JIMMA UNIVERSITY

INSTITUTE OF HEALTH

FACULTY OF MEDICAL SCIENCES

DEPARTMENT OF BIOMEDICAL SCIENCES

CORRELATION OF ANTHROPOMETRIC PARAMETERS AND FAMILY HISTORY OF HYPERTENSION WITH INTER-ARM BLOOD PRESSURE DIFFERENCE AMONG NORMOTENSIVE ADULTS IN GINCHI, ETHIOPIA

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ABSTRACT

Background: *Raised inter-arm blood pressure difference has been linked to cardiovascular dise ase and its risk factors. Hypertension is the major cause of cardiovascular mortality worldwide. In clinical practice, one-arm blood pressure measurement is common regardless of a blood pressure difference between arms. This practice is linked to delay in hypertension diagnosis and is associated with a higher prevalence of poor hypertension control. As a result, the purpose of this study is to determine the correlation of anthropometric parameters and a family history of hypertension with the inter-arm blood pressure difference.*

Methods: *A community-based cross-sectional study was conducted among normotensive adult residents of Ginchi town from September 25 to November 15, 2022. A multistage sampling technique was employed to select 567 study participants, and data on socio-demographic characteristics, and family history of hypertension were collected through an interviewer-administered questionnaire. Blood pressure and pulse rate were measured by digital blood pressure apparatus (Omron HEM-907XL, BP monitors) whereas weight and height were measured by a combined digital weight and height scale. Arm circumference and waist circumference were measured by non-stretching tape. The data were entered into Epidata version 4.6.0.6 and analyzed using SPSS version 26. Pearson's correlation coefficient was used to demonstrate the correlation between continuous variables whereas the correlation between continuous variables and categorical variables was analyzed by two independent sample t-tests and one-way ANOVA. Tables, pie charts, bar graphs, and narratives were used to present it.*

Results: *A total of 567 normotensive adults were enrolled in this study, and approximately 52.96% had raised inter-arm blood pressure difference, with 39.2% (95% CI, 35.1-43.3) having raised systolic inter-arm blood pressure difference and 13.76% (95% CI, 11-16.9) having raised diastolic inter-arm blood pressure difference. Raised systolic inter-arm blood pressure difference showed a statistically significant correlation with height, arm circumference, body mass index, family history of hypertension, right arm mean arterial blood pressure, left arm mean arterial blood pressure, and right arm pulse rate; while raised diastolic inter-arm blood pressure difference showed a statistically significant correlation with weight, arm circumference, waist circumference, body mass index, family history of hypertension, right arm mean arterial blood pressure and left arm mean arterial blood pressure.*

Conclusion and Recommendations: *Raised interarm blood pressure difference among normotensive adults was 52.96% and significantly correlated with anthropometric parameters, pulse rate, mean arterial blood pressure, and a family history of hypertension. Therefore, the measurement of blood pressure in both arms should be included in routine clinical practice. Also, further research is required to clarify the mechanism and causal link of inter-arm differences with anthropometric parameters, mean arterial blood pressure, and pulse rate.*

Keywords: *Inter-arm Difference; Mean Arterial Blood Pressure; Correlation; Hypertension*

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ACRONYMS AND ABBREVIATIONS

AC----------Arm Circumference

AIAD----------Absolute Inter-Arm Difference

ANOVA----------Analysis of Variances

BMI----------Body Mass Index

BP----------Blood Pressure

CAD----------Coronary Artery Disease

CD----------Cluster Designate

CI----------Confidence Interval

cm----------Centimeter

CmH20----------Centimeter of Water

COVID-19----------Corona Virus Disease 2019

CVD----------Cardio Vascular Disease

DBP----------Diastolic Blood Pressure

DIAD----------Diastolic Inter-Arm Difference

DIABPD----------Diastolic Inter-Arm Blood Pressure Difference

DIABPD1----------Diastolic Inter-Arm Blood Pressure of the first measurement

DIABPD2----------Diastolic Inter-Arm Blood Pressure of the second measurement

ETB----------Ethiopian Birr

IAD----------Inter-arm Difference

IASBPD----------Inter-Arm Systolic Blood Pressure Difference

Kg----------Kilogram

LADBP----------Left Arm Diastolic Blood Pressure

LAMABP----------Left Arm Mean Arterial Blood Pressure

LAPR----------Left Arm Pulse Rate

LASBP----------Left Arm Systolic Blood Pressure

MABP----------Mean Arterial Blood Pressure

MDIABPD----------Mean Diastolic Inter-Arm Blood Pressure Difference

mmHg----------Millimeters of mercury

MSIABPD----------Mean Systolic Inter-Arm Blood Pressure Difference

MUAC----------Mid-Upper Arm Circumference

NO----------Nitric Oxide

OPD----------Outpatient Department

OR----------Odds Ratio

PWV----------Pulse Wave Velocity

RADBP----------Right Arm Diastolic Blood Pressure

RAMABP----------Right Arm Mean Arterial Blood Pressure

RAPR----------Right Arm Pulse Rate

RASBP----------Right Arm Systolic Blood Pressure

SBP----------Systolic Blood Pressure

SIAD----------Systolic Inter-Arm Difference

SBPD----------Systolic Blood Pressure Difference

SD----------Standard Deviation

SIABPD----------Systolic Inter-arm Blood Pressure Difference

SIABPD1----------Systolic Inter-Arm Blood Pressure of the first measurement

SIABPD2----------Systolic Inter-Arm Blood Pressure of the second measurement

SPSS----------Statistical Package for Social Sciences

WC----------Waist Circumference

WHO----------World Health Organization

1. INTRODUCTION

1.1 Background of the study

The difference in a person's systolic and diastolic blood pressure between their arms is known as an inter-arm blood pressure difference (1). In diverse general populations, healthy pregnant women, and persons at a higher risk of cardiovascular disease, such as those with hypertension, diabetes mellitus, chronic kidney disease, or peripheral vascular disease, a disparity in blood pressure readings between the arms can be seen (2). Systolic inter-arm differences in blood pressure have been linked to an increased risk of cardiovascular events, including mortality, in a large cohort of individuals without a history of vascular illness (3).

The cause of an inter-arm difference is unclear; it was initially thought to be subclavian stenosis on the side of the lower reading arm, but there is currently scant evidence to support this association in the absence of significant (i.e., 35 mmHg) systolic blood pressure differences between the arms (2). A growing body of evidence links IAD to increased arterial stiffness, which appears as an increase in pulse wave velocity or pulse pressure (4,5). It appears likely that asymmetries in arterial stiffness play a significant role in the pathophysiology of IAD and are responsible for the independent correlations between IAD and cardiovascular risk. Since both disorders share similar underlying causes, stenosis and arterial stiffness likely contribute to the phenomena of IAD; hence, making the distinction may be somewhat academic (6).

The results of further research using a well-established one-dimensional model of the major systemic arteries showed that pulse wave velocity (PWV) was uniformly increased or decreased in the arteries of 1) the supra-aortic region leading up to the arm, 2) the brachial region, 3) the forearm, and 4) all of these (the entire arm pathway) for the left arm, right arm, and both arms (7). The arms' cross-sectional area, vascular bed compliance, and resistance varied similarly. Significant inter-arm SBP differences were observed with changes to the brachial, forearm, and/or entire arm pathways and were related to the altered transmission of forward waves and amplitude/timing of reflected waves. However, inter-arm differences in segmental PWV and cross-sectional area (but not bilateral changes) did not cause these differences. Resistance and compliance in the vascular bed were modest. It concludes that variations in artery stiffness and geometry between arms may be a factor in systolic blood pressure changes between arms (7).

1.2 Statement of the problem

Inter-arm blood pressure difference is well-established to be linked to a combination of cardiovascular disease and risk factors. Globally, IASBPD greater than or equal to 10 mmHg is found to be present in 19.6% of the population (8).

In Africa, a study conducted in Benin with a cross-sectional study design reported that SIABPD ≥ 10mmHg was 19% (9). But there has been no previously conducted and published research in Ethiopia that revealed the magnitude of the inter-arm blood pressure difference among normotensive adults, particularly in the study setting in Ginchi town.

According to studies conducted in the Netherland and Iran, inter-arm SBPD (15 mmHg) was associated with older age, higher systolic blood pressure, diabetes mellitus, hypertension, peripheral arterial disease, carotid artery stenosis, and higher carotid intima-media thickness, as well as a lower ankle-brachial index (10,11).

Studies in the United States of America, Italy, and India revealed that a significant risk factor for the inter-arm blood pressure difference is a family history of hypertension, which is independent of other factors like age and weight. Offspring of hypertensive parents typically have a greater blood pressure than children of normotensive parents, though their BP levels are frequently considerably below the hypertensive range (11–13).

Additionally, a study in China found that the blood pressure difference between the arms is favorably correlated with body mass index (14). According to a study conducted in India height and weight were directly correlated with both systolic and diastolic blood pressures (SBP and DBP) (1). Further research conducted in Korea found that MABP had positive relationships with systolic IAD and diastolic IAD (DIAD) in blood pressure in both males and females (15).

If individuals were not screened for blood pressure in both arms, it may result in missed inter-arm differences. Raised IAD is associated with hypertension (16). Hypertension is a risk factor for coronary heart disease and the single most important risk factor for stroke (17). It has been identified as the leading risk factor for morbidity and mortality worldwide (18). If left undiagnosed and untreated, it can lead to economic loss, psychological issues (such as low self-esteem, depression, and anxiety), decreased job productivity, and a worse quality of life for both men and women who suffer from it, with serious ramifications for families and society as a whole (19). Because of its great incidence and ability to predict cardiovascular illness, clinical guidelines (20,21) recommend measuring blood pressure in both arms. Even though 77% of

doctors were aware that blood pressure in both upper limbs should be checked during initial hypertension examinations, only 30% agreed with the recommendation, and only 13% followed it (20).

In addition, currently there is no clinical guideline that recommends measuring anthropometric parameters, routinely in conjunction with arterial blood pressure. Through early detection, simple lifestyle modifications, and the help of modern medical treatment, the effect of the inter-arm blood pressure difference can be largely controlled, and individuals with a raised inter-arm blood pressure difference can lead a prolonged and healthy life.

To my knowledge there is no research done in Ethiopia on the proposed study. Also, most of the previous studies conducted globally were among unhealthy adults, except for a few. Further, previous studies had not addressed the association between the inter-arm blood pressure difference with pulse rate and mid-upper arm circumference. Therefore, this study determines an association of anthropometric parameters and family history of hypertension with the inter-arm blood pressure difference.

1.3 Significance of the study

This study aims to provide valuable information on the correlation of anthropometric parameters and a family history of hypertension with inter-arm blood pressure differences. For study participants, it provides key information about their blood pressure status, and inter-arm blood pressure differences. This may help to create awareness among them so that they can be screened early and take preventive measures against its consequences.

The study findings may encourage and direct health professionals to implement routine and both arm blood pressure measurements, as well as assess the family history of hypertension, and anthropometric parameters, among individuals visiting health facilities during their visit, which may meet the needs of the clients.

For higher institutions, this study may provide them with insights into the progress of the problem situation regarding the public health importance of inter-arm blood pressure difference and discourse in understanding its severity, which may give them the idea to conduct training or seminars that will equip health professionals with new motivation in assessing inter-arm blood pressure difference and correlated factors among healthy adults.

