Vascular Health and Risk Management

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Prevalence and Risk Factors of Peripheral Artery Disease in Diabetic Patients: Insights from a Retrospective Cross-Sectional and Cohort Study in Abu Dhabi

Aysha Abdulla Alyahyaee[1], Esraa Mahmoud[1], Alyazia Aziz AlAzeezi[1], Amal Abdul Rahim Al Zarooni[1], Nico JD Nagelkerke[2], Latifa Baynouna Al Ketbi[1]

[1]Academic Affairs Department, Ambulatory Healthcare Services, Abu Dhabi Health Services Company, Abu Dhabi, United Arab Emirates; [2]Community Medicine Department, United Arab Emirates University, Abu Dhabi, United Arab Emirates

Correspondence: Amal Abdul Rahim Al Zarooni, Email a.alzarouni2019@gmail.com

Background: Peripheral artery disease (PAD), a common manifestation of systemic atherosclerosis, is linked to high morbidity and mortality. Risk factors such as age, male gender, and hyperlipidemia significantly contribute to PAD. This study aims to estimate the Predictors and associations of peripheral artery diseases in the Abu Dhabi population.

Methods: Cross-sectional analysis of diabetic patients who had ankle brachial index tests in 2018–2019. Data collected from electronic medical records include demographics, treatment history, comorbidities (hypertension, smoking), lab results (HbA1c, renal function, lipid profile), and findings from sudoscan test used to assess the function of small nerve fibers and evaluate autonomic dysfunction. A cohort study from the Abu Dhabi Cardiovascular Risk Study (ADRS), to determine the predictors and relationships associated with peripheral artery disease in Abu Dhabi. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.

Results: Among the 359 patients from the cross-sectional study, 65.5% had normal ABI, 14.2% had low abnormal ABI, and 20.3% had high abnormal ABI. The average age was 65.3 years, with 66.3% females and 75.49% United Arab Emirates (UAE) nationals. Most patients (65.2%) were on non-insulin treatments, and 75.8% had hypertension. The mean HbA1c level was 7.3%. Regarding renal function, 51.5% had stage 1 estimated glomerular filtration rate (eGFR), and 9.2% had abnormal eye grading. Ulcers were present in 95.8%, and 9.7% had vascular referrals. Multivariate analysis showed no significant predictors of abnormal ABI ($p > 0.05$). In the cohort study of 8699 patients, PAD prevalence was highest among those aged 40–59, with significant associations with age, smoking, and diabetes.

Conclusion: Abnormal ABI was present in 34.5% of patients, with no significant association with various risk factors. However, the cohort study showed that age, smoking, and diabetes are significantly related to PAD development.

Keywords: PAD, peripheral artery disease, DM, diabetes mellitus, ABI, ankle brachial index

Introduction

Peripheral artery disease (PAD) is a condition characterized by the stenosis or occlusion of arteries outside the coronary and cerebral circulation, primarily in the lower extremities, due to atherosclerotic plaque buildup. This leads to decreased blood flow, resulting in symptoms like claudication, rest pain, and ischemia, while also increasing the risk of adverse cardiovascular events, including myocardial infarction (MI) and stroke. Peripheral artery disease is influenced by several risk factors that contribute to the narrowing and blockage of arteries, particularly in the legs. These risk factors are often similar to those for other cardiovascular diseases and include both modifiable and non-modifiable factors. Non-modifiable risk factors for developing PAD increase with age, particularly in individuals over 60. Older adults are more likely to have accumulated damage in the arteries due to the aging process. Additionally, sex, ethnicity, and family history also contribute to the risk of PAD. On the other hand, modifiable risk factors include diabetes mellitus which

Received: 4 November 2024
Accepted: 23 January 2025
Published: 24 March 2025

accelerates PAD pathogenesis via endothelial dysfunction, and hyperglycemia-induced inflammation.[1] Furthermore, hypertension, smoking, dyslipidemia, and obesity are known modifiable risk factors for developing PAD.

PAD can be a silent condition for many years and when manifesting has a significant impact on patient's lives. Early detection, risk factor management, and appropriate treatment are crucial to preventing or mitigating PAD complications which include the risk of amputation, heart attack, stroke, and death.[2,3]

Presenting late is commonly associated with challenges in management with unsatisfactory outcomes, such as ischemia to vital organs such as bowel, limb ulcers, gangrene, or even amputations.[4] Patients with PAD should receive a comprehensive program of guideline-directed medical therapy to prevent complications and improve their quality of life. Current guidelines recommend supervised exercise therapy as the primary treatment for all patients with PAD.[5] There are very few publications on diabetes mellitus (DM) and PAD in the Arab world.[6] The prevalence of peripheral artery disease was estimated at 11.7% in Saudi Arabia and 3% in Qatar, Bahrain, UAE, Oman, Yemen, and Kuwait. However, the high rates of diabetes and other metabolic conditions in Middle Eastern countries may contribute to the increased burden of peripheral artery disease.[7] For example, diabetes was found to be in 25.7% of Bahrain, 23.7% of the Kingdom of Saudi Arabia, 17.1% of the United Arab Emirates, and 16.9% of Jordan.[8] Atherosclerosis is one of the most common complications of diabetes.[9]

The ankle-brachial index (ABI) is used to screen for and diagnose PAD.[10] In general, the ABI test has a sensitivity of more than 90% and a specificity of 95% for detecting PAD.[10] Ambulatory Healthcare Services (AHS) Centers introduced a screening program in 2018 for high-risk patients; asymptomatic patients with diabetes, age above 65, history of smoking, hyperlipidemia, and hypertension) or family history of PAD, Individuals with known atherosclerotic disease in another vascular bed (eg coronary, carotid subclavian, renal, mesenteric artery stenosis, or Abdominal aortic aneurysm (AAA)), and symptomatic Diabetic patients (leg pain/numbness and tingling/signs of claudication. This study aimed to estimate the Predictors and associations of peripheral artery diseases in Abu Dhabi.

Methods

Subjects and Methods

This study utilized two studies. The first study is a retrospective cross-sectional of diabetic patients who had ABI from January 2018 to January 2019.

