Novelty Journals

ISSN 2394-7330

International Journal of Novel Research in Healthcare and Nursing
Vol. 7, Issue 1, pp: (675-686), Month: January - April 2020, Available at: www.noveltyjournals.com

Effect of Body Position Change on Blood Pressure Readings from Both Arms

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Abstract: **Arterial blood pressure, one of vital signs, is an important indicator of a person's health status. Therefore, its measurement is part of every complete physical examination. Factors affect blood pressure reading include; position inconsistency and arm position. Scanty data are present testing the influence of body position on blood pressure readings. The aim of this work was to study the effect of body position change on blood pressure readings from both arms. Material and Methods: Forty adult patients (male and females) from outpatient clinic in the governmental hospitals from Beirut Lebanon were included in the present study. One tool was used to collect necessary data "A Blood Pressure Measuring Sheet" it was developed by the researchers for recording blood pressure readings from both arms using a mercury sphygmomanometer in three different positions; standing, sitting and supine. Results: A statistically significant difference was noted denoting that supine position was better than sitting and standing in the measuring the right and left arm systole among the studied patients. A statistically significant difference was also declared between both arms in sitting position. The left arm blood pressure measurement was less than right arm in sitting position with a statistically significant difference. Conclusion: Body positions can significantly influence blood pressure readings. Also both arms blood pressure readings are changed by changing position.**

Keywords: **Blood pressure, changing position, arm measurement.**

1. INTRODUCTION

Checking blood pressure (BP) is an integral medical care part. It is frequently monitored during vital sign assessment by nurses and doctors. Blood pressure is defined as "the force exerted by the blood against the blood vessel wall" [(1).] Systolic pressure indicates how much blood pressure is exerting against artery walls when the heart beats. Diastolic pressure indicates how much blood pressure is exerting against walls of artery while the heart is resting between beats. In a healthy adult systolic pressure measurement is about 120 mm Hg and falls to about 70 mm Hg (a minimum value - diastolic pressure) in each heart cycle. [(2)]

The difference between the systolic and diastolic pressures, is known as pulse pressure (about 50 mm Hg). The mean pressure is the average pressure throughout the cardiac cycle. As systole is shorter than diastole; the mean pressure is slightly less than the value halfway between systolic and diastolic pressure. It equals the diastolic pressure plus one third of the pulse pressure. [(1, 2)] The mean arterial pressure is determined by four main factors; the cardiac output, the total peripheral resistance, the elasticity of the arterial wall and the blood volume [(2).]

Clinically; hypertension (HTN) is that level of BP at which is when the force of blood pushing against the walls of blood vessels, is consistently too high. The medical team, in any institution, therapy aims to reduce blood pressure–related morbidity and mortality.[(3)] Current clinical criteria for defining hypertension are generally based on the average of two or more seated blood pressure readings during each of two or more outpatient visits. The recent classification recommends blood pressure criteria for defining normal blood pressure, prehypertension, hypertension (stages I and II), and isolated systolic HTN, which is a common occurrence among the elderly. Blood Pressure was classified based on systole and

diastole by CDC in 2019(Center of disease control and prevention), as: normal if <120/80 mmHg, elevated if 120–129/<80 mmHg, HTN Stage 1 when 130-139/80–89 mmHg, Stage 2 HTN if systolic at least 140 or diastolic at least 90 mm Hg. Individuals are considered in hypertensive crisis: if systolic >180 and/or diastolic > 120, mmHg respectively. [4]

Blood Pressure measurement accuracy is the key for high risk patients' prognosis. Hypertension (HTN) doubles the risk of cardiovascular diseases, including coronary heart disease (CHD), congestive heart failure (CHF), ischemic and hemorrhagic stroke, renal failure, and peripheral arterial disease. Blood pressure levels, the rate of age-related blood pressure and the prevalence of hypertension vary among countries and among subpopulations within a country. [3] It has been estimated that HTN accounts for 6% of deaths worldwide. In industrialized societies; blood pressure incidence increases steadily during the first two decades. [3, 5]