For policymakers/planners, this study might be helpful as an input for future planning to decide whether routine both arm blood pressure measurement evaluation should be indicated for specific circumstances or generally in normotensive adults. Also, for future researchers, the result of this research will be an input for further studies and can be used as related literature.

2. LITERATURE REVIEW

2.1 Inter-arm blood pressure difference and its magnitude

Since the creation of the mercury manometer by Poiseuille in 1846, blood pressure has been virtually invariably expressed in millimeters of mercury (mm Hg). Blood pressure refers to the force that the blood applies to any given portion of the artery wall. A column of mercury can be pushed against gravity up to a height of 50 millimeters if a vessel has a pressure of 100 mm Hg. On occasion, pressure is expressed in centimeters of water (cm H2O). A pressure of 10 cm H2O is defined as a pressure high enough to defy gravity and lift a column of water to a height of 10 cm. Due to the specific gravity of mercury being 13.6 times greater than that of water and the fact that 1 centimeter is 10 times larger than 1 millimeter, one millimeter of mercury pressure equals 1.36 centimeters of water pressure (22).

One of the vital indicators that are commonly measured in both healthy and ill people is arterial blood pressure. It is a reliable screening tool for several conditions, including hypertensive retinopathy, coronary heart disease, renal failure, and stroke (17). It is a significant modifiable risk factor for the diseases mentioned above. Alarmingly, hypertension poses a financial risk to the healthcare system. The prevalence of hypertension is rising exponentially, given the lifestyle of the current generation. Because of the current generation's sedentary lifestyle; non-communicable diseases are becoming far more common. The inter-arm difference in systolic blood pressure is associated with the future occurrence of hypertension, coronary heart disease, stroke, etc., in addition to being a very straightforward and effective screening technique (23).

IAD in BP was first discovered 90 years ago. IAD may result from several factors, including vascular atheroma, emboli, and thrombi. IAD could be a sign of future cardiovascular disease risk due to peripheral vascular dysfunction. The progression of the disease may be signaled by an increase in IAD in a variety of clinical situations. A reliable and independent prognostic marker of acute ischemic stroke is an IAD greater than or equal to 10 mmHg. It has been discovered that there is a substantial correlation between SIAD and the presence and severity of extra cranial arterial stenosis, as well as a significant correlation between DIAD and the presence and severity of intracranial arterial stenosis (24).

In 230 patients getting treatment for hypertension in primary care, a cohort study in the UK found that 24% (55/230) of participants had a mean inter-arm difference in systolic blood pressure of 10 mm Hg or more, and 9% (21/230) had a difference of 15 mm Hg or more (25). In Guangdong, China, a cross-sectional study of 7788 hypertensive patients (3673 male and 4115 female, aged 62.3±13.6 years) found that the mean IAD was 4.044.33 mm Hg in systolic and 3.193.43 mm Hg in diastolic. Systolic IAD (sIAD) prevalence rates of 5 mmHg and 10 mmHg were 28.9% (n = 2247) and 12.8% (n = 996), respectively (26).

Also, a study conducted in India among 100 hypertensive individuals with a comparative cross-sectional design revealed that, compared to the control group's mean IADSBP value of 3.3077 +/- 2.50303 mmHg, the mean for the hypertensive group was 11.6373 +/- 4.29221 mmHg. In terms of statistics, the "p" value was very significant (0.001). IADSBP in the hypertensive group ranged from 10 to 15 mmHg in 43% of cases and 15 to 20 mmHg in 18% of cases (16).

Additionally, a study among a total of 1800 patients with a mean age of 34 years and a cross-sectional study design at Hamad General Hospital's emergency department found that the right and left arms' median absolute systolic blood pressure differences (DSBP) were 6 (3–10) mmHg. This value was consistent for both the first (DSBP1) and second readings (DSBP2). DSBP1 and DSBP2 had an absolute average of 7 (4–10) mmHg. The 95th percentile of the population had an inter-arm blood pressure differential of 20 mmHg in systolic blood pressure (SBP) (27).

A subsequent cross-sectional study of 477 patients in India found that the absolute inter-arm difference (AID) was present in 80.5 percent of SBP and 74.8 percent of DBP and was greater than 10 mm Hg in 5.0 percent of SBP and 3.8 percent of DBP (19).

Although all of these studies were conducted among individuals with co-morbidity, there were a few studies conducted among healthy adults. For instance, a cross-sectional study carried out in Ontario, Canada, on 18 young healthy adults revealed that the prevalence of systolic blood pressure inter-arm differences greater than or equal to 10 mmHg was 5.6 percent when measured sequentially and 11.1 percent when measured simultaneously. However, neither technique revealed any diastolic blood pressure inter-arm differences of this magnitude (28).

The mean systolic (p-value = 0.0002*) and diastolic (p-value = 0.000*) blood pressures of the two arms were also significantly different, according to a study conducted among students aged 19-21 years at Aziz Fatimah Medical and Dental College Faisalabad (23).

Another study, which included 806 adult Koreans aged 30 to 64 years and used a cross-sectional design with no history of major cardiovascular disease, found that the mean inter-arm difference for SBP and DBP was 3.3 mmHg and 2 mmHg, respectively. There were significant inter-arm variations in SBP and DBP (>10 mmHg) in 3.7% and 0.9% of individuals, respectively (15).

Additionally, a cross-sectional study conducted in Italy among 220 adult subjects demonstrated that in 9 subjects (4.1%) an abnormal IAD was found, with lower BPs measured in the non-dominant arm (147 ± 28/78 ± 9 vs. 154 ± 15/92 ± 11 mmHg dominant, p<.01) (12). Moreover, the study carried out in India among 300 healthy subjects in the age group of 18–60 years with a cross-sectional design indicated that 38.03 percent of participants had systolic IAD (SIAD) and 13.88 percent had diastolic IAD, with roughly 51.91 percent of respondents having significant IAD (greater than or equal to 10 mmHg) (1).

Further, the household cross-sectional survey undertaken amongst 293 females who were participating in agricultural farm activities in lower Eastern Kenya showed that mean diastolic blood pressure (right-arm 75.4 mmHg; left-arm 76.2 mmHg) and systolic blood pressure (right-arm 124.4 mmHg; left-arm 123.3 mmHg) showed marginal but statistically significant inter-arm variations. Prehypertension and hypertension were more common in the right arm blood pressure readings (51.2 percent and 12.3 percent, respectively) than in the left arm (47.8 percent and 10.6 percent; p = 0.001) readings (29).

2.2 Inter-arm blood pressure difference and socio-demographic characteristics

Socio-demographic characteristics such as age, sex, marital status, occupational status, ethnic background, educational background, etc. were well addressed in many of the studies conducted globally. But only a few studies demonstrated the correlation between socio-demographic characteristics and the inter-arm blood pressure difference. A cross-sectional study conducted in Korea among 806 participants aged 30 to 64 years without a history of major cardiovascular disease showed that a large inter-arm difference in DBP was associated with sex and age (15). According to the studies conducted in the Netherlands with a cross-sectional design in 2017 and 2019 among 7344 and 220 participants, respectively, higher age was related to a large inter-arm SBD greater than or equal to 15 mmHg (10,12).

Also, the cross-sectional study conducted in China, which included 7788 hypertensive patients (3673 male and 4115 female, aged 62.3±13.6 years), revealed that higher sIAD was correlated

with age. However, no significant prevalence distribution of higher IAD was seen according to the age categories, regardless of the cutoff of 5 or 10 mm Hg, which may be attributable to the low sample size (26). Furthermore, a study of 477 patients in India using the same study design discovered that SBP was moderately correlated with age, while DBP was fairly correlated with age (19).

A further cross-sectional study conducted in Iran among 578 patients who had an average age of 57.5±10.5 years and were potential candidates for coronary angiography revealed that 9.6% (n = 43) of patients older than 50 years and 11.0 percent (n = 27) of women had IASBPD greater than or equal to 10 mmHg (30).

A cross-sectional study conducted in Taiwan among 1120 patients (mean age 60.8613.7 years, 636 males and 484 females) found that an inter-arm SBP difference greater than or equal to 10 mmHg was found to be significantly associated with females (31). Another study conducted in India with a cross-sectional design among 300 healthy subjects in the age group of 18–60 years found that the percentage of individuals with systolic IAD (SIAD) was 37%, of which 27% were men and 10% or so were women. The percentage of participants with diastolic IAD (DIAD) was 13%, of which 7% were men and 6% were women (1).

Despite the fact with the above studies some studies make their findings controversial. A cross-sectional study conducted in Canada and Ontario among 18 young healthy adults showed that age was not significantly correlated with any inter-arm differences (28). Additionally, the study conducted in Qatar with a cross-sectional design among 1800 patients with a mean age of 34 years found that no meaningful association could be detected between the IABPD and the study variables such as age, demographics, regions of interest, and risk factors (27).

A further cross-sectional study that was carried out among 230 students in Nepal demonstrated a positive but sluggish correlation between age and the inter-arm SBP difference ($r = +0.135$, $p = 0.04$; the difference in inter-arm SBP is not significantly correlated with gender). Age and sex had no statistically significant correlation with inter-arm DBP (32).

2.3 Association between inter-arm blood pressure difference and family history of hypertension

Many studies are being conducted to assess the relationship between inter-arm blood pressure difference and cardiovascular disease, but only a few have addressed the relationship between inter-arm blood pressure difference and a family history of hypertension.

A cross-sectional study conducted in Italy among 220 participants aged greater than or equal to 18 years found that patients with an Inter-arm difference (IAD) were more likely to have a positive family history of cardiovascular disease (33.3 vs. 10.4%, p= 0.034) and arterial hypertension (66.7 vs. 35.1%, p= 0.044) than those with a normal IAD (12).

Additionally, in a study conducted in India among 300 healthy subjects in the age group of 18–60 years with a cross-sectional design, a family history of hypertension was found to be statistically associated with SIAD (1). A further cross-sectional study conducted in India among 284 medical students demonstrated that 143 participants had family history of hypertension, and 33 (23.1%) of them had elevated IAD in BP, compared to 14 (9.9%) participants who did not have family history of hypertension (1). Thus, this limited discussion revealed the presence of limited inquiry into the relationship between inter-arm blood pressure difference and family history of hypertension, indicating the need for additional research.

2.4 Correlation between inter-arm blood pressure difference and anthropometric parameters

Anthropometric parameters such as height, weight, waist circumference, and body mass index were addressed differently in the previous studies. A cross-sectional study conducted in Korea among 806 participants aged 30 to 64 years without a history of major cardiovascular disease revealed that an absolute inter-arm difference in SBP was positively associated with height, weight, waist circumference, arm circumference, and body mass index. Systolic and diastolic inter-arm blood pressure differences greater than or equal to 10 mmHg were seen when participants' heights were 162.6±8.6 and 161.2±8.2 cm respectively. The systolic and diastolic inter-arm blood pressure differences were greater than or equal to 10 mmHg when participants' weights were 67.3±14.5 and 70.9±13.9kg, respectively. An inter-arm difference of DBP≥10 mmHg was only independently associated with BMI (OR: 1.33 per kg/m2; 95% CI: 1.06-1.67) (15).

According to another study conducted in India among 300 healthy subjects with a cross-sectional design, DIAD didn't exhibit a significant correlation with height or weight. SIAD, on the other hand, showed a substantial and positive link with weight, waist circumference, and body mass index in all subjects. SIAD and BMI were significantly correlated in males (1). Additionally, a cross-sectional study conducted among 100 healthy medical students aged 19–21 years in Pakistan found that BMI was significantly (p-values 0.001) correlated with both diastolic and systolic inter-arm blood pressure. IAD was noticeably higher in obese individuals with BMIs greater than 25 kg/m2 (33).

