The future Alert of Inter-arm blood pressure difference Among young healthy population: A Cross-sectional Study

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Article

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Abstract

Background: More than 100 years ago, the difference in blood pressure (BP) between arms was first reported. Recent studies have shown that different blood pressure between the right and left arm leads to cardiovascular events. The aim of the present study was to establish of an inter-arm blood pressure difference (IAD) and the dominant hands effect on the elevation blood pressure among young healthy population.

Methods: This was a cross-sectional study using quantitative method for both data collection and data analysis and carried out at the Sulaimanyah governorate Kurdistan Region, Iraq among a young, healthy population. Data were expressed as percentages of individuals with systolic IAD and diastolic IAD and mean (± standard deviation) for the inter-arm difference in systolic blood pressure and diastolic blood pressure (DBP). To evaluate the association between IAD and age, BMI, heart rate, systolic BP, and diastolic BP Pearson's correlation test was used. The Chi-square test was used to compare the prevalence inter-arm difference category between groups.

Results: Three thousand and thirty volunteers participated in our study. The sIABP was equal in 163 of 3030 persons (5.37%), dIABP was equal in 222 out of 3030 persons (7.32%), from a total of 792/3030 persons (26.1 %) sIAD > 10 mmHg, and dIAD > or =10 mmHg was found in 927 out of 3030 persons (33.5%) in the right arm, and 32.4% in the left arm. In 2692 of 3030 volunteers BP, initially recorded in the dominant hand (right arm), showing sIAD> or = 10 mmHg was found in 943 (37.1%) volunteers, and when the first measurement was done in 338 left-handed volunteers it showed sIAD> or = 10 mmHg in 112 of 338 (34.1%), P < 0.001; 95% confidence interval for systolic right hand were (115.73: 116.73), and for systolic left hand 95% confidence interval were (113.17:114.15).

Conclusion: significant inter-arm systolic and diastolic BP differences above (10 mm Hg) is common in the young, healthy population. Hand dominance is a significant consideration while measuring blood pressure. It is mandatory to measure blood pressure in both arms in a sitting position with a stable condition.

1. Introduction

Blood pressure should be measured in both arms due to differences in values between them to avoid under-diagnosis of hypertension [1]. In the clinical setting, both systolic and diastolic values should be measured [2]. Accurate assessment of blood pressure is mandatory to prevent cardiovascular, cerebrovascular, and renal diseases because hypertension is a modifiable risk factor that increases mortality and morbidity [3]. Detection of inter-arm difference is an indication of peripheral vascular disease; therefore, knowledge of evaluation, recent guidelines, and risk factors is essential [2]. IAD is recognized as a sign of peripheral vascular disease (PVD), and it may be a prognostic factor for cardiovascular disease and causes decreasing of ankle-brachial pressure index (ABPI) [2].

In the latest United Kingdom guideline for the management of hypertension, [2] and the 2017 American College of Cardiology/American Heart Association Guideline and the seventh report of Joint National Committee, [3] taking BP in both arms is recommended and the higher value should be recorded. Difficulty in the measurement of BP in bilateral arms arises due to cost, lack of time, manpower, and workforce; in most of the other studies, BP was measured in the right arm for detection of hypertension [3]. The prevalence of IAD has been estimated only in older adults, diseased adults, and pregnant women. In a young healthy population, the prevalence is unknown as few studies have been done [1]. There are many studies and meta-analyses on diseased patients or in patients admitted to ICU [4–9], but rarely IABPD has been studied in healthy populations [10, 11]. In Hirono's study of 700 cardiovascular disease patients, 11% of patients had higher BP in the left arm than the right by approximately 5 mmHg, but in 16 % of patients the right arm BP was higher than the left by a minimum 5 mmHg, the other having IAD of less than 5% [12]. In a study by Cassidy and Jones, right arm blood pressure was higher than the left arm by approximately 4-5 mmHg [13]. The right arm SBP was higher in 147 hypertensive patients by approximately 2-3 mmHg [14]. Another study with 877 patients in whom IASBPD > 2 mmHg showed that SBP was similar in 9%, higher in the right arm in 48%, and higher in the left arm in 43% of patients with no difference in mean SBP between left or right arms [1]. The aim of the present study was to establish of an inter-arm blood pressure difference (IAD) and the dominant hands effect on the elevation blood pressure among young healthy population.

