

# Prevalence of Inter-Arm Blood Pressure Difference in Normal and Hypertensive Patients



Igbokwe VU<sup>1</sup>, Adebayo-Gege GI<sup>2</sup> and Seriki AS<sup>2\*</sup>

<sup>1</sup>Department of Physiology, Nnamdi Azikwe University, Nigeria

<sup>2</sup>Department of Physiology, Bingham University, Nigeria

Submission: August 14, 2017; Published: August 29, 2017

\*Corresponding author: Seriki AS, Department of Physiology, Faculty of Basic Medical Sciences, Bingham University, Nigeria, Tel: +2348036041121; Email: seriki.adinoyi@gmail.com

## Abstract

**Background/Aim:** Blood pressure (BP) is the pressure exerted by blood circulating upon the walls of blood vessels. During each heartbeat, BP varies between a maximum (systolic) and a minimum (diastolic) pressure. The blood pressure range considered normal is 100 -140 (systolic) over 60-90 (diastolic) in mmHg. Systolic pressure occurs when the heart contracts and it is normally recorded as the first phase of the korotkoff sounds. Diastolic pressure occurs when the heart relaxes and it is recorded as the fifth phase of the korotkoff sound. Hypertension (HTN) or high blood pressure is a cardiac chronic medical condition in which the systemic arterial blood pressure is elevated.

**Method:** A total of 120 subjects were used for this research, with 60 subjects serving as normotensive patients and another 60 serving as hypertensive patients. Each group consisted of 30 males and 30 females. With the consent of participants, the following parameters were taken; Weight, Height, Age (years), Blood Pressure (of right and left arms using both mercury and digital sphygmomanometers).

**Result:** There was no significant difference between the blood pressure of the right and left arms in both male and female in the hypertensive and normotensive subjects.

**Conclusion:** There is no significant inter-arm blood pressure difference in both hypertensive and normotensive human male and female, using either mercury or digital sphygmomanometer.

**Keywords:** High blood pressure; Inter-arm blood pressure; Systolic pressure; Diastolic pressure

## Introduction

Blood pressure is an important factor in diagnosis and has been used for more than a century as a leading indicator of overall health. Normal blood pressure is not fixed but varies from person to person and subject to many influencing factors both inside and outside the body. It constantly changes to suit the flow requirements of the various parts of the circulation and the circulation as a whole. It also varies across the day being highest in the morning and lower towards evening and this is called the “diurnal variation.”

Hypertension (HTN) or high blood pressure is a cardiac chronic medical condition in which the systemic arterial blood pressure is elevated. It is classified as either primary (essential) hypertension or secondary hypertension. About 90-95% of cases are categorized as “primary hypertension,” which means high blood pressure with no obvious medical cause [1]. The remaining 5-10% of cases (Secondary hypertension) is caused by other

conditions that affect the kidneys, arteries, heart or endocrine system. There is usually no symptom associated with HBP but in rare cases, severe hypertension can cause headaches, visual changes, dizziness, nosebleeds, heart palpitations, and nausea. High blood pressure puts excessive stress on the artery wall and increases the risk of heart failure, kidney disease and stroke. High blood pressure is controlled with medication, diet and changes in lifestyle.

The Joint National Committee on Prevention, Detection, Evaluation and Treatment of high blood pressure has classified blood pressure into four categories, namely; normal, pre-hypertension, stage-one hypertension, and stage-two hypertension [2]. The normal category refers to blood pressure range of less than 120/80mmHg, prehypertension is in the 120-139/80-89mmHg range, stage one is 140-159/90-99mmHg range and stage two is blood pressure equal to or greater than 160/100mmHg [2].

This study is aimed at determining the prevalence of inter-arm blood pressure difference in both normal and hypertensive patients with or without treatment. It is also determine which arm is more suitable for the measurement of blood pressure. A thorough physical examination begins with evaluation of the patient's vital signs, especially blood pressure. Accurate measurement of blood pressure is of paramount importance as raised blood pressure is a common condition that does not have any clinical manifestation until target organ damage develops.