Further studies with a cross-sectional design conducted in India and China among 477 and 1426 participants, respectively, showed that SBP was moderately/positively correlated with BMI while DBP was fairly correlated with BMI (14,19). In contrast to the above findings, a cross-sectional study conducted in India among 284 medical students discovered that in both males and females, SIADs and DIADs in BP exhibit a negative association with height. Females' DIAD in BP exhibits a statistically significant (P = 0.002) inverse relationship with height. Males' and females' weight and BMI exhibit a favorable link with SIAD and DIAD in BP; however, the findings were not statistically significant. Generally, these mentioned studies addressed anthropometric parameters such as height, weight, waist circumference, and body mass index, except arm circumference (13).

2.5 Association between inter-arm blood pressure and mean arterial blood pressure

The mercury manometer, created by Poiseuille in 1846, has been the standard reference for measuring pressure; hence blood pressure is usually always measured in millimeters of mercury (mm Hg). Blood pressure refers to the force that the blood applies to a specific section of the artery wall. The average of the arterial pressures measured millisecond by millisecond over a period of time is known as the mean arterial pressure (22).

Because at normal heart rates, a larger portion of the cardiac cycle is spent in diastole than in systole, it is not equal to the average of the systolic and diastolic pressures. As a result, for the majority of the cardiac cycle, the arterial pressure remains closer to the diastolic pressure than the systolic pressure. Thus, diastolic pressure accounts for roughly 60% of mean arterial pressure and systolic pressure accounts for 40%. Be aware that the mean pressure is closer to the diastolic pressure than the systolic pressure at all ages. The average of the systolic and diastolic pressures

provides a more accurate representation of the mean arterial pressure at very high heart rates since diastole makes up a smaller portion of the cardiac cycle (22).

As far as my search shows, only two studies have correlated inter-arm blood pressure with mean arterial blood pressure. For instance, a cross-sectional study conducted in Korea among 806 participants aged 30 to 64 years without a history of major cardiovascular disease discovered that the mean SBP was independently correlated with an inter-arm difference of SBP greater than or equal to 10 mmHg (OR: 1.04 per mmHg; 95 percent CI: 1.02-1.07) (15).

A subsequent cross-sectional study conducted in India among 284 medical students revealed that right-arm MABP correlates with both systolic IAD and diastolic IAD (DIAD) in blood pressure in both men and women (13). However, a significant correlation was found between the inter-arm blood pressure difference and mean arterial blood pressure; these two studies are limited in their conclusions. Therefore, this study aimed to provide some insight that will either strengthen or refute the previous findings.

To summarize that all of the studies discussed were conducted with a cross-sectional study design. In addition, except for two studies conducted in Africa, all of the studies were conducted in Asia, North America, and Europe. Also, there is a great discrepancy in the number of samples (maximum = 7788 in China and minimum = 18 in Canada), the kinds of participants, and the results of the studies. Moreover, most of the studies conducted previously were institutionally based, except for a few.

Furthermore, some studies were limited in their ability to correlate arm circumference and pulse rate with inter-arm blood pressure difference, which this study was addressed. Therefore, this study aimed to determine the correlation of anthropometric parameters and family history of hypertension with the inter-arm blood pressure difference in Ethiopia, specifically among normotensive adult residents of Ginchi town.

2.6 Conceptual framework

A conceptual framework to determine the correlation of anthropometric parameters and family history of hypertension with inter-arm blood pressure differences among normotensive adults

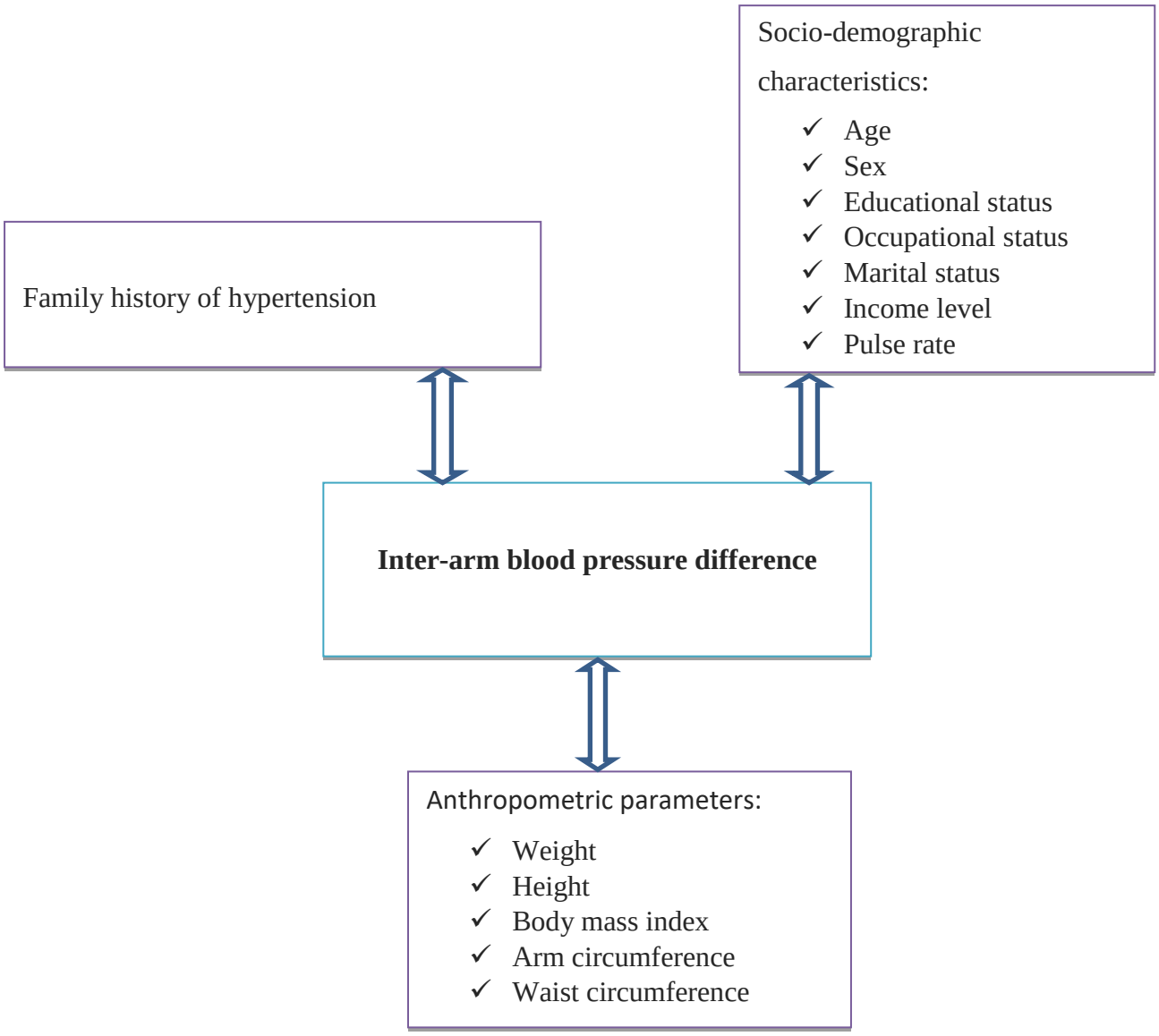

Figure 1: A conceptual framework to determine the correlation of anthropometric parameters and family history of hypertension with inter-arm blood pressure differences among normotensive adults, developed from different kinds of literature, 2022.

3. OBJECTIVES

3.1 General Objective

- To determine the correlation of anthropometric parameters and family history of hyperten sion with inter-arm blood pressure differences among normotensive adults residents of Ginchi town, West Shewa, Oromia, Ethiopia, 2022.

3.2 Specific Objectives

- To determine the magnitude of raised inter-arm blood pressure differences among normotensive adults residents of Ginchi town, 2022.
- To determine the correlation of anthropometric parameters with inter-arm blood pressure differences among normotensive adults residents of Ginchi town, 2022.
- To determine an association of a family history of hypertension with inter-arm blood pressure differences among normotensive adults residents of Ginchi town, 2022.

4. MATERIALS AND METHODS

4.1 Study area and Period

This study was conducted in Oromia regional state, West Showa zone, Dendi Woreda, Ginchi town from September 25, 2022, to November 15, 2022. Ginchi town is located in Dendi Woreda, West Shoa Zone of the Oromia Region, 75 kilometers west of Addis Ababa and 35 kilometers east of the Zonal capital Ambo, at 11.55° latitude and 15.5° longitude. The town has a total area of 2267.28 hectares. According to the 2007 Population Census Report for the Oromia Region, Ginchi town had 20,260 residents made up of 4,466 households in 2007. Applying the census population growth rates for the urban centers of the region of 2.9% per annum, the current population of the town is estimated to be 24,960, with 12,230 male and 12,730 female residents, and 5547 households.

4.2 Study Design

A community-based cross-sectional study was conducted in Ginchi town.

4.3 Populations

4.3.1 Source Populations

All normotensive adults in Ginchi town.

4.3.2 Study Populations

All selected normotensive adults in Ginchi town who was fulfilling the eligibility criteria.

4.4 Eligibility Criteria

4.4.1 Inclusion Criteria

Normotensive Adult Subjects 18-64 years and reside in Ginchi town at least for 06 months and more and were available during the study period were included in the study

4.4.2 Exclusion Criteria

A known and diagnosed case of chronic diseases, pregnancy, and adults on a regular treatment for chronic diseases were excluded from the study

4.5 Sample size determination and Sampling technique

4.5.1 Sample Size Determination

The sample size was determined by using a single population proportion formula with the assumptions of a two-sided significance level (α=5%), 95% confidence level, and considering a 50% prevalence of inter-arm blood pressure difference among normotensive adults, because as far as my search there is no previous study conducted in Ethiopia on the proposed study, and accordingly the calculated sample size was 567.

$$n_o = \frac{(Z\alpha/2)^2 \times P(1-P)}{d^2}$$

$$n_o = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384$$

This sample size used when the population or household size is > 10,000 but since my household number is <10,000 or 5547 I have used the correction formula as follows:-

$nf = \left(\text{no}/\left(\frac{1+no}{N}\right)\right)$ = 360 households (deff) = 360 (1.5) = 540. Then by considering a non-response rate of 5% the final sample size was 567.

When:"n" is the required sample size; "Z" is a standard score corresponding to a 95% confidence level; "P" population proportion of 50%; "D" is the margin of error of 5%; "N" is a total number of households; "deff" is design effect; and "α" is level of significance.

4.5.2 Sampling Technique

A multistage sampling technique was used for this study. Currently, Ginchi town consists of 5547 households, 20 ketenas, and 4 kebeles. From these kebeles, only two kebeles were selected by using the lottery method. Because each of the chosen kebeles has five ketenas or clusters, only two ketenas were chosen from each using the lottery method. Then the final sample size was selected from the four ketenas by using a systematic random sampling method after the final sample size had been allocated proportionally among the four ketenas.

