Jimma University

Institute of Health Sciences

Department of Biomedical Sciences

Assessment of Inter-Arm Blood Pressure Difference and its Associated Factors among Hypertensive Patients at Jimma Medical Center, Jimma, Southwest Ethiopia: A Comparative Cross-Sectional Study

By: Hassen Chakisso (BSc)

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Jimma Ethiopia

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A Thesis Submitted to Jimma University, Institute of Health, Department of Biomedical Sciences in Partial Fulfillment of the Requirement For Degree of Master Science in Medical Physiology.

Advisors:

1. Mr. Tewodros G/Mariam (Assistant professor of Medical Physiology)
2. Mr. Diriba Dereje (Lecturer of Medical Physiology)

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ABSTRACT

Background: *Measuring blood pressure (BP) is a simple procedure to screen individuals with elevated BP. However, the concept of measuring BP in both arms to detect an inter-arm BP difference, which prevents misdiagnosis of hypertension and may predict future cardiovascular disease risk has not gained attention. In addition, guidelines advise measuring BP in both arms during hypertension screening but it is widely ignored in practice.*

Objectives: *This study aimed to assess inter-arm blood pressure difference and its associated factors among hypertensive patients at Jimma Medical Center, Jimma, Southwest Ethiopia, 2021.*

Methods: *A comparative cross-sectional study design was utilized. A total of 101 hypertensive & 101 non-hypertensive respondents were selected using systematic random and purposive sampling techniques respectively. Data were collected using a semi-structured questionnaire, physical measurement, and laboratory investigation. Data were entered into epi data version 4.6.0.5 & exported to SPSS version 26 for analysis. Chi-square test, independent t-test, Pearson correlation, and Binary logistic regression were used for analysis. P-value <0.05 was considered significant for statistical analyses.*

Result: *The prevalence of systolic inter-arm BP difference (SIABPD) in the hypertensive group was 32.7% and in healthy controls, it was 19.8%, whereas diastolic inter-arm BP difference (DIABPD) was 17.8% and 7.9% among hypertensive and non-hypertensive participants, respectively. Factors independently associated with systolic IABPD were DM with an AOR of 4.12, SBP with an AOR of 1.042 [AOR = 1.042; 95% CI: 1.012, 1.073), p = 0.005], BMI of 25-29.9 kg/m2, and ≥30 kg/m2 with AORs of 5.84 [AOR = 5.842; 95% CI: 1.206, 28.292, p = 0.028] and 7.55 [AOR = 7.546; 95% CI: 1.533, 37.140, p = 0.013] respectively, and ABI (ankle-brachial index) ≤ 0.9 with an AOR of 4.23 [AOR = 4.233; 95% CI: 1.309,13.689, p = 0.016] among hypertensive patients. In addition, DM with AOR of 5.13 [AOR= 5.127, 95% CI (1.467, 17.916), p=0.010], waist circumference with AOR of 4.01 [AOR=4.008, 95% CI (1.120, 14.337), p=0.033], DBP with AOR of 1.028 [AOR=1.028, 95% CI 1.001, 1.056, P=0.043], and total cholesterol with AOR of 1.011 [AOR=1.011, 95% CI 1.001, 1.020, P=0.033] were independent predictors of DIABPD in hypertensive patients.*

Conclusion*: This study discovered that hypertensive patients had a significantly higher prevalence of inter-arm BP difference than non-hypertensive controls. The independent predictors of systolic inter-arm BP difference in hypertensive patients were BMI, DM, SBP, and ABI (ankle-brachial index) whereas DM, waist circumference, DBP, and total cholesterol were independent predictors of diastolic IABPD in hypertensive patients. Framingham risk score (FRS) was significantly correlated with systolic IABPD. Therefore, systolic IABPD may predict future CVD risk. Measurement of BP in both arms should be part of routine clinical practices in health care systems.*

Keywords*: Inter-arm BP difference, hypertension, cardiovascular risk, Framingham risk score*

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ABBREVIATIONS

AHA	American heart association
AOR	Adjusted odds ratio
ASC	American Society of Cardiology
ABI	Ankle-brachial index
BP	Blood pressure
BMI	Body mass index
CVD	Cardio Vascular Disease
COR	Crude odds ratio
DIABPD	Diastolic inter-arm blood pressure difference
ESC	European Society of Cardiology
ESH	European Society of Hypertension
FRS	Framingham risk score
HDL-C	High-density lipoprotein cholesterol
HMIS	Health management information system
HTN	Hypertension
IAD	Inter-arm differences
IABPD	Inter-arm blood pressure difference
ICA	Internal carotid artery
JMC	Jimma Medical Center
LDL-C	Low-density lipoprotein cholesterol
LVH	Left ventricular hypertrophy
NASCET	North American Symptomatic Carotid Surgery Trial
NCD	Non-communicable diseases

