The Egyptian Journal of Hospital Medicine (January 2023) Vol. 90 (2), Page 3598-3602

The Effect of Inter-Arm Blood Pressure Difference on Left Ventricular Function: Review Article

Mohamed Hussien EL-maghrabi, Mesbah Taha Hassanein, Ibtesam Ibrahim El-dosouky, Eman Hesham Sedik
Cardiology Department, Faculty of Medicine, Zagazig University, Zagazig City 44519, Egypt
***Correspondence author: Mohamed Hussien EL-Maghrabi**.
Tel: 01153948885, E-mail: mailto:mhumagh@yahoo.com

ABSTRACT

Background: A significant but yet manageable risk factor for cardiovascular disease is hypertension. Increased mortality and morbidity are linked to it. Accurate blood pressure measurement is necessary for the early diagnosis of hypertension and the prevention of its consequences blood pressure (BP). The reading of blood pressure is typically identical in each arm. However, the term "inter-arm difference" refers to the natural occurrence of a reading disparity between the two arms Inter-arm blood pressure difference (IAD). **Objective:** To evaluate the incidence of different blood pressure between the two arms and to determine the connection between variations in interarm blood pressure and left ventricle (LV) systolic and diastolic parameters. **Conclusion:** Since monitoring BP is a straightforward but vital factor in identifying the population most at risk for future vascular events, particularly in HTN patients who appear to have control of their condition, learning It is crucial to know how common IAD is among adults.

Keywords: Inter-arm blood pressure difference, blood pressure, and left ventricular function.

Abbreviations: Blood pressure (BP), Systolic blood pressure(SBP), Diastolic blood pressure (DBP), Inter-arm blood pressure difference (IAD), Target organ damage (TOD), Millimeter of mercury (mmHg), Ambulatory blood pressure monitoring (ABPM), Home blood pressure monitoring (HBPM), National Hypertension Project (NHP), Hypertension (HTN), coronary artery disease (CAD), Hypertension-Mediated Organ Damage (HMOD), Chronic kidney disorders (CKD), Left ventricular hypertrophy (LVH), Inter-arm blood pressure difference (IABPD), peripheral vascular disease (PVD),ankle-brachial pressure index (ABPI).

INTRODUCTION

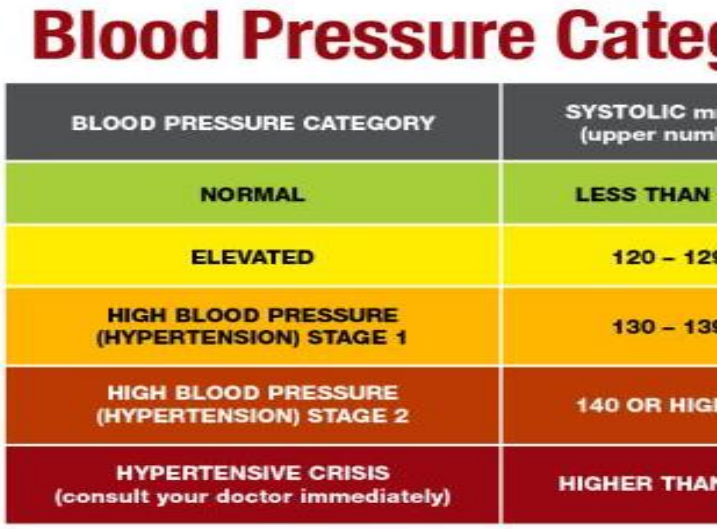
The prevalence of IADs rises in tandem with the population's underlying cardiovascular issues. When scheduling upcoming studies and when delivering therapeutic care, it is important to consider population-specific variations in the prevalence of IAD [(1)].

Usually, the same blood pressure readings were obtained in both arms. But there is frequently an Inter-arm (IAD), also referred to as a reading difference between the two arms [(2)]. The SBP can be relevant if it is greater than 10 mmHg. It might be a physiological occurrence in young people caused by one arm's stronger muscles compressing the artery more than the other. Additional pathogenic factors include aortic aneurysms, subclavian artery stenosis, vasculitis, connective tissue diseases, aortic coarctation, and thoracic outlet syndrome [(3)].

Hypertension:

According to the majority of major guidelines, hypertension should be diagnosed when a person's systolic blood pressure (SBP) in the clinic or doctor's office is more than or equal 140 mmHg (≥140) and/or diastolic BP (DBP) readings of more than 90 mmHg (≥90) as shown in tables 1 and 2 [(4)].

Table (1): Blood pressure categories.