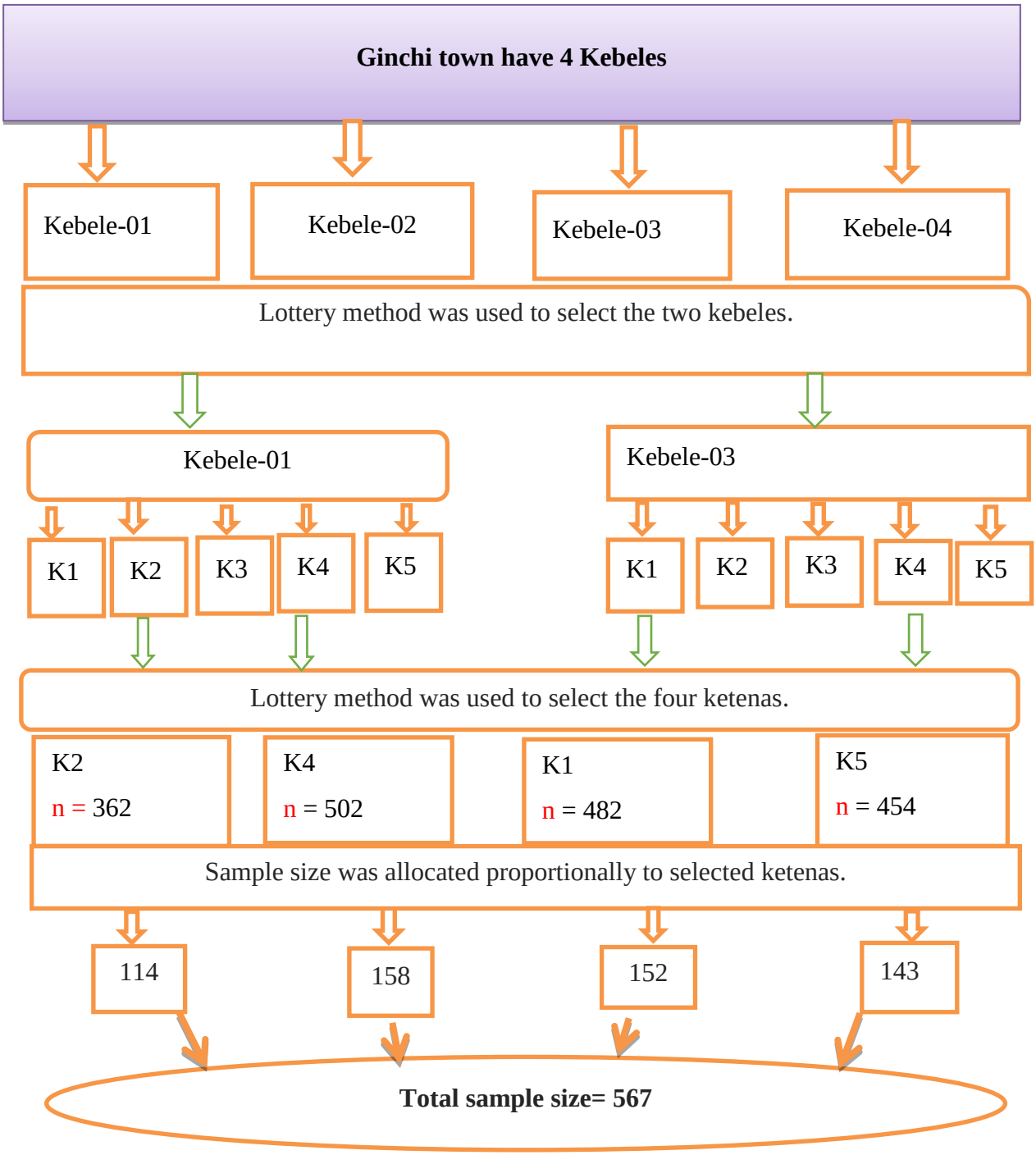

Figure 2: Schematic presentation of sampling procedures for correlation of anthropometric parameters and family history of hypertension with inter-arm blood pressure differences among normotensive adults.

Then after the random start was selected by lottery method every third households were selected. Next, from the selected household, we were selected only one adult who fulfilled the criteria by lottery method.

4.6 Study Variables

4.6.1 Dependent Variables

Inter-arm blood pressure difference

4.6.2 Independent Variables

- Socio-demographic Characteristics: Age, Sex, educational status, occupational status, income level, marital status, and pulse rate.
- Anthropometric Parameters: Height, Weight, Waist circumference, Arm circumference, and Body Mass Index
- Family history of hypertension

4.7 Data collection Instruments and Process

4.7.1 Data Collection Instrument

After reviewing various kinds of literature, the questionnaire to assess socio-demographic and family history of hypertension was adapted. An adult digital blood pressure apparatus was used to measure blood pressure and pulse rate among study participants. A combined digital weight and height scale were used to measure weight, and height whereas non-stretchable tape was used to measure arm circumference and waist circumference. Also, 3 liters of denatured 75% alcohol, twelve packs of disposable glove, 150 pieces of N95 surgical mask and two folds of large-size gauze were used during data collection.

4.7.2 Data Collection Procedure

Data was collected by the interviewer-administered interview method and measurement of blood pressure, pulse rate, and anthropometric parameters by two BSc. nurses (one male and one female) working in the area, who were recruited from the health facilities in the town, and one general practitioner who supervises them. The training was given to the data collectors and supervisor on the contents of the data collection procedure for half a day before the data

collection period by the principal investigator. BP apparatus, combined weight and height scale, and non-stretching tape were cleaned with alcohol and gauze before every measurement for infection prevention. COVID-19 prevention measures were strictly followed. Data collectors, supervisor and principal investigator were used N95 surgical masks at each contact with the study participants.

Weight and Height

Body weight and height were measured by using a combined weight and height scale with the brand name Seca, (Made in India, and manufactured date, 03/2020) which was calibrated accordi ng to the manufacturer's calibration procedure. Weight was measured in the erect position without footwear and with the participant lightly clothed. The measurements were taken using the same instrument and in kilograms, rounding to the nearest 0.1kg (34).

Height was measured after removing the shoes, the patient was asked to stand upright on the flat floor, keeping the feet parallel to the heels, buttocks, shoulders, and back of the head, all while touching a hard surface. The head was held comfortably erect, with the lower border of the orbit in the same horizontal plane as the external auditory meatus. The arms were placed by the body's sides. The measurements were made with the same tool and were rounded to the nearest 0.1 cm (34).

Body Mass Index (BMI)

This was calculated as body weight (in kg) divided by the square of body height (in m) (34).

Waist Circumference (WC)

WC was measured at the end of several consecutive natural breaths, at a level parallel to the floor, at the midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid-axillary line, with a stretch-resistant tape that was wrapped snugly around the subject but not to the point that the tape would constrict. Then the result was rounded to the nearest 0.1 cm (34).

Mid upper Arm Circumference

MUAC was measured to the nearest 0.1 cm, using a flexible non-stretch tape laid at the midpoint between the acromion and olecranon processes on the shoulder blade and the ulna, respectively, of the arm (34)**.**

Blood pressure

Blood pressure was measured by using digital blood pressure apparatus (Omron HEM-907XL,

BP monitors, made in Japan, manufactured date, 02/2022) with the brand name Intelli Sense, which was calibrated according to the manufacturer's calibration procedure. The blood pressure measurement was done in a quiet place with the subject in a sitting position after at least 5 minutes of rest. The subjects were asked if he/she consumed any food or drink within the last 30 minutes before the blood pressure measurement. BP was measured first in the arm presented without prompting, using BP apparatus. During the BP measurement, the hand was kept at the level of the heart, and supported. The BP was measured twice in each arm. The value was averaged. The cuff was swapped to the other arm, and two readings were taken at a 5-minute interval. The inter-arm BP difference was calculated as the difference between the average BP in the right arm and the average BP in the left arm. To reduce bias the same BP instrument was used throughout the study. To minimize diurnal variations, readings were taken at the same time of the day (35).

Pulse rate

Pulse rate was measured by using digital blood pressure apparatus (Omron HEM-907XL, BP monitors, made in Japan, manufactured date, 02/2022) with the brand name Intelli Sense, which was calibrated according to the manufacturer's calibration procedure. Pulse rate was measured twice in each arm, and the value was averaged.

Mean arterial blood pressure

Mean arterial blood pressure for each arm was calculated by adding average diastolic blood pressure of that arm on one third of average systolic blood pressure minus average diastolic blood pressure of the same arm. It is written as: $MABP = Pd + 1/3(Ps - Pd)$ (22).

4.7.3 Operational Definition and Definition of terms

Normotensive means having normal blood pressure of systolic blood pressure between 90-140 mmHg and diastolic blood pressure between 60-90 mmHg (21).

Inter-arm blood pressure difference is blood pressure difference calculated from the difference between average blood pressure in the right arm and average blood pressure in the left arm (1).

Raised systolic inter-arm BP difference: ≥10 mm of Hg difference between average SBP in the right arm and average SBP in the left arm (13).

Raised diastolic inter-arm BP difference: ≥10 mm of Hg difference between average DBP in the right arm and average DBP in the left arm (13).

Family history of hypertension: is defined as having either mother or father with hypertensive disease (13).

4.8 Data Quality Assurances

To assure the quality of the data, a properly designed data collection tool was prepared before starting the actual data collection process. The training was given to the data collectors and supervisor on the contents of the data collection procedure for half a day before the data collection period by the principal investigator. The tool was translated to "Afan Oromo" and then back to English to ensure its consistency. Then, it was pre-tested on 5% of the total sample size (28 participants) among the population of Wolenkomi town before the actual data collection to evaluate the readability, understandability, completeness, and reliability of the questionnaire and modified accordingly. Finally, the Afan Oromo version was used to collect the data. Data were collected by two nurses through interviewer administered interview method and physical examination to measure blood pressure, pulse rate, and anthropometric parameters. Standard operating procedures were followed during anthropometric, pulse rate, and blood pressure measurements and closed supervision was given by the principal investigator, and supervisor. Collected data were reviewed by the principal investigator and the problem faced at the time of data collection was discussed, and corrective measures were taken immediately. After data collection, all collected data were checked on a daily basis for completeness and clarity.

4.9 Data Processing and Analysis

The data was coded and entered into Epidata version 4.6.0.6 before being exported to SPSS version 26 for analysis using variable-specific statistical tests. Simple frequencies, Q-Q plot and box plot were done to look for missing values, normality and outliers respectively. The study has both numerical and categorical variables. Numerical variables are continuous variables such as blood pressure, pulse rate, age, height, weight, waist circumference, arm circumference, body mass index, and income level which were summarized as an arithmetic mean and standard deviation. Categorical variables such as sex, educational status, occupational status, marital status, and family history of hypertension were summarized by frequency and percentage. Correlation between continuous variables (inter-arm BP difference, height, weight, BMI, WC, AC, right and left pulse rate, right, and left arm mean arterial BP) was done by Pearson's coefficient of correlation analysis, whereas the correlation between continuous variables (systolic

inter-arm difference and diastolic inter-arm difference) and categorical variables was done by a two independent sample t-test and a one-way ANOVA using software SPSS version 26. The p-values less than 0.05 were considered as statistically significant. Tables, pie charts, bar graphs, and narratives were used to present the results

4.10 Ethical Considerations

Ethical approval was obtained from Jimma university institutional review board (Ref.NO. 76/22), and a support letter was submitted to the Dendi woreda administration, the Dendi woreda health office, and the Ginchi town municipality, and after they were informed about the whole purpose of the research, written permission was obtained before starting data collection. The participants were informed about the objective of the study and their right not to answer the question asked by the interviewers. They were assured of the confidentiality, risks, and benefits of the study procedures. The name or any other identifying information was not recorded on the questionnaire, and all information taken from the study participants was kept strictly confidential and in a safe place. The information that was retrieved was used only for study purposes. Written consent was obtained from each participant. The participants were given the freedom to leave the study at any given moment on their own accord and without any obligation. An anthropometric and blood pressure measurement procedure were implemented to measure his or her weight, height, body mass index, waist circumference, arm circumference, pulse rate and blood pressure. Gauze and alcohol were used to clean every tool before every measurement to avoid contamination and for infection prevention. COVID-19 prevention measures were strictly followed.

