

East African Medical Journal Vol. 100 No. 1 January 2023

PREVALENCE AND PREDICTORS OF PERIPHERAL ARTERY DISEASE AMONG HYPERTENSIVE PATIENTS IN A TERTIARY HOSPITAL IN NORTH - CENTRAL NIGERIA

Abiola Idris Yusuf, Senior Registrar {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria, Olawale Mathias Akinlade, Senior Registrar {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria, Olaide Rasheed Awodun, Senior Registrar {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria, Olalekan Wasiu Yusuf, Senior Registrar {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria, James Ayodele Ogunmodede, Senior Lecturer {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria, Philip Manma Kolo, Professor of Medicine, Department of Internal Medicine, University of Ilorin Teaching Hospital, Kwara State, Nigeria

Corresponding author: Abiola Idris Yusuf, Senior registrar {cardiology division}, Department of Internal Medicine, University of Ilorin Teaching Hospital Kwara State, Nigeria. Email: idreezabiola@outlook.com

PREVALENCE AND PREDICTORS OF PERIPHERAL ARTERY DISEASE AMONG HYPERTENSIVE PATIENTS IN A TERTIARY HOSPITAL IN NORTH - CENTRAL NIGERIA

A. I. Yusuf, O. M. Akinlade, O. R. Awodun, O. W. Yusuf, J. A. Ogunmodede, and P. M. Kolo

ABSTRACT

Objective: The objective of the study was to determine the prevalence of peripheral artery disease and its predictors among hypertensive patients attending the University of Ilorin Teaching Hospital.

Design: Hospital-based comparative cross-sectional study.

Setting: General outpatient clinic and cardiology clinic

Participants: 150 hypertensive patients and 150 normotensive patients were recruited.

Main outcome measures: The participants were physically examined, and their blood samples were taken for analysis. Ankle-brachial index was determined among the participants using a handheld Doppler machine. Data obtained were analyzed using SPSS 20 computer software package.

Results: The prevalence of peripheral artery disease among the hypertensive subjects and normotensive patients were 20% and 3.3% respectively. The predictors of peripheral artery disease were age of the patient (OR, 1.04; 95% CI, 1.01 - 1.08), duration of hypertension (OR, 1.08; 95% CI, 1.02 - 1.15), abnormal body mass index (OR, 1.10; 95% CI, 1.02 - 1.20), low-density lipoprotein cholesterol (OR, 3.41; 95% CI, 1.17 - 9.97) and total cholesterol (OR, 5.56; 95% CI, 2.33 - 13.27).

Conclusion: Peripheral artery disease is a common complication among hypertensive patients studied. The predictors of peripheral artery disease among

these patients were the age of the patient, duration of hypertension, obesity, and dyslipidemia.

INTRODUCTION

Systemic hypertension (SH) is one of the most important modifiable risk factors for cardiovascular disease (CVD)¹ and it contributes to significant risk factors for stroke, heart failure (HF), and peripheral artery disease (PAD).² The prevalence of hypertension is increasing rapidly in developing countries, where the inadequate treatment and control of elevated blood pressure (BP) are contributing greatly to the growing epidemic of CVD.³

Hypertension plays an important role in the pathogenesis of atherosclerotic vascular disease (AVD) and has been associated with an increased risk of PAD.⁴ Emdin *et al.* found that a 20mm Hg higher than usual systolic blood pressure (SBP) is associated with a 63% higher risk of PAD.⁵ It has also been found that individuals with SH and PAD are at an increased risk of chronic kidney disease, HF, and stroke.⁵

In the past, it was reported that AVD was rare among Africans. However, a post-mortem study in Ethiopia demonstrated that atherosclerotic lesions of the aorta were present in 47% of the autopsied Ethiopians aged 10 years and above.⁶ Tracie *et al.* found a higher prevalence of PAD in African-Americans (22.8%), compared to Whites (13.2%) and Hispanics (13.7%).⁷ In a study done in the Central African Republic using ankle-brachial index (ABI), a prevalence of between 15.0% and 32.4% of PAD was reported.⁸

ABI of less than or equal to 0.9 has been strongly associated with cardiovascular events and mortality in a variety of populations.