BLOOD PRESSURE CATEGORY	SYSTOLIC m (upper num
NORMAL	LESS THAN
ELEVATED	120 – 12
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 13
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIG
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN

Received: 14/09/2022
Accepted: 17/11/2022

Table (2): Hypertension is defined by Readings of ambulatory and home blood pressure all adults are affected by these definitions (>18 year old)**.**

	SBP/DBP, mm Hg
Office BP	≥140 and/or ≥90
Ambulatory blood pressure monitoring (ABPM).	
24-h average	≥130 and/or ≥80
Day time (or awake) average	≥135 and/or ≥85
Night time (or asleep) average	≥120 and/or ≥70
Home blood pressure monitoring (HBPM)	≥135 and/or ≥85

High-normal blood pressure is used to identify people who could benefit from lifestyle changes and who would receive pharmaceutical treatment in the event of strong indications [4,5].

Both young and old persons can have High SBP (>140 mmHg) and low DBP are considered to be signs of systolic hypertension on its own (90 mmHg). The most prevalent type of primary hypertension isolated systolic hypertension affects adolescents, children, and young adults. The elderly, however, who exhibit a stiffness of the principal arteries and an increase in heart rate (difference between SBP and DBP), are also particularly susceptible to it [6].

Prevalence of hypertension:

Regardless of income status, hypertension has a high frequency that is consistent around the world. With increasing ageing, hypertension becomes more prevalent, with a prevalence of >60% in individuals older than 60. People with hypertension will become more sedentary as populations age; by 2025, there will be close to 1.5 billion of them [7].

Based on information from the National Hypertension Project (NHP), in Egypt, hypertension is one of the most prevalent non-communicable disorders. According to the latest WHO data on non-communicable illnesses in Egypt, HTN prevalence has increased to 40%. Those older than 60 years old who had suffered from hypertension in greater than 50% of cases. Accordingly, if there are more than 80 million people in Egypt, 15 million of them will have high blood pressure (HTN), and 7 million of them will require medication and ongoing monitoring [8]. Only 38% of Egyptians with hypertension had high blood pressure and knew it, and only 24% were taking medication, compared to 14% of those with control blood pressure (140/90 mmHg), making the problem worse. 60% of people with hypertension also had additional cardiovascular risk factors, including obesity, diabetes, impaired glucose tolerance, hypertriglyceridemia, hypertriglyceridemia, low HDL cholesterol, high LDL cholesterol, and high cholesterol are all types of high blood fats [9].

Based on office BP, it was revealed that hypertension affected 1.13 billion people worldwide in 2015, with approximately 150 million of those people living in central and Eastern Europe. In 2015, the global age-standardized adult male and female prevalence rates for hypertension were 24 and 20%, respectively with a range of 30 to 45% [10].

The leading factor and most frequent cause of risk of death is that can be modified is cardiovascular disease, is high blood pressure. With a predicted growth of 13% from 2000 to 2025, the estimated 29.5% global prevalence of hypertension (HTN) in women, compared to 11% in males. 1 In both economically developed and developing nations, women generally demonstrated greater knowledge, treatment, and control rates of HTN than men [11].

HTN was classified as mild if BP was 140–159/90–109 mm Hg and severe if ≥160/110 mm Hg [9].

Based on the Egyptian recommendations' risk score approach for hypertension individuals, a global cardiovascular risk was evaluated. Patients with established cardiovascular conditions were thought to have a very high risk of heart attacks and strokes in the future (peripheral arterial disease, cerebrovascular disease, and coronary artery disease). Patients who have more than three cardiovascular risk factors (male gender, female or male age >55 or >45, current smokers, dyslipidemia, obesity), organ damage, and diabetes mellitus were considered to be at high risk. Whereas intermediate-risk patients had one to three cardiovascular risk factors. Patients in the low-risk group did not have any target organ damage or additional risk factors [11].

People with high blood pressure who have more than stage I (160/100 mmHg) were found to have damage to the target organ, including 20% of people with ECG-LVH, 16% of people with CAD, 5% of people with systolic heart failure, and 3.2% of people with renal failure have this condition. Egypt has one of the highest rates of people dying because of CAD. High blood pressure was an acknowledged key risk factor for CAD [9].