Normally blood pressure measurement is taken on one arm using a sphygmomanometer, which is of various types, and listening for the first and fifth korotkoff sounds. But diagnosis is not made until several measurements have been taken on various visits of the patient. It was assumed that blood pressure on both arms were the same so it didn't matter which arm was used. However, more than half a century ago it was observed that blood pressures of the upper limbs vary slightly [3]. So arguments have arisen as to which arm should be used for the measurement of blood pressure. The right arm has been commonly used as most people are right handed. But it has been argued that the left arm is closer to the heart and should be used instead. Differences in blood pressure of the two arms in a healthy individual should normally be negligible. However a wide difference in the blood pressure readings of both arms suggests that there might be a definite underlying problem and may serve as diagnostic clue to clinical condition [4]. Several studies performed during the first half of the century found a difference of more than 10mmHg between arms in a significant proportion (20%-45%) of patients studied. However, most of these studies were small, lacked quality, and limited to hypertensive patients [5].

The accurate assessment of blood pressure (BP) is vital for the correct diagnosis and treatment of hypertension. Current guidelines for the management of hypertension suggest that differences greater than 20/10mmHg requires reference to a specialist or simultaneous measurement to exclude anatomical abnormality or coarctatio [6].

A lack of equality in blood pressure between the two arms is well recognized as a result of anatomical abnormalities such as subclavian artery stenosis [7], but significant inter-arm BP differences have also been reported in patients without apparent arterial disease. A large inter-arm blood pressure difference is also assumed to help identify patients with aortic dissection. For example, differences in limb blood pressure measurements have been reported to be present in 50% of patients with thoracic aortic dissection [8,9]. On the other hand, some patients with large inter-arm differences in blood pressure rarely have an aortic dissection [4].

Most cited studies used only a few readings to assess the inter-arm difference on a single occasion, and the methods used to assess the inter-arm BP differences varied, including mercury sphygmomanometers and oscillometric devices [10-13]. Some researchers used sequential readings, while other investigators

believed that readings taken simultaneously in the 2 arms would be more accurate. A major problem inherent in all of these studies was the spontaneous variability of BP, which can produce spurious differences between the 2 arms if only a few readings are used. For this reason and more, this work is important.

### Materials and Method

#### Materials

Mercury Sphygmomanometer, Omron digital sphygmomanometer, Littman stethoscope, measuring tape and weighing scale.

#### Data Collection Methodology

A total of 120 subjects were used for this research, with 60 subjects serving as normotensive patients and another 60 serving as hypertensive patients. All the 120 subjects were Nigerians. Subjects in the normotensive group were young people within the confines of Bingham University whose ages range from 16-24 years. Subjects in the hypertensive group were older people in Mararaba Medical Center whose ages range from 30-60 years. Each group consisted of 30 males and 30 females. Normotensive subjects with a history of hypertension were excluded. The various subjects used for this study were first communicated and the importance of the study was explained to them. The patients from the Medical Centre used for the study were also communicated through the doctors working in the hospital. With the consent of participants, the following parameters were taken; Weight, Height, Age (years), Blood Pressure.

#### Measurement of Height and Weight

The height of subjects was taken using the measuring tape. The tape was secured to the wall and the subjects were asked one after the other to stand erect against the tape with no shoes on, looking straight ahead. The heights were measured in meters. The weight of the subjects was taken using the weighing scale. The subjects were asked one after the other to stand erect on the scale with no shoes on and putting on light outdoor clothes. The weight was measured in kilograms.

#### Blood Pressure Measurements

The blood pressure of the subjects was measured using both the mercury and Omron digital sphygmomanometer in no particular order. This was done as follows:

Using the mercury sphygmomanometer; the patient was made to sit comfortably in a chair and asked to place his or her arm on the table at heart level. The patient was then allowed to rest for a few minutes. Then the patient was asked to raise his or her sleeves if they were putting on long sleeves. The cuff of sphygmomanometer was then wrapped around the upper arm just above the cubital fossa with the centre of the rubber bag placed over the brachial artery. The radial pulse was then felt by placing two fingers on the lateral side of the wrist. The valve of the pump was closed and the pressure of the cuff was raised rapidly until no more pulse was

felt. Then the earpieces of the stethoscope were placed on both ears such that they faced inwards and the diaphragm placed on the cubital fossa in between the rubber tubes of the cuff. While listening for the korokoff sound, the pressure of the cuff was gradually reduced by opening the valve of the pump. The first sound (stage 1) heard was taken as the systolic blood pressure while the point at which no sound was heard at all (stage 5) was taken as the diastolic blood pressure as read on the manometer [14].

