

# Interarm Blood Pressure Difference in Young Healthy Adults

Poonam Karmacharya,<sup>1</sup> Anshu Bhattarai,<sup>1</sup> Indu Tiwari<sup>1</sup>

<sup>1</sup>Manipal College of Medical Sciences, Pokhara, Nepal.

## ABSTRACT

**Background:** Inter-arm difference in blood pressure is the difference in the systolic and the diastolic blood pressure between arms of an individual. According to American heart association, interarm Blood Pressure difference of more than 10 mm of Hg are associated with peripheral vascular disease. The present study aims to determine the magnitude of interarm difference in young healthy individuals and to assess whether family history of hypertension, age, sex and Body mass index is related to higher interarm difference

**Methods:** A cross-sectional study was carried out among 270 students of Manipal College of Medical Sciences, Pokhara, Nepal. Blood pressure was measured in both the arms using a mercury sphygmomanometer. (Elko 300) Statistical analysis was done using paired t test, chi-square and Pearson's correlation test using SPSS 23.

**Results:** The absolute mean Inter-arm difference for systolic blood pressure was  $11.03 \pm 0.67$  mm Hg and for diastolic blood pressure was  $6.020 \pm 0.21$  mm Hg. There is significant inter-arm difference for systolic blood pressure and diastolic blood pressure ( $p < 0.001$ ). Inter-arm systolic blood pressure difference was significantly associated with family history of hypertension, age and Body Mass Index ( $p < 0.001$ ) Meanwhile, there was no statistically significant association of sex, family history of hypertension, age and Body Mass Index with inter-arm difference for diastolic blood pressure.

**Conclusions:** Significant inter-arm systolic and diastolic blood pressure differences was found in the young, healthy population. Positive correlation of increased Inter-arm difference in Blood Pressure with family history of hypertension was confirmed. This emphasizes the importance of measuring blood pressure in both arms to be a routine practice as we aim for early diagnosis and prompt treatment of hypertensive disorders.

**Keywords:** Blood pressure; healthy adults; interarm difference

## INTRODUCTION

Interarm blood pressure difference (IAD) can be observed among the general populations. According to the guidelines for hypertension from the National Institute for Health and clinical Excellence 2019, when considering a diagnosis of hypertension, we should measure blood pressure in both arms.<sup>1</sup> The presence of interarm blood pressure difference between arm measurements has been implicated in an early diagnosis of hypertension. It has also been confirmed that IAD evaluation can be a non-invasive and simplest to identify individuals predisposed to cardiovascular and peripheral incidents.<sup>2</sup>

So far, most of the IAD research has focused on the elderly, diabetics, people with high blood pressure, and with cardiovascular diseases. Very few studies have been carried out to find the IAD in the healthy adolescents, Therefore, this study intend to assess the inter-arm

difference in blood pressure in healthy young adults and its relation with gender, age, BMI and with family history of hypertension.

## METHODS

The study is a cross sectional study conducted among undergraduate MBBS and nursing students in department of Physiology, Manipal College of Medical Sciences, Pokhara. Data was collected after ethical approval from the Institution Ethics Committee of the same institute (Reference number: MEMG/IRC/305/GA)

Convenience sampling was used. The minimum sample size calculated was 267. However, we have included 270 patients in the study.

Students with a history of hypertension, cardiovascular disease, kidney disease, who were on medication and who were not willing to participate were excluded

**Correspondence:** Dr Poonam Karmacharya, Department of Physiology, Manipal college of Medical Sciences, Pokhara, Nepal. Email: Poonam.karmacharya@manipalpokhara.edu.np, Phone: +9779806622499.

from this study. Informed consent was taken from the participants prior to data collection. Weight was taken using standard digital weighing scale. The scale was kept on a flat surface and the participant was requested to stand in the center of the scale with bare foot without any support. The height was taken using a non elastic measuring tape, bare foot upon firm even surfaced floor.

Blood pressure was measured with the standard mercury sphygmomanometer. (Elko 300) Participants were asked to sit comfortably and rest 5 minutes with legs uncrossed. During measurement of the BP, the blood pressure monitor was held at heart level and the hands were supported. Care was taken to ensure that the size of the cuffs corresponded to the circumference of the tested arm.

BP was measured twice in each arm (with at least 3 minutes rest between each reading) and the values were averaged.<sup>2</sup> IAD of BP was determined as the change between the mean DBP and SBP between the left and right arms.

The data were organized and coded into computer files, by using SPSS version 23. Data were expressed as percentages of individuals with systolic IAD and diastolic IAD and mean ( $\pm$  standard deviation) for the inter-arm difference in systolic blood pressure and diastolic blood pressure (DBP). Inferential statistics such as paired t test was done to identify if there is any significant difference between IAD of SBP and DBP. Chi-square test was done to explore the association between systolic and diastolic inter- arm BP difference with sex and family history of hypertension whereas, Pearson correlation test was applied to govern the association between age and BMI with the diastolic and systolic IAD.  $P < .001$  was considered highly significant and taking confidence interval of 95%.