Study Participants

The inclusion criteria for this study were type 2 diabetic patients who are following Ambulatory Health Services, and who had ankle brachial index measures from 2018–2019.

Sample Size

The sample size was calculated based on a population size of 2700000, with an anticipated frequency of 50 and a design effect of 1. The sample needed was 358 with a 95% confidence interval and a 5% margin of error.

Data Collection

Data was collected from patients' medical records. A predesigned checklist was prepared to collect data about patients' demographics (age, sex, nationality), Diabetes Mellitus (DM) treatment, duration and control, hypertension (HTN), and smoking status. Laboratory results collected were (HgA1c, Renal function test including eGFR and creatinine, lipid profile, Urine albumin: creatinine ratio (ACR)) and sudoscan test findings. Data about Diabetes mellitus complications: ulcer development, admission due to COVID-19, vascular referral, death, and Ankle-brachial index (ABI) were collected. Data were collected using systematic retrieval from the Ambulatory Health Services (AHS) information technology department, and the rest by the investigators. PAD was diagnosed based solely on ABI reading.

The second study is a retrospective cohort study in 2023, Abu Dhabi Cardiovascular Risk Study. The sample size was 8699 patients participating in the cardiovascular screening program from 2011 to 2023. The data were collected from the patient's electronic medical records. A predesigned checklist was prepared to collect data about patients' demographics; medical history, social history, and disease were collected. Some of this data was collected using systematic retrieval from the AHS IT department, and the rest by the investigators. PAD was diagnosed based on an ABI reading and

confirmed diagnosis documented in the patient's medical record. From this cohort study, the participants with PAD were included, from these patients, only 2 had PAD before initial screening and 73 had PAD after initial screening and the associated risk factors were analyzed. A more detailed description of the methodology is provided in DOI: https://doi.org/10.1161/JAHA.124.035930.[11]

Ethical Considerations

The cross-sectional study was approved by the Al Ain Human Ethics Committee, approval number 13/58, and Ambulatory Healthcare Services IRB 19-2022.

The retrospective cohort study was approved by the Al Ain Human Ethics Committee, approval number 13/58, and Ambulatory Healthcare Services IRB 19–2022. All methods were carried out under relevant guidelines and regulations. The authors confirm that the study was conducted following the Helsinki Declaration.

Consent Statement in the Ethics Approval and Consent to Participate

The IRBs waived informed consent because the study was designed to collect retrospective data gathered during patient care and anonymized at analysis.

Data were analyzed using the SPSS program version 26. To assess the association between the variables, the Chi-squared test ($\chi 2$) was used for qualitative data that was expressed as numbers and percentages. Quantitative data was presented as mean and standard deviation (Mean ± SD), where the independent sample *t*-test was used for parametric variables. The Odds Ratio was calculated at a Confidence Interval (CI) of 95% to assess the independent predictors of ABI. A p-value of less than 0.05 was regarded as statistically significant. A p-value of <0.05 was considered statistically significant.

Results

In the cross-sectional study (34.5%) of the participants had PAD. Figure 1 shows that of the studied 359 participants, 235 (65.5%) had normal ABI, 51 (14.2%) had Low abnormal or borderline ABI and 20.3% had High abnormal ABI. The mean age of the studied patients was 65.32 ± 11.71 years. Of them, 238 (66.3%) were females and 182 (77.4%) were UAE nationals. It was found that a non-significant relationship was found between ABI diagnosis and all participants' demographic characteristics ($p \geq 0.05$).

The majority 234 (65.2%) were on non-insulin treatment and 138 (38.4%) had a DM duration of >10 years. About 272 (75.8%) had Hypertension and 23 (6.4%) were current smokers. Despite that abnormal ABI was found among 30 (58.8%) of patients who were on non-insulin treatment, a non-significant relationship was found between ABI diagnosis

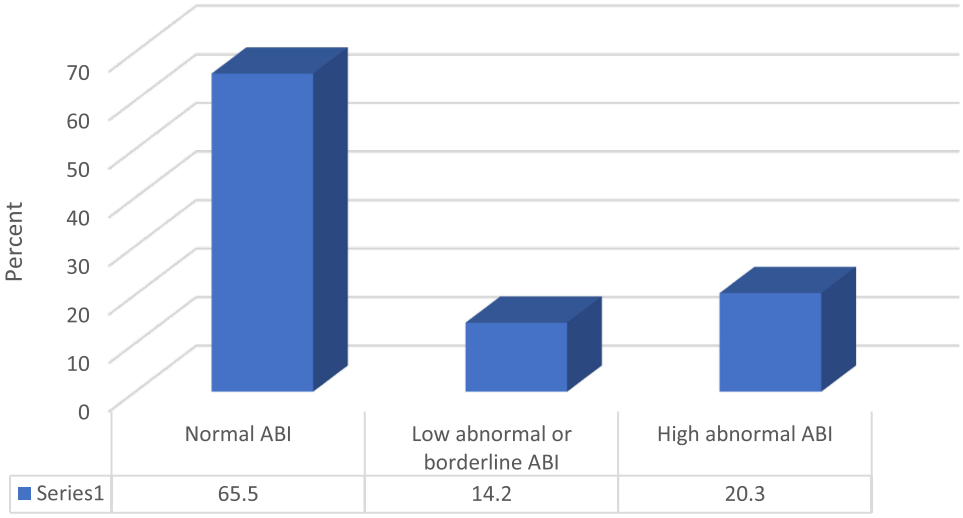

Figure 1 Percentage Distribution of The Results ABI Report (No: 359).

and Type of DM treatment ($p \geq 0.05$). The same non-significant relationship was found between ABI diagnosis and DM duration, HTN, and smoking status ($p \geq 0.05$) (Table 1).