Based on clinical trials data, the maximum protection against combined cardiovascular disease (CVD) endpoints is achieved with BP levels (≤160 or ≤90 mmHg). However, HTN treatment has not reduced CVD risk to the level in non-hypertensive individuals. Blood pressure control targets (e.g., office or clinic blood pressure < 130/80 mmHg) may be appropriate for patients with diabetes, CHD, chronic kidney disease, or with additional cardiovascular disease risk factors. [6]

The gold standard for clinical blood pressure measurement has always been readings taken by a trained health care provider using a mercury sphygmomanometer and the Korotkoff sound technique. Yet, there is an increasing evidence that this procedure may lead to misclassification of large numbers of individuals as hypertensive. There are three main reasons for this interpretation: inaccuracies in the methods; the inherent variability of blood pressure; and the tendency for blood pressure to increase in the presence of a physician (the so-called white coat effect). [5, 7]

Number of subjects related factors can cause significant deviations in measured blood pressure. These include: room temperature, exercise, alcohol or nicotine consumption, body and arm positioning, muscle tension, bladder distension, talking, and background noise. [8]

The new American Heart Association guidelines for blood pressure measuring showed that; arm position relative to the heart incorporates an essential concern in measurement. Exact readings must be obtained at heart level due to difference in hydrostatic pressure when the measurement device is higher than or below the heart.[9]

Researchers found an alteration of 15 points or more in the measurement between the left and right arms raised the threat of peripheral vascular and cerebrovascular disease by two and a-half times. The World Health Organization/International Society of Hypertension (WHO/ISH) guidelines recommend BP reading while the arm is supported. The sphygmomanometer or the cuff should not be above the level of heart; otherwise low reading will be documented, while if cuff is below the heart, the reading is likely to be high. Doctors ought to routinely compare readings of blood pressure from the two arms to avert preventable complications.[10, 11]

Likewise, BP reading differs with the body position change. There are four main assumed positions: sitting with legs uncrossed and back arm supported, standing with arm supported, and supine position with or without legs crossed. Researchers reported that: the diastolic pressure was found to be high in sitting position and not supporting the back, while systolic pressure was high in supine position and sitting with cross legged due to the inherent mechanisms that ought to maintain perfusions to vital organs.[11, 12].

Although antihypertensive therapy reduces CVD and renal disease risks; large segments of the hypertensive population are either untreated or inadequately treated.[3, 4] This signifies the importance of precise, standardized blood pressure position measurements for both accurate early diagnosis as well as follow up of hypertensive patients.

Aim:

The aim was to study effect of body positions change on the blood pressure readings from both arms.

Research hypotheses:

1- Body position affects blood pressure readings from both arms

2- Alternating the arms for measurement by way of body position change affects the blood pressure readings.

International Journal of Novel Research in Healthcare and Nursing
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Significance of the study:

The necessity of such study was developed from the clinical need to emphasis the diagnostic power of noninvasive hemodynamic assessment methods; that is perceived as prospective in diagnosis and treatment of hypertension. However, the possibility to evaluate BP measurement could limit the costs of repeated BP monitoring. Hoping the study recommendations and clinically relevant findings will be used widely in clinical practice.

2. MATERIALS AND METHODS

Design of the research is Quasi-experimental research design.

Subjects and settings:

A convenience sample of 40 adult patients (male and females) from outpatient clinic in the governmental hospitals from Beirut Lebanon was included in the study. Eventually; twenty-two of them had an uncontrolled increased blood pressure, they were diagnosed later through both clinical examination and routine laboratory investigation as essential hypertension.

Tool:

One tool was utilized; entitled as "**The Blood Pressure Measurement Recording Sheet**"; it was developed by the researchers based on a review of related literature[5, 8,11], for the aim of recording blood pressure readings.

Attached sheet: The patient's socio-demographic and clinical data sheet which included; age, sex, and diagnosis…. etc.