2. Materials And Methods

2.1. Background and study design: This was a cross-sectional study using quantitative method for both data collection and data analysis and carried out at the Sulaimanyah governorate Kurdistan Region, Iraq among a young, healthy population.

2.2. Population: Volunteers were 3,030 outdoor young healthy for the study from 13 May 2019 up to 22 February 2020. Direct permission was received from volunteers for clinical knowledge and ethical approval was received from the University of Raparin. The inclusion criteria were: being between the ages of 15 and 40 years; and being in good health. The exclusion criteria excluded 205 volunteers: one case was below 15 years; 49 were above 40 years; 155 had chronic diseases by a medical diagnosis like; 8 were hypertensive; 7 were known to have diabetes mellitus; 10 had hyperthyroidism; 25 had hypothyroidism; 45 had hypercholesterolemia; 22 had renal diseases; 1 had heart problems; and 27 had genetic disease all of which were thalassemia.

2.3. Instrument and tools: For data collection, the study instruments were composed of an oscillometer monitor (OMRON model M2 HEM-7120-E, Healthcare Co., Ltd., Japan, accuracy ± 3mmHg, pulse indicator, Arm Cuff 22-32cm, with Movement Indicator, Hypertension indicator, and Irregular heartbeat detection) and standard mercury Sphygmomanometer (ALPK2-300 VSN Aluminum die cast body brown, manometer 0 -300 mmHg, Accuracy ± 2mmHg , air system Velcro cuff with latex bag, bulb with valves, weight 1.18 kg), with a fingertip pulse oximeter (model YK-80C) and stethoscope (MDF single head

stethoscope). The tools selected were based on an extensive review of related literature and studies about inter-arm blood pressure differences in the young, healthy population.

2.4. Blood Pressure Measurements and data collection: The data were collected using a constructed tool, and face-to-face interviews with the participants. Volunteers were seated for 10 minutes before measurements and refrained from smoking or caffeine ingestion and exercise for > 30 minutes. The volunteer's arm was kept at heart level during the measurement, and using an appropriately sized cuff, two measurements were made in the sitting position, and the mean BP in each arm was recorded. At least one to two minutes elapsed between BP measurements. BP was taken in the first arm (dominant hand); the arm was supported during each measurement. No tight clothing constricted the arm, participants sat in a chair with legs flat on the floor; three trained nurses experienced in collecting clinical data measured brachial BP.

2.5. Statistical Analysis: The data were organized and coded into computer files, by using SPSS version 25. Data were expressed as percentages of individuals with systolic IAD and diastolic IAD and mean (± standard deviation) for the inter-arm difference in systolic blood pressure and diastolic blood pressure (DBP). To evaluate the association between IAD and age, BMI, heart rate, systolic BP, and diastolic BP Pearson's correlation test was used. The Chi-square test was used to compare the prevalence inter-arm difference category between groups; $P<0.05$ was considered significant, while $P < .001$ was considered significant.

3. Results

We studied 3235 young, healthy participants from 13 May 2019 to 22 February 2020. We excluded 205 volunteers; they were not healthy **(Figure 1).**

Finally, 3,030 volunteers remained (1377 (45.4%) male, 1653 (54.6%) female, mean age 19.5 (± 5) years old, mean BMI 22.3 (± 3.9)) all were in good health. Of 3030 participants, 2732 (90.1 %) were single, 297 of 3030 volunteers (9.8%) were married, only one female was divorced. There was no relationship between these factors and IAD, ($P = 0.451$). Regarding the weight of participants 1904 out of 3030 (62.8%) had normal weight, and 124 (4.1%) were obese. A total of 115 /3030 persons (3.7%) had a hard-physical occupation (hard duty), 751 out of 3030 volunteers (24.7%) had a moderate duty, and 2164 out of 3030 volunteers (71.4%) had a low duty **(Tables 1, 2, 5).**