More than half of the study patients 135 (57.1%) were DM-controlled with a mean HbA1c level of 7.3 ± 1.59. Most of the patients 185 (51.5%) had an eGFR stage 1, while 7(1.9%) had eGFR stage 4. The mean values of Creatinine, eGFR, and Urine Creatinine Albumin ratio (unit in mg/mmol) were 74.79 ± 30.44, 85.34 ± 21.18, and 12.08 ± 32.69, respectively. Most of the patients 229 (83.3%) had hyperlipidemia, and the mean values of low-density lipoprotein (LDL), High-density lipoprotein (HDL), and cholesterol (unit in mmol/l) were 2.17 ± 0.92, 1.25 ± 0.35, and 4.15 ± 1.04, respectively. The sudoscan had abnormal results among 83 (23.1%) of patients. It was found that participants with a high abnormal ABI had a significantly higher mean value of eGFR (91.26 ± 17.69) compared to other groups ($p \geq 0.05$). On the other hand, a non-significant relationship was found between ABI diagnosis and DM control, other laboratory results, or sudoscan results ($p \geq 0.05$) (Table 2).

The result demonstrates that only 36 (10%) of patients had diabetic retinopathy (DR), and 33 (9.2%) had an abnormal right or left eye grading. A non-significant relationship was found between ABI diagnosis and DR, right or left eye grading ($p \geq 0.05$). With regards to significant outcomes, 35 (9.7%) were admitted due to COVID-19, and 3(0.8%) had an ulcer development. Vascular referral was found among 35 (9.7%) of patients and 6 (1.7%) were deceased. It was found that patients with high abnormal ABI had a significantly higher percentage of those who had vascular referrals compared to those with normal patients 14 (19.2%) ($p \geq 0.05$). On the other hand, a non-significant relationship was found between

Table 1 Relationship Between ABI Diagnosis and Participants' Demographic Characters, DM Treatment, DM Duration, HTN, and Smoking Status (No: 359)

Variable	Total No. (%)	Normal ABI No. (%)	Low Abnormal or Borderline ABI No. (%)	High Abnormal ABI No. (%)	$\chi 2$	p-value
Age (years) mean	65.32 ± 11.71	65.77 ± 11.57	66.37 ± 12.22	63.15 ± 11.7	1.63	0.197
Gender						
Female	238 (66.3)	152 (64.7)	41 (80.4)	45 (61.6)	5.51	0.063
Male	121 (33.7)	83 (35.3)	10 (19.6)	28 (38.4)		
Nationality						
Non-UAE	88 (24.51)	53 (22.6)	16 (31.4)	19 (26)	4.22	0.377
UAE National	271(75.49)	182 (77.4)	35(68.6)	54 (73.9)		
Type of DM treatment						
Insulin	27 (7.5)	15 (6.4)	8 (15.7)	4 (5.5)	11.26	0.187
Oral	3 (0.8)	1 (0.4)	1 (2)	1 (1.4)		
Both	79 (22)	56 (23.8)	11 (21.6)	12 (16.4)		
Non-insulin	234 (65.2)	150 (63.8)	30 (58.8)	54 (74)		
Not on any	16 (4.5)	13 (5.5)	1 (2)	2 (2.7)		
Duration of the Disease						
<5 years	41 (11.4)	28 (11.9)	6 (11.8)	7 (9.6)	4.83	0.565
5–10 years	121 (33.7)	79 (33.6)	17 (33.3)	25 (34.2)		
>10 years	138 (38.4)	84 (35.7)	20 (39.2)	34 (46.6)		
NA	59 (16.4)	44 (18.7)	8 (15.7)	7 (9.6)		
Hypertension						
No	87 (24.2)	57 (24.3)	9 (17.6)	21 (28.2)	2.02	0.364
Yes	272 (75.8)	178 (75.7)	42 (82.4)	52 (71.2)		
Smoking status						
Never smoker	311 (86.6)	202 (86)	49 (96.1)	60 (82.2)	6.79	0.137
x-smoker	25 (7)	19 (8.1)	1 (2)	5 (6.8)		
Current smoker	23 (6.4)	14 (6)	1 (2)	8 (11)		

Table 2 Relationship Between ABI Diagnosis and DM Control, Laboratory Results and Sudoscan Results (No: 359)

Variable	Total No. (%)	Normal ABI No. (%)	Low Abnormal or Borderline ABI No. (%)	High Abnormal ABI No. (%)	χ2	p-value
HbA1c						
Controlled	205 (57.1)	135 (57.4)	29 (56.9)	41 (56.2)	0.72	0.948
Uncontrolled	150 (41.8)	97 (41.3)	22 (43.1)	31 (42.5)		
Not done	4 (1.1)	3 (1.3)	0 (0.0)	1 (1.4)		
HbA1c	7.3 ± 1.59	7.3 1± 1.68	7.28 ± 1.46	7.29 ± 1.4	2	0.961
eGFR stage						
NA	13 (3.6)	11 (4.7)	1 (2)	1 (1.4)	9.8	0.458
1	185 (51.5)	115 (48.9)	24 (47.1)	46 (63)		
2	118 (3.29)	77 (32.8)	20 (39.2)	21 (28.8)		
3a	25 (7)	18 (7.7)	3 (5.9)	4 (5.5)		
3b	11 (3.1)	9 (3.8)	1 (2)	1 (1.4)		
4	7 (1.9)	5 (2.1)	2 (3.9)	0 (0.0)		
Creatinine	74.79 ± 30.44	76.79 ± 33.19	75.24 ± 30.51	68.25 ± 18.5	2.4	0.168
eGFR	85.34 ± 21.18	83.91 ± 21.63	83.24 ± 22.61	91.26 ± 17.69	6.01	0.049
Urine Creatinine Albumin ratio	12.08 ± 32.69	11.67 ± 26.96	20.38 ±61.54	7.93 ± 18.31	0.85	0.653
Hyperlipidemia						
Normal	60 (16.7)	38 (16.2)	5 (9.8)	17 (23.3)	4.06	0.131
Abnormal	299 (83.3)	197 (83.8)	46 (90.2)	56 (76.7)		
LDL result	2.17 ± 0.92	2.16 ± 0.94	2.22 ± 1.06	2.15 ± 0.76	0.2	0.903
HDL result	1.25 ± 0.35	1.23 ± 0.35	1.28 ± 0.34	1.29 ± 0.37	0.15	0.47
Cholesterol	4.15 ± 1.04	4.13 ± 1.04	4.28 ± 1.27	4.1 ± 0.86	0.33	0.845
Sudoscan						
Abnormal	83 (23.1)	58 (24.7)	13 (25.5)	12 (16.4)	4.63	0.327
Normal	42 (11.7)	31 (13.2)	5 (9.8)	6 (8.2)		
Not done	234 (65.2)	146 (62.1)	33 (64.7)	55 (75.3)		