Hypertension-Mediated Organ Damage (HMOD):

Hypertension-mediated organ damage is the term used to describe the structural or functional changes caused by elevated blood pressure in the blood vessels of the arteries and/or the organs they serve. Eyes, brain, heart, kidneys, central and peripheral arteries, and kidneys are examples of end organs. The care of patients who have already been classified as high risk (those who have been diagnosed with CVD, stroke, or diabetes), Chronic kidney disorders (CKD), or familial hypercholesterolemia) is unlikely to change in the event that another detection of

HMOD is made. It can, however, provide important therapeutic guidance on management for hypertensive patients with low or moderate overall risk due to HMOD presence and preferential pharmaceutical treatment based on the specific impact on HMOD [24]. Patients with more advanced stages of HTN had damage to their target organs, such as CAD, LVH, systolic cardiac failure, and renal failure. HTN a significant risk factor that has been discovered for CAD, and the mortality rate from secondary CAD in Egypt is among the highest in the world [9].

Inter-arm blood pressure difference (IABPD)

Due to variances in readings, it is important to monitor both arms' blood pressure to prevent under-diagnosis of hypertension. Both the systolic and diastolic readings should be taken in a clinical setting. Because hypertension is a preventable risk factor that raises mortality and morbidity, accurate blood pressure measurement is essential preventing cardiovascular, cerebrovascular, and renal disorders. The difference between the arms' systolic blood pressure is referred to as the "inter-arm difference" (IAD). which can be easily assessed clinically without the use of additional tools and appears to be acceptable to patients. Unrecognized variations mistakes in the interpretation and management of blood pressure can result from different blood pressure readings in the arms putting people in danger without need for it. Understanding the examination procedure, current best practises, and risk factors is essential because finding a Peripheral vascular disease is indicated by Inter-arm difference. IAD can lower the ankle-brachial pressure index (ABPI), which might serve as a prognostic marker for heart disease. It is understood to be a sign of PVD [12].

Prevalence and degree of IAD that carries risk:

The Joint National Committee's seventh report, the 2017 American College of Cardiology/American Heart Association guideline and the most recent British government's hypertension management recommendations all advise taking your blood pressure in both arms. Record the value that is higher the difficulty of taking both arms' upper blood pressure could be attributed to a number of factors, including cost, lack of workforce, manpower, and time. In the majority of studies, the right arm's blood pressure was checked in order to look for hypertension. On sick people, elderly patients admitted to ICUs, and pregnant women, several research and meta-analyses have been carried out, however, studies on IABPD in young, healthy populations are scarce. As there have been few research, it is uncertain how common IABPD is in the populations [12]. 700 patients with cardiovascular disease participated in Hirono's study, and 11% of them had a left arm BP that was about 5 mmHg higher than the right, while 16% had a right arm BP that was at least 5 mmHg higher than the left, and the other has an IAD of under 5% [13].

The right arm's blood pressure was 4-5 mmHg higher than the left, according to a study done by Cassidy and Jones. 147 hypertensive patients' right arm SBP ranged between 2 and 3 mmHg higher [14]. Systolic variations of less than 10 mmHg are widespread, occurring in 11% of people with hypertension, 4% of the population overall and 7% of those with diabetes [15].

In fact, cross-sectional studies have connected diabetic retinopathy and diabetic nephropathy, respectively, with retinopathy and a lower systolic IAD of 15 mmHg. The observed IAD is most likely explained by arterial stiffening, which is indicated by arterial stiffness and/or a faster heartbeat rate, despite the fact that there are opposing theories regarding the cause of an IAD. This is because there is a correlation between an IAD and the accompanying scream. Systolic IAD values below 15 and, more recently, below 10 millimetres have been linked prospectively to cardiovascular and all-cause death in study level meta-analyses [16].

Meta-analysis using prospective individual participant data (IPD) was finished to give solid evidence for practitioners taking blood pressure. It was known as INTERPRESS-IPD and combines information from 57 000 participants across 24 cohorts (arterial stiffness and/or a faster heartbeat rate). In a validated multivariable model that takes into account factors like After adjustment, even after accounting for variables such as IAD was still a significant predictor of cardiovascular and all-cause mortality, even after controlling for factors such as age, sex, ethnicity, smoking status, systolic blood pressure, and diabetes and/or hypertension diagnoses data from North America, East Asia, Europe, Africa South of the Sahara were combined. Rising risks were linked to higher magnitudes of IAD, and a lower 5 mmHg systolic IAD cutoff was established. A marker for increased overall mortality has been identified [17]. National and international guidelines have long recommended taking blood pressure readings in both arms during the initial assessment of hypertension in order to standardize future blood pressure measurements and evaluate the effects of treatment on the arm with the higher reading. The recommendations did not go into great depth about how or why it's important to check both arms' blood pressure. The 2018 European Society of Cardiology and European Society of Hypertension (ESC/ESH) guidelines and upcoming NICE guidelines both state that a systolic IAD of less than 15 mmHg is currently "associated with an elevated risk of cardiovascular events." [6-18]. IABPD with systolic blood pressure (SBP) greater than 5 or 10 mm Hg was discovered to be an independent predictor of poor cardiovascular outcome and all-cause death in a cohort study of people without a history of cardiovascular disease [15].