4.11 Dissemination plan of results

After being defended at the Department of Medical Physiology, Faculty of Health science, Institute of Health, Jimma University, it will be submitted to the department of Medical Physiology, Dendi woreda health office, and other concerned bodies. The result will be disseminated through workshops, seminars, and professional conferences and attempts will be made to publish in relevant international journals.

5. RESULTS

5.1 Socio-demographic characteristics of study participants

Five hundred and sixty- seven (567) normotensive adults were enrolled in this study and giving a response rate of 100%. More than half 329 (58%) of them were males. The mean age of the respondents was 35.63 ± 11.579, ranging between 18 to 64 years. About 241 (42.5%) of the respondents had completed secondary education. Nearly more than half, 312 (55%) were married, one-fourth 150 (26.5%) were self-employed and the mean monthly family income was 3682.98 ± 1774.56 ETB [Table 1].

Table 1: Socio-demographic characteristics of normotensive adults residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

Variable	Category	Frequency	Percent (%)
Age	≤ 20 years	59	10.4
	21-30 years	156	27.5
	31-40 years	166	29.3
	41-50 years	123	21.7
	>50 years	63	11.1
	Mean ± SD 35.63 ± 11.57 years		
Sex	Male	329	58.0
	Female	238	42.0
Occupation	Government employee	138	24.3
	Self-employed	150	26.5
	Student	96	16.9
	Daily laborer	82	14.5
	Farmer	14	2.5
	Housewife	67	11.8
	Others *	20	3.5
Marital status	Single	240	42.4
	Married	312	55.0
	Divorced	14	2.47
	Widowed	1	0.18
Educational status	No formal schooling	18	3.2
	Primary completed	129	22.8
	Secondary completed	241	42.5
	Tertiary level completed	179	31.6
Income level	<1400	158	27.9
	1400-3500	150	26.5
	3501-5000	138	24.3
	>5000	121	21.3
	Mean ± SD 3682.98 ±1774.56 ETB.		

Key*: driver and non-governmental organization; ETB: Ethiopian birr; SD: Standard deviation

5.2 Blood pressure measurement results of study participants

The mean right-arm systolic blood pressure was 120.62 ± 10.43 mmHg and the mean right-arm diastolic blood pressure was 77.23 ± 7.02 mmHg. The mean left-arm systolic blood pressure was 115.20 ± 11.10 mmHg and the mean left-arm diastolic blood pressure was 75.26 ± 7.28 mmHg. The mean right arm pulse rate was 71.49 ± 11.02 beats/minute whereas the mean left arm pulse rate was 72.23 ± 10.93 beats/minute. The mean right and left arm mean arterial blood pressure was 91.51 ± 8.16 mmHg and 88.59 ± 7.85 mmHg respectively [Table 2].

Table 2: Blood pressure measurement results of normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia (n=567)

Variables	Males (n=329)	Females (n=238)	Total (n=567)
RASBP	122.09 ± 9.73	118.58 ± 11.03	120.62 ± 10.43
RAPR	70.52 ± 11.49	72.83 ± 10.22	71.49 ± 11.02
LASBP	115.69 ± 10.36	114.53 ± 12.04	115.20 ± 11.10
LAPR	71.04 ± 11.07	73.87 ± 10.53	72.23 ± 10.93
RADBP	77.59 ± 6.99	76.73 ± 7.05	77.23 ± 7.02
LADBP	74.80 ± 7.38	75.90 ± 7.12	75.26 ± 7.28
RAMABP	92.21 ± 8.37	90.54 ± 7.77	91.51 ± 8.16
LAMABP	88.49 ± 7.75	88.72 ± 8.02	88.59 ± 7.85

RASBP: Right arm systolic blood pressure, RAPR: Right pulse rate, LASBP: Left arm systolic blood pressure, LAPR: Left pulse rate, RADBP: Right arm diastolic blood pressure, LADBP; Left arm diastolic blood pressure, RAMABP: Right arm mean arterial blood pressure, LAMABP: Left arm mean arterial blood pressure

5.3 Anthropometric parameters and family history of hypertension of study participants

About 206 (36.33%) respondents had a family history of hypertension [Figure 3]. Regarding the anthropometric measurements, the mean weight was 63.55 ± 13.14 kg whereas; the mean height was 165.57 ±7.62 kg. The mean arm circumference, waist circumference and body mass index was 27.42 ± 4.27 cm, 81.55 ± 11.10 cm and 23.03 ± 4.15 kg/m2 respectively [Table 3].

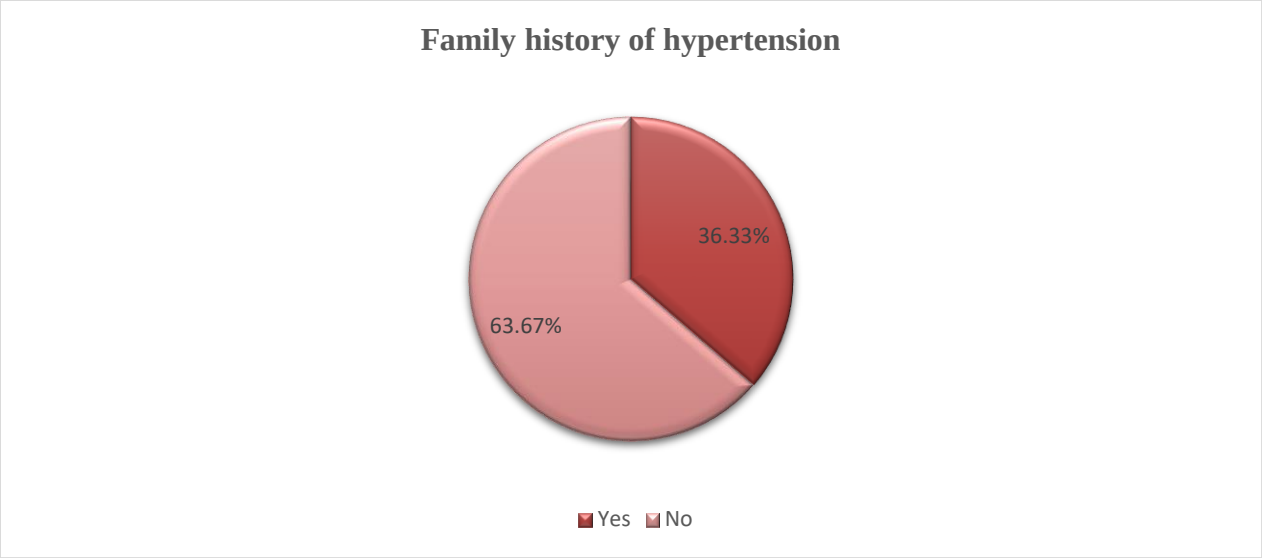

Figure 3: A pie chart showing the magnitude of family history of hypertension among normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia (n=567)

Table 3: Anthropometric measurements of normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

Variables	Males (n=329)	Females (n=238)	Total (n=567)
Height	167.32 ± 7.12	163.15 ± 7.65	165.57 ±7.62
Weight	66.85 ± 13.10	58.98 ± 11.79	63.55 ± 13.14
Arm circumference	27.69 ± 4.00	27.05 ± 4.60	27.42 ± 4.27
Waist circumference	82.50 ± 10.89	80.23 ± 11.28	81.55 ± 11.10
Body mass index	23.72 ± 4.14	22.07 ± 3.98	23.03 ± 4.15

5.4 Inter-arm blood pressure difference status of study participants

Among the total participants, the mean systolic inter-arm blood pressure difference was 7.61 ± 5.38 mmHg, while the mean diastolic inter-arm blood pressure difference was 4.34 ± 3.71 mmHg [Table 4]. The raised systolic inter-arm blood pressure difference seen in this study was 39.2% with 95% confidence interval (35.1, 43.3); of which 29.63% were males and about 9.53% were females. Also, the raised diastolic interarm blood pressure difference among total

participants was 13.76% with 95% confidence interval (11, 16.9); of which 12.17% were males and about 1.59% were females [Figure 4]. About 99.2% of SIABPD was due to average right-arm systolic blood pressure being greater than average left-arm systolic blood pressure. Also, 98.7% of DIABPD was due to average right-arm diastolic blood pressure being greater than average left-arm diastolic blood pressure.

Table 4: Inter-arm blood pressure differences of normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

Variables	Males (n=329)	Females (n=238)	Total (n=567)
SIABPD	8.79 ± 5.51	5.97 ± 4.73	7.61 ± 5.38
DIABPD	5.26 ± 4.13	3.06 ± 2.54	4.34 ± 3.71

SIABPD: Systolic inter-arm blood pressure difference; DIABPD: Diastolic inter-arm blood pressure difference

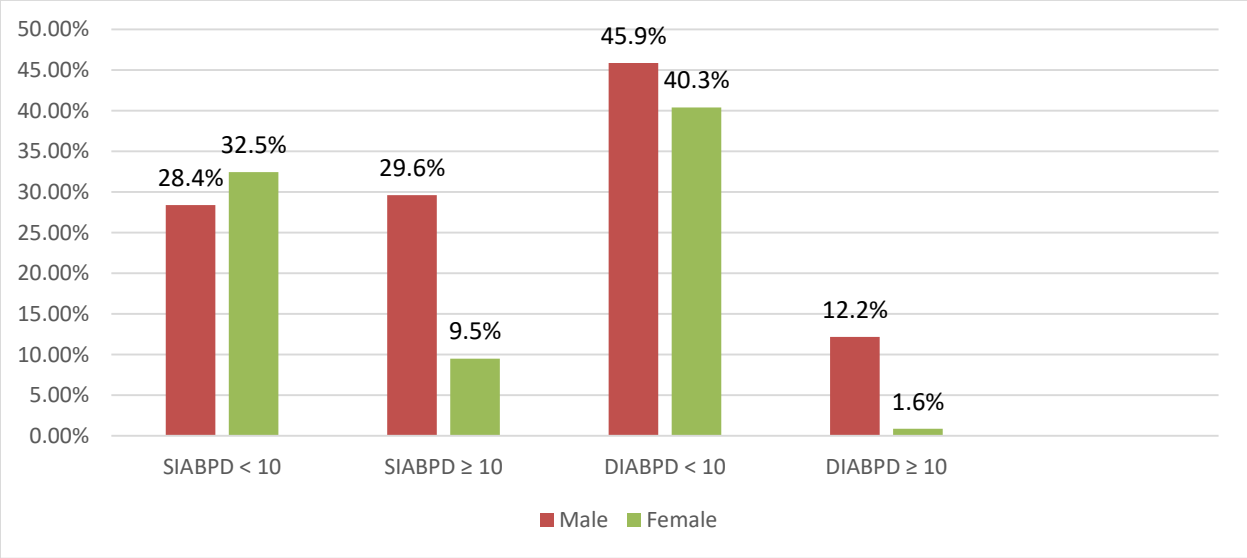

Figure 4: A graph showing the distribution of SIABPD and DIABPD by their sex among normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

5.5 Inter-arm blood pressure difference and socio-demographic characteristics

The result of one-way ANOVA revealed that there is a significant mean difference in educational level ($p = 0.013$), income level ($p = 0.014$), and marital status ($p = 0.000$) in terms of SIABPD. The post hoc was used to analyze the independent variable. The results of post hoc showed that participants with an income level of 1400-3500 have a significantly higher SIABPD than participants who are with an income level of <1400 ($p = 0.024$), 3501-5000 ($p = 0.046$) and >5000 ($p = 0.009$). In addition participants with no formal schooling have a significantly high SIABPD than participants with primary ($p = 0.008$), and secondary school completed ($p = 0.008$). Also, participants with tertiary level completed have a significantly high SIABPD than participants in primary ($p = 0.017$), and secondary school completed ($p = 0.019$).

