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RESEARCH ARTICLE

Inter-Arm Blood Pressure Difference in a Typical University Family Medicine Clinic

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Abstract

Purpose: The purpose of this study was to determine the point prevalence of Inter-Arm Blood Pressure Difference (IAD) in a University Family Health Center (UFHC).

Methods: 217 patients seen by the Uniformed Services University's (USU) UFHC were assessed in this non-randomized screening study. Blood pressure was measured simultaneously in both arms with automated sphygmomanometers in a seated position during normal scheduled appointment screening process after 5 minutes of sitting. The measure was repeated after one minute. The main outcome measure was to establish the point prevalence of either a systolic or diastolic IAD difference of ≥ 10 mmHg. Paired t-tests were used for categorical variables of active duty status, family history, gender, and smoking status, while an ANOVA test was used for race. Continuous variables of BMI and age were analyzed using a Pearson correlation.

Results: The point prevalence of an IAD > 10 mmHg for either systolic or diastolic values combining two measurements was 14.2% for all participants with a mean age of 27.9 years. IAD had statistical significant association with hypertension, higher BMI, male gender, and non-Caucasians.

Conclusions: An IAD of > 10 mmHg is prevalent in > 10% of a typical University Health Center population. Bilateral blood pressure readings should be taken at least once in an adult population. The frequency of repeated measurements and their true prognostic value requires greater study.

Keywords

Inter-arm difference, Blood pressure, Cardiovascular disease

Abbreviations

UFHC: University Family Health Clinic; IAD: Inter-Arm Difference

Introduction

Inter-arm difference (IAD) of ≥ 10 mmHg carries an increased cardiovascular risk especially in previously diagnosed hypertension or vascular disease [1]. Clarke published extensively on IAD being a specific measure associated with cardiovascular disease [2]. Does this mean simultaneous inter-arm blood pressure should be standard practice? The 2017 High Blood Pressure Clinical Practice Guideline by the American College of Cardiology recommends blood pressure should be checked initially in both arms and if significant difference to use the arm with the higher blood pressure for subsequent measurements [3,4]. IAD risk is based on a body of literature that has explored a wide array of patient populations including studies of general patient populations with ranges of 3% in non-hypertensive patients in Korea, and a rural England study by Clark Clark, et al. with an incidence of 20% for all comers [5,6].

It remains unclear if IAD is an early identification of an impending cardiovascular diagnosis [2,5,7,8]. Previous studies have not been representative of a population seen within a typical University Family Health Clinic (UFHC) [1,2,5-11]. The Uniformed Services University UFHC cares for a relatively young active duty military population. A similar population was studied by Van der Hoeven which looked at Israeli Air Force applicants and found a prevalence of 12% [12]. One might surmise that a military population would have a lower incidence of hypertension because of the aerobic physical fitness requirement, which in the general population has been shown to reduce blood pressure in normotensive and hypertensive individuals [13]. Instead, the United States

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military has higher hypertensive rates than the general population when compared to young healthy individuals [14]. This oddity in hypertensive rates in the United States military was previously shown with rates of 11% of active duty members under the age of 40, which is in contrast to the general United States population reported by the Center for Disease Control in 2013 for those under 40 as 7.3% [14,15]. The purpose of this study is to establish the point prevalence of ≥ 10 mmHg between arms for systolic or diastolic in a typical UFHC.

Methods

This IRB approved study was performed at the Uniformed Services UFHC. Participants were recruited during the normal screening process for scheduled appointments. 217 patients voluntarily agreed to participate in this nonrandomized study. The only exclusion criteria was being under 18-years-old. All participants completed a consent and screening questionnaire to assess for family and personal medical history, demographics, ethnicity, medications, smoking status, and pregnancy status. Body mass index was calculated from height and weight. As per previous literature, blood pressure was measured simultaneously in both arms with automated sphygmomanometers to reduce overestimation of IAD [2]. All blood pressure measurements were obtained in a comfortably seated position with the participant's back supported, legs uncrossed, and bilateral upper arms exposed and supported at heart level for at least 5 minutes prior to any measurements taken [16,17]. The measure was repeated after one minute. Participants and the screener were also asked to remain silent during the measurement process [12,16]. Each sphygmomanometer was calibrated to the manufacturer's guidelines by medical maintenance. In addition, all blood pressure measurements were documented as part of the medical record for the primary care provider to review. The main outcome measure was to establish the point prevalence with an IAD of > 10 mmHg systolic or diastolic by on averaged calculation of both measurements. For statistical analysis paired t-tests were used for categorical variables of active duty status, family history, gender, and smoking status, while an ANOVA test was used for race. Continuous variables of BMI and age were analyzed using a Pearson correlation.

