DOI: https://doi.org/10.54393/pjhs.v5i11.2350

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 11 (November 2024)

Original Article

OPEN ACCESS

Ankle-Brachial Index as a Predictor of Peripheral Arterial Disease in Newly Diagnosed Hypertensive Patients

Safdar Ali Pervez[1*], Munir Ahmed Channa[2], Mahesh Kumar[2], Abdul Hayee Phulpoto[1], Abdul Qayoom Memon[1] and Asif Aziz[3]

[1]Department of Medicine, Khairpur Medical College, Civil Hospital, Khairpur, Pakistan
[2]Department of Medicine, Muhammad Medical College and Hospital, Mirpurkhas, Pakistan
[3]Department of Medicine, Gambat Medical College, Gambat, Pakistan

ARTICLE INFO

Keywords:
Hypertension, Peripheral Arterial Disease, Ankle-Brachial Index, Blood Pressure, Cardiovascular Risk

How to Cite:
Pervez, S. A., Channa, M. A., Kumar, M., Phulpoto, A. H., Memon, A. Q., & Aziz, A. (2024). Ankle-Brachial Index as a Predictor of Peripheral Arterial Disease in Newly Diagnosed Hypertensive Patients: Peripheral Arterial Disease in Hypertensive Patients. Pakistan Journal of Health Sciences, 5(11). https://doi.org/10.54393/pjhs.v5i11.2350

***Corresponding Author:**
Safdar Ali Pervez
Department of Medicine, Khairpur Medical College, Civil Hospital, Khairpur, Pakistan
sufee1981@gmail.com

Received Date: 5th October, 2024
Acceptance Date: 21st November, 2024
Published Date: 30th November, 2024

ABSTRACT

Hypertension was a major risk factor for cardiovascular disorder including Peripheral Arterial Disease (PAD). **Objective:** To evaluate the risk of Peripheral Arterial Disease (PAD) in newly diagnosed hypertensive patients using Ankle-Brachial Index (ABI) measurements and to determine its potential role as a predictor of cardiovascular risks in this population. **Methods:** The study was an observational, cross-sectional study. This study was conducted in Khairpur Medical College Civil Hospital Khairpur Mirs. The duration of this study was six months, from November 2023 to April 2024This study include n= 246 newly diagnosed hypertension. Three levels of ABI had been identified through determining the ABI in both legs: low ABI (<0.9), normal ABI (0.9-1.4), and high ABI (>1.4). Student's t-test. Pearson correlation test have been utilized when assessing the significance of the association between ABI levels and blood pressure values. **Results:** ABI was normal in 60% of the 246 participants, low in 20% and high in 20% of them. In comparison to those who had normal and high ABI, participants who had low ABI showed considerably higher SBP in both lower limbs ($p < 0.001$). Furthermore, there was additionally a significant distinction ($p < 0.001$) in the SBP and DBP among people who had high ABI. Participants with average ABI had higher SBP in their right upper limb than those who suffered from elevated ABI ($p < 0.001$). **Conclusions:** This study showed that in individuals who have recently identified high blood pressure, there was a significant relationship among ABI levels and arterial pressure levels.

INTRODUCTION

The heart pumps blood throughout the body, it exerts force on the artery walls. This force is known as Blood Pressure (BP). Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) are the two standard values used to express it [1]. Blood pressure is measured in two ways: diastolic blood pressure is the pressure in the arteries during diastole, or the time between heartbeats, and systolic blood pressure is the pressure in the arteries during a heartbeat. When taken collectively, these metrics offer a significant indicator of cardiovascular health [2, 3]. Both alcohol abuse and smoking have direct and indirect effects on blood pressure, further compounding the risk [4]. Specifically, in elderly people, Peripheral Artery Disease (PAD) is a widespread condition which is strongly connected to cardiac risk factors such as atherosclerosis, and hypertension [5]. Whenever utilized as an evaluation instrument for recently identified high blood pressure people with disabilities, the Ankle-Brachial Index (ABI) provides essential details concerning premature PAD being recognized. Ankle to brachial systolic Arterial Blood flow ratio (ABI) is an easy to understand, minimally invasive diagnostic. ABI scores < 0.9 are predictive of PAD and point to restriction or congestion of the vasculature [6, 7]. It additionally seems essential to recognize PAD early due to enhances the chance of unfavourable cardiovascular complications, such as haemorrhage and myocardial infarction, which can be fatal. The pharmaceutical therapies, changes in behaviour, and, if needed surgery alternates may collectively minimize such hazards for those who have lower ABI scores as they get early