However, relatively little data exist regarding a high ABI.⁹ Moreover, the clinical implications of ABI greater than 1.40 remain controversial. Some cohort studies have reported that higher ABIs were related to more cardiovascular events.⁹ On the contrary, a general population study has shown that ABI greater than 1.40 did not identify individuals at increased risk of cardiovascular mortality.¹⁰

Data on the prevalence and predictors of PAD using a handheld device for the assessment of ABI in Nigeria are sparse. The study therefore aimed at determining the patterns of ABI using handheld Doppler and the predictors of PAD among hypertensive patients attending University of Ilorin Teaching Hospital (UITH).

METHODOLOGY

Study design:

This research work was a hospital-based comparative cross-sectional study.

Study location:

The study was carried out at the Cardiology Clinic and General outpatient Department (GOPD) of UITH.

Study subjects:

Adult patients with SH attending the Cardiology Clinic of UITH were recruited to participate in the study provided they met the inclusion criteria and signed the consent form. Patients with diabetes mellitus, chronic kidney disease, heart failure, and leg ulcers were excluded.

Subject selection and method of sampling:

A systematic random sampling method was used to recruit patients with SH for the study. A total of 150 patients and 150 controls were recruited. Patient participants were matched

with the controls in terms of age and gender. The controls were recruited from GOPD and among relatives of patients.

Procedure & data acquisition:

First visit: The study subjects recruited were informed about the study and its benefits and written informed consent was obtained. They were then scheduled for the second visit within 1-3 weeks. The following procedures were carried out:

1. A semi-structured interviewer-administered questionnaires were used by the investigator to document the demographic and relevant clinical information of the participants.
2. A detailed physical examination was carried out including an examination of the cardiovascular system.
3. ABI was calculated by determining the brachial SBP and ankle SBP. These were determined by using an appropriate cuff and handheld Doppler probe (Summit Doppler LifeDop 250 Vascular Doppler 8MHz)

The ABI for each leg was calculated using the formula; $ABI = \text{Highest pressure recorded at the ankle for that leg} / \text{Highest brachial pressure obtained for both arms}$.¹¹ The ABI for each leg was calculated and the lower value was regarded as the overall ABI for that subject.

The presence of PAD was defined by ABI of less than or equal to 0.9 while the absence of PAD was defined by ABI greater than 0.9.¹²

Second visit: At this visit blood samples for investigation were taken after the participants had fasted for about 8 to 10 hours. Samples for the following investigations were taken; fasting blood sugar, fasting lipid profile, and serum electrolyte urea and creatinine.

Data analysis:

Data obtained were analyzed using the Statistical Package for Social Sciences version 20 (SPSS 20, IBM USA, Armonk, NY 10504) computer software package. The demographic

and clinical data of the patients were summarized in tables using frequencies, and percentages. The mean and standard deviation were calculated for ABI among subjects with and without SH and the difference between these two values was tested using Student's T-test. The prevalence of PAD was calculated for each group and a Chi-square test was applied to test the difference. The association between the presence of PAD and other parameters was determined by the Chi-square test. Pearson's correlation was done to determine the relationship between ABI and clinical, and biochemical profiles of hypertensive patients. Binary logistic regression analysis was conducted to determine the predictors of PAD in patients with SH.

Ethical consideration:

Ethical approval for the study was obtained from the ethical review committee of UIITH. Informed consent was obtained from the prospective subjects using a consent form that stated in clear and simple terms, the purpose of the study and the procedures to be carried out on them.

RESULTS

Socio-demographic data, and clinical and biochemical profiles of the study participants.