There is a significant mean difference in income level ($p = 0.000$), and marital status ($p = 0.049$) in terms of DIABPD. The results of post hoc showed that participants with an income levels of 3501-5000 have a significantly high DIABPD than participants who are with an income levels of <1400 ($p = 0.000$), 1400-3500 ($p = 0.000$) and >5000 ($p = 0.046$). Furthermore, Pearson correlation analysis showed that there is a statistically significant correlation between DIABPD and age ($r = 0.085$, $p = 0.044$).

5.6 Inter-arm blood pressure difference and anthropometric parameters

Pearson correlation analysis result demonstrated that SIABPD has a statistically significant relationship with male participants' height ($r = - 0.12$, $p = 0.029$), weight ($r = 0.18$, $p = 0.001$), waist circumference ($r = 0.21$, $p = 0.000$), and body mass index ($r = 0.25$, $p = 0.000$). Also among male participants, height ($r = - 0.14$, $p = 0.009$), weight ($r = 0.29$, $p = 0.000$), arm circumference ($r = 0.26$, $p = 0.000$), waist circumference ($r = 0.20$, $p = 0.000$), and body mass index ($r = 0.28$, $p = 0.000$) have significant correlations with DIABPD [Table 5].

Among female participants, SIABPD has a statistically significant correlation with height ($r = -0.27$, $p = 0.000$), weight ($r = 0.34$, $p = 0.000$), arm circumference ($r = 0.26$, $p = 0.000$), waist circumference ($r = 0.28$, $p = 0.000$), and body mass index ($r = 0.23$, $p = 0.000$), while such a correlation with DIABPD has not been seen [Table 5].

Table 5: Pearson correlation of SIABPD and DIABPD with anthropometric parameters among male (n=329) and female (n=238) normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia.

IABPD	Parameters	Height		Weight		AC		WC		BMI	
		M	F	M	F	M	F	M	F	M	F
SIABPD	Pearson Correlation	**- 0.12***	**- 0.27****	**0.18****	**0.34****	- 0.003	**0.26****	**0.21****	**0.28****	**0.25****	**0.23****
	Sig.(2-tailed)	0.029	0.000	0.001	0.000	0.96	0.000	0.000	0.000	0.000	0.000
DIABPD	Pearson Correlation	**-0.14****	0.033	**0.29****	0.005	**0.26****	- 0.047	**0.20****	0.009	**0.28****	- 0.02
	Sig.(2-tailed)	0.009	0.613	0.000	0.940	0.000	0.472	0.000	0.888	0.000	0.743

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

IABPD: Inter-arm blood pressure difference; SIABPD: Systolic inter-arm blood pressure difference; DIABPD: Diastolic inter-arm blood pressure difference; BMI: Body mass index; AC: Arm circumference; WC: Waist circumference; M: Male; F: Female

SIABPD has a statistically significant correlation with height ($r = -0.095$, $p = 0.024$), arm circumference ($r = 0.086$, $p = 0.041$), and body mass index ($r = 0.115$, $p = 0.006$) among total participants of the study, whereas weight ($r = 0.096$, $p = 0.022$), arm circumference ($r = 0.149$, $p = 0.000$), waist circumference ($r = 0.096$, $p = 0.023$) and body mass index ($r = 0.131$, $p = 0.002$) have statistically significant correlation with DIABPD [Table 6].

Table 6: Pearson correlation of SIABPD and DIABPD with anthropometric parameters among normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

IABPD	Parameters	Height	Weight	Arm circumference	Waist circumference	Body mass index
SIABPD	Pearson Correlation	**- 0.095***	0.069	**0.086***	0.042	**0.115****
	Sig. (2-tailed)	0.024	0.103	0.041	0.321	0.006
DIABPD	Pearson Correlation	0.002	**0.096***	**0.149****	**0.096***	**0.131****
	Sig. (2-tailed)	0.967	0.022	0.000	0.023	0.002

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

IABPD: Inter-arm blood pressure difference; SIABPD: Systolic inter-arm blood pressure difference; DIABPD: Diastolic inter-arm blood pressure difference

5.7 Inter-arm blood pressure difference and family history of hypertension

The result of the independent sample t-test revealed that there is a statistically significant difference in the mean of SIABPD ($p = 0.000$) and DIABPD ($p = 0.030$) between individuals with a family history of hypertension and no family history of hypertension. Therefore, both SIABPD and DIABPD had a statistically significant association with a family history of hypertension [Table 7].

Table 7: SIABPD and DIABPD with a family history of hypertension by independent sample t-test among normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

IABPD	Family history of hypertension	Number	Degree of freedom	Mean	Mean difference	Standard deviation	p-value	95% CI of the Difference	
								Upper	Lower
SIABPD	Yes	206	565	9.3835	2.7831	5.41507	**0.000**	3.67805	1.88822
	No	361		6.6004		5.10222			
DIABPD	Yes	206	565	4.5956	0.702	4.03128	**0.030**	1.33750	0.6645
	No	361		3.8936		3.05034			

When p< 0.05, the mean difference is significant. IABPD: inter-arm blood pressure difference; SIABPD: systolic inter-arm blood pressure difference; DIABPD: diastolic inter-arm blood pressure difference; CI: Confidence interval

5.8 Inter-arm blood pressure difference, mean arterial blood pressure, and pulse rate

Pearson correlation coefficient analysis revealed that SIABPD has a statistically significant correlation with left-arm mean arterial blood pressure (r = - 0.309, p = 0.000), right pulse rate (r = 0.160, p = 0.004), and left pulse rate (r = 0.138, p = 0.012), whereas DIABPD has a statistically significant correlation with left-arm mean arterial blood pressure (r = - 0.288, p = 0.000) among male participants [Table 8].

SIABPD has a statistically significant correlation with LAMABP (r = - 0.170, p = 0.009) among female participants, while DIABPD has a statistically significant correlation with RAMABP (r = 0.309, p = 0.000) and LAMABP (r = 0.152, p = 0.019) [Table 8].

Table 8: Pearson correlation of SIABPD and DIABPD with mean arterial blood pressure and pulse rate among male (n=329) and female (n=238) normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia.

IABPD	Parameters	RAMABP		LAMABP		RAPR		LAPR	
		M	F	M	F	M	F	M	F
SIABPD	Pearson Correlation	0.054	0.086	**- 0.309****	**- 0.170****	**0.160****	0.084	**0.138***	0.051
	Sig. (2-tailed)	0.331	0.189	0.000	0.009	0.004	0.198	0.012	0.438
DIABPD	Pearson Correlation	0.066	**0.309****	**- 0.288****	**0.152***	0.015	0.006	0.021	- 0.027
	Sig. (2-tailed)	0.233	0.000	0.000	0.019	0.786	0.932	0.705	0.683

*. The Correlation is significant at the 0.05 level (2-tailed).

**. The Correlation is significant at the 0.01 level (2-tailed).

IABPD: Inter-arm blood pressure difference; SIABPD: Systolic inter-arm blood pressure difference; DIABPD: Diastolic inter-arm blood pressure difference; RAMABP: Right arm mean arterial blood pressure; LAMABP: Left arm mean arterial blood pressure; RAPR: Right arm pulse rate; LAPR: Left arm pulse rate; M: Male; F: Female.

Among the total participants in this study, SIABPD was significantly correlated with RAMABP ($r = 0.089$, $p = 0.034$), LAMABP ($r = - 0.249$, $p = 0.000$), and RPR ($r = 0.101$, $p = 0.016$), while DIABPD is significantly correlated with RAMABP ($r = 0.157$, $p = 0.000$), and LAMABP ($r = - 0.143$, $p = 0.001$). [Table 9]

Table 9: Pearson correlation of SIABPD and DIABPD with mean arterial blood pressure and pulse rate among normotensive adults, residents of Ginchi town from September 25 to November 15, 2022, Ethiopia, (n=567)

IABPD	Parameters	RAMABP	LAMABP	RAPR	LAPR
SIABPD	Pearson Correlation	**0.089***	**- 0.249****	**0.101***	0.068
	Sig. (2-tailed)	0.034	0.000	0.016	0.108
DIABPD	Pearson Correlation	**0.157****	**- 0.143****	- 0.019	- 0.031
	Sig. (2-tailed)	0.000	0.001	0.658	0.460

*. The Correlation is significant at the 0.05 level (2-tailed).

**. The Correlation is significant at the 0.01 level (2-tailed).

IABPD: Inter-arm blood pressure difference; SIABPD: Systolic inter-arm blood pressure difference; DIABPD: Diastolic inter-arm blood pressure difference; RAMABP: Right arm mean arterial blood pressure; LAMABP: Left arm mean arterial blood pressure; RAPR: Right arm pulse rate, LAPR: Left arm pulse rate.

6. DISCUSSION

This study was conducted to determine the correlation of anthropometric parameters and family history of hypertension with the inter-arm blood pressure difference among normotensive adults. The findings of this study revealed that the inter-arm blood pressure difference has a significant correlation with anthropometric parameters, pulse rate and a family history of hypertension.

In this study, the prevalence of a raised systolic inter-arm blood pressure difference was 39.2% (95% CI, 35.1 - 43.3). The raised diastolic inter-arm blood pressure difference was 13.76% (95% CI, 11 - 16.9). This study is consistent with the study carried out in India which indicated that 38.03% of participants had raised systolic inter-arm blood pressure difference (SIABPD), and 13.88 % had raised diastolic inter-arm blood pressure difference (DIABPD), with roughly 51.91 % of respondents having raised inter-arm blood pressure difference (1).

But it is inconsistent with a cross-sectional study carried out in Ontario, Canada, that revealed the prevalence of raised systolic inter-arm blood pressure differences was 5.6% (28). This discrepancy may be due to a greater difference in sample size (18 vs. 567), the mean age of study participants (25 ± 4 vs. 35.63 ± 11.579 years), and the methods of blood pressure measurement (simultaneous vs. sequential).

