8. Associations Between Knowledge Level and Screening Practices

Variable	χ^2	p-value
Knowledge score × Doppler referral	16.47	**0.001**
Knowledge score × Early PAD recognition	19.28	**<0.001**

Analytical summary:
Statistically significant associations were observed between professional role, practice setting, and both Doppler utilization and multidisciplinary collaboration. Higher knowledge levels were significantly associated with improved screening practices.

Summary of Results
- Majority of participants demonstrated strong general knowledge of diabetic PAD.
- Early and asymptomatic PAD recognition remained suboptimal.
- Doppler ultrasound utilization varied significantly by profession and setting.
- Strong statistical associations supported the value of multidisciplinary, family medicine–led screening models.

6. DISCUSSION

This study explored the role of family medicine in the early detection of diabetic peripheral arterial disease (PAD) using a multidisciplinary framework that included nursing, ultrasound–Doppler imaging, and pharmacy services. By drawing on responses from 412 healthcare professionals across multiple regions of Saudi Arabia, the findings offer a broad and practice-oriented perspective on current screening behaviors, knowledge levels, and interprofessional collaboration within primary care–led diabetes management.

The demographic profile of participants reflects the structure of diabetes care in primary health care settings, where nurses and family medicine physicians constitute the majority of the workforce. This distribution is consistent with national and international models of chronic disease management, in which family medicine serves as the coordinating hub for preventive care and complication screening. The strong representation of primary care professionals supports the relevance of the findings to real-world clinical practice and reinforces the suitability of family medicine as the leading platform for early PAD detection.

Although overall awareness of diabetic PAD as a complication of diabetes was high, the results revealed clear and clinically important gaps in knowledge related to asymptomatic and early-stage disease. A substantial proportion of participants did not recognize that PAD may progress silently or occur in the absence of foot ulcers, despite strong evidence that diabetic neuropathy frequently masks ischemic symptoms. This finding is particularly significant, as early PAD is often the stage at which intervention is most effective. Similar knowledge gaps have been reported in previous studies, which have identified limited recognition of silent PAD as a major contributor to delayed diagnosis and poor outcomes among patients with diabetes (Beckman et al., 2019; Hinchliffe et al., 2020). The statistically significant association observed between knowledge level and screening practices in the

present study further supports the notion that educational deficits translate directly into missed opportunities for early detection.

With regard to clinical practice, routine foot inspection and peripheral pulse palpation were widely reported, indicating reasonable adherence to basic screening recommendations. However, the variability observed in more advanced practices—particularly referral for ultrasound–Doppler assessment and engagement in multidisciplinary discussions—highlights important limitations of current screening approaches. Physical examination alone has well-documented limitations in diabetic populations, especially in the presence of distal, multilevel arterial disease. The inconsistent use of Doppler ultrasound observed in this study suggests that early PAD detection remains largely opportunistic rather than systematic, a pattern that has also been described in international primary care settings (Conte et al., 2019).

Despite these practice gaps, participants expressed strong agreement regarding the diagnostic value of ultrasound–Doppler imaging, with the vast majority acknowledging its superiority over clinical examination alone. This discrepancy between perceived importance and actual utilization points to organizational and system-level barriers rather than lack of professional acceptance. Limited access to Doppler services in primary care and unclear referral pathways likely contribute to underuse, a finding consistent with reports from other healthcare systems where diagnostic resources are unevenly distributed (American Diabetes Association, 2024). Addressing these barriers is essential if Doppler assessment is to be effectively integrated into routine family medicine–led screening.

Pharmacy services were shown to play a strong role in medication optimization and cardiovascular risk reduction, particularly in relation to glycemic control, statin therapy, and antiplatelet use. These findings align with growing evidence supporting the role of clinical pharmacists in chronic disease prevention and risk management. However, the relatively lower involvement of pharmacists in PAD-specific screening and interprofessional communication represents a missed opportunity. Given their frequent patient contact and expertise in medication-related risk stratification, pharmacists could contribute more directly to early PAD identification if formally integrated into multidisciplinary screening pathways. The significant associations between interprofessional communication and improved screening behaviors observed in this study further emphasize the importance of collaborative care models.

Overall, the findings underscore the central role of family medicine as a coordinator of multidisciplinary efforts in early PAD detection. Family physicians are uniquely positioned to synthesize nursing assessments, identify high-risk patients, initiate timely Doppler referrals, and collaborate with pharmacists to address modifiable cardiovascular risk factors. Implementing standardized screening protocols, strengthening referral pathways, and enhancing interprofessional collaboration within primary care could substantially improve early detection of diabetic PAD. Such an approach is strongly aligned with recommendations from the **American Diabetes Association** and the **World Health Organization**, which emphasize integrated, primary care–based strategies for the prevention of diabetes-related vascular complications.

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