A total of three hundred participants were recruited for this study consisting of one hundred and fifty each for hypertensive and controls. The mean ages of both the hypertensive and normotensive subjects were similar (52.45 ± 13.46 versus 51.96 ± 13.81 years, $P=0.99$). The gender distribution between the two groups was also similar.

The mean systolic BP was significantly higher in the hypertensive subjects than in the normotensive controls (142.90 ± 15.66 versus 124.69 ± 9.10) with a P-value of <0.001 . About 45% of the hypertensive patients in this study

had been hypertensive for a period of between 1 and 4 years while only 6.7% of them had hypertension for more than 20 years as shown in Figure 1.

The mean ABI values of hypertensive subjects was significantly lower than that of the control (1.01 ± 0.11 versus 1.04 ± 0.09 ; P-value = 0.009). While the mean BMI was significantly higher in hypertensive subjects compared to

normotensive controls (28.09 ± 5.16 versus 26.38 ± 5.39 ; P-value = 0.008).

The mean values of serum creatinine, total cholesterol, LDL, and triglyceride levels were also significantly higher among hypertensive patients compared to the controls (P = 0.004, <0.001, <0.001, and <0.001 respectively). (Table 1).

Table 1

Socio-demographic characteristics, clinical and biochemical profiles of study participants

Variable	Hypertensives Mean $\pm$ SD n= 150	Normotensives Mean $\pm$ SD n=150	χ^2	t-value	P-value
Mean age	52.45 $\pm$ 13.46	51.96 $\pm$ 13.81			0.99
Gender					
Male	53(35.3)	56(37.3)	0.13		0.72
Female	97(64.7)	94(62.7)			
Education					
None	17(11.3)	25(16.7)	7.14		0.07
Primary	21(14.0)	14(9.3)			
Secondary	29(19.3)	43(28.7)			
Tertiary	83(55.3)	68(45.3)			
SBP(mmHg)	142.90 $\pm$ 15.66	124.69 $\pm$ 9.14		12.97	<0.001*
BMI(Kg/m ²)	28.09 $\pm$ 5.16	26.38 $\pm$ 5.39		2.71	0.008*
ABI	1.01 $\pm$ 0.11	1.04 $\pm$ 0.09		2.64	0.009*
SC(umol/l)	83.47 $\pm$ 0.87	80.32 $\pm$ 0.74		2.90	0.004*
FBS(mmol/l)	4.96 $\pm$ 0.68	5.07 $\pm$ 0.60		1.52	0.13
LDL(mmol/l)	2.82 $\pm$ 0.56	2.27 $\pm$ 0.43		9.80	<0.001*
HDL(mmol/l)	0.96 $\pm$ 0.14	0.99 $\pm$ 0.12		1.80	0.07
TG(mmol/l)	1.46 $\pm$ 0.30	1.32 $\pm$ 0.01		4.31	<0.001*
TC(mmol/l)	4.57 $\pm$ 0.87	4.15 $\pm$ 0.62		5.18	<0.001*

*P is significant at < 0.05; χ^2 , chi-square, SD; standard deviation, BP, systolic blood pressure; BMI, body mass index; ABI, ankle brachial index; SC, serum creatinine; FBS, fasting blood sugar; LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol.