In this study, among total participants, SIABPD had a statistically significant correlation with height, arm circumference, and body mass index. This will be explained as anthropometric parameters such as height, weight, body mass index, and arm circumference was found to be associated with BP in some studies (36,37). Increased BMI and weight can affect blood pressure in two ways: by stimulating the sympathetic nervous system or by increasing sodium retention by the kidneys (22). It has been shown that, as BMI and fat tissue increase, so does the volume of circulating angiotensin (38,39). Angiotensin II has short- and long-term action in increasing BP levels. In the short term, it acts rapidly as a powerful vasoconstrictor, and over the course of days or weeks, it raises BP through decreased salt excretion from the kidneys, therefore increasing fluid volume (22). Furthermore, because of free fatty acids are produced in adipose tissue, they are undeniably higher in overweight and obese individuals (40,41). Acute and chronic insulin resistance increased sympathetic activity due to oxidative stress, interference with NO-induced

vasodilation, and more are the pathophysiological pathways that correlate elevated free fatty acids with hypertension (40,42). Also, obesity is linked with the circulating level of leptin, which is derived from fatty tissue, and its primary role is to control appetite by inducing the feeling of satiety and by increasing sympathetic outflow (43). Although obese individuals appear resistant to the former effect of leptin, the increased sympathetic activity persists, contributing to their increased BP (44). This increased BP may result in a large inter-arm blood pressure difference. This finding is consistent with the cross-sectional study conducted among normotensive adults in India and Korea (1,15).

Among female participants, SIABPD has a statistically significant correlation with height, weight, arm circumference, waist circumference, and body mass index. It is in line with the study conducted in India, which revealed that in females, SIABPDs exhibit an association with height whereas weight and BMI exhibit a favorable link with SIABPD (13). But it is inconsistent with another study conducted in India (1). This discrepancy may be due to a difference in percentage of women participated in the two studies.

Among male participants, SIABPD has a statistically significant correlation with height, weight, waist circumference, and body mass index. It is in line with the study in India that revealed a significant correlation between SIABPD with height and body mass index (1,13). The possible explanation is that height is directly associated with endothelial progenitor cells or bone marrow derived hematopoietic stem cells (CD34 positive cells) which contribute to endothelial repair and vascular maintenance, that is inversely associated with: carotid intima-media thickness, active arterial thickening and cardio ankle-vascular index (45,46).

Additionally, our study revealed that weight, arm circumference, waist circumference, and body mass index have a statistically significant correlation with DIABPD. This might be explained as waist circumference is related to central obesity, and its biological mechanisms with hypertension have been postulated, including that tissue concentration or blood elevation of free fatty acids, caused by the accumulation of visceral fat in the abdomen, could be responsible. As a result, elevated free fatty acids not only increase vasoconstriction by increasing vascular sensitivity to an adrenergic stimuli, but they also blunt reflex Vaso-relaxation by inhibiting nitric oxide production (47). Both of these effects lead to hypertension. Other mechanisms like sympathetic nervous system over-activation, excess secretion of angiotensinogen, and renal

sodium retention secondary to hyperinsulinemia may also be involved in abdominal obesity-related hypertension (47,48). This finding is in line with the study conducted in Korea among normotensive adults (15), whereas it is inconsistent with the study conducted in India, in which DIABPD didn't exhibit a significant correlation with height or weight (1). This inconsistency may be due to differences in sample size (300 vs. 567) and study setting (institutional vs. community-based). Further, our study showed that DIABPD had a statistically significant correlation with arm circumference, whereas the previous studies had not addressed it. The possible explanation is that MUAC represents higher muscle mass in men and adiposity in women (49).

Also among male participants, height, weight, arm circumference, waist circumference, and body mass index have significant correlations with DIABPD. This finding is inconsistent with the study conducted in India, which revealed there is no significant correlation of DIABPD with height, weight, waist circumference, and body mass index (13). This may be due to differences in sample size (284 vs. 567), sampling technique (systematic vs. multi-stage), study setting (institutional vs. community-based), and age of study participants.

This study revealed that there is a statistically significant difference in the means of SIABPD and DIABPD between individuals with a family history of hypertension and those without. In addition, there is a statistically significant association of a family history of hypertension with both systolic and diastolic inter-arm blood pressure differences. This may be associated with shared family environment and genetics. The presence of two hypertensive parents not only increases the genetic component of elevated BP in offspring but a shared environment (health habits conducive to hypertension) may also increase a child's proclivity to become hypertensive (50). This is consistent with the findings of studies conducted in Italy and India among normotensive adults (1,12,13). In this study systolic inter-arm blood pressure difference has a statistically significant correlation with pulse rate whereas the previous studies didn't addressed it.

6.1 Strengths and Limitations of the study

6.1.1 Strengths of the study

- This study was conducted at the community level with a larger sample size, whereas most of the previous related studies were conducted at the institutional level with a smaller sample size.
- It also addressed certain variables, such as arm circumference and pulse rate, which were kept as limitations by the previous studies.

6.1.2 Limitations of the study

- The study used the sequential method of BP measurement, which might have resulted in higher values of BP.
- This study used a cross-sectional study design and therefore had only one point of contact for BP assessments, which providing inter-arm BP differences over a short period.

7. Conclusion and Recommendations

7.1 Conclusion

In this study the prevalence of raised systolic inter-arm blood pressure difference was 39.16% (95% CI, 35.1 - 43.3) whereas that of raised diastolic inter-arm blood pressure difference was 13.76% (95% CI, 11 - 16.9). Also this study showed a link between inter-arm blood pressure differences and anthropometric parameters as well as a family history of hypertension. In addition systolic inter-arm blood pressure was found to be have a statistically significant correlation with mean arterial blood pressure and pulse rate. Further diastolic inter-arm blood pressure difference was found to be have a statistically significant correlation with both right and left arm mean arterial blood pressure.

7.2 Recommendations

For study participants

- They should have to be checked their both arm blood pressure status regularly.

For health professionals

- They should have to pay attention to the routine and both arm blood pressure measurement of their clients.

For future researchers

- Further research is required to clarify the mechanism and causal link of inter-arm blood pressure differences with anthropometric parameters, pulse rate and mean arterial blood pressure.

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ANNEXES

Annex I: English version of the information sheet, consent form and Questionnaire

Part One: English Version of the Information Sheet

Hello: Good morning /afternoon?

I would like to start by extending a sincere welcome. It is my pleasure to introduce myself; my name is_____I am data collector of Mr. Habtamu Tadesse Eticha who is graduating student by Master of Science in Medical Physiology at the Institute of Health, Jimma University. I am here today to collect data on *"Correlation of Anthropometric Parameters, and Family History of Hypertension with Inter-arm Blood Pressure Differences among Normotensive Adults in Ginchi town, Dendi Woreda, West Shewa Zone, Oromia Regional State, Ethiopia, 2022."*

Procedures

Your selection for this particular study is randomly and participation in this study is based on your voluntariness. You have a full right not to participate in this study; however, we encourage you to participate since your responses are very important to look at the prevalence of inter-arm blood pressure difference and its correlation with anthropometric parameters, mean arterial blood pressure and family history of hypertension. If you agree to participate, you will be asked some general questions about your background, (such as your age, sex, occupation, marital status, educational status, income level), and family history of hypertension. A Weight, Height, arm circumference, waist circumference, pulse rate and blood pressure will be measured which will help me to determine the body mass index, IABPD and mean arterial blood pressure. The interview, blood pressure and anthropometric measurement will last about 10 to 15 minutes.

Risks and Discomforts

In this particular study there are no procedures and questions that may harm or give you a feeling of discomfort. You can refuse to answer any question or stop the interview at any time. It is also your right not to give a response to some of our questions if you don't want to respond.

Benefits

What we will learn from the research will be used to recommend policy makers and health planners to appropriately design effective and accessible services in order to prevent cardiovascular outcome as a result of raised inter-arm blood pressure difference. In the course of the interview, you may learn new information about inter-arm blood pressure difference.

Confidentiality

Your name will not be recorded on the questionnaire neither reported in any project document and all your answers will be strictly confidential and will be kept in a locked cabinet. The findings of this study will be presented in different seminars and workshops and your personal information will not be mentioned. If you have any questions, please feel free to ask at any time. Therefore, your honest and genuine responses are crucial for the success of this study. So we kindly request your participation. Do you have any questions with regard to this study? If you want to ask a further clarification on the study you can contact Mr. Habtamu Tadesse, the principal investigator of this study via his cell phone number **0913436538** or **Email address:** habsaryab15@gmail.com at any time that you need clarification.

May I have your permission to go to the consent form?

1. Yes..... (Continue)

2. No..... (Stop)

Part II: English Version of the consent form

According to the above information given to me regarding the objective of the study, procedures, risks and discomforts, benefits of the study and confidentiality of the responses, I agree to be interviewed for all the questions that the interviewer asks me and I approve with my signature. If the participant is unable to sign please ask her/him to put inked thumb prints on the consent form.

Name and signature of the consenting interviewer_____, _____

Respondent signature_____ _____

May I have your permission to proceed to the interview?

1. Yes..... (If yes, start the interview)
2. No..... (Thank you, stop here)

Result of the interview:

1. Completed
2. Partially completed

Supervisors name & signature_____, _____

The time that the interview has started_____

The time that the interview has completed_____

Part III: English Version of the Questionnaire

Instruction: Circle the response from the alternatives

Part one: Questionnaire to assess Socio-demographic characteristics

No.	Question	Response	Remark
101	Sex	1. Male 2. Female	
102	Age	.....(in year)	
103	Occupational status	1. Government employee 2. Self employed 3. Student 4. Daily laborer 5. Retired 6. Farmer 7. Others (specify)…….	
104	Marital status	1. Single 2. Married 3. Divorced 4. Widowed	
105	Educational status	1. No formal schooling 2. Primary completed 3. Secondary completed 4. Tertiary completed	
106	Average monthly income	……ETB	

Part two: Questionnaire to assess Anthropometric Parameters

No.	Question	Response	Remark
201	How much his/her Height is?	…….(in cms)	
202	How much his/her Weight is?	……..(in kgs)	
203	How much his/her Arm circumference is?	……..(in cms)	
204	How much his/her Waist circumference is?	……..(in cms)	
205	How much his/her BMI is?	……..(in kg/m2)	

Part three: Questionnaire to assess Medical conditions

No.	Question	Response	Remark
301	Do you have family history of hypertension?	1.Yes 2. No	
302	How much First measurement of Right arm blood pressure is?	Systolic …(in mmHg Diastolic...(in mmHg)	
303	How much first measurement of right arm pulse is?	……(in beats/minute)	
304	How much First measurement of Left arm blood pressure is?	Systolic …(in mmHg Diastolic...(in mmHg)	
305	How much First measurement of Left arm pulse is?	……(in beats/minute)	
306	How much Second measurement of right arm blood pressure is?	Systolic …(in mmHg Diastolic...(in mmHg)	
307	How much Second measurement of right arm pulse is?	……(in beats/minute)	
308	How much Second measurement of left arm blood pressure is?	Systolic …(in mmHg Diastolic...(in mmHg)	
309	How much Second measurement of left arm pulse is?	……(in beats/minute)	
310	How much Average systolic blood pressure of the right arm is?	…….(in mmHg)	
311	How much Average pulse rate of the right arm is?	……(in beats/minute)	
312	How much Average systolic blood pressure of the left arm is?	…….(in mmHg)	
313	How much Average pulse rate of the left arm is?	……(in beats/minute)	
314	How much systolic inter-arm blood pressure difference is?	…….(in mmHg)	
315	How much Average diastolic blood pressure of the right arm is?	…….(in mmHg)	

316	How much Average diastolic blood pressure of the left arm is?	…….(in mmHg)	
317	How much diastolic inter-arm blood pressure difference is?	…….(in mmHg)	
318	How much right arm mean arterial blood pressure is?	…….(in mmHg)	
319	How much left arm mean arterial blood pressure is?	…….(in mmHg)	

Annex II: Afan Oromo version of the information sheet, consent form and Question naire

Dabalata I: Waraqaa odeeffannoo, uunka haayammaa fi Gaaffii Afaan Oromoo

Kutaa Tokkoffaa: Waraqaa odeeffannoo Afaan Oromoo

Akkam jirtu: Akkam bultanii /ooltanii?