DOI: https://doi.org/10.54393/pjhs.v5i11.2350

treatment [8, 9]. Clinicians may more effectively recognize subclinical cardiovascular disease and start adequate prevention efforts via incorporating ABI examination into typical clinical care for recently identified people with high blood pressure [10]. With respect to either the greatest or minimum degrees of ankle stress, there are different methods for figuring out ABI. The most elevated ankle pulse has been adopted as an average in the latest recommendations released by the American Heart Association (AHA) and the Inter-Society Consensus for the Handling of Peripheral Arterial Disease (TASC II). These suggestions, at the same time, have not been frequently embraced and therefore could overestimate the real frequency of PAD [11]. What is the prevalence of Peripheral Arterial Disease (PAD) in newly diagnosed hypertensive patients, as determined by Ankle-Brachial Index (ABI), and how effectively can ABI serve as a predictor of cardiovascular risk in this population?

This study aimed to evaluate the risk of Peripheral Arterial Disease (PAD) in newly diagnosed hypertensive patients using Ankle-Brachial Index (ABI) measurements and to determine its potential role as a predictor of cardiovascular risks in this population.

METHODS

The study was an observational, cross-sectional study, conducted in Department of Hypertension and Cardiovascular at Khairpur Medical College Civil Hospital Khairpur Mirs. The duration of this study was six months, from November 2023 to April 2024. A total of 246 participants were enrolled using convenience sampling method. Inclusion criteria were participants aged between 30-55 years, newly diagnosed Hypertensive Patient without any antihypertensive medications, of both sex were involved in study. Exclusion criteria were diabetic participants, long standing hypertension, and peripheral nervous system disorder. The formula for estimating proportions was as follows: n= Z2. P. (1-P)/d2, n=sample size, Z= (1.96 or 95% confidence level), P=estimated proportion (0.20 or 20%), d= margin of error (0.05 or 5%). The required sample size was n=246. Each participant had their body measurements conducted in a lab following along to a set procedure. Weight/height2 was used to compute BMI. A computerized oscillometric devices (Watch BP Office, Microlife, Widnau, Switzerland) was employed to evaluate the ABI. Before having their blood pressure quantified, every individual was permitted to lie down in a lying down position for no less than of 5 minutes. Before the test, the individuals had been warned not to drink any tea, coffee, or other cardiomodulator agents. ABI was determined through determining the highest brachial systolic arterial blood pressure of each arm (Rt or Lt) and multiplying it by the mean systolic blood pressure from either ankle. Every three minutes, for a length of one minute, the systolic and diastolic Blood Pressures (BP) were taken into consideration. The blood pressure was taken, the cuffs were taken off, and the patients were free to depart. The ABI was computed and the blood pressure data was recorded daily. Data were analyzed by using SPSS version 21.0. Continuous variables such as age and blood pressure were expressed as mean ± SD. Categorical variables, including smoking status and gender, were presented as percentages. Student's t-test was used to evaluate the relationship between ABI and blood pressure. Student's t-test was used to compare the means of ABI between different groups (blood pressure levels), which was appropriate for comparing the means of two independent groups. Pearson Correlation Test was applied to analyze the linear relationship between ABI and blood pressure parameters. P<0.005 was considered as significant. The study was approved by the Institutional Review Board (KMC/RERC/74), ensuring adherence to ethical standards. Informed consent was obtained from all participants prior to their involvement in the study.

RESULTS

This study of 246 newly diagnosed hypertensive individuals, with a mean age of 50 years and 60% male, assessed their risk for Peripheral Artery Disease (PAD) using the Ankle Brachial Index (ABI). The participants had an average BMI of 25–29.9, indicating overweight status, and 25% were smokers. The mean LDL cholesterol was 110 ± 35 mg/dL, triglycerides 150 ± 40 mg/dL, and total cholesterol 195 ± 30 mg/dL. Additionally, 40% of participants were sedentary, increasing their risk for PAD progression. These findings were detailed in table 1.