Furthermore, 1369 out of 3030 (45.2 %) persons had never previously had their blood pressure measured; a total of 3030 volunteers 1634 had normal BP, 592 had pre-hypertension, but hypertension stage1 was recorded in 420, and hypertension Stage 2 was recorded in 221volunteers **(Table S1&S2).**

Regarding the prevalence of inter-arm difference, a total of 163/3030 persons (5.37%) sIABP was equal, a total of 222/3030 persons (7.3%) dIABP was equal, a total of 926/3030 persons (30.7 %) sIAD was 1-4 mmHg, 1149 of 3030 persons (37.88%) sIAD was 5-10 mmHg, and 792 out of 3030 (26.1 %) persons sIAD > 10 mmHg **(Table 3)**. The dIAD > or =10 mmHg was found in 508/1515 persons (33.5%)

in the right arm, and 419/1293 persons (32.4%) in the left arm **(Table 4)**. The IAD was greater in males (P < .001) **(Table 5)**.

Moreover, a total of 85/3030 persons (3%) were past smokers, 288 of 3030 persons (9.5%) were current smokers mostly smoking 10 to 20 cigarettes per day, a total of 290/3030 persons (9.6%) were smoking a hookah **(Table S3)**. Nearly all had IAD ranging from 1-20 mmHg, and 30% of their IAD was above 10 mmHg (P < .001) **(Table 5)**. In 2692 volunteers, BP was initially recorded in the dominant hand (right arm), but showed sIAD 5-9 mmHg in 787out of 2692 persons (30.99%), and sIAD> or = 10 mmHg was found in 943 of 2692 volunteers (37.1%) in the right arm. The first measurement was done in 338 left-handed volunteers and showedsIAD 5-9 mmHg in 99 out of 338 volunteers (30%), and sIAD> or = 10 mmHg in 112 out of 338 (34.1%), (P <.001) **(Table 4)**. In addition, the blood oxygen level SPO2 of the all volunteers was normal. There was no association with basic SPO_2, (P = 0.20) **(Table 5)**.

On the other hand, the height of participants had an effect on IAD (P =.041), and the residential area had a significant effect on IAD; urban participants had more inter-arm difference than rural area participants, (P =.002) **(Table 5)**. The blood group has no effect on inter-arm difference, (P = 0.65) **(Table 5)**; a total of 440/3030 volunteers (14.5 %) were under weight, 558 of 3030 volunteers (18.4%) were overweight. The IAD of overweight persons showed that 180 of 558 volunteers (32.2%) had IAD; 123 had IAD approximately 5-10 mmHg, and 57 had > 10 mmHg, (P = .046). In addition, 124 of 3030 volunteers (4.1%) were obese, just 30 of 124 (24%) had IAD; 18 had IAD approximately 5-10 mmHg, and 12 had >10 mmHg, (P =.04) **(Table S4)**. The heart rate of 985 of 3030 volunteers was above 90 bpm, and 234 of 985 had IAD; in 162 (% 69.2) were between 5-10 mmHg, in 72 (%30.76) were >10 mmHg, (P =.001) **(Table S5)**.

4. Discussion

One of the main goals of this study to establish prevalence of IAD and effect of dominant hand on elevation blood pressure.in young healthy population. The present study revealed that prevalence sIAD more than 10 mmHg was found in 792 of 3030 volunteers (26.1%), and dIAD > or =10 mmHg was found in 927 of 3030 volunteers (30.5%). In our study, the dominant hand had a significant effect on elevation blood pressure. The left-handed persons SBP was higher in the left hand than the right hand.

Most of the previous studies were on patients with cardiovascular diseases and diabetic patients [4, 6, 7, 12, 15,16,17]. Few studies were done with young, healthy population [10]. Our study involved young, healthy populations from the age of 15 to 40 years. The prevalence of IAD is greater in known hypertensive patients [18]. According to NICE, and Beevers's guidance, the range of IAD below 10 mmHg can be healthy, but more than 10 mmHg should be referred to a specialist [19, 20]. Harvey's did not find a role of hand dominance with IABPD [21]. In our study, the dominant hand has higher blood pressure than non-dominant, as shown by Olmedilla’s and Loenneke's studies, and they hypothesised this might be related to larger circumference due to greater muscle mass and biceps girth [22, 23]. In other studies, the right arm had higher SBP with no relationship to hand dominancy [13, 14]. Our study in left-handed persons, showed higher SBP in the left arm than the right arm.