Methods:

- A permission to carry out the study was obtained from authorized persons after explanation of its aim.
- The "blood pressure measuring recording sheet" was developed by the researchers based on a review of related literature.
- The content validity of the tool was tested by a jury of (5) experts in nursing as well as physiology- medicine field.
- **A pilot study:** Was done to determine the accuracy and reliability of BP readings. Inter-rater reliability was established among the researchers who did not vary in readings by more than 2-4 mm/Hg.
- The study tool was tested for its reliability using Alpha Cronbach's statistical test; it was (0.735)
- **Ethical considerations;** An informed written consent was obtained from the patients, several brief questions were asked to obtain demographics and determine if they had pre-existing conditions and or they had chronic disease.

The process of measurement was a follows:

- Two BSc nurses were trained and instructed to measure blood pressure in the three positions; namely: supine (lying), sitting (fowler) and standing position from both right then left arms.
- A total of six blood pressures measurements were taken, two in the sitting (fowler), then two in supine (lying), and finally standing position respectively. The average of each position readings was noted down in a data entry form.
- The Blood pressure was measured from both arms starting with the right arm then the left; in the three mentioned positions.
- Each patient took 10 minutes to relax before the initial assessment for accuracy of readings. There were five to ten minute minimum resting periods between each BP measurement within each position to assure reliable readings.
- The brachial artery was occluded by the appropriate cuff size placed around the upper arm and inflated to above systolic pressure. As it is gradually deflated, pulsatile blood flow is re-established and accompanied by sounds that can be detected by a stethoscope held over the artery just below the cuff.
- **Important Points for clinical blood pressure measurement**

- The used Blood pressure apparatus (instrument) -mercury sphygmomanometer- was initially tested prior measurement to ensure their accuracy.
- The best fitting cuff was used for each participant and was placed directly on the skin (AHA. 2019). [13]

- To maintain results control and to avoid observer bias; the researchers used the same sphygmomanometer for all participants.

- The subjects' circadian activity was adjusted regarding stress and activity. Participants were also asked not to smoke or drink alcohol, coffee, or energizers that potentially increase BP or even to take drugs influencing BP (e.g. pain relievers) within 12 h before measurement.

- Extrinsic factors like talking, room temperature and stress were eliminated. The measurement room was quiet, well lighted; neither the patient nor the observer talked during the measurement; as this can change blood pressure readings; thus more than one reading was obtained to emphasis the reliability and prevents variations.

- Each patient was seated comfortably with the back supported, the upper arm was bared without constrictive clothing and the legs were not be crossed.

- The readings were obtained while the arms were at the heart level at three positions; that in sitting and standing positions the arms were at right angles and supported at heart level, while on lying position the arms were lying freely on the examination bed. The bladder of the mercury sphygmomanometer cuff was ensured to be encircling at least 80% of the arm circumference.

- The mercury column was deflated at 2 to 3 mm/s, and the first and last audible sounds were taken as systolic and diastolic pressure and the column was read to the nearest 2 mm Hg.

- All the study participants' blood pressure measurements were repeated at 30 second intervals.

- Data were collected, by the two trained nurses, over duration of two months from the outpatient clinic in the previously mentioned setting.

- **Statistical Analysis** was done after data was collected. It was coded and transformed into special designed form so as to be suitable for computer feeding. All entered data were verified for any error. The statistical package for social sciences (SPSS) version 20 was utilized for statistical analysis. The findings were tabulated with presentation of the appropriate statistical tests using Microsoft excel software. Statistical analysis was done alpha error of 0.05. P values less than or equal to 0.05 were considered significant.

Comparisons between both arms in the 3 different positioning of the patients were done.

Limitation of the study:

The researchers did not address the type and years of hypertension diagnosis; as this was not in the scope and the aim of the study. Moreover, our results may not be generalization as a small percentage representing 4% of subjects had RA, CHF, Dyslipidemia and DVT. This emphasis the importance for future researches to revise the specific method for gathering data.

3. RESULTS

Table (1): Sociodemographic - clinical characteristics of the studied subjects. It shows that almost half of the studied subjects were of age group 50 and less than 60, with a Mean ± SD 50.7±8.1. It also demonstrated that 52.5% were male.

As regard to medical history; 55% suffered from chronic disease as Hypertension, DM, RA, CHF, Dyslipidemia and DVT. Hypertension alone represented 45%.

Table (1): Frequency Distribution of the Sociodemographic- clinical characteristics of the study subjects.