Table 1: Demographic Variables of study participants (n=246)

Demographics	Variables	Total Number of Participants Mean ± SD/ N (%)
Age	-	50 ± 10
Gender	Male	146 (60%)
	Female	198 (40%)
BMI (Kg/m^2)	-	27.5 ± 4.2
Smoking Status	Smokers	62 (25%)
	Non-Smokers	184 (75%)
Hypertension Stage	Stage 1	172 (70%)
	Stage 2	74 (30%)
ABI Categories	Normal (1.0-1.4)	148 (60%)
	Borderline (0.91-0.99)	49 (20%)
	PAD (<0.9)	49 (20%)
Lipid Profile	Total Cholesterol	195 ± 30
	LDL Cholesterol	110 ± 35
	HDL Cholesterol	45 ± 10
	Triglycerides	150 ± 40
Physical Activity	Sedentary	98 (40%)
	Active	148 (60%)

The right Ankle-Brachial Index (ABI) showed significant negative correlations with systolic blood pressure (SBP) in both the right upper limb ($r = -0.310$, $p = 0.021$) and the left upper limb ($r = -0.340$, $p = 0.010$). Conversely, a positive correlation was observed between right ABI and SBP in the

DOI: https://doi.org/10.54393/pjhs.v5i11.2350

right lower limb (r = 0.510, p < 0.001). The left ABI demonstrated a significant negative correlation with SBP in the left upper limb (r = −0.390, p = 0.005). However, diastolic blood pressure (DBP) correlations were not significant (p > 0.05). Pearson correlation analysis was employed to assess these relationships. These findings highlight the potential value of ABI in evaluating systolic blood pressure, as shown in table 2.

Table 2: Correlation of ABI with Blood Pressure (BP) Variables (n=246)

Variables	Left ABI (p)	Right ABI (r)	Right ABI (p)	Left ABI (r)
SBP Right Upper Limb (mmHg)	-0.310	0.021	-0.340	0.010
SBP Left Upper Limb (mmHg)	-0.200	0.150	-0.390	0.005
SBP Right Lower Limb (mmHg)	0.510	<0.001	0.130	0.300
SBP Left Lower Limb (mmHg)	0.280	0.040	0.150	0.250
DBP Right Upper Limb (mmHg)	-0.190	0.170	-0.110	0.450
DBP Left Upper Limb (mmHg)	-0.170	0.190	-0.180	0.180
DBP Right Lower Limb (mmHg)	0.070	0.550	0.010	0.920

Patients with low ABI, indicating PAD, have significantly higher systolic (SBP) and diastolic blood pressure (DBP) compared to those with normal or high ABI, suggesting elevated peripheral resistance. Statistically significant differences in SBP (p<0.001) and DBP (p=0.001-0.004) were observed across ABI groups, with a t-value of 5.51 (p<0.001), indicating a clear association between blood pressure and ABI levels (Table 3).

Table 3: Left ABI as a Predictor of Blood Pressure Variations in Diagnosed Hypertensive Participants

Predictor Markers	Right Upper Limb (SBP) Mean ± SD	Left Upper Limb (SBP) Mean ± SD	Right Lower Limb (SBP) Mean ± SD	Left Lower Limb (SBP) Mean ± SD	Right Upper Limb (DBP) Mean ± SD	Left Upper Limb (DBP) Mean ± SD	Right Lower Limb (DBP) Mean ± SD	Left Lower Limb (DBP) Mean ± SD	t-value	p-Value
Low ABI (<0.9)	160 ± 20	158 ± 22	165 ± 19	163 ± 20	95 ± 14	94 ± 12	97 ± 13	96 ± 11	-	>0.001*
Normal ABI (0.9-1.4)	135 ± 15	130 ± 14	145 ± 17	130 ± 16	85 ± 8	84 ± 7	87 ± 9	86 ± 7	-	-
High ABI (>1.4)	145 ± 18	143 ± 17	150 ± 19	148 ± 21	90 ± 10	89 ± 12	91 ± 11	92 ± 13	5.51	>0.001*
p-Value	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.003	0.004	-

Participants with low ABI (<0.9) showed significantly higher systolic and diastolic blood pressure (SBP and DBP) compared to those with normal or high ABI, indicating a link to PAD. For example, right upper limb SBP was 160 ± 21 mmHg for low ABI versus 136 ± 17 mmHg for normal ABI. Similarly, DBP in the low ABI group was 96 ± 13 mmHg in lower limbs compared to 85 ± 9 mmHg for normal ABI. The high ABI group had higher BP than the normal group, suggesting arterial stiffness, but less than the low ABI group. A t-value of 7.1 and p-value < 0.001 confirmed these differences were statistically significant (Table 4).