Results

All statistical analysis was performed in SPSS. The study participants consisted of 110 males and 107 females for total of 217 with a mean age of 27.9 years (Table 1). There were 168 active duty participants and 49 non-military. The overall mean BP was 119/79 with an average of 120/75 for the right arm and 118/74 for the left arm. The distribution of measures was in a normal

Table 1: Patient characteristics.

Gender:
Male: 110 Female: 107
Race:
Caucasian: 144 Non-Caucasian: 77
Age:
Mean: 27.9
Military Status:
Active-duty: 168 Civilian: 49
BMI:
Mean: 24.7

Table 2: Inter-arm blood pressure difference by prevalence with systolic blood pressure, diastolic blood pressure, and combined measure and mean of the measurements.

Systolic Inter-arm Blood Pressure Difference ≥ 10 mmHg			
1st measurement	*2nd measurement*	*Patients with IAD in 1st & 2nd measurements*	*Averaged measurements*
22/217 (10%)	18/217 (8.3%)	7/217 (3.2%)	26/217 (12%)
Diastolic Inter-arm Blood Pressure Difference ≥ 10 mmHg			
1st measurement	*2nd measurement*	*Patients with IAD in 1st & 2nd measurements*	*Averaged measurements*
9/217 (4.1%)	3/217 (1.4%)	1/217 (0.5%)	5/217 (2.3%)
Combined: Systolic and/or Diastolic Inter-arm Blood Pressure Difference ≥ 10 mmHg			
1st measurement	*2nd measurement*	*Patients with IAD in 1st & 2nd measurements*	*Averaged measurements*
29/217* (13.3%)	20/217** (9.2%)	8/217 (3.6%)	31/217 (14.2%)

*Two patients had a > 10 IAD with both systolic and diastolic pressures on the first measures; **One patient had a > 10 IAD with both systolic and diastolic pressures on the second measure.

bell-shaped distribution. The mean IAD was 5.2 systolic and 3.5 for diastolic. 22.5% of participants had at least one IAD measure of ≥ 10 mm of hg, but the overall point prevalence of IAD ≥ 10 mmHg on two averaged readings was 14.2% (Table 2). IAD prevalence in for active duty military was 11.9% as opposed to 20% for non-military.

A breakdown of statistical analysis can be seen in Table 3 with analysis for patient characteristics and in Table 4 using blood pressure classifications. An IAD difference > 10 mm of Hg and hypertension (> 120 systolic or > 80 diastolic) had a statistically significant association with a p value of 0.02 using a Fisher's Exact test. Higher BMI demonstrated a small statistical

Table 3: Statistical analysis of patient characteristics and inter-arm blood pressure difference.

		Systolic IAD *(p-value and 95% CI)*	**Diastolic IAD** *(p-value and 95% CI)*	**Statistical Test**
Gender	110 M/107 F	p = 0.014 (0.28, 2.45)	p = 0.286 (-0.31, 1.06)	t-test
Age	27.9 years (mean)	p = 0.155 (r = 0.097)	p = 0.602 (r = -0.036)	Pearson correlation
BMI	24.7 (mean)	p = 0.04 (r = 0.139)	p = 0.997 (r = 0)	Pearson correlation
Caucasian vs. Non-Caucasian w/IAD	144/73	p < 0.001	p = 0.788	ANOVA
Family History of hypertension	107/217	p = 0.878 (-1.02, 1.19)	p = 0.31 (-0.33, 1.04)	t-test
Family History of Diabetes	80/217	p = 0.437 (-1.66, 0.72)	p = 0.916 (-0.71, 0.79)	t-test
Family History of Dyslipidemia	67/217	p = 0.508 (-0.76, 1.52)	p = 0.434 (-0.43, 1)	t-test
Family History of Heart Operations	31/217	p = 0.944 (-1.52, 1.63)	p = 0.855 (-0.89, 1.08)	t-test
Family History of Obesity	54/217	p = 0.691 (-1.53, 1.02)	p = 0.79 (-0.69, 0.90)	t-test
Family History - Myocardial Infarction before the age of 50	18/199	p = 0.618 (-1.49, 2.50)	p = 0.771 (-1.43, 1.06)	t-test
Family History - Stroke	6/211	p = 0.805 (-2.94, 3.78)	p = 0.934 (-2.19, 2.01)	t-test