In our study sIAD in smokers is significantly higher than non-smokers. It is like Donfrancesco's study, which involved young, healthy smoker Italian adults [24]. In Daniel's study, there was no significant IAD associated with smoking and hypertension [25]. Our study shows a significant difference associated with smoking and high blood pressure; (P <.001 and P <.001, respectively). In the same study, there was no association between IAD and BMI [26]. In our study, there is a significant difference (P= .046). Singh, in his pairwise meta-analysis of five studies, found that IASBPD had no relation to age, sex, diabetes, hypertension, dyslipidemia, or smoking [26]. In the present study, IABPD is greater in males, hypertensive, and smokers, but because we only involved young, healthy populations, we do not have data on diseased populations. Thus, our results did not show any relationship between IAD and cardiovascular risk. However, Clark et al and some other studies found that an IAD > 15 mmHg is a risk factor for vascular diseases and death [18]. At first, the IAD was suspected as a sign of aortic aneurysm [27], but in an early study, the IAD has no relation with aneurysm [28]. CE Clark showed that IAD>10mmHg in patients with CVD was 19%, but patients without CVD it was 2.7 % [2]. Moll found that 83% of patients had innominate or subclavian artery stenosis on the side that had higher blood pressure [29]. Hennereci and Lawson found that 78-88% of subclavian steal syndrome caused IAD [30, 31]. Baribeau and Sin Lau found that sIAD > or = 15 mmHg is related to carotid and aortic artery disease by angiography; therefore, the affected arm had hypertension [32, 33]. Siyu and Johansson showed that DBP has a significant effect on cardiovascular disorders [34, 35], and Hu et al showed the appearance of flow-mediated dilation of the arm due to dIAD that caused arterial endothelium lesion [36]. The dIAD > or = 4 mmHg and sIAD > or = 6 mmHg caused intracranial and extra cranial arterial stenosis, respectively [37]. The prevalence of sIABPD >10 mmHg (26.1%) in our study is higher than all previous studies [1,10,38,18,39], even in young, healthy normotensive adults [21]. In previous studies, sIAD ≥10 mmHg was 5-15%, 3-7%, 23.5%, 23,5%, 1.4-38%, 34%, respectively [40,41,18,43,39,5,15,43,7], and dIAD ≥10 mmHg was 7%, 14%. 14.5%, respectively. [1,42,18,43,39]. Nevertheless, in our study the sIAD > or = 10 was % 36.79 % of participants without any previous vascular disease. In a few studies, the BP is higher in the right arm than the left arm [13, 41]. BP should be measured in both arms so as not to miss hypertension. Poon showed that 30% of hypertensive patients had normal blood pressure in whom single arm BP had been measured [45]. Our study showed that obesity has a high risk of increasing IAD as Kimura's study in Japan showed that obese patients had more sIAD > 10 mmHg [46]. sIAD is higher in the right arm in the general population, according to Johansson's study and other studies [35]. However, in Wei ma’s study sIAD is higher in the left arm than the right site but dIAD is lower. Clark in his cross-sectional study showed that IASBPD > 10 & 15 mmHg is related to PAD [18]. Canepa et al measured carotid-femoral pulse wave velocity for detection of arterial stiffness and found that persons who had IAD > 10 mmHg have recorded higher (cf-PWV) [47]. Jiji also showed that IAD has a significant relation with arterial stiffness; therefore, detection of IABPD is mandatory to decrease cardiovascular morbidity and mortality [43]. Verberk's meta-analysis showed that the IABPD should be measured precisely because this concurrent checking of BP in both arms is required [42]. Daniel recommends measuring blood pressure in the arm with higher blood pressure to diagnose potential hypertension [25]. However, this cross-sectional study was conducted with young, healthy adults who are apparently stable, Because of a lack of long-term follow-up; we could not conclude on the long-term effects of these results. The sequential or simultaneous measurement requires further research.