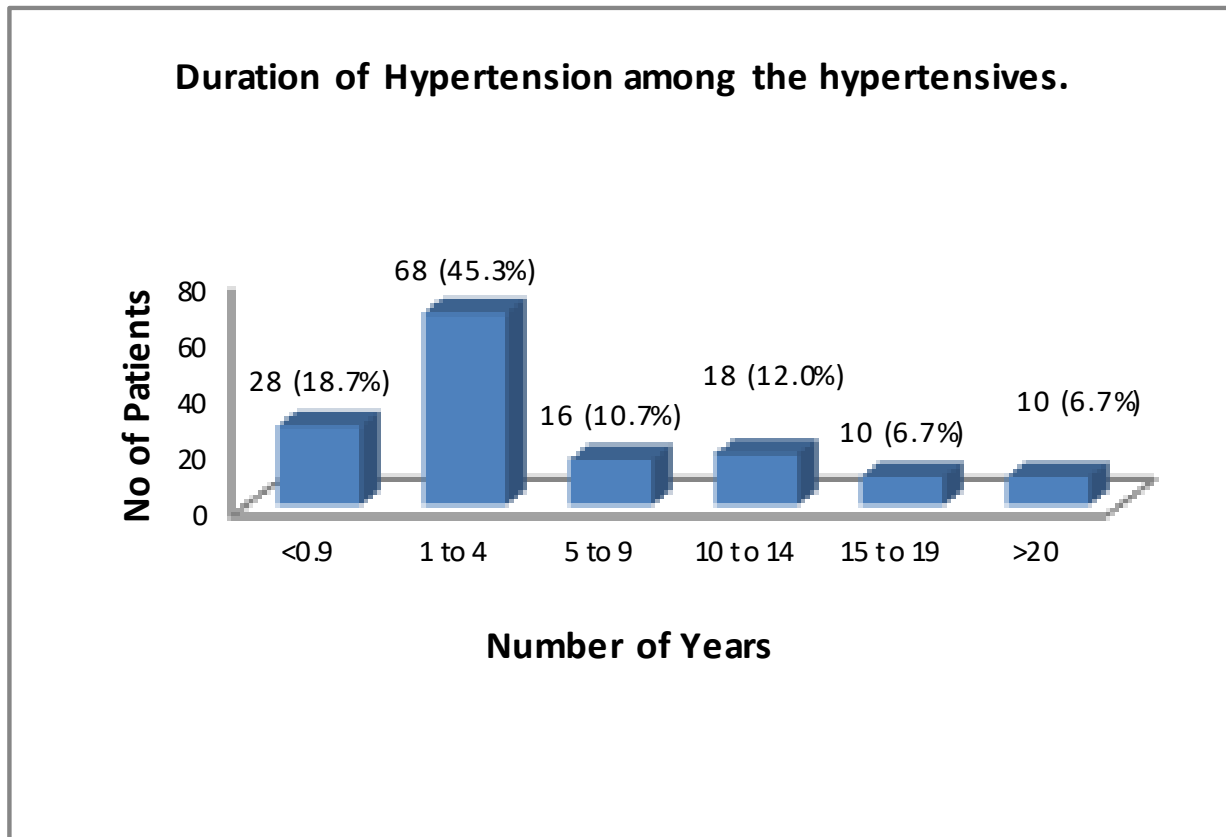


Figure 1: Bar chart showing the duration of hypertension among hypertensive patients

Prevalence of PAD among the study participants
The prevalence of PAD among hypertensive patients was 20% and 3.3% among the controls.

The difference was statistically significant with a P-value of < 0.001. (Table 2).

Table 2

Prevalence of PAD among the hypertensive and non-hypertensive patients

Variables	Hypertensives n=150	Normotensives n=150	χ^2	T-value	P-value
Mean ABI	1.01 $\pm$ 0.11	1.04 $\pm$ 0.09		2.64	0.009*
Normal ABI	99 (66.0)	115 (76.7)	20.642		<0.001*
Borderline ABI	21 (14.0)	30 (20.0)	,		
Low ABI	30 (20.0)	5 (3.3)			
PAD Present	30(20.0)	5(3.3)	20.216		<0.001*
PAD Absent	120(80.0)	145(96.7)			

* P is significant at < 0.05; PAD, peripheral artery disease; χ^2 , chi-square

Socio-demographic characteristics, and clinical and biochemical profiles of the participants with PAD

The mean age of the hypertensive patients with PAD was significantly higher than those without PAD ($P = 0.01$). The majority of patients with PAD among the hypertensive patients were between the age of 55 and 65 years. While the majority of the controls with PAD were older than 65 years of age.