ABI diagnosis and ulcer development, admission due to COVID-19, or death ($p \geq 0.05$) (Table 3). Multivariate logistic regression analysis was done to assess the risk factors (independent predictors) of ABI among studied patients, none of the studied variables were found to have a significant association with ABI ($p \geq 0.05$) (Table 4).

Table 3 Relationship Between ABI Diagnosis DM Complications, Ulcer Development, Admission Due to COVID, Vascular Referral and Death (No: 359)

Variable	Total No. (%)	Normal ABI No. (%)	Low Abnormal or Borderline ABI No. (%)	High Abnormal ABI No. (%)	χ2	p-value
Diabetic retinopathy						
Normal	151 (42.1)	97 (41.3)	20 (39.2)	34 (46.6)	1.64	0.949
Diabetic retinopathy	36 (10)	25 (10.6)	6 (11.8)	5 (6.8)		
Not done	165 (46)	108 (46)	24 (47.1)	33 (45.2)		
NA	7 (1.9)	5 (2.1)	1 (2)	1 (1.4)		

(*Continued*)

Table 3 (Continued).

Variable	Total No. (%)	Normal ABI No. (%)	Low Abnormal or Borderline ABI No. (%)	High Abnormal ABI No. (%)	χ2	p-value
Right eye grading						
Abnormal	33 (9.2)	22 (9.4)	5 (9.8)	6 (8.2)		
No clear view	1 (0.3)	1 (0.4)	0 (0.0)	0 (0.0)	4.46	0.813
Normal	150 (41.8)	96 (40.9)	21 (41.2)	33 (45.2)		
Not clear	11 (3.1)	10 (4.3)	1 (2)	0 (0.0)		
Not done	164 (45.7)	106 (45.1)	24 (47.1)	34 (46.6)		
Left eye grading						
Abnormal	33 (9.2)	22 (9.4)	5 (9.8)	6 (8.2)		
No clear view	1 (0.3)	1 (0.4)	0 (0.0)	0 (0.0)	5.12	0.744
Normal	149 (41.5)	95 (40.4)	21 (41.2)	33 (45.2)		
Not clear	16 (4.5)	13 (5.5)	3 (5.9)	0 (0.0)		
Not done	160 (44.6)	104 (44.3)	22 (43.1)	34 (46.6)		
Admission due to Covid						
No	324(90.3)	214 (91.1)	43 (84.3)	67 (91.8)	2.41	0.299
Yes	35 (9.7)	21 (8.9)	8 (15.7)	6 (8.2)		
Ulcer						
No	348(96.9)	227 (96.6)	49 (96.1)	72 (78.6)	3.09	0.541
Yes	3 (0.8)	2 (0.9)	1 (1.4)	1 (1.4)		
NA	8 (2.2)	6 (2.8)	0 (0.0)	0 (0.0)		
Vascular referral						
No	324(90.3)	21 (94)	44 (86.3)	59 (80.8)	12.13	0.002
Yes	35 (9.7)	14 (6)	7 (13.7)	14 (19.2)		
Death						
No	353(98.3)	232 (98.7)	49 (96.1)	72 (98.6)	1.83	0.4
Yes	6 (1.7)	3 (1.3)	2 (3.9)	1 (1.4)		

Table 4 Multivariate Logistic Regression Analysis of Risk Factors of NES Among Studied Patients

Variable	B	Wald	p-value	Odds Ratio (CI:95%)
Age (years)	0.01	0.73	0.391	0.98 (0.94–1.02)
Gender	0.48	0.98	0.321	1.61 (0.62–4.19)
Nationality	0.08	0.2	0.651	1.09 (0.57–1.58)
Type of DM treatment	0.11	0.54	0.965	0.13 (0.14–1.06)
Duration of the Disease	0.02	0.01	0.91	0.98 (0.96–1.37)
Hypertension	0.34	0.88	0.346	0.7 (0.34–1.35)
Smoking status	0.09	0.1	0.749	0.9 (0.5–1.63)
DM control	0.54	1.61	0.204	1.71 (0.74–3.94)
HbA1c	0.02	0.21	0.869	0.97 (0.73–1.29)

(*Continued*)

Table 4 (Continued).

Variable	B	Wald	p-value	Odds Ratio (CI:95%)
eGFR stage	0.01	0.001	0.975	1.01 (0.36–2.82)
Creatinine	0.01	0.55	0.458	0.98 (0.95.01)
eGFR	0.007	0.11	0.736	0.99 (0.95–1.03)
Urine Creatinine Albumin ratio	0.011	1.55	0.212	1.01 (0.99–1.02)
Hyperlipidemia	0.1	0.05	0.815	1.1 (0.47–2.55)
LDL result	0.28	0.54	0.461	0.75 (0.35–1.6)
HDL result	0.56	1.34	0.24	2.47 (1.76–4.58)
Cholesterol	0.11	0.1	0.747	1.12 (0.56–2.23)
Sudoscan	0.29	2.58	0.108	1.34 (0.93–1.94)
Diabetic retinopathy	0.36	2.19	1.38	0.96 (0.43 1.12)
Right eye grading	1.12	2.44	0.118	3.08 (0.75–12.66)
Left eye grading	0.94	1.91	0.166	0.38 (0.1–1.48)

Table 5 shows the results from the cohort study. Only 73 (0.85%) patients were diagnosed with PAD over the follow-up period. 24 females out of 4334 developed PADS while 49 males out of 4191 developed PADS. The highest prevalence of PAD was found between the ages of 70–70 (0.3%) followed by the age group 40–59 (0.2%). The correlation of PAD