Table 4: Right ABI as a Predictor of Blood Pressure Variations in Diagnosed Hypertensive Participants

Predictor Markers	Right Upper Limb (SBP) Mean ± SD	Left Upper Limb (SBP) Mean ± SD	Right Lower Limb (SBP) Mean ± SD	Left Lower Limb (SBP) Mean ± SD	Right Upper Limb (DBP) Mean ± SD	Left Upper Limb (DBP) Mean ± SD	Right Lower Limb (DBP) Mean ± SD	Left Lower Limb (DBP) Mean ± SD	t-value	p-Value
Low ABI (<0.9)	160 ± 21	158 ± 19	165 ± 23	162 ± 22	96 ± 13	94 ± 15	97 ± 11	96 ± 15	-	>0.001*
Normal ABI (0.9-1.4)	136 ± 17	130 ± 11	145 ± 10	130 ± 11	85 ± 9	84 ± 6	88 ± 6	88 ± 7	-	-
High ABI (>1.4)	145 ± 18	146 ± 17	152 ± 20	91 ± 11	90 ± 11	95 ± 11	93 ± 12	92 ± 13	7.1	>0.001*
p-Value	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.003	0.004	-	-

DISCUSSION

ABI measurements that were important, a comprehensive clinical history, and an assessment of physical characteristics enable healthcare workers to assess the patient's whole cardiovascular health [12]. Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) for each of the legs showed consistently elevated among people having low ABI values an indication of PAD than in participants with normal or high ABI values [13]. In the current study to find that, the peripheral artery constriction, which lowers blood flow to the limbs, was the hallmark of Peripheral Artery Disease (PAD). The body raises blood pressure in an attempt to make up for the compromised perfusion. An increased risk of cardiovascular problems, such as heart attack, stroke, and further advancement of PAD, was indicated by elevated SBP and DBP in patients with low ABI [14, 15]. In the present study to find that, the relationship between the blood pressure in each ankle and the limbs; a significant correlation was found between the ABIs in both ankles and the blood pressure in the right upper and left lower limbs, and a significant correlation was found between the left ankle and the blood pressure in both upper and lower limbs. The participants' ABIs were all within the normal range for ABI, which was typically 0.9 to 1.3, indicating that none of the participants had severe peripheral artery disease [16]. In the current study to found that, this implies that arterial stiffness and abnormalities in arterial pressure especially among the limbs can be observed in the ABI. The purpose of this research was to examine the differences in blood pressure parameters across groups with low, normal, and high Ankle-Brachial Index (ABI) levels. By identifying these contrasts, the study aims to highlight the associations between ABI levels, hypertension, and Peripheral Arterial Disease (PAD). Specifically, it explores how low ABI