The prevalence of PAD among hypertensive males was 17% while the prevalence of PAD among hypertensive females was 21.6% and no significant difference was found in the gender distribution of the hypertensive patients with PAD.

The mean BMI among hypertensive patients with PAD was higher than that of hypertensive patients without PAD ($P = 0.01$). Only two out

of thirty patients with PAD among the hypertensive patients had normal BMI and all the controls with PAD were obese.

The mean difference in BP was not statistically significant between the hypertensive patients with PAD and those without PAD ($P = 0.60$ for SBP and $P = 0.28$ for DBP). The difference between the means of serum creatinine and FBS of the hypertensive patients with and without PAD were also similar (P values = 0.47 and 0.39 respectively). While the mean LDL and total cholesterol were significantly higher among the hypertensive patients with PAD than those without PAD (P -value = <0.001 and <0.001 respectively) the serum HDL was lower among hypertensive patients with PAD than those without PAD (P -value of 0.04). (Tables 3 and 4).

Table 3
Clinical and biochemical profiles of subjects with PAD

Variable	Hypertensives PAD Absent n=120 Mean $\pm$ SD	Hypertensives PAD Present n=30 Mean $\pm$ SD	t-value	P-value
Age	51.03 $\pm$ 14.16	58.13 $\pm$ 8.09	2.64	0.01*
BMI	27.98 $\pm$ 5.17	30.46 $\pm$ 4.55	2.41	0.01*
ABI	1.05 $\pm$ 0.07	0.84 $\pm$ 0.08	13.68	<0.001*
SBP (mmHg)	144.01 $\pm$ 14.90	145.68 $\pm$ 18.0	0.53	0.60
DBP (mmHg)	86.73 $\pm$ 11.20	84.27 $\pm$ 5.98	1.08	0.28
SC (umol/l)	83.79 $\pm$ 10.35	82.20 $\pm$ 11.93	0.73	0.47
FBS (mmol/l)	4.99 $\pm$ 0.61	4.87 $\pm$ 0.92	0.89	0.39
LDL (mmol/l)	2.62 $\pm$ 0.42	3.3 $\pm$ 0.74	6.67	<0.001*
HDL (mmol/l)	0.97 $\pm$ 0.14	0.91 $\pm$ 0.13	2.13	0.04*
TG (mmol/l)	1.44 $\pm$ 0.38	1.56 $\pm$ 0.30	1.61	0.11
TC (mmol/l)	4.32 $\pm$ 0.73	5.44 $\pm$ 0.75	7.48	<0.001*

*P is significant at < 0.05 ; SD; standard deviation, SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; SC, serum creatinine; FBS, fasting blood sugar; LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol

Table 4*Socio-demographic data and clinical profiles of the participants with PAD*

Variable	Hypertensives PAD Present n = 30	χ^2	P-value	Normotensives PAD Present n = 5	χ^2	P-value
Gender						
Male	9(17.0)	0.47	0.49	3(5.36)	1.14	0.29
Female	21(21.6)			2(2.08)		
Age						
18-44	0(0.0)	21.75	<0.001*	0(0.0)	16.33	0.01*
45-54	10(25.6)			0(0.0)		
55-64	16(40.0)			1(10.52)		
>65	4(12.9)			4(3.03)		
BMI						
Normal	2(4.3)	15.32	0.002*	0(0.0)	29.28	<0.001*
Overweight	12(22.6)			0(0.0)		
Mild Obesity	8(23.5)			1(4.3)		
Moderate obesity	8(47.1)			4(26.7)		

*P is significant at < 0.05; χ^2 , chi-square; BMI, body mass index; LV, left ventricular

Relationship between ABI, clinical and biochemical profiles of the hypertensive patients

Table 5 shows the correlation between clinical and biochemical profiles of hypertensive patients with ABI. The age of the patients ($r = -0.2$, $P = 0.01$), duration of hypertension ($r = -0.27$, $P = <0.001$), and BMI ($r = -0.20$, $P = 0.01$) had weak negative correlations with ABI.