A different prospective study (CoCoNet) with 3699 participants found that patients with higher IABPD SBP had a higher rate of CAD and cerebrovascular disease as well as a higher 10-year cardiovascular risk [19].

IABPD of 15 mm Hg or higher was associated with CAD in 63% of patients, and multi-vessel CAD was present according to a study that included 283 patients who had coronary angiography, 83% of those with CAD had the condition were examined for the relationship between IABPD and CAD [13]. Additional studies discovered no connection between IABPD and IABPD of 10 mm Hg or higher was found to increase the onset of CAD in other prospective studies, despite the fact that these investigations were limited by the use of non-invasive methods of diagnosis [21].

Pathophysiology of IAD:

Under physiologically normal conditions, the blood pressure value is frequently the same in both arms. A BP disparity between the two arms is common in many general populations, nevertheless. The "inter arm difference" (IAD) phenomena was initially identified more than a century ago. An IAD of less than 5 mmHg is considered normal. A systolic blood pressure difference of more than 10 mmHg is referred to as an IAD. A difference in systolic pressure of more than 10 mmHg is indicative of substantial IAD in the US, where 15% to 20% of the population has it [22].

IAD could have pathological as well as physiological causes. When a structural problem exists or when a muscle contracts and narrows an artery supplying the arm that stops an artery from flowing blood smoothly, the interarm blood pressure differential might happen in younger people [3].

It was typically occured in older persons as a result of a blockage brought on by atherosclerosis. Vacuities, fibro muscular hyperplasia, connective tissue diseases, aortic aneurysm, aortic coarctation, and compression of the thoracic outlet were additional causes [23].

It has been observed that people with diabetes, chronic kidney disease, and hypertension, or peripheral artery disease had different blood pressure readings in their arms. There are also identified variations in groups free of chronic illness. Inter-arm disparities have a wide range of reported prevalences; they are often more prevalent when hypertension is present [15].

Consequently, for upcoming vascular assessment and risk factor treatment, finding an interarm BP difference is crucial. Since a difference in More than 10 to 15 mmHg of interarm blood pressure predicts or serves as an indicator for a number of vascular conditions, such as congenital anomalies, vasculitis, connective tissue disorders, peripheral vascular disease, and cerebrovascular disease, it has become clear from numerous studies that you should check your blood pressure in both arms [1].

According to several research, IAD in Young, healthy patients' blood pressure is typical and unrelated to age, BMI, or heart rate. It also doesn't rely on which arm is measured first. IAD in BP was thought to be connected to conditions like cardiovascular, endocrine, metabolic, diabetes, and CKD in people [24].

CONCLUSION

In general, it is more common practice today to take blood pressure in one arm. In this scenario, there is a chance that the alterations, which are suggestive of any underlying vascular disorders, may go unnoticed, increasing the likelihood of a missed diagnosis of HTN and inappropriate care, which carries a danger to cardiovascular health. Since measuring BP is a straightforward yet crucial factor in identifying the group of people who are most likely to have vascular events in the future, especially in HTN patients who appear to be under control, Studies are required to establish the incidence of IAD in the study area's adult population.

- **Conflict of Interests:** There are no competing interests.
- **Funding:** None.
- **Authors' contributions:** The authors collaborate at every stage of the article.
- **Acknowledgements:** To patients and all colleges who helped to end this work.

REFRENCES

1. **Clark E, Campbell L, Powell J (2007):** The interarm blood pressure difference as predictor of cardiovascular events in patients with hypertension in primary care: Cohort study. J. Hum. Hypertens., 21:633-638.
2. **Gopalakrishnan S, Savitha K, Rama R (2018):** Evaluation of inter-arm difference in blood pressure as predictor of vascular diseases among urban adults in Kancheepuram District of Tamil Nadu. J. Family Med. Prim. Care, 7:142-146.
3. **Patrick S (2022):** Different Blood Pressure in Right and Left Arm Could Signal Trouble. Availablefrom:http://www.health.harvard.edu/blog/differentblood-pressure-in-right-and-left-arms-could-signaltrouble-201202014174.
4. **Unger T, Borghi C, Charchar F *et al.* (2020):** International Society of Hypertension Global Hypertension Practice Guidelines. Hypertension, 75: 1334-1357.
5. **Mach F, Baigent C, Catapano A *et al.* (2020):** ESC/ EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. Eur. Heart J., 41:111–188.
6. **Williams B, Mancia G, Spiering W *et al.* (2018):** ESC/ESH Guidelines for the management of arterial hypertension: The Task Force for the Management Of

Arterial Hypertension of the European Society of Hypertension. Eur. Heart J.,39 (33): 3021-3104.