DOI: https://doi.org/10.54393/pjhs.v5i11.2350

(indicative of PAD) and high ABI (linked to arterial stiffness) relate to elevated systolic and diastolic blood pressures compared to normal ABI levels. The parameters of blood pressure were measured across different groups. The Upper Limb's SBP variations were far greater among those with Low ABI, but participants who had more ABI reported considerably greater SBP in the two lower limbs [17]. The participants in the normal ABI group may have adequate arterial regulation that suggests their arteries were capable of expanding to an appropriate level in reaction to increased blood circulation, according to their larger SBP. However, the heightened SBP could indicate that the above limbs' greater systolic arterial pressure has been triggered by other systematic variables, that include stress, heightened cardiac output, or initial stages hypertension. We were agreed from the previous study [18]. On the other hand, people with high ABI might be suffering from arterial stiffness that can cause peripheral artery systolic blood pressure to fall regardless of expanding essential hypertension. Patients having various levels of arterial stiffness might display different patterns of elevated blood pressure in the upper extremity on right side comparing to the lower extremities or the left upper limb, particularly where the arterial stiffness remains more confined [19]. While there was a correlation between higher mortality and high ABI values (≥1.3) indicating arterial stiffness, the risk was generally smaller than that of ABI values <0.9, which suggest more severe PAD (Peripheral Arterial Disease). In patients with underlying diseases such as hypertension, high ABI values were more concerning even though they were not as frequently associated with symptomatic PAD. In a similar vein, borderline-low ABI values (0.9–1.1) should be cautiously watched as they may signal early PAD or other cardiovascular problems. In general, a complete cardiovascular evaluation and continued monitoring were necessary to control and minimize any consequences that may arise from high or borderline-low ABI levels [20]. Based on the findings, incorporating ABI measurement into routine hypertension management could help identify early signs of Peripheral Arterial Disease (PAD), especially in patients with high Systolic Blood Pressure (SBP). Since ABI was correlated with SBP, particularly in the upper and lower limbs, it can serve as a valuable tool in assessing vascular health and PAD risk in hypertensive patients. Healthcare providers should consider using ABI to personalize treatment plans and detect PAD early, improving overall management and reducing cardiovascular risks.

CONCLUSIONS

This study reveals significant correlations between ABI and blood pressure, particularly Systolic Blood Pressure (SBP) in both upper and lower limbs. The findings underscore ABI's potential as a valuable tool for assessing hypertension severity and the risk of Peripheral Arterial Disease (PAD) in hypertensive patients. The positive correlation between ABI and SBP in the lower limbs suggests that higher blood pressure may increase PAD risk, highlighting the importance of including ABI measurement in routine hypertension management.

Authors Contribution

Conceptualization: SAP
Methodology: MAC, MK, AHP, AQM
Formal analysis: AHP, AQM
Writing, review and editing: AQM, AA

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Li J, Somers VK, Gao X, Chen Z, Ju J, Lin Q *et al.* Evaluation of optimal diastolic blood pressure range among adults with treated systolic blood pressure less than 130 mm Hg. Journal of the American Medical Association Network Open. 2021 Feb; 4(2): e2037554-. doi: 10.1001/jamanetworkopen.2020.37554.

[2] Schutte AE, Kollias A, Stergiou GS. Blood pressure and its variability: classic and novel measurement techniques. Nature Reviews Cardiology.2022 Oct; 19(10): 643-54. doi: 10.1038/s41569-022-00690-0.

[3] Shrivastava A, Chakkaravarthy M, Shah MA. A new machine learning method for predicting systolic and diastolic blood pressure using clinical characteristics. Healthcare Analytics. 2023 Dec; 4: 100219. doi: 10.1016/j.health.2023.100219.

[4] Drawz PE, Beddhu S, Kramer HJ, Rakotz M, Rocco MV, Whelton PK. Blood pressure measurement: a KDOQI perspective. American Journal of Kidney Diseases. 2020 Mar; 75(3): 426-34. doi: 10.1053/j.ajkd.2019.08.030.

[5] Golledge J. Update on the pathophysiology and medical treatment of peripheral artery disease. Nature reviews cardiology. 2022 Jul;19(7):456-74.doi: 10.1038/s41569-021-00663-9. Epub 2022 Jan 7.

[6] Cáceres-Farfán L, Moreno-Loaiza M, Cubas WS. Ankle-brachial index: more than a diagnostic test?. Archivos Peruanos de Cardiología y Cirugía Cardiovascular. 2021 Oct; 2(4): 254. doi: 10.47487/apcyccv.v2i4.168.

Herraiz-Adillo A, Cavero-Redondo I, Alvarez-Bueno C,

DOI: https://doi.org/10.54393/pjhs.v5i11.2350

[7] Pozuelo-Carrascosa DP, Solera-Martinez M.The accuracy of toe brachial index and ankle brachial index in the diagnosis of lower limb peripheral arterial disease: a systematic review and meta-analysis. Atherosclerosis. 2020 Dec; 315: 81-92. doi:10.1016/j.atherosclerosis.2020.09.026.