While serum LDL ($r = -0.45$, $P = <0.001$) and total cholesterol ($r = -0.44$, $P = <0.001$) had moderate negative correlation with ABI. On the other hand, serum HDL had a weak positive correlation with ABI ($r = 0.18$, $P = 0.03$). The patient's BP and serum triglyceride did not correlate with ABI.

Table 5*Relationship between ABI and clinical and biochemical profiles of the hypertensive patients*

Risk Factor	Correlation with ABI n = 150 r	P-value
Age	-0.2	0.01*
SBP	-0.08	0.33
DBP	-0.02	0.86
Duration of hypertension	-0.27	<0.001*
BMI	-0.20	0.01*
HDL	0.18	0.03*
LDL	-0.45	<0.001*
TG	-0.14	<0.09
TC	-0.44	<0.001*

r, Pearson's correlation coefficient; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; ABI, ankle brachial index; LDL, low-density lipoprotein cholesterol; HDL, high-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol.

Predictor of PAD among hypertensive patients

To determine the predictors of PAD among the subjects, a binary logistic regression was done. The predictors of PAD were age of the patient (odds ratio (OR), 1.04; 95% confidence interval

(CI), 1.01 - 1.08), duration of hypertension (OR, 1.08; 95% CI, 1.02 - 1.15), BMI (OR, 1.10; 95% CI, 1.02 - 1.20), LDL (OR, 3.41; 95% CI, 1.17 - 9.97) and total cholesterol (OR, 5.56; 95% CI, 2.33 - 13.27). (Table 6)

Table 6
Predictors of PAD among the hypertensive patients

Variables	Odds Ratio	95% CI	P- value
Age	1.04	1.01 - 1.08	0.01*
Duration of HTN	1.08	1.02 - 1.15	0.01*
BMI	1.10	1.02 - 1.20	0.02*
HDL	0.02	0.01 - 0.07	0.001*
LDL	3.41	1.17 - 9.97	0.03*
TG	0.53	0.12 - 2.36	0.41
TC	5.56	2.33 - 13.27	0.001*

*P is significant at < 0.05; CI, confidence interval at 95%; HTN, hypertension; BMI, body mass index, LDL, low-density lipoprotein, HDL, high-density lipoprotein; TG, triglyceride; TC, total cholesterol.

DISCUSSION

The mean age for this study was 52.45 ± 13.46 years for the hypertensive subjects and this is similar to findings from other studies in Nigeria^{13 14} and other African countries.¹⁵ In contrast, the studies done outside Africa reported higher ages^{16 17} and this may not be unconnected to the fact that systemic hypertension and its complications tend to occur much earlier among Africans than Caucasians.¹⁸ The sex distribution of the participants in this study has a female preponderance and this is similar to previous studies done both within and outside Nigeria^{4 13 15 16} and this likely reflects better health-seeking behaviour among the female population¹⁹.

In this study, the prevalence of PAD using ABI of ≤ 0.9 was 20% and 3.3% among hypertensive and controls respectively. Studies on the prevalence of PAD among hypertensive and normotensive subjects in Nigeria are few. However, in southern Nigeria, a prevalence of 24% and 8.7% was reported which is similar to

this index study¹³. In the study by Newman et al, 19.7% of the participants (older adults with systolic hypertension) had PAD and this is also similar to this index study.²⁰

The prevalence of PAD increased with age and also age is an independent predictor of PAD in this study. The relationship between age and PAD in this study is in tandem with earlier studies,^{4 20} atherosclerotic diseases are known to increase with age, this may explain why older hypertensive patients are more at risk compared with younger ones.

The presence of PAD has no significant relationship with the distribution of gender in this study and this was similar to what was reported by Collins et al.²¹ Though some studies reported a higher prevalence among females.^{4 22} This discrepancy may not be unconnected to the fact that a small sample size was used in this study.