Socio-demographic characteristics	Studied subjects (n=40)	
	No.	%
Age		
30-	3	7.5
40-	12	30.0
50-	**21**	**52.5**
≥60	4	10.0

International Journal of Novel Research in Healthcare and Nursing
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Min-Max Mean±SD	30-65 50.7±8.1	
Sex Male Female	 **21** 19	 **52.5** 47.5
Medical history	**Studied persons (n=40)**	
	No.	**%**
Normal Suffer chronic disease	18 **22**	45.0 **55.0**
DM Hypertension Others[#]	3 **18** 4	7.5 **45.0** 10.0

[#]Others include RA, CHF, Dyslipidemia, and DVT

Table 2 reveals that; the mean right and left systolic blood pressure measurements in supine position tended to be lesser than sitting and standing among the studied patients with significant differences (F=5.95 (0.003)* and 2.73 (0.07)*); respectively. It was also noted that; the right mean BP was lesser in the supine position representing (96.2±10.9) when compared to sitting position (101.8±11.1) with a significant difference (F=2.72).

Table (2): Comparison between the mean blood pressure measurements at the three studied body positions. (Total sample=40)

Blood pressure	**Position**			**F Test (P)** **[#]LSD**
	Standing (1)	**Sitting (2)**	**Supine (3)**	
Right systolic BP Min-Max Mean±SD	 90-165 136.9±16.7	 100-180 139.9±16.6	 100-160 127.9±14.9	F=5.95 (0.003)* (1,3)* (2,3)*
Right diastolic BP Min-Max Mean±SD	 60-101 81.8±10.8	 68-110 82.8±10.1	 60-101 80.3±10.3	F=0.57 (0.565)
Right mean BP Min-Max Mean±SD	 70-120 100.2±11.3	 80-126.7 101.8±11.1	 73.3-120.0 96.2±10.9	F=2.72 (0.07) (2,3)*
Left systolic BP Min-Max Mean±SD	 95-165 137.1±16.5	 95-170 136.9±17.2	 100-160 129.9±13.0	F=2.73 (0.07) (1,3)* (2,3)*
Left diastolic BP Min-Max Mean±SD	 60-101 80.5±10.5	 60-101 80.8±10.6	 60-101 80.3±9.9	F=0.025 (0.98)
Left mean BP Min-Max Mean±SD	 73.3-118.3 99.3±11.3	 71.7-123.3 99.5±11.7	 73.3-120.0 96.9±10.8	F=0.77 (0.47)

* significant at P≤0.05

[#]LSD Fishers Least Significant Difference Post Hoc test

Mean Arterial Pressure (MAP)=((2 x DP)+SP)/3 or DP + ⅓(SP-DP)

DP= diastolic pressure, SP= systolic pressure.

Table (3) showed significant difference between left and right arms in sitting position in both the systolic pressure where t=4.31(<0.0001)*, as well in the diastolic pressure where t=3.79 (0.001)* in addition to the mean sitting blood pressure (BP) from both arms t=5.72 (<0.0001)*. Where mean BP readings in the left arm were lesser than those from right arm representing: 136.9±17.2, 80.8±10.6 and 99.5±11.7 respectively.

Novelty Journals

ISSN 2394-7330

International Journal of Novel Research in Healthcare and Nursing
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Table (3): Comparison between mean blood pressure measured at both right and left arms in the three body positions. (Total sample=40)