Table 5 Cohort Study; Correlation of New PAD with Gender, Age Group, Education Level, HTN, Diabetes, CKD, Stroke, ACS, High Cholesterol, Central Obesity, and Current Smoker

	PAD: No	PAD: Yes	Total
Gender N (%)			
Female	4310 (99.4%)	24 (0.6%)	4334
Male	4142 (98.8%)	49 (1.2%)	4191
Total	8452 (99.1%)	73 (0.9%)	8525
Age group % of Total			
<30	32.9%	0.0%	32.9%
30–39	25.2%	0.1%	25.3%
40–49	17.6%	0.2%	17.7%
50–59	13.5%	0.2%	13.8%
60–69	7.3%	0.1%	7.4%
70–79	2.3%	0.3%	2.6%
>80	0.3%	0.0%	0.3%

(*Continued*)

https://doi.org/10.2147/VHRM.S501096

Table 5 (Continued).

	PAD: No	PAD: Yes	Total
Education level % of Total			
Illiterate	14.3%	0.3%	14.5%
Primary	9.6%	0.2%	9.8%
Intermediate	34.3%	0.2%	34.5%
Secondary	10.3%	0.1%	10.4%
University	28.8%	0.1%	28.8%
Postgraduate	1.9%	0.0%	1.9%
Disease % of Total			
HTN	13.8%	0.4%	14.2%
Diabetes	19.2%	0.6%	19.8%
CKD	1.4%	0.1%	1.5%
Stroke	57.4%	0.9%	58.3%
ACS	1.3%	0.1%	1.4%
High Cholesterol	14.7%	0.4%	15.1%
Central obesity % of Total	42.9%	0.2%	43.0%
Current smoker % of Total	10.9%	0.1%	11.0%

with education level was highest among the Illiterate education level (0.3%). Of the (14.2%) of subjects who were known to have hypertension (0.4%) had PAD. (19.8%) of participants reported having DM from both genders and (0.6%) reported having PAD. (1.5%) of subjects who were known to have chronic kidney disease (CKD) had a lower prevalence of PAD (0.1%). Prevalence of PAD was reported among patients who had a stroke in (0.9%) out of (58.3%) of males and females. A low prevalence number of PAD (0.1%) was documented among participants with a history of Acute Coronary Syndrome (ACS) N (1.4%). (15.1%) of participants among both genders are known to have high cholesterol levels, and (0.4%) are reported to have PAD. A total of (11%) of subjects are currently smokers, (0.1%) developed PAD. On the other hand, for participants who are known to have central obesity (43%,) the prevalence of PAD was reported at (0.2%).

Cox regression, showed a significant relationship between PAD and current smokers, age, and diabetes with P values (0.040), (<0.001), and (<0.001), respectively. Other studies' Variables show no significant relationship Table 6.

Table 6 Cohort Study: Cox Regression, Between PAD and Smoking, Age and Diabetes

	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Current Smoker	0.706	0.344	4.216	1	0.040	2.027	1.033	3.977
Age at screening	0.067	0.008	62.772	1	<0.001	1.069	1.051	1.087
DM_ before	0.931	0.268	12.084	1	<0.001	2.537	1.501	4.289

Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval Lower Bound	Asymptotic 95% Confidence Interval Upper Bound
HAZARD_PAD_WITH DM before	.860	.016	.000	.829	.890

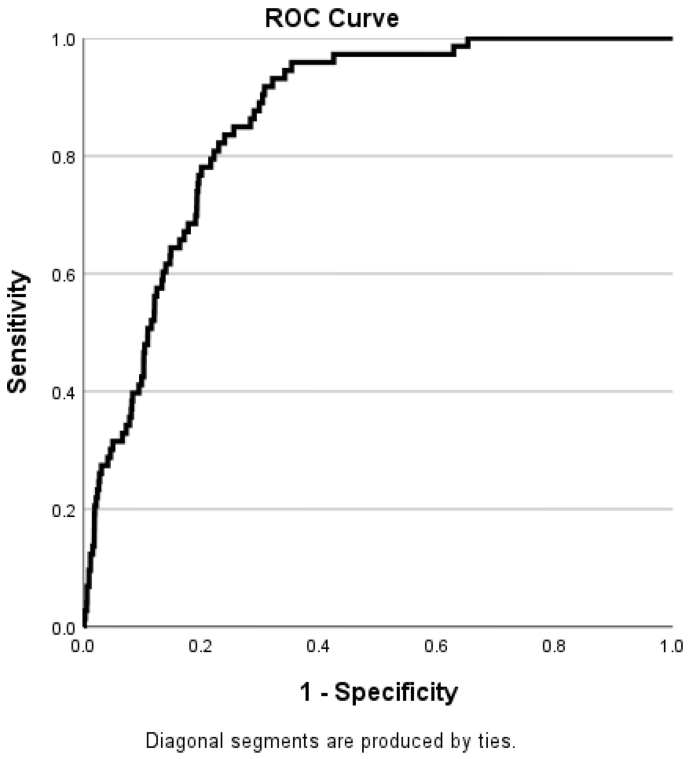

Figure 2 Roc Curve With Good Area For Diabetes and PAD.

ROC curve was done to see the hazard risk of diabetes and PAD; it showed an area under the curve of 0.860. On the other hand, the ROC curve was used to measure the hazard risk in non-diabetic patients, which was 0.882 (Figures 2 and 3). Figure 4 Box plot shows that diabetic patients who did not have PAD still carry a higher hazard risk of developing PAD. While non-diabetic patients carry a lower hazard risk of developing PAD.