Using the Omron digital sphygmomanometer; the patient was made to relax and asked to raise his or her sleeves as high as possible if they were putting on long sleeves. The cuff of the sphygmomanometer was then wrapped round the upper arm not too tight but such that it did not down the arm with the center of the rubber bag over the brachial artery. Then the digital sphygmomanometer was put on. Since it is automatic it increased the pressure in the cuff automatically and gave the readings for both systolic and diastolic and also gave the pulse readings. Both measurements were done first on the right arm and then on the left arm.

**Table 1:** Reading for hypertensive males.

Sphygmomanometer	Right Arm		Left Arm	
	Systolic	Diastolic	Systolic	Diastolic
Mercury	160±18.343	101±13.538	159±17.094	102±13.690
Digital	171±25.894	111±30.800	173±23.943	112±32.293

Values are expressed as mean±standard deviation (SD)

**The result of diastolic blood pressure measurement for hypertensive males:** For the right arm males using a mercury sphygmomanometer; the pressure range was from 80 to 120mmHg with an average of 101mmHg and that of the left arm was from 81 to 120mmHg with an average of 102mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 72 to 189mmHg with an average of 111mmHg and that of the left arm was from 68 to 195mmHg with an average of 112mmHg (Table 1).

### Hypertensive females

**The result of systolic blood pressure measurement for hypertensive females:** For the right arm using mercury sphygmomanometer, the pressure range was from 131 to 181mmHg with an average of 157mmHg and that of the left arm

**Table 2:** Reading for hypertensive females.

Sphygmomanometer	Right Arm		Left Arm	
	Systolic	Diastolic	Systolic	Diastolic
Mercury	157±15.961	93±17.171	157±21.653	92±13.440
Digital	171±23.864	91±15.966	174±23.273	93±16.772

Values are expressed as mean ± standard deviation (SD)

### Non hypertensive males

**The result of systolic blood pressure measurement for non-hypertensive males:** For the right arm using mercury sphygmomanometer; the pressure range was from 91 to 138mmHg with an average of 110mmHg and that of the left arm was from 90 to 121mmHg with an average of 102mmHg. For the right arm

### Method of Statistical Analysis

The authenticity of the results was assured using students T-test. This test was carried out to determine whether there was a significant difference between the obtained results (between the blood pressure of the right arm and the left arm).

### Results

#### Hypertensive males

**The result of systolic blood pressure measurement for hypertensive males:** For the right arm using mercury sphygmomanometer, the pressure range was from 131 to 184mmHg with an average of 160mmHg and that of the left arm was from 138 to 180mmHg with an average of 159mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 122 to 222mmHg and an average of 171mmHg and that of the left arm was from 135 to 215mmHg and an average of 173mmHg.

was from 130 to 191mmHg with an average of 157mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 140 to 211mmHg and an average of 171mmHg and that of the left arm was from 143 to 211mmHg and an average of 91mmHg.

**The result of diastolic blood pressure measurement for hypertensive females:** For the right arm using a mercury sphygmomanometer, the pressure range was from 60 to 117mmHg with an average of 93mmHg and that of the left arm was from 60 to 109mmHg with an average of 92mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 64 to 127mmHg with an average of 91mmHg and that of the left arm was from 61 to 131mmHg with an average of 93mmHg (Table 2).

using digital sphygmomanometer, the pressure range was from 93 to 144mmHg and an average of 11mmHg and that of the left arm was from 88 to 166mmHg and an average of 114mmHg.

**The result of diastolic blood pressure measurement for hypertensive females:** For the right arm using a mercury sphygmomanometer, the pressure range was from 42 to 80mmHg

with an average of 60mmHg and that of the left arm was from 40 to 82mmHg with an average of 61mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 40 to

96mmHg with an average of 55mmHg and that of the left arm was from 44 to 96mmHg with an average of 61mmHg (Table 3).