Blood pressure	Arm side		Paired t-Test (P)
	Right arm	Left arm	
Standing position			
Systolic BP Min-Max Mean±SD	 90-165 136.9±16.7	 95-165 137.1±16.5	 t=0.315 (0.76)
Diastolic BP Min-Max Mean±SD	 60-101 81.8±10.8	 60-101 80.5±10.5	t=1.66 (0.106)
Mean BP Min-Max Mean±SD	 70-120 100.2±11.3	 73.3-118.3 99.3±11.3	t=1.14 (0.26)
Sitting position			
Systolic BP Min-Max Mean±SD	 100-180 139.9±16.6	 95-170 136.9±17.2	t=4.31 (<0.0001)*
Diastolic BP Min-Max Mean±SD	 68-110 82.8±10.1	 60-101 80.8±10.6	t=3.79 (0.001)*
Mean BP Min-Max Mean±SD	 80-126.7 101.8±11.1	 71.7-123.3 99.5±11.7	t=5.72 (<0.0001)*
Supine position			
Systolic BP Min-Max Mean±SD	 100-160 127.9±14.9	 100-160 129.9±13.0	t=1.54 (0.131)
Diastolic BP Min-Max Mean±SD	 60-101 80.3±10.3	 60-101 80.3±9.9	t=0.013 (0.99)
Mean BP Min-Max Mean±SD	 73.3-120.0 96.2±10.9	 73.3-120.0 96.9±10.8	t=0.45 (0.66)

*significant at P≤0.05

Table 4 illustrates that among the studied hypertensive cases (n=18); the right systolic BP was affect by position, as it tends to drop in supine than standing and sitting positions with a significant difference of F=5.22 (0.008)*

In addition; on observing the mean BP measured at the three body positions among studied non-hypertensive (n=22); the right systolic BP was lowest in supine than sitting with significant difference F=6.49 p=(0.003)*. Also the right and left systolic and diastolic mean pressures were at its highest in siting position when compared the other two positions.

Table (4): Comparison between mean blood pressure measured at the three body positions among studied hypertensive and non-hypertensive patients.

Blood pressure		Position			F Test (P) #LSD
		Standing (1)	Sitting (2)	Supine (3)	
Hypertensive patients (n=18)	**Right systolic BP** Min. – Max. Mean ± SD.	 115-165 147.8±11.2	 100-180 148.9±15.3	 100-160 137.1±13.4	F=5.22 (0.008)* (1,3)* (2,3)*
	Right diastolic BP Min. – Max. Mean ± SD.	 80-100 86.0±8.6	 70-110 85.7±9.1	 60-100 83.3±8.8	F=0.636 (0.53)

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	Right mean BP Min. – Max. Mean ± SD.	 98.3-120.0 106.6±7.2	 80.0-126.7 106.8±9.9	 73.3-120.0 101.2±9.6	F=2.73 (0.073) (2,3)*
	Left systolic BP Min. – Max. Mean ± SD.	 100-165 147.0±13.1	 95-170 146.9±15.3	 100-160 135.8±13.3	F=4.73 (0.012)* (1,3)* (2,3)*
	Left diastolic BP Min. – Max. Mean ± SD.	 60-100 83.7±9.5	 60-100 83.9±9.5	 60-100 79.6±10.2	F=1.39 (0.256)
	Left mean BP Min. – Max. Mean ± SD.	 73.3-118.3 104.8±9.4	 71.7-123.3 104.9±10.3	 73.3-120.0 98.3±9.7	F=3.24 (0.046)* (1,3)* (2,3)*
Non-hypertensive subjects (n=22)	**Right systolic BP** Min. – Max. Mean ± SD.	 90-136 123.5±12.1	 110-150 129.0±10.5	 106-130 116.8±7.3	F=6.49 (0.003)* (2,3)*
	Right diastolic BP Min. – Max. Mean ± SD.	 60-101 76.7±11.3	 70-104 79.2±10.2	 60-101 76.7±11.2	F=0.307 (0.74)
	Right mean BP Min. – Max. Mean ± SD.	 70-112.7 92.3±10.6	 83.3-115.3 95.8±9.5	 76.7-109.3 90.1±9.3	F=1.56 (0.22)
	Left systolic BP Min. – Max. Mean ± SD.	 95-138 124.9±11.3	 105-140 124.9±10.5	 105-135 122.8±8.6	F=0.256 (0.78)
	Left diastolic BP Min. – Max. Mean ± SD.	 65-101 76.6±10.6	 65-101 77.0±10.9	 65-101 81.2±9.7	F=1.09 (0.34)
	Left mean BP Min. – Max. Mean ± SD.	 75.0-113.3 92.7±9.9	 78.3-112.7 92.9±9.9	 78.3-107.3 95.1±8.3	F=0.35 (0.71)

* significant at P≤0.05 #LSD Post Hoc test

MAP=((2 x DP)+SP)/3 or DP + ⅓(SP-DP)

Table 5 shows that systolic, diastolic and mean BP in hypertensive cases (n=18) were affected significantly in sitting position by changing the arm of measurement; in which the left arm readings were lesser than right arm in sitting position with a significant difference of T=2.55, p=(0.019)* and T=2.35, p=(0.029)* T=3.27,p=(0.004)* respectively.