## RESULTS

The study recruited 270 healthy students aged between 18- 22 years from 2021-2022. Mean height and weight of the study population was  $159.85 \pm 7.79$  cm and  $53.91 \pm 11.1$  kgs respectively (Table 1). Mean BMI of the study group was  $20.90 \pm 2.71 \text{ kg/m}^2$ . Most participants were males ( $n=160$ ) and 123 out of 270 participants had family history of hypertension (Table 2).

**Table 1. Baseline Characteristics of study population.**

| Variables                | Total             | Male              | Female            |
|--------------------------|-------------------|-------------------|-------------------|
| Age(years)               | $20.55 \pm 2$     | $20.61 \pm 0.80$  | $20.46 \pm 0.67$  |
| Height(cm)               | $159.85 \pm 7.79$ | $162.58 \pm 8.48$ | $155.88 \pm 4.22$ |
| Weight(kgs)              | $53.91 \pm 11.1$  | $57.19 \pm 12.23$ | $49.14 \pm 7.20$  |
| BMI (kg/m <sup>2</sup> ) | $20.90 \pm 2.71$  | $21.41 \pm 2.88$  | $20.16 \pm 2.25$  |

**Table 2. General Characteristics and family history of Hypertension (HTN) of the participants.**

| Variables                      | Number    | Percentage    |
|--------------------------------|-----------|---------------|
| Sex                            | Male      | 160<br>59.3%  |
|                                | Female    | 110<br>40.7%  |
| Family history of hypertension | Present   | 123<br>45.55% |
|                                | Absent    | 147<br>54.44% |
|                                | <18.5     | 56<br>20.7%   |
| BMI(kg/m <sup>2</sup> )        | 18.5-24.9 | 143<br>53.0%  |
|                                | 25-29     | 9.45<br>16.7% |
|                                | >30       | 26<br>9.6%    |

The mean right arm systolic blood pressure (SBP) and diastolic blood pressure (DBP) were  $119.93 \pm 8.043$  and  $84.92 \pm 14.26$  respectively. Similarly the mean left hand SBP and DBP were found to be  $110.96 \pm 8.50$  mmHg and  $77.39 \pm 14.71$  respectively.(Table 3).

The absolute mean IAD for SBP and DBP were  $11.33 \pm 0.67$  mmHg and  $6.020 \pm 0.21$  respectively. The proportion for  $IAD \geq 10$  mmHg for both SBP and DBP were found to be 26.3 and 23.7 respectively .

The IAD in SBP was significantly associated with family history of hypertension ( $p < 0.001$ ). However, IAD in DBP did not show any association with the family history of hypertension (Table 4).

**Table 3. Clinical measurement of Blood Pressure of study sample.**

| Systolic Blood Pressure (mmHg) |                        | Diastolic Blood pressure (mmHg) |                        |
|--------------------------------|------------------------|---------------------------------|------------------------|
| Rt. Hand                       | Lt. Hand               | Rt. Hand                        | Lt. Hand               |
| $119.93$<br>$\pm 8.043$        | $110.96$<br>$\pm 8.50$ | $84.92$<br>$\pm 14.26$          | $77.39$<br>$\pm 14.71$ |

**Table 4. Comparison of inter-arm differences of BP in relation to sex and family history of hypertension.**

| Variables and Categories | Systolic BP differences |                  | Diastolic BP differences |                  |               |
|--------------------------|-------------------------|------------------|--------------------------|------------------|---------------|
|                          | <10 mmHg                | >10 mmHg         | <10 mmHg                 | >10 mmHg         |               |
| Total                    | Frequency               | 199              | 71                       | 206              | 64            |
|                          | Percentage              | 73.7             | 26.3                     | 76.3             | 23.7          |
|                          | Mean difference         | $11.33 \pm 0.67$ |                          | $6.020 \pm 0.21$ |               |
| Sex                      | Male (160)              | 108<br>(67.5%)   | 52<br>(32.5%)            | 122<br>(76.3%)   | 38<br>(23.8%) |
|                          | Female (110)            | 91<br>(82.7%)    | 19<br>(17.3%)            | 84<br>(76.41%)   | 26<br>(23.6%) |

|                                | p value (x <sup>2</sup> ) | 0.008      |            | 0.61        |            |
|--------------------------------|---------------------------|------------|------------|-------------|------------|
| Family history of hypertension | Present (123)             | 55 (44.7%) | 68 (55.3%) | 90 (73.2%)  | 33 (26.8%) |
|                                | Absent (147)              | 144 (98%)  | 3 (2%)     | 116 (78.9%) | 31 (21.1%) |
|                                | P value                   | 0.00       |            | 0.87        |            |