[8] Danieluk A and Chlabicz S. Automated measurements of ankle-brachial index: a narrative review. Journal of Clinical Medicine. 2021 Nov; 10(21): 5161. doi: 10.3390/jcm10215161.

[9] Poredos P, Stanek A, Catalano M, Boc V. Ankle-Brachial Index: Diagnostic Tool of Peripheral Arterial Disease and Predictor of Cardiovascular Risk-An Update of Current Knowledge. Angiology. 2024 Jan: 00033197241226512. doi: 10.1177/00033197241226512.

[10] Singhania P, Das TC, Bose C, Mondal A, Bhattacharjee R, Singh A *et al.* Toe brachial index and not ankle brachial index is appropriate in initial evaluation of peripheral arterial disease in type 2 diabetes. Diabetology & Metabolic Syndrome.2024 Feb; 16(1): 52. doi: 10.1186/s13098-024-01309-9.

[11] Erzinger FL, Polimanti AC, Pinto DM, Murta G, Cury MV, Silva RB, Biagioni RB, Belckzac SQ, Joviliano EE, Araujo WJ, Oliveira JC. Brazilian Society of Angiology and Vascular Surgery guidelines on peripheral artery disease.Jornal Vascular Brasileiro.2024 Oct 28;23:e20230059. doi: 10.1590/1677-5449.202300592.

[12] Myslinski W, Stanek A, Feldo M, Mosiewicz J. Ankle-brachial index as the best predictor of first acute coronary syndrome in patients with treated systemic hypertension. BioMed Research International. 2020 Jul; 2020(1): 6471098. doi: 10.1155/2020/6471098.

[13] Uchida S, Kamiya K, Hamazaki N, Nozaki K, Ichikawa T, Yamashita M *et al.* The Association between the Level of Ankle-Brachial Index and the Risk of Poor Physical Function in Patients with Cardiovascular Disease. Journal of Atherosclerosis and Thrombosis.2024 Apr; 31(4): 419-28. doi: 10.5551/jat.64531.

[14] Pereira Filho AJ, Sartipy F, Lundin F, Wahlberg E, Sigvant B. Impact of ankle brachial index calculations on peripheral arterial disease prevalence and as a predictor of cardiovascular risk. European Journal of Vascular and Endovascular Surgery.2022 Aug; 64(2-3) : 217-24. doi: 10.1016/j.ejvs.2022.05.001.

[15] Sukhija R, Aronow WS, Yalamanchili K, Peterson SJ, Frishman WH, Babu S. Association of ankle-brachial index with severity of angiographic coronary artery disease in patients with peripheral arterial disease and coronary artery disease.Cardiology.2005 Apr; 103(3): 158-60. doi: 10.1159/000084586.

[16] Chang YM, Lee TL, Su HC, Chien CY, Lin TY, Lin SH *et al.* The Association between Ankle-Brachial Index/Pulse Wave Velocity and Cerebral Large and Small Vessel Diseases in Stroke Patients. Diagnostics.2023 Apr; 13(8): 1455. doi: 10.3390/diagnostics13081455.

[17] Yang W, Sun L, He Y, Xu X, Gan L, Guo T *et al.* Association between four-limb blood pressure differences and arterial stiffness: a cross-sectional study. Postgraduate Medicine. 2022 Apr; 134(3): 309-15. doi: 10.1080/00325481.2022.2046415.

[18] Richard NA, Hodges L, Koehle MS. Elevated peak systolic blood pressure in endurance-trained athletes: Physiology or pathology?. Scandinavian Journal of Medicine & Science in Sports. 2021 May; 31(5): 956-66. doi: 10.1111/sms.13914.

[19] Laurent S and Boutouyrie P. Arterial stiffness and hypertension in the elderly.Frontiers in Cardiovascular Medicine.2020 Oct; 7: 544302.doi:10.3389/fcvm.2020.544302.

[20] Hasan M, Verma MK, Gupta N, Jasrotia RB, Gangwar V, Tiwari S. risk of peripheral arterial disease (PAD) development by measuring ankle brachial index (ABI) in newly diagnosed hypertensive patients: a cross-sectional study. International Journal of Medicine & Public Health. 2024 Jul; 14(3): 268. doi:10.70034/ijmedph.2024.3.48.