Hypertension contributes to the pathogenesis of atherosclerosis, the basic underlying pathological process of PAD. Similarly, in this study the longer the duration of hypertension the higher the risk of PAD. Most studies on

PAD have little or no information on the duration of hypertension and the risk of developing PAD. There is a need for further research on this association.

Ix et al. reported that an abnormally high BMI has a significant association with PAD even among those who have never smoked.²³ This observation is similar to what was reported in this study.

In a study conducted by Saidu et al, it was reported that total cholesterol, LDL, and triglycerides were significantly higher among hypertensive patients compared with the controls.²⁴ This is similar to the observation in this study thus demonstrating that hypertension plays a significant role in the development of lipid disorders.

This study also revealed that serum total cholesterol and LDL were associated with PAD and they were independent predictors of PAD among the hypertensive subjects. Similarly, Meijer et al. in a prospective study to determine the risk factors of PAD also reported serum total cholesterol as an independent predictor of PAD 1.15 OR, 95% CI 1.06 to 1.24 after adjusting for age and sex.²² Emanuelsson et al also found a strong association between LDL and PAD in a study that involved over 100,000 participants (OR 1.96, 95% CI: 1.26–3.06).²⁵ It was concluded that lowering LDL reduces the risk of major adverse limb events among patients with PAD.

CONCLUSION

PAD is not an uncommon atherosclerotic disease among hypertensive patients of African origin and it portends a poor prognosis. The presence of dyslipidemia, old age, long duration of hypertension, and obesity increase the risk of PAD among hypertensive patients, and prompt screening

among this group of patients may help in early diagnosis and treatment.

REFERENCES

1. Whelton PK. Epidemiology of hypertension. *Lancet* (London, England). 1994 Jul 9;344(8915):101–6.
2. Lawes CM, Hoorn-Vander S, Rodgers A. Global burden of blood-pressure-related disease, 2001. *Lancet*. 2008 Mar 9;371(9623):1513–8.
3. Kolo PM, Jibrin YB, Sanya EO, Alkali M, Peter IB, Moronkola RK. Hypertension-related admissions and outcome in a tertiary hospital in northeast Nigeria. *Int J hypertens*. 2012;2012.
4. Martha UE, Andrew E, Osemwingie OA. Hypertension and lower extremity peripheral artery disease: An overlooked association. *Nig J Cardio*. 2013;10(1):26–30.
5. Emdin CA, Anderson SG, Callender T, Conrad N, Salimi-Khorshidi G, Mohseni H, et al. Usual blood pressure, peripheral arterial disease, and vascular risk: cohort study of 4.2 million adults. *BMJ*. 2015;351:h4865.
6. Maru M. Prevalence of atherosclerosis of the aorta in Ethiopians: a postmortem study. *East Afr Med J*. 1992 Apr 1;69(4):214–8.
7. Collins TC, Petersen NJ, Suarez-Almazor M, Ashton CM. The Prevalence of Peripheral Arterial Disease in a Racially Diverse Population. *Arch Intern Med*. 2003 Jun 23;163(12):1469–74.
8. Guerchet M, Aboyans V, Mbelesso P, Mouanga AM, Salazar J, Bandzouzi B, et al. Epidemiology of peripheral artery disease in elder general population of two cities of central Africa: Bangui and Brazzaville. *Eur J Vasc Endovasc Surg*. 2012;44(2):164–9.
9. Fowkes FG, Murray GD, Butcher I, Heald CL, Lee RJ, Chambless LE, et al. Ankle brachial index combined with Framingham Risk Score to predict cardiovascular events and mortality: a meta-analysis. *JAMA*. 2008 Jul 9;300(2):197–208.
10. Wattanakit K, Folsom AR, Duprez DA, Weatherley DB, Hirsch AT. Clinical significance of a high ankle-brachial index: insights from the Atherosclerosis Risk in Communities (ARIC) Study. *Atherosclerosis*. 2007 Feb;190(2):459–64.