Simannaa onnee irraa madde isiniif gochuudhaan jalqabuun barbaada. Of beeksisuun yeroon jalqabu ani maqaan koo_____ walitti qabaa oddeefannoo daataa Obbo Haabtaamuu Taaddasaa Itichaa barataa Yuunivarsiitii Jimmaa Faakaalittii Fayyaatti, Barnoota Meedikaal Fiiziyoloojiin Maastarsii Saayinsiitiin eebbifamuuf jirutti. Ani haar'a asitti kanan argameef "Hariiroo Garaagarummaa Dhiibbaa Dhiigaa Harka Gidduu, Seenaa Maatii Dhiibbaa Dhiigaa fi Paaraameetiroota Antiroopoomeetrikii Ga'eesota Magaalaa Ginchii, Aanaa Dandii, Goodina Shawaa Lixaa, Naannoo Oromiyaa, Itoophiyaa, 2022" irratti ragaa walitti qabuufi.

Hoj-maata

Filatamuun keessan qorannoo addaa kanaaf carraadhaan yoo ta'u, hirmaannaan qorannoo kanaa kan hundaa'e fedhii keeessan irratti. Qo'annoo kana irratti hirmaachuu dhiisuuf mirga guutuu qabdu; Haa ta'u malee kaayyoo qorannoo kanaa kan ta'e "Faca'insa fi hariiroo IABPD fi seenaa maatii dhiibbaa dhiigaa, paaraameetiroota antiroopoomeetirikii gidduu jiru ilaaluuf" hirmmaannaan keessan baay'ee barbaachisaa waan ta'ef, hirmaachuun keessan ni jajjabeefamaa. Yoo hirmaachuuf walii galtan, waa'ee seenaa keessanni gaaffilee waliigalaa tokko tokko (kanneen akka umurii, saala, sadarkaa barnootaa, sadarkaa gallii, haala gaa'ilaa fi seenaa maatii dhiibbaa dhiigaa) keessani isin gaafanna. Ulfaatinni, Dheerinni, naannawaan harkaa, naannawaan mudhii, fi dhiibbaan dhiigaa keessan ni safaramu. Kunis body mass index, IABPD fi dhiibbaa dhiigaa giddugaleessaa arteerii shallaguuf nu gargaara. Gaaffiin afaanii fi safartuuwwan armaan oliitti caqafaman turti daqiiqaa 10 hanga 15 keeessatti ni xumuramu.

Miidhaa fi haala mijataa hin taanee

Qorannoo kana keessatti hojimaatni fi gaaffiiwwan isin miidhu ykn miira addaa namatti hin tole isinitti uumuu danda'an hin jiran. Gaaffii kamiyyuu deebisuu diduun ykn gaaffii fi deebii kana yeroo barbaaddanitti addaan kutu ni dandeessu. Akkasumas gaaffii keenya tokko tokkoof deebii kennuu dhiisuun mirga keessanni.

Faayidaalee

Wanti qorannoo kana irraa barannu qaamolee imaammata baasani fi fayyaa gorsanif kan oolu ta'a. Karoorsittootnni dhibee onnee fi ujummoolee dhiigaa garaagarummaa dhiibbaa dhiigaa harka gidduu olka'een dhufu ittisuuf tajaajila bu'a qabeessaa fi dhaqqabamaa ta'e haala sirrii ta'een dizaayinii gochuu akka danda'an odeeffannoo bu'uura ta'e kennuu. Hirmaatootaaf sadarkaa dhibbaa dhigaa isaanii fi garaagarummaa harka lamaan gidduu irratti odeffannoo gahaa kennuu.

Iccitii eeguu

Maqaan keessan gaaffilee irratti hin galmaa'u. Akkasumas galmee piroojektii kamiyyuu keessatti hin gabaafamu. Dabalataanis deebiin keessan hundi iccitii cimaa ta'ee kan qabamu ta'a. Icha argannoowwan qorannoo kanaa seminaaraa fi workshopii adda addaa irratti ni dhiyaatu, garuu odeeffannoon nama dhuunfaa hin kaafamu. Gaaffii yoo qabaattan yeroo barbaaddanitti bilisaan gaafachuu ni dandeessu.

Kanaafuu, deebiin isin amanamuummaanni fi dhugaadhaan kennitan milkaa'ina qorannoo kanaatiif murteessaadha. Kanaaf nuti hirmaannaa keessan kabajaan isin gaafanna. Qorannoo kana ilaalchisee gaaffii qabduu? Yoo qorannoo kana irratti ibsa dabalataa gaafachuu barbaaddan Obbo Haabtaamuu Taaddassaa, qorataa muummee qorannoo kanaa karaa lakkoofsa bilbila harkaa isaanii 0913436538 ykn imeeyilii isaanii: habsaryab15@gmail.com yeroo barbaaddanitti ibsa barbaaddan gaafachuu dandeessuu.

Unka hayyamaa dhaquuf hayyama keessan argachuu nan danda'aa?

1. Eeyyee..... (Itti fufa)
2. Lakki..... (Dhaabaa).

Kutaa II: Uunka haayamaa Afaan Oromoo

Odeefannoo armaan oliitti Kaayyoo qorannichaa ilaalchisee, hojimaata, miidhaa fi miira namatti hin tolle, faayidaa qorannichaa fi iccitii deebii kennaman, irratti naaf kennaman hubadhe qorannicha irratti hirmaachuuf fedhii qabaachuu koo mallattoo kootiin raggaasiseera. Yoo hirmaattuun/hirmmaattaan mallatteessuu hin dandeenye iddoo maallattoo irratti mallattoo qubbaa harkaa qalama tuuqsisuun akka kaa'uu/keessuu gaafadhu.

Maqaa fi mallattoo walitti qabaa odeeffannoo_____, _____

Mallattoo deebii kennaa_____ _____

Gara gaaffii fi deebiitti itti fufuuf hayyama keessan argachuu danda'aa?

1. Eeyyee..... (Yoo eeyyee ta'e gaaffii fi deebii jalqabi) .
2. Lakki..... (Galatoomaa, asitti dhaabbi)

Bu’aa af-gaaffii kanaa:

1. Xumurame
2. Gar-tokkoon xumurame

Maqaa fi mallattoo supparvaayizarootaa_____, _____

Yeroo af-gaaffiin eegale_____

Yeroo af-gaaffiin xumurame_____

Kutaa III: Gaaffii Afaan Oromootiin

Qajeelfama: Deebii filannoowwan irraa argame irratti geengoo itti mari.

Kutaa tokkoffaa: Gaaffii amala Hawaasummaa fi dimoogiraafii madaaluuf gargaaru

Lakk	**Gaaffii**	**Deebii**	**Yaada**
101	Saala	1. Dhiira 2. Dhalaa	
102	Umurii	.....(waggaadhaan)	
103	Haala hojii	1. Hojjetaa mootummaa 2. Daldalaa 3. Barataa 4. Hojjetaa guyyaa guyyaa 5. Soorama kan bahe 6. Qonnaan bulaa 7. Kanneen biroo (ibsi).....	
104	Haala gaa'ilaa	1. Qeerroo/Qarree 2. Kan Fuudhee ykn heerumte 3. Kan wal hiikee/hiiktee 5. Dubartii/dhiira abbaan manaa/haati manaa irraa du'e/duute	
105	Sadarkaa barumsaa	1. Barnoota idilee hin qabu/du 2. Sadarkaa tokkoffaa xumurera/te 3. Sadarkaa lammaffaa xumurera/te 4. Sadarkaa lammaffaa oli	
106	Sadarkaa galii	……(qarshiidhaan)	

Kutaa lamaffaa: Gaaffii Paarameetaroota Antiroopoomeetiriikii madaaluuf gargaaran

Lakk	Gaaffii	Deebii	Yaada
201	Dheerinni isaa/ishee meeqa?	…….(cms tiin)	
202	Ulfaatini isaa/ishee meeqa?	……..(kgs tiin)	
203	Naannawaan harka isaa/ishee meeqa?	……..(cms tiin)	
204	Naannawaan Mudhii isaa/ishee meeqa?	……..(cms tiin)	
205	Body mass index isaa/ishee meeqa?	……..(kg/m2 tiin)	

Kutaa sadaffaa: Gaaffii haala fayyaa madaaluuf gargaaru

Lakk	Gaaffii	Deebii	Yaada
301	Seenaa dhiibbaa dhiigaa maatii qabduu?	1.Eeyyee 2. Lakki	
302	Safartuun jalqabaa dhiibbaa dhiigaa harka mirgaa meeqa?	Sistoolikii .....(mmHg tiin Diyaastoolikii.....(mmHg tiin)	
303	Safartuun jalqabaa palsi reetiin harka mirgaa meeqa?	……..(beats/min tiin)	
304	Safartuun jalqabaa dhiibbaa dhiigaa harka bitaa meeqa?	Sistoolikii .....(mmHg tiin Diyaastoolikii.....(mmHg tiin)	
305	Safartuun jalqabaa palsi reetiin harka bitaa meeqa?	……..(beats/min tiin)	
306	Safartuun dhiibbaa dhiigaa harka mirgaa Lammaffaa meeqa?	Sistoolikii .....(mmHg tiin Diyaastoolikii.....(mmHg tiin)	
307	Safartuun palsi reetiin harka mirgaa Lammaffaa meeqa?	……..(beats/min tiin)	
308	Safartuun dhiibbaa dhiigaa harka bitaa Lammaffaa meeqa?	Sistoolikii .....(mmHg tiin Diyaastoolikii.....(mmHg tiin)	

309	Safartuun palsi reetiin harka bitaa Lammaffaa meeqa?	……..(beats/min tiin)	
310	Dhiibbaan dhiigaa sistoolikii giddu galeessaan harka mirgaa meeqa?	…….(mmHg tiin)	
311	Palsi reetiin giddu galeessaan harka mirgaa meeqa?	……..(beats/min tiin)	
312	Dhiibbaan dhiigaa sistoolikii giddu galeessaan harka bitaa meeqa?	…….(mmHg tiin)	
313	Palsi reetiin giddu galeessaan harka bitaa meeqa?	……..(beats/min tiin)	
314	Garaagarummaan dhiibbaa dhiigaa harka gidduu sistoolikii meeqa?	…….(mmHg tiin)	
315	Dhiibbaan dhiigaa diyaastoolikii giddu galeessaan harka mirgaa meeqa?	…….(mmHg tiin)	
316	Dhiibbaan dhiigaa diyaastoolikii giddu galeessaan harka bitaa meeqa?	…….(mmHg tiin)	
317	Garaagarummaan dhiibbaa dhiigaa harka gidduu diyaastoolikii meeqa?	…….(mmHg tiin)	
318	Dhibbaan dhiigaa aarterii aveereejiin kan harka mirgaa meeqa?	…….(mmHg tiin)	
319	Dhibbaan dhiigaa aarterii aveereejiin kan harka bitaa meeqa?	…….(mmHg tiin)	

Declaration

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in this or any other university and that all sources of materials used for the thesis have been fully acknowledged.

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