In non-hypertensive patients; the left arm reading was lower than the right arm in supine position for the systolic , diastolic, and mean BP with significant difference T=3.58, p=(0.002)*, T=3.13.p=(0.006)*and T=5.15 (<0.0001)* respectively.

While the right arm systolic measurement was less than left arm in supine position where T=5.07, p=(<0.0001)*. As well the mean supine BP was T=2.62, at p=(0.018)*

Table (5): Comparison between mean blood pressure measurement at both right and left arms in the three body positions among studied hypertensive and non-hypertensive cases.

Blood pressure	Hypertensive patients (n=18)			Non-hypertensive subjects (n=22)		
	Arm side		Paired t-test (P)	Arm side		Paired t-test (P)
	Right arm	Left arm		Right arm	Left arm	
Standing position						
Systolic BP Min – Max Mean ± SD	 115 – 165 147.8 ± 11.2	 100 – 165 147.0 ± 13.1	T=0.67 (0.512)	 90 – 136 123.5 ± 12.1	 95 – 138 124.9 ± 11.3	T=1.7 (0.107)
Diastolic BP Min – Max	 80 – 100	 60 – 100	T=1.63 (0.118)	 60 – 101	 65 – 101	T=0.395

Mean ± SD	86.0 ± 8.6	83.7 ± 9.5		76.7 ± 11.3	76.6 ± 10.6	(0.69)
Mean BP						
Min – Max	98.3 – 120.0	73.3 – 118.3	T=1.43 (0.17)	70 – 112.7	75.0 – 113.3	T=0.89
Mean ± SD	106.6 ± 7.2	104.8 ± 9.4		92.3 ± 10.6	92.7 ± 9.9	(0.38)
Sitting position						
Systolic BP						
Min – Max	100 – 180	95 – 170	T=2.55	110 – 150	105 – 140	T=3.58
Mean ± SD	148.9 ± 15.3	146.9 ± 15.3	(0.019)*	129.0 ± 10.5	124.9 ± 10.5	(0.002)*
Diastolic BP						
Min – Max	70 – 110	60 – 100	T=2.35	70 – 104	65 – 101	T=3.13
Mean ± SD	85.7 ± 9.1	83.9 ± 9.5	(0.029)*	79.2 ± 10.2	77.0 ± 10.9	(0.006)*
Mean BP						
Min – Max	80.0 – 126.7	71.7 – 123.3	T=3.27	83.3 – 115.3	78.3 – 112.7	T=5.15
Mean ± SD	106.8 ± 9.9	104.9 ± 10.3	(0.004)*	95.8 ± 9.5	92.9 ± 9.9	(<0.0001)*
Supine position						
Systolic BP						
Min – Max	100 – 160	100 – 160	T=0.72 (0.48)	106 – 130	105 – 135	T=5.07
Mean ± SD	137.1 ± 13.4	135.8 ± 13.3		116.8 ± 7.3	122.8 ± 8.6	(<0.0001)*
Diastolic BP						
Min – Max	60 – 100	60 – 100	T=1.49 (0.15)	60 – 101	65 – 101	T=1.79
Mean ± SD	83.3 ± 8.8	79.6 ± 10.2		76.7 ± 11.2	81.2 ± 9.7	(0.091)
Mean BP						
Min – Max	73.3 – 120.0	73.3 – 120.0	T=1.52	76.7 – 109.3	78.3 – 107.3	T=2.62
Mean ± SD	101.2 ± 9.6	98.3 ± 9.7	(0.143)	90.1 ± 9.3	95.1 ± 8.3	(0.018)*

* Significant at P≤0.05

4. DISCUSSION

The present study was conducted using mercury sphygmomanometer; and each patient's blood pressure was measured a total of six times, testing two arm, while arms were at a right angle to the body on sitting and standing positions, while they were pointing forward, or simply parallel to the upper body when lying.