11. Aboyans V, Criqui MH, Abraham P, Allison MA, Creager MA, Diehm C, et al. Measurement and interpretation of the Ankle-Brachial Index: A scientific statement from the American Heart Association. *Circulation*. 2012 Dec 11;126(24):2890–909.
12. Halliday A, Bax JJ. The 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in Collaboration With the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc surg*. 2018 Mar 1;55(3):301–2.
13. Odenigbo CU, Ajaero C, Oguejiofor OC. Prevalence of peripheral artery disease in adult hypertensive patients in Nnewi, Nigeria. *Sahlgrenska Med J*. 2013;16(1):15–8.
14. Adeko OO, Ariba AJ, Familoni OB, Odusan O, Osalusi SB. The pattern of ankle-brachial index among adults in Sagamu South-West Nigeria. *Niger J Cardio*. 2016;13(1):28–32.
15. Yeboah K, Puplampu P, Yorke E, Antwi DA, Gyan B, Amoah AGB. Body composition and ankle-brachial index in Ghanaians with asymptomatic peripheral arterial disease in a tertiary hospital. *BMC Obes*. 2016;3:27–34.
16. Farkas K, J  rai Z, Kolossv  ry E, Lud  nyi DL, Clement DL, Kiss I. High prevalence of peripheral arterial disease in hypertensive patients: the Evaluation of Ankle-Brachial Index in Hungarian Hypertensives screening program. *J Hypertens*. 2012 Aug 1;30(8):1526–32.
17. Bozkurt AK, Tasci I, Tabak O, Gumus M, Kaplan Y. Peripheral artery disease assessed by ankle-brachial index in patients with established cardiovascular disease or at least one risk factor for atherothrombosis--CAREFUL study: a national, multi-center, cross-sectional observational study. *BMC Cardiovasc Disord*. 2011 Jan 19;11(4):1471–2261.
18. Ojji DB, Alfa J, Ajayi SO, Mamven MH, Falase AO. Pattern of heart failure in Abuja, Nigeria: an echocardiographic study. *Cardiovasc J Afri*. 2009 Nov 1;20(6):349–52.
19. Bertakis KD, Azari R, Helms LJ, Callahan EJ, Robbins JA. Gender differences in the utilization of health care services. *J fam Pr*. 2000;49(2):147–52.
20. Newman AB, Sutton-Tyrrell K, Rutan GH, Locher J, Kuller LH. Lower extremity arterial disease in elderly subjects with systolic hypertension. *J Clin Epidemiol*. 1991;44(1):15–20.
21. Collins TC, Suarez-Almazor M, Bush RL, Pertson NJ. Gender and peripheral arterial disease. *Am Fam Med*. 2006;19(2):132–40.
22. Meijer WT, Grobbee DE, Hunink MGM, Hofman A, Hoes AW. Determinants of Peripheral Arterial Disease in the Elderly: The Rotterdam Study. *Arch Intern Med*. 2000 Oct 23;160(19):2934–8.
23. Ix JH, Biggs ML, Kizer JR, Mukamal KJ, Djousse L, Zieman SJ, et al. Association of Body Mass Index With Peripheral Arterial Disease in Older Adults The Cardiovascular Health Study. *Am J Epidemiol*. 2011 Nov 1;174(9):1036–43.
24. Saidu H, Karaye KM, Okeahialam BN. Plasma lipid profile in Nigerians with high-normal blood pressure. *BMC Res Notes*. 2014;7(1):930.
25. Emanuelsson F, Nordestgaard BG, Tybjaerg-hansen A, Benn M. High LDL Cholesterol Levels and Risk of Peripheral Vascular Diseases-A Mendelian Randomization Study Including 106,548 Individuals From the General. *Am Hear Assoc*. 2018;136:A19762.