Furthermore, the IAD for SBP was significant according to age (p value <0.005) and highly significant according to BMI (p value <0.001). However, IAD for DBP was not significant both according to age and BMI (Table 5)

**Table 5. Correlation (Pearson) of age and BMI and interarm blood pressure difference.**

| Variables | SBP                     |         | DBP                     |         |
|-----------|-------------------------|---------|-------------------------|---------|
|           | Correlation coefficient | P value | Correlation coefficient | P value |
| Age       | 0.143                   | 0.019   | 0.001                   | 0.98    |
| BMI       | 0.28                    | 0.000   | 0.06                    | 0.31    |

## DISCUSSION

Blood pressure (BP) is created by the force of blood pushing against the wall of blood vessels (arteries) as the heart pumps it. Normal adult BP is defined as systolic BP of 120 mmHg and diastolic BP of 80 mmHg. Under normal physiological circumstances, the BP reading is often same for both the arms. However, a BP difference between both arms is frequently encountered in various general populations.<sup>3</sup> This phenomenon known as “inter-arm difference” (IAD). Right and left arm differences of a few mm of Hg are quite normal, but more than 10 mm of Hg could significantly increase the risk for cardiovascular diseases.<sup>4</sup>

The cause for IAD can be both physiological and pathological. In the left hand, the subclavian artery originates from the aorta and thus makes an acute angle, causing decrease blood flow. The right subclavian artery arise from the brachiocephalic artery without significant angulation.<sup>2</sup> This makes the blood pressure to be greater in the right arm compared to that in the left arm. Another reason for the blood pressure in the right arm to be greater is due to the developed muscles mass and biceps girth in dominant hand than in the arm which was non-dominant.<sup>5</sup>In our study, the dominant hand had a significant effect on elevation blood pressure. This finding is consistent with the study done by Rawand et al.<sup>2</sup> and Manjula et al.<sup>6</sup>

Anatomical explanations have been proposed for IAD but there is evidence for an association with Peripheral

vascular disease(PVD), suggesting a pathological rather than a physiological aetiology.<sup>7</sup> In older people, it is usually due to a blockage arising due to atherosclerosis.<sup>8</sup> Other causes are subclavian artery stenosis, aortic aneurysm, aortic coarctation and vasculitis.

Kim et al showed that the presence of IAD  $\geq 10$  mmHg is a strong independent prognostic marker in acute ischemic stroke.<sup>9</sup> Cross-sectional studies has reported higher prevalence of systolic IAD in the presence of diabetes and cardiovascular, cerebrovascular, or peripheral arterial diseases.<sup>10</sup> IAD is associated with increased left ventricular mass and greater arterial stiffness.<sup>11,12</sup>

The present study investigated the distribution of interarm BP differences in healthy young adults and identified their associated factors. It confirms the presence of significant interarm differences in systolic blood pressure and diastolic blood pressure in young healthy adults.

Inter-arm differences  $\geq 10$  mmHg in SBP and DBP were found to be 26.3% and 23.7% of participants respectively, which is nearer to some previous studies,<sup>13,14</sup> whereas other studies have shown prevalence values lower than this study.<sup>15</sup>

In this study, systolic inter-arm pressure difference was significantly associated with a positive family history of hypertension. It shows that people with a family history of hypertension are more prone to inter-arm BP differences. The similar opinion reflected in the study of Seethalakshmi Ket al.<sup>16</sup>

Igarashi et al also reported interarm blood pressure difference associated with the family history of hypertension as well as with the coronary and peripheral artery disease.<sup>17</sup> Thus inter-arm pressure difference may be regarded as a simple marker for coronary and peripheral artery diseases. However, the study by Lane et al did not find any relation between inter-arm difference and the presence of hypertension, diabetes mellitus, or previous cardiovascular disease.<sup>18</sup>

Similarly, our study did show strong correlation of IAD of systolic blood pressure with age and BMI which is similar to the finding of a previous study.<sup>19,20</sup> However the finding is inconsistent with the various studies which showed that BMI and age is not significantly correlated with the IAD.<sup>5,21</sup>

In our study association was found between IAD of SBP and sex but no association between IAD of DBP and sex. Previous studies have shown that mean IAD was

unrelated to sex.<sup>17</sup>

However, this cross sectional study was conducted with young, healthy adults who are apparently stable and because of a lack of long term follow up, we could not conclude long term effects of these results. The sequential measurement requires further research. Furthermore, the study groups included a small population of the medical college. Larger studies with follow up using careful and standardized bilateral assessments of BP are needed to confirm this important observation, and to examine the additional contribution as a risk factor that recognition of the IAD can make to cardiovascular risk assessment.

### CONCLUSIONS

The study shows that there is significant inter-arm systolic blood pressure difference among the healthy young adults and it is associated with positive family history of hypertension, age and BMI. Therefore, blood pressure measurement should be done in both the arms routinely in clinical practice.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest.

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