William C and Shiel W (2018) informed that; on measuring BP, the arm has to be on heart level, that while sitting and standing positions; the arm should be extended out straight and to be about 2-3 inches below the shoulder to approximate the level of the heart. He explained that; when arms hang down straight, the BP may be falsely diminished by as much as 12 mm Hg. below its true value.[14] Researches emphasized that; readings will not be affected meaningfully if the person is lying down, as long as the arm is kept alongside at the level of the body.[15,16]

This was supported also by Muntner et al. (2019) who pointed that Mercury sphygmomanometer has been the traditional gold standard way for recording BP; despite the fact that mercury is being banned in many countries. It has been replaced with aneroid and oscillometric devices, both of which are being used with increasing frequency but have not been accepted as being as accurate as mercury.[16]

The current study findings illustrated that; the mean right and left systolic blood pressure readings in supine position tended to be lesser than sitting and standing. Also; the mean right supine BP was lesser when compared to sitting position significantly.

Our observations are contrary to those presented in the study by Vrachatis *et al*. which reported that: in healthy persons; BP in the supine was higher than in the sitting position.[17] Likewise, Krzesiński *et al*. on randomized trial of hypertensive patients, declared that systolic and diastolic BP in the sitting position were lower significantly than in the supine position.[18]

Our readings contradict with Cicolin who stated that; the average Systolic BP was higher when measured in supine than sitting position, whereas the mean DBP was usually highest in sitting position. Also declared that; fowler's BP was significantly differed from sitting and supine BP, showing values that are always intermediate between those obtained using the two most common positions.[21]

International Journal of Novel Research in Healthcare and Nursing
Vol. 7, Issue 1, pp: (675-686), Month: January - April 2020, Available at: www.noveltyjournals.com

Comparing BP measured, a significant difference was found between left and right arms in sitting position in both the systolic and diastolic pressure, and in the mean sitting BP from both arms. Where mean BP readings in the left arm were lesser than from right arm. While other both arms readings remains consistent when compared by standing and lying positions.

In adults over the age of 50, there is usually a rise in the difference in blood pressure of the arms. However, the rise should never be taken as normal if it is over 15 mm Hg., because age and associated diseases may be responsible for the BP increase in between the arms.

The American Heart Association (AHA) recommended that; doctors and nurses should measure blood pressure in both arms for every patient during each visit. The BP measurement in sitting position is most often used in the general physician's office, so we have to consider that the effects of hydrostatic forces as a major determinant of the differences in BP between positions; which specify the obtained differences.[22]

Researchers at Harvard-affiliated Massachusetts General Hospital and colleagues measured BP, in both arms, in nearly 3,400 men and women age 40 or older with no signs of heart disease. The average arm-to-arm difference was about 5 points in systolic blood pressure. [23]

Also Tedla K (2017) enforced the medical necessity to check BP from both arms. As a great difference in systolic BP between arms – greater than 10 or 15 mm Hg- may be a sign of increased cardiovascular disease – defining association between inter-arm BP difference and the increase risk in cardiovascular death. This emphasizes the importance of undergoing further vascular assessment."[24]

On analyzing data obtained from the studied hypertensive and non-hypertensive participants; 45% were hypertensive. Where; the right systolic BP tended to drop significantly in supine than standing and sitting positions.

This goes in line with Krzesiński P et al. (2016) who stated that; in hypertensive patients, the supine BP reading during 10-minutes rest was lower than in sitting position; and explained that approach by: these periods of rest before successive supine BP measurements provide relaxation and stabilization of BP. [25]

Van der Wel *et al*. (2011) observed that; supine BP measurement declines if repeated at minimally every 5 minutes, emphasizing on the recommendation of 10-minute supine position relaxation for steadiness of BP. It is widely accepted that diastolic pressure measured is higher while sitting than supine (by ≈5 mm Hg). While when the cuff and arm position is adjusted at the level of the right atrium in both positions, the supine systolic pressure reported to be 8 mm Hg higher than the upright position.[26]

On disagreement researches in a group of outpatient hypertensive patients, found significant reduced sitting BP readings than in supine position when the patient's right arm was maintained at the right atrium level. [26, 27]

As regard to the non-hypertensive (55%); the right systolic supine BP was significantly lowest than sitting. Where; the right and left systolic and diastolic mean pressures were at the highest in siting position when compared the two positions.