Discussion

While only 73 patients out of the 8699 patients were diagnosed with PAD after the follow-up period of 9.2 years in the ADRS, in the cross-sectional study it was 30% among the screened population. The baseline screening of the ADRS did not include ABI and they were not followed with ABI testing therefore the higher prevalence in the second sample reflects prevalence better. Nevertheless, those are not community-based, and the prevalence could be even higher. The incidence of PAD cases has been increasing globally from 13% in the high-income regions of the world to as high as 29% in low-/middle-income regions of the world.[12]

A study done in Al Ain City, UAE in 2014, showed approximate results to our study, which showed the prevalence of significant PAD (ABI < 0.9) was 9% in males and 9% in females, and probable PAD (ABI ≤ 1.0) was 39%.[13] Several

https://doi.org/10.2147/VHRM.S501096

Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval Lower Bound	Asymptotic 95% Confidence Interval Upper Bound
HAZARD_PAD_WITHOUT DM before	.882	.032	.000	.819	.945

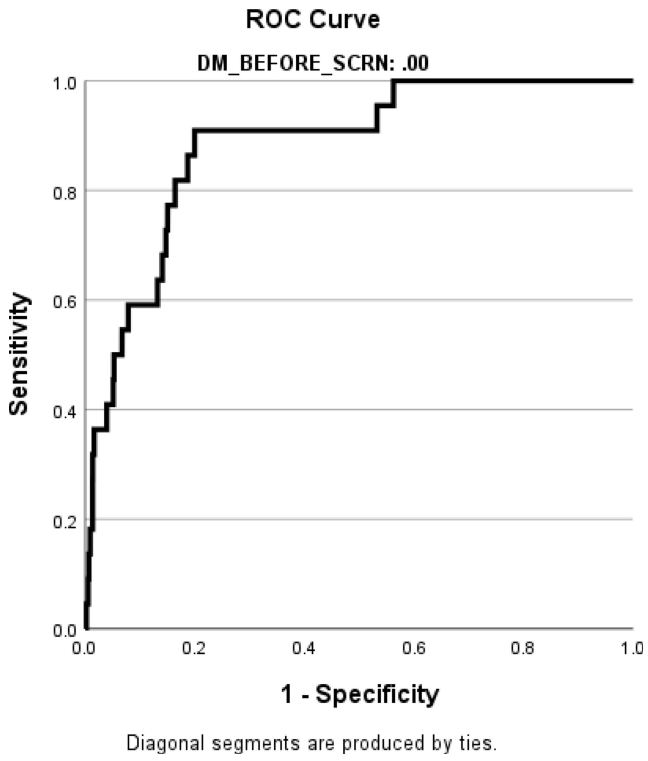

Figure 3 Roc Curve With Good Area For Non-Diabetes and PAD.

studies reported increasing numbers of PAD within the Gulf regions lately. A recent study done in UAE showed the prevalence of PAD among the studied participants was 22.7%. The highest frequency of PAD was found among 60-year-old and above participants at 45.5%. The prevalence of PAD was higher amongst females compared to males (30.9 vs 18.5%).[14]

A study was done in India to estimate Type 2 diabetic patients having asymptomatic PAD using ABI, which reported insignificant differences between genders.[15] Similarly, in this study, it was found that a non-significant relationship was found between ABI diagnosis and all participant's demographic characteristics.

We see that without screening only 0.84% will be noticed and managed. This result highlights the importance of screening in high-risk patients. American Diabetes Association (ADA) recommends screening individuals with diabetes and age ≥50 years, any microvascular disease, foot complications, or end-stage organ damage from diabetes and to consider screening anyone with a diabetes duration of ≥10 years.[16]

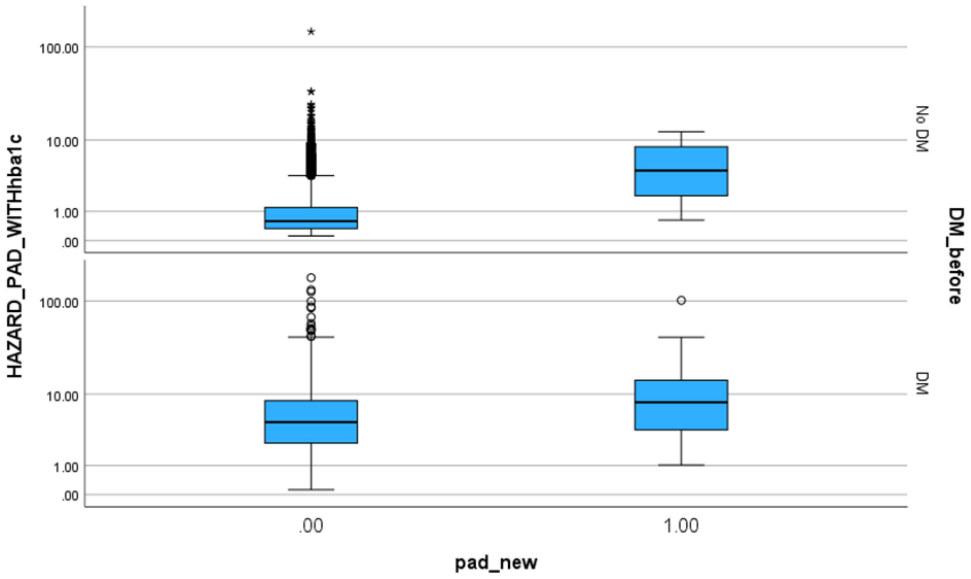

Figure 4 Box Plot for Hazard of PAD In Diabetic and Non-Diabetic.

Concerning associations, the ADRS cohort showed different associations than the cross-sectional study. Smoking, Diabetes, and age were significant associations although, in the diabetic cross-sectional study, there was no significant association. This could not be due to different risk factors but more likely due to a better methodology and design of a long-duration cohort compared to a cross-sectional study. Also, the population in the ADRS cohort is from the community while the cross-sectional study is patients who chose to come to the center and agreed to do the recommended investigations.

A study reported similar insignificance, which reported a non-significant relationship was found between ABI diagnosis and DM duration, HTN, and smoking status.[17] While current smoking was the only significant predictor of ABI < 0.9.[13] Countering our results.