Table 4: Analysis of inter-arm blood pressure difference and blood pressure by classification.

Covariates	**IAD Mean Change**		**Statistical Test**	**P-Value**
	< 10	≥ 10		
Hypertension Category (Using Averaged Measurement)				
Normal	147	17	Fisher's Exact test	0.02
*Stage I Hypertension**	35	11		
*Stage II Hypertensive***	5	2		
Hypertension Category (Using Lowest Measurement)				
Normal	159	26	Fisher's Exact test	1
*Stage I Hypertension**	24	4		
*Stage II Hypertensive***	4	0		
Hypertension Category (Using Highest Measurement)				
Normal	115	9	Chi-sq test	< 0.001
*Stage I Hypertension**	53	10		
*Stage II Hypertensive***	19	11		

**Stage I hypertension: 120/80 to 139/89; **Stage II hypertension: 140/90 to 159/99.*

significance with higher IAD with a p value of 0.04 using a Pearson correlation. Non-Caucasian with IAD had a statistically significant association with IAD > 10 mmHg as compared to Caucasians with a p value of < 0.001 using ANOVA comparing only those with an IAD.

Discussion

This study supports the previous literature with a prevalence of > 10% IAD > 10 mmHg in the general population. Our study included a younger mean age, 27.9 years, as compared to previous studies. In the United States it is quite rare in clinical practice to look for an IAD despite a large body of literature over the past 17 years. Due to the increased prevalence of CAD and PVD associated with IAD > 10 mmHg, the United Kingdom recommends monitoring an inter-arm difference, while no association in the United States does as the long term significance remains unknown [18]. United States guidelines do call for at least one time bilateral blood pressure measurements with subsequent readings taken in the higher of the two arms. Previous observational studies on IAD show it is a modest predictor of future cardiovascular events in those without cardiovascular disease [2].

A strength of this study was the use of a repeated simultaneous measure of IAD. Only 5.0% of participants had a measure ≥ 10 mmHg in either their systolic or diastolic for both measurements. 22.5% of participants had at least one systolic or diastolic measure ≥ 10 mm of hg. If a third measure had been done it may have further decreased our prevalence. Although the question remains, is a single reading sufficient to screen for IAD or is there a need for multiple readings? A limitation of this study was the sample size and especially in comparison of much larger general population studies. Another limitation was our inability to use the same model of electronic sphygmomanometer for all measures as the deflation rates were not the same and could contribute to some overestimation. This limitation highlights the real consideration for clinics from the financial aspect of purchasing new sphygmomanometers.

We feel that IAD should not be routine but should be an adjunct to screen once in young adulthood as it may detect anatomical associated IAD. From there it should be a consideration for use as an annual measurement in hypertensive patients or those with increased cardiovascular risks. The argument for not routinely performing bilateral measurements stems from no current clinical guidance on how to manage an IAD > 10 mmHg [19]. The United States Preventive Services Task Force recommends measuring blood pressure annually for adults > 40 years, diagnosed with hypertension, overweight or obese, or African Americans; and every 3 to 5 years for adults 18 to 39 years who are normotensive. A reasonable approach would be to integrate IAD use with these parameters and at the very least to perform serial monitoring in the arm with the higher pressure reading.

Future research should focus on monitoring the changes in IAD over time from young and healthy to symptomatic cardiovascular or peripheral vascular disease. This would allow study of the natural progression and opportunities for treatment and prevention.

Conflict of Interest Statement

None to declare.

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