Likewise, this was confirmed by a previous observations in normotensive subjects; where supine BP measurement was higher than in the sitting position.[25] This also goes in accordance to similar results reports relating the reduced systolic and diastolic BP to the supine position in both hypertensive as well as in normotensives participants. As well results of Salice *et al*. suggest that supine BP readings are significantly lower than in sitting position. [17, 28]

In a comparison between mean BP measurement at both right and left arms in the three body positions among studied participants; systolic, diastolic and mean BP in hypertensive subjects were affected significantly in sitting position by changing the arm of measurement; in which the left arm readings significant were lesser than right arm in sitting position .

Cicolini et al confirmed in his study that; BP significantly varies according to body position in essential hypertensive patients, despite small on average BP variation in clinical practice, and noticed that Fowler's position readings are intermediate between those recorded in sitting and supine positions. Also a relevant proportion of subjects showed large differences in BP from one position to another, suggesting that more emphasis should be posed on body position by clinicians and guidelines. Recommending more than two recordings at each BP measurement, taking the two measurements mean value to minimize error or variation.[21]

Van der et al. (2011) and Vrachatis et al (2014) also stated that; measuring diastolic BP was found to be higher in sitting than supine position (by ≈5 mm Hg); while systolic pressure was recorded 8 mm Hg higher in the supine position from both arms. [17, 26]

Researchers illustrated that; checking hypertensive patients BP from both arms is a simple and non-invasive tool for assessing cardiovascular disease (CVD) risk. If Systolic BP is confirmed high, with a large difference in systolic blood pressure between arms ≥ 10 mm Hg; then clients may double risk to develop CVD with higher death threat.[24]

While results in non-hypertensive patients illustrated that; the left arm reading was significantly lower than the right arm in supine position for the systolic, diastolic, and mean BP. Also the right arm systolic and mean BP measurements were less than left arm in supine position. While no significant differences were observed on measuring blood pressure in either standing or supine positions.

Muntener et al. (2019) stated on the AHA statement that; the raise in RT arm systolic clinic BP measurement in normotensive persons, could be related to an unclear reasons; whether those adults has white-coat hypertension or has masked hypertension which has increased cardiovascular disease risk in both patients.[16]

Van der Steen MS (2011) stated that: where normotensive persons BP measurements show negligible variations with position changes; however, autonomic nervous system (ANS) imbalance may tend to cause reduction in BP with the upright position. They documented a significant difference of day-night positions influence on both body and arm positions BP readings, that supine systolic BP measurements was higher defining the risk for developing heart diseases. [26, 29]

Thus; the present study introduces an innovative piece of science in BP measurement: emphasizing that body and arm positions has a consequence in BP readings. Nevertheless, it is recommended that BP should be checked from both arms at the first clinical examination to identify inter arm differences to classify cardiovascular disorders risk groups.

5. CONCLUSIONS

The hypotheses were proved since both arm and body position can significantly influence blood pressure measurements. The present study concluded that; BP measurements significant differences in the sitting, standing and supine positions. The mean right and left arm systolic and mean blood pressure tends to be lesser in supine position than sitting and standing.

In hypertensive participants; the right systolic BP tended to drop significantly in supine than standing and sitting positions. As regard to the non-hypertensive; the right systolic supine BP was significantly lower than sitting, and the left arm reading was significantly lower than the right arm in supine position.

6. RECOMMENDATIONS

- Thus, it was recommended to take multiple blood pressure readings especially in the first outpatient visit to get an accurate measurement.
- The routine blood pressure measurements should be from both arms, not just one.
- This study should be replicated on heterogeneous larger groups of healthy young adults, where a variety of the effects of variables could be considered or controlled to determine variables that may affect BP readings.

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