However, in our study, the highest incidence was noted among the age group of 46–55 years old. There are several correlations associated with PAD, as per the Centers for Disease Control and Prevention, the risk factors for PAD include age 60 and above, high blood pressure, high cholesterol levels, diabetes, and smoking. The odds of having PAD increase with each additional risk factor, from a 1.5-fold increase with one risk factor to a 10-fold increased risk with three or more risk factors.

Analysis of data from the National Health and Nutrition Examination Survey demonstrated that the most significant PAD risk factors are hypertension, diabetes mellitus, chronic kidney disease, hyperlipidemia, and smoking.[5] Despite the high prevalence of CKD and hypertension in this study, none was significant predictors of PAD. A study done in Nigeria showed the predictors of peripheral vascular disease (PVD) in the study group were eGFR, diastolic blood pressure (BP), urinary, and smoking history.[18]

In this study, most of the studied population had controlled diabetes mellitus (controlled was defined with HbA1c ≤ 7%) with a mean HbA1c level of 7.3 ± 1.59 compared to other studies in the region where most of the patients had poor glycemic control.[13,19] As in the other studies, the studied population had a high percentage of patients with hyperlipidemia (around 83%), a similar study done in Dubai showed a similar result where 84% of the studied population had hyperlipidemia.[20] As we have used sudoscan results as a tool to determine patients with diabetic neuropathy, other studies used clinical assessment of patients using symptoms and examination to determine whether patients had diabetic neuropathy, 23% of the population studied had abnormal sudoscan, while it was nearly 34% in another study.[20] In our study, the relationship between abnormal sudoscan result and abnormal ankle-brachial index was non-significant but was significant in (Al Sabbah et al, 2019).[20] Most of the studies in the region compared the urinary creatinine: albumin ratio with the association with PAD, in our study, we compared both the eGFR result and urinary albumin: creatinine ratio

https://doi.org/10.2147/VHRM.S501096

with the abnormal ABI result, and we found a significant relationship between abnormal ABI and high mean value of eGFR (CKD stage1), but as for albumin creatinine ratio there was non-significant relationship between the value of ACR and abnormal ABI in our study, or between the value of ACR and PAD in a study done in Egypt.[19]

The current study demonstrates that only 10% of patients had diabetic retinopathy (DR). A non-significant relationship was found between ABI diagnosis and DR. Patients with highly abnormal ABI had a significant vascular referral compared to those with normal ABI patients. On the other hand, a non-significant relationship was found between ABI diagnosis and ulcer development, admission due to COVID-19, or death ($p \geq 0.05$). Another study has the opposite result to what was found, that patients with an abnormal ABI of < 0.9 or $\geqq 1.3$ were found to have older age, higher prevalence of coronary artery disease, high prevalence of cerebrovascular disease, lower diastolic blood pressure, higher pulse pressure, higher body mass index (BMI), higher triglyceride, lower HDL-cholesterol, lower eGFR, higher prevalence of microalbuminuria, more advanced DR stages and higher prevalence of anti-hypertensive medications and statins use.[21]

Another study done in China found that the prevalence of abnormal lower ABI was greater in elderly (≥65 years) patients (12.2%) than in younger (<65 years) patients (3.6%).[22] Low ABI in younger patients was found to be independently associated with HbA1c, the urinary albumin: creatinine ratio, diabetic peripheral neuropathy, diabetic retinopathy, and cerebrovascular disease. A low ABI in elderly patients was found to be independently associated with age, smoking, HbA1c, uric acid, total cholesterol, diabetic peripheral neuropathy, diabetic retinopathy, diabetic nephropathy, and cerebrovascular disease. A high ABI in younger patients was associated with being male.[22] Peripheral Artery Disease (PAD) in the Middle East is linked to poor outcomes. However, its prevalence and impact in the region seem to be underestimated so raising awareness and conducting further research is critical.[10]

Limitation

The research was limited to Thiqa insurance only due to coverage issues, which might have the element of selection bias. The sample size is only from patients who are following AHS, and a large population has regular follow up in private institutions.

The cohort study is starting from 2011 to 2023, in which period, the ankle-brachial index screening was not applied, as it was applied annually from 2018. Due to the COVID pandemic, this screening method has not been done in all patients, as the guidelines would recommend, which leads to not all diabetic patients having the ankle-brachial index screening. Therefore, the presented data might be lacking the true information of a large group of the studied participants.

Relying solely on ABI for PAD diagnosis is one of the study limitations as no alternative method for confirming the PAD diagnosis as imagining study was used.

The strength of our study is that in the Arab world, there are very few publications regarding DM and PAD, so our study will present information that we need to see. Presenting the data from both the cross-sectional study and the cohort will present the information in both the short and long term.

Conclusion

The Cross-sectional study reveals a high prevalence of abnormal ankle-brachial index in Diabetic patients in Abu Dhabi which accounts for 34.5%. The Cohort study concluded that age, current smokers, and diabetes have a significant relationship with peripheral arterial disease.

Recommendation for future research on the studied participant to see the results of the following ankle-brachial index results of the years following. Also, for better and more accurate results, a clinical study to see participants' symptoms, physical examination findings and imaging results and correlate them. ABI is a screening tool for diabetic patients and non-diabetic patients; we need further screening tools to determine the risk of PAD as they have a high hazard risk.

Abbreviations

DM, Diabetes Mellitus; COVID, Coronavirus −19; ABI, Ankle-Brachial Index; PAD, Peripheral Arterial Disease; UAE, United Arab Emirates; AHS, Ambulatory Health Services; DR, Diabetic Retinopathy; CKD, Chronic Kidney Disease; HTN, Hypertension; ACR, Albumin: Creatinine Ratio; ADRS, Abu Dhabi Cardiovascular Risk Study.

Data Sharing Statement

Data is available on request due to restrictions. All relevant data are presented in the paper.

Ethical Approval and Consent to Participate

The study was approved by the Ambulatory Healthcare Services Ethics Committee IRB 19-2022. All methods were carried out under relevant guidelines and regulations. The authors confirm that the study was conducted following the Helsinki Declaration.

Author Contributions

All authors took part in drafting, revising, or critically reviewing the article. All authors gave final approval of the version to be published, have agreed on the journal to which the article has been submitted and agree to be accountable for all aspects of the work.