7. **Chow CK, Teo KK, Rangarajan S *et al.* (2013).** PURE Study Investigators. Prevalence, awareness, treatment, and control of hypertension in and urban communities in high-, middle-, and low-income countries. JAMA., 310:959–968.
8. **Ibrahim M, Damasceno A (2012):** Hypertension in developing countries. Lancet, 380(9841):611-619. doi: 10.1016/S0140-6736(12)60861-7.
9. **Ibrahim M (2014):** The Egyptian hypertension society: Egyptian hypertension guidelines. The Egyptian Heart Journal, 2: 66-83.
10. **NCD Risk Factor Collaboration (2017):** Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. Lancet, 389:37–55.
11. **Abdel Aal A, Youssef G, El Faramawy A *et al.* (2021):** Registry of the Egyptian specialized hypertension clinics: Sex-related differences in clinical characteristics and hypertension management among low socioeconomic hypertensive patients. J. Clin. Hypertens., 5: 1–9.
12. **Essa A & Ahmed K (2022):** Prevalence of inter-arm blood pressure difference among young healthy adults: Results from a large cross-sectional study on 3235 participants. Annals of Medicine and Surgery, 77: 103-119.
13. **Hirono A. Kusunose K. Kageyama N *et al.* (2018):** Development and validation of optimal cut-off value in inter-arm systolic blood pressure difference for prediction of cardiovascular events, J. Cardiol., 71 (1): 24–30.
14. **Cassidy P, Jones K (2001):** A study of inter-arm blood pressure differences in primary care, J. Hum. Hypertens., 15 (8): 519–522.
15. **Clark E, Taylor S, Butcher I *et al.* (2016):** Inter-arm blood pressure difference and mortality: a cohort study in an asymptomatic primary care population at elevated cardiovascular risk. Br. J. Gen. Pract., 66:297–308.
16. **Cao K, Xu J, Shangguan Q *et al* (2015)**: Association of an interarm systolic blood pressure difference with all-cause and cardiovascular mortality: An updated meta-analysis of cohort studies. Int. J. Cardiol., 189: 211–219.
17. **Clark E, Taylor S, Shore C *et al* (2016):** Prevalence of systolic inter-arm differences in blood pressure for different primary care populations: systematic review and meta-analysis. Br. J. Gen. Pract., 66(652): 838-847.
18. **Jones R, McCormack T, Constanti M *et al.* (2020):** Diagnosis and management of hypertension in adults: NICE guideline update 2019. Br J Gen Pract., 2020 Jan 30;70(691):90-91. doi: 10.3399/bjgp20X708053. Erratum in: Br. J. Gen. Pract., 70(692):111-132. PMID: 32001477.
19. **Kim A, Kim Y, Park B (2016):** Significant interarm blood pressure difference predicts cardiovascular risk in hypertensive patients: CoCoNet study. Medicine, 15: 38-49.
20. **Igarashi Y, Chikamori T, Tomiyama H *et al.* (2007):** Clinical significance of inter-armpressure difference and Ankle-brachialpressure index in patients with suspected coronary artery disease. J. Cardiol., 50:281–289.
21. **Das S, Iktidar A, Das J *et al.* (2022):** Inter-arm Blood pressure difference as a tool for predicting coronary artery disease severity. Open Heart, 9:e002063. doi:10.1136/openhrt-2022-002063.
22. **Lowry C, Awick L, Slayman K *et al.* (2022):** Inter-armBlood Pressure Differences; 2015. Available from: http://www.nurse-practitioners-and-physician-assistants.advanceweb. com /Features/Articles/Inter-arm-Blood-Pressure-Differences. Aspx.,
23. **Mehlsen J, Wiinberg N (2014):** Interarm difference in blood pressure: Reproducibility and association with peripheral vascular disease. Int. J. Vasc. Med., 8(3): 24-33.
24. **Grossman A, Prokupetz A, Gordon B *et al*. (2014):** Inter-arm blood pressure differences in young, healthy patients. J. Clin. Hypertens., 15(8):575–578.