**Table 3:** Reading for non-hypertensive males.

Types of sphygmomanometer	Right Arm		Left Arm	
	Systolic	Diastolic	Systolic	Diastolic
Mercury	110±9.479	60±9.912	102±7.278	61±11.464
Digital	115±9.330	55±8.351	114±12.119	61±11.523

Values are expressed as mean ± standard deviation (SD)

**Non hypertensive females**

**The result of systolic blood pressure measurement for hypertensive non females:** For the right arm using mercury sphygmomanometer, the pressure range was from 131 to 181mmHg with an average of 157mmHg and that of the left arm

was from 130 to 191mmHg with an average of 157mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 140 to 211mmHg and an average of 171mmHg and that of the left arm was from 143 to 211mmHg and an average of 91mmHg.

**Table 4:** Reading for non-hypertensive females.

Types of sphygmomanometer	Right Arm		Left Arm	
	Systolic	Diastolic	Systolic	Diastolic
Mercury	107±8.506	64±8.791	101±9.504	63±9.132
Digital	112±9.864	63±7.967	108±6.706	61±9.330

Values are expressed as mean ± standard deviation (SD)

**The result of diastolic blood pressure measurement for non-hypertensive females:** For the right arm using a mercury sphygmomanometer, the pressure range was from 94 to 125mmHg with an average of 64mmHg and that of the left arm was from 80 to 120mmHg with an average of 63mmHg. For the right arm using digital sphygmomanometer, the pressure range was from 90 to 128mmHg with an average of 63mmHg and that of the left arm was from 96 to 125mmHg with an average of 61mmHg (Table 4).

**Result of statistical analysis:** All the results gotten were subjected to student t-test and the following results were gotten.

**Hypertensive males**

**Between the right and left arms for systolic readings using mercury sphygmomanometer:** The t-test yielded a t-value of 0.1323 which showed no statistical difference between the pressure of the right and left arms at p≤0.05.

**Between the right and left arms for diastolic readings using mercury sphygmomanometer:** The t-test yielded a t-value of 0.2036 which showed no significant difference between the diastolic pressures of the right and left arms.

**Between the right and left arms for systolic readings using digital sphygmomanometer:** The t-test yielded a t-value of 0.2036 which showed no significant difference between the systolic pressures of the right and left arms.

**Between the right and left arms for diastolic readings using digital sphygmomanometer:** The t-test yielded a t-value of 0.0599 which showed no significant difference between the diastolic pressures of the right and left arms.

**Hypertensive females**

**For systolic readings using mercury sphygmomanometer:** The t-test yielded a t-value of 0.0000 which showed no significant difference between the diastolic pressures of the right and left arms.

**For diastolic readings using mercury sphygmomanometer:** The t-test yielded a t-value of 0.1716 which showed no significant difference between the diastolic pressures of the right and left arms.

**For systolic readings using digital sphygmomanometer:** The t-test yielded a t-value of 0.3367 which showed no significant difference between the diastolic pressures of the right and left arms.

**For diastolic readings using digital sphygmomanometer:** The t-test yielded a t-value of 0.3232 which showed no significant difference between the diastolic pressures of the right and left arms.

**Non-hypertensive males**

**For Systolic reading using Mercury Sphygmomanometer:** The t-test yielded a t-value of 3.6664 which showed no significant difference between the diastolic pressures of the right and left arms.

**For diastolic reading using mercury sphygmomanometer:** The t-test yielded a t-value of 0.3614 which showed no significant difference between the diastolic pressures of the right and left arms.

## For systolic reading using digital sphygmomanometer:

The t-test yielded a t-value of 0.3581 which showed no significant difference between the diastolic pressures of the right and left arms.

## For diastolic reading using digital sphygmomanometer:

The t-test yielded a t-value of 2.3092 which showed no significant difference between the diastolic pressures of the right and left arms.

## Non-hypertensive females

### For systolic readings using mercury sphygmomanometer:

The t-test yielded a t-value of 2.5765 which showed no significant difference between the diastolic pressures of the right and left arms.

### For diastolic readings using mercury sphygmomanometer:

The t-test yielded a t-value of 0.4321 which showed no significant difference between the diastolic pressures of the right and left arms.

### For systolic readings using digital sphygmomanometer:

The t-test yielded a t-value of 1.8368 which showed no significant difference between the diastolic pressures of the right and left arms.

### For diastolic readings using digital sphygmomanometer:

The t-test yielded a t-value of 0.8929 which showed no significant difference between the diastolic pressures of the right and left arms.