5. Conclusion

Significant Inter-arm difference (>10 mm Hg) is common in the young, healthy population. Hand dominancy is significant for considering while measuring blood pressure. In Left-handed (dominant) persons, the pressure is higher than their right site. The rate was mostly between 5-10 mm Hg. When IAD is more than 20 mm Hg requires proper assessment to detect any underlying pathology. It is mandatory to measure blood pressure in both arms in a sitting position with a stable condition. The sequential measurement or the simultaneous measurement needs more research to find the benefit of each. The Inter-arm blood pressure difference is significant in young, healthy persons needs to follow up for a long time.

Declarations

Ethical Approval and Consent to participate: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of University of Raparin (Number 245 On 27 February 2019)

Consent for publication: Direct permission was received from volunteers for clinical knowledge and for publication.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Author Contributions: Conceptualization, SKA. and RE; methodology, SKA. and RAE.; software, SKA. and RAE.; validation, SKA, and RAE.; formal analysis, SKA.; investigation, SKA and RAE; resources, SKA; data curation, RAE, SKA; writing—original draft preparation, SKA, RAE; writing—review and editing, SKA, and RAE.; visualization. All authors have read and agreed to the published version of the manuscript.

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Abbreviations

ABPI: ankle-brachial pressure index

BMI body mass index

BP: blood pressure

CVD: cardiovascular diseases

DIABP: Diastolic Inter Arm Blood Pressure

DIAD: Diastolic Inter Arm Difference

IAD: inter-arm difference

IASBPD: Inter Arm Systolic Blood Pressure Difference

ICU: Intensive Care Unit,

PVD: Peripheral vascular disease

SIABP: Systolic Inter Arm Blood Pressure

SIAD: Systolic Inter Arm Difference

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Figures

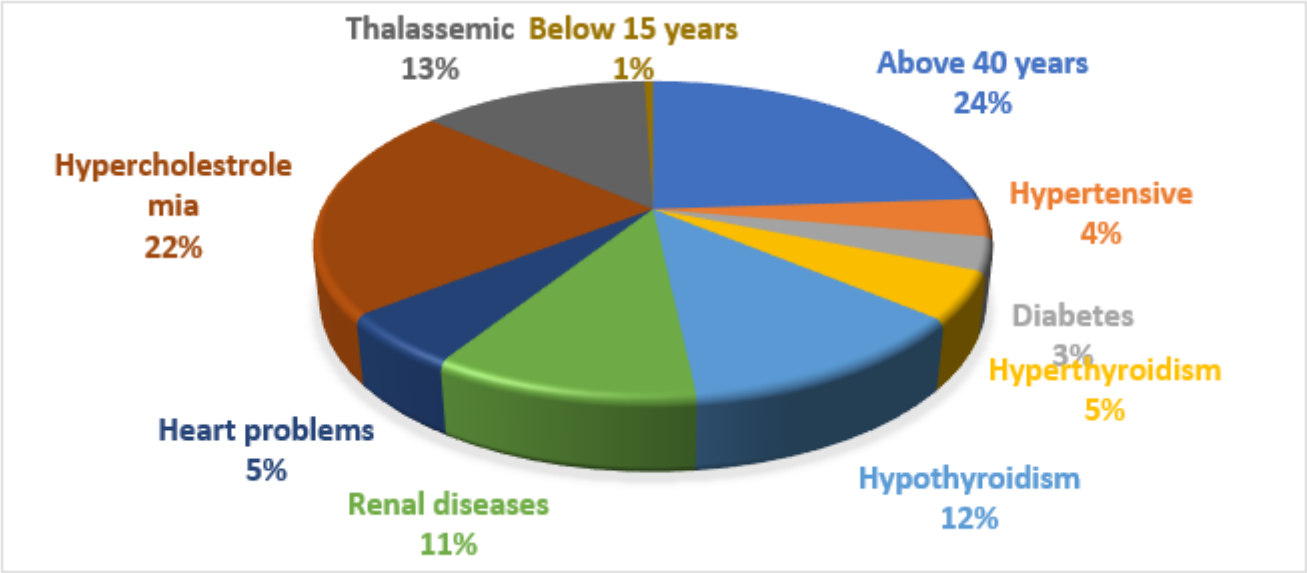

Figure 1

Excluded 205 volunteers with their reasons.

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