Funding

The authors received no funding for this study.

Disclosure

The authors declare that they have no competing interests.

References

1. Hadi HAR, Suwaidi JA. Endothelial dysfunction in diabetes mellitus. Vasc Health Risk Manag. 2007;3(6):853–876.
2. Early diagnosis & treatment of peripheral artery disease essential to improve outcomes, reduce amputation risk. American Heart Association. Available from: http://newsroom.heart.org/news/early-diagnosis-treatment-of-peripheral-artery-disease-essential-to-improve-outcomes-reduce-amputation-risk. Accessed December 30, 2024.
3. Martelli E, Enea I, Zamboni M, et al. Focus on the Most Common Paucisymptomatic Vasculopathic Population, from Diagnosis to Secondary Prevention of Complications. Diagnostics. 2023;13(14):2356. doi:10.3390/diagnostics13142356
4. Dhaliwal G, Mukherjee D. Peripheral arterial disease: epidemiology, natural history, diagnosis and treatment. Int J Angiol. 2007;16(02):36. doi:10.1055/s-0031-1278244
5. Firnhaber JM, Powell CS. Lower Extremity Peripheral Artery Disease:Diagnosis and Treatment. Am Fam Physician. 2019;99(6):362–369.
6. Abouhamda A, Alturkstani M, Jan Y. Lower sensitivity of ankle-brachial index measurements among people suffering with diabetes-associated vascular disorders: a systematic review. SAGE Open Med. 2019;7:2050312119835038. doi:10.1177/2050312119835038
7. Sliem H, Ahmed S, Nemr N, El-Sherif I. Metabolic syndrome in the Middle East. Indian J Endocrinol Metab. 2012;16(1):67. doi:10.4103/2230-8210.91193
8. Guraya SY, London NJM. The prevalence and management strategies for peripheral artery disease associated with diabetes mellitus in the Arab world. J Taibah Univ Med Sci. 2016;11(4):310–316. doi:10.1016/j.jtumed.2015.12.003
9. Cade WT. Diabetes-Related Microvascular and Macrovascular Diseases in the Physical Therapy Setting. Phys Ther. 2008;88(11):1322–1335. doi:10.2522/ptj.20080008
10. El-Menyar A, Al Suwaidi J, Al-Thani H. Peripheral arterial disease in the Middle East: underestimated predictor of worse outcome. Glob Cardiol Sci Pract. 2013;2013(2):13. doi:10.5339/gcsp.2013.13
11. AlKetbi LB, Nagelkerke N, AlAlawi N, et al. Disease Risk Score Derivation and Validation in Abu Dhabi, United Arab Emirates: a Retrospective Cohort Study. J Am Heart Assoc. 2024:e035930. doi:10.1161/JAHA.124.035930
12. Al-Zakwani I, M Mabry R, Zubaid M. Association between education and major adverse cardiac events among patients with acute coronary syndrome in the Arabian Gulf. BMJ Glob Health. 2019;4(1):e001278. doi:10.1136/bmjgh-2018-001278
13. Al-Kaabi JM, Al Maskari F, Zoubeidi T, Abdulle A, Shah SM. Peripheral Artery Disease in Type 2 Diabetic Patients from the United Arab Emirates. J Diabetes Metab. 2014;05(06). doi:10.4172/2155-6156.1000388
14. Sayed-Taha L, Fatima S, Sayed-Taha S, Jaber A, Sharbatti S. Prevalence of Peripheral Arterial Disease in Ages 40 or Above in the UAE. Cardiol Res Cardiovasc Med. 2023;8(1). doi:10.29011/2575-7083.100088
15. Thakkar SC, Tanna PJ, Baghel R, Adwal SK. Prevalence Of Asymptomatic Peripheral Arterial Disease And Its Asssociation With Age And Gender In Type 2 Diabetes Mellitus In A Tertiary Care Teaching Hospital: a Cross-Sectional Study. Asian J Pharm Clin Res. 2022;140–143. doi:10.22159/ajpcr.2022.v15i8.45725
16. American Diabetes Association Primary Care Advisory Group; ElSayed NA, Baig A, Bradley S, et al. Introduction: standards of Care in Diabetes—2024 Abridged for Primary Care Professionals. Clin Diabetes. 2024;42(2):181. doi:10.2337/cd24-aint
17. Aquino SHSD, Melo IT, Souza CDFD, Costa FDA. Ankle-brachial Index and associated factors in individuals with coronary artery disease. Rev Assoc Médica Bras. 2020;66(4):407–413. doi:10.1590/1806-9282.66.4.407
18. Ovwasa H, Aiwuyo HO, Ca OO, et al. Prevalence and Predictors of Peripheral Vascular Disease Amongst Predialysis Hypertensive Chronic Kidney Disease Patients in Southern Nigeria. Cureus. 2023. doi:10.7759/cureus.36752
19. El-Malky HA, Dawood AED, El-Desoky MS, Kamel MA. Ankle Brachial Index Screening for Peripheral Arterial Disease in Asymptomatic Diabetic Patients. Egypt J Hosp Med. 2021;83(1):1575–1581. doi:10.21608/ejhm.2021.171405

20. Al Sabbah H, Alketbi M, Dghaim R. Prevalence of Complications in Type 2 Diabetics in Dubai, UAE: a Cross-sectional Study. Arab J Nutr Exerc AJNE. 2019. doi:10.18502/ajne.v4i2.5161
21. Chen SC, Hsiao PJ, Huang JC, et al. Abnormally Low or High Ankle-Brachial Index Is Associated with Proliferative Diabetic Retinopathy in Type 2 Diabetic Mellitus Patients. PLoS One. 2015;10(7):e0134718. doi:10.1371/journal.pone.0134718
22. Li X, Wang Y-Z, Yang X-P, Xu Z-R. Prevalence of and risk factors for abnormal ankle–brachial index in patients with type 2 diabetes. J Diabetes. 2012;4(2):140–146. doi:10.1111/j.1753-0407.2011.00171.x