## Discussion

Results show that there is no significant difference between the blood pressure of the right and left arms of both male and females in hypertensive and normotensive human subjects, using mercury and digital sphygmomanometer. There was however a slight difference which is not significant. A small difference in blood pressure readings between arms isn't a health concern.

However, a difference of more than 10 millimeters of mercury (mmHg) for either arm systolic pressure or diastolic pressure may be a sign of an underlying problem- such as narrowing of the main arteries to that arm. It may also indicate Kidney disease, Diabetes, or Heart defects, and may require a patient to see the doctor [14]. It may however also be either due to functional changes in the condition of the arterial walls, and perhaps, of the capillary beds in the two arms, or due to excitement and nervousness shown by the subjects during the measurement [14].

A difference of 10 to 15mm Hg for systolic pressure that shows up repeatedly may be a risk factor for vascular disease and for a greater risk of developing cardiovascular disease and related complications during the next 10 years. When a blood pressure is higher in one arm, the doctor is expected to use the blood pressure reading from that arm to monitor the blood pressure of the patient. This however is not the case in the current study.

## Conclusion

There is no significant prevalence of inter-arm blood pressure difference in both hypertensive and normotensive human male and female. Blood pressure could therefore be taken in either of the arms in males and females, and in normotensive and hypertensive patients, using either mercury or digital sphygmomanometer, without fears of error in the results. However, a patient with a difference of more than 10 millimeters of mercury (mmHg) for either arm systolic pressure or diastolic pressure may need to see the doctor to rule out presence of any kidney disease, diabetes, or heart defects.

## References

1. Carretero OA, Oparil S (2000) Essential hypertension. Part I: definition and etiology. *Circulation* 101(3): 329-335.
2. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, et al. (2003) The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA* 289(19): 2560-2572.
3. (1939) Differences in the arm blood pressures in the two arms. *JAMA* 112: 2458.
4. Adam JS, Judd EH (1966) Blood pressure: assessment of inter-arm differences. *Arch Intern Med* 156: 2005-2008.
5. Cyriax EF (1921) Unilateral alterations in blood pressure: the differential blood pressure sign, second communication. *Q J Med* 14: 309-313.
6. Kazao E, Mona Y, Juhee J, William G, Joseph ES, et al. (2007) Consistency of blood pressure differences between the left and right arms. *Arch Intern Med* 167(4): 388-393.
7. Shadman R, Criqui MH, Bundens WP (2004) Subclavian artery stenosis: prevalence, risk factors, and association with cardiovascular diseases. *Jam Coll Cardiol* 44: 618-623.
8. Slater EE, DeSanctis RW (1976) The clinical recognition of dissecting aortic aneurysm. *Am J Med* 60(5): 625-633.
9. Dinsmore RE, Hutter AM, Pastore JO, DeSanctis RW (1979) Right ventricular infarction. Clinical diagnosis and differentiation from cardiac tamponade and pericardial constriction. *Am J of Cardiol* 43(3): 465-471.
10. Fotherby MD, Panayiotou B, Potter JF (1993) Age-related differences in simultaneous inter arm blood pressure measurements. *Postgrad Med J* 69(809): 194-196.
11. Lane D, Beevers M, Barnes N (2002) Inter-arm differences in blood pressure: when are they clinically significant? *J Hypertens* 20(6): 1089-1095.
12. Arnett DK, Tang W, Province MA (2005) Inter-arm differences in seated systolic and diastolic blood pressure: the Hypertension Genetic Epidemiology Network study. *J Hypertens* 23(6): 1141-1147.
13. Singer AJ, Hollander JE (1996) Blood pressure: assessment of inter-arm differences. *Arch Intern Med* 156(17): 2005-2008.

14. Clark CE, Campbell JL, Evans PH, Millward A (2006) Prevalence and clinical implications of the inter-arm blood pressure difference: a systematic review. J Hum Hypertens 20(12): 923-931.



This work is licensed under Creative Commons Attribution 4.0 License  
DOI: [10.19080/JOCCT.2017.07.555716](https://doi.org/10.19080/JOCCT.2017.07.555716)

**Your next submission with Juniper Publishers  
will reach you the below assets**

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats  
**( Pdf, E-pub, Full Text, Audio)**
- Unceasing customer service

**Track the below URL for one-step submission**  
<https://juniperpublishers.com/online-submission.php>