NC	Neck circumference
OR	Odds ratio
RBS	Random blood sugar
RR	Relative risk
SAS	Subclavian artery stenosis
SD	Standard deviation
SIABPD	Systolic interarm blood pressure difference
SPSS	Statistical Package for the Social Sciences
TC	Total cholesterol
TG	Triglycerides
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

Accurately measuring blood pressure is the prerequisite for detecting cardiovascular disease early (1). Globally, cardiovascular disease is the leading cause of death, accounting for an estimated 31% of all deaths. Hypertension is the major predisposing modifiable risk factor for CVDs. One of the main contributing factors to cardiovascular disease is arteriosclerosis, and it is the main cause of morbidity and mortality. The most commonly used procedure to assess arteriosclerosis is measuring blood pressure (2–4). The inter-arm blood pressure difference (IABPD) is the absolute variation or discrepancy in blood pressure between the right and left arm. A few mmHg of variation in BP between the right and left arms is normal, but more than 10 mmHg difference can considerably increase the risk of cardiovascular events. Various studies conducted in different populations show that there are wide variations in the prevalence of IABPD (5,6).

The clear cause of an inter-arm blood pressure difference is not established; initially regarded as subclavian artery stenosis on the arm with lower BP(7). There is a growing body of evidence that associates IABPD with increased arterial stiffness, which is manifested as raised pulse wave velocity (PWV)(8). It is likely that IABPD is mainly due to asymmetrical arterial stiffness, and that this pathophysiology underlies the association of IABPD with cardiovascular risk. Both arterial stiffness and stenosis probably contribute to IABPD since both conditions share common underlying causes(9). The cause of IABPD might be anatomical or pathological. Anatomically, it has been proposed that angulation of the left subclavian artery's origin relative to the right cause higher turbulence, facilitating unequal atherosclerosis development. Pathologically, the most common cause of symptomatic upper limb ischemia, where IABPD is significant, is atherosclerosis(6,10).

It is a common finding in various general populations and was first noticed over a century ago. Inter-arm blood pressure difference has received attention globally because it has been associated with peripheral vascular disease, increased cardiovascular and all-cause mortality. It's an easy, non-invasive parametric test that clinical practitioners can measure without the use of any additional equipment(2,5). Dual-arm blood pressure measurement is an easy to attain, and cost-effective technique but an important physical measure to identify individuals at risk of developing cardiovascular events in the future and taking appropriate preventive measures. IABPD may predict future CVD risk and prevent the misdiagnosis of hypertension. Assessment of risk markers to

identify individuals with elevated cardiovascular risk is encouraged by international hypertension guidelines(3,7).

A recent meta-analysis stated that BP should be measured in both arms during the cardiovascular assessment. It is a key part of cardiovascular risk assessment and should become routine clinical practice. A systolic BP difference of ten or more mm Hg between arms is recommended to be the upper limit of normal(2,11). IABPD has been identified as a risk factor for CVDs (12). Aside from human and instrument-related errors that can impair BP measurement, it's important to recognize that patients' blood pressures can differ in both arms. Inter-arm BP difference provides diagnostic and predictive value, as well as prognostic value, as it indicates the severity of the disease. IABPD of ≥10 mmHg on many occasions necessitates further diagnostic evaluation (13,14).

Currently, international hypertension guidelines recommend that BP should be assessed in both arms at the initial visit, and subsequently monitoring it on the higher BP reading arm. However, compliance with such guidelines has been low among health care providers. Thus, it cannot be overemphasized that dual-arm BP measurement should be a routine practice for early diagnosis and prompt treatment of hypertensive disorders. This is because there are variations, and only one arm measurement could result in underdiagnoses of HTN, commonly known as the "silent killer." Guidelines also acknowledge the association of interarm BP differences with hypertension and cardiovascular risk(15–18).

Measuring IABPD could be a simple, and cost-effective way to identify those individuals with an increased risk of cardiovascular disease and atherosclerosis. Interarm BP differences detect the additional risk of having a cardiovascular event beyond that predicted by existing cardiovascular risk scores alone(2). Therefore; the development of novel cardiovascular disease risk markers to easily predict cardiovascular risk and stratify treatment priorities is a critically desired task(10,19).

In general, Failure to recognize the IABPD may lead to inadequate treatment of hypertensive patients and result in a delay in the diagnosis of HTN. Thus, it is very important to measure BP in both arms(20).

1.2 Statement of the problem

Hypertension is a major global concern and a serious public health problem throughout the world(13) especially, in low-income countries, with a high risk of hospitalization and mortality(21). Hypertension is one of the key preventable risk factors for cardiovascular events, affecting around 1.3 billion people worldwide. If left untreated, it can lead to problems with the heart, brain, kidneys, eyes, and blood vessels. Therefore, early detection of HTN is crucial to reduce such devastating complications(22). The prevalence of hypertension in Africa was 27% (15). The national prevalence of hypertension in Ethiopia was 19.6% (21).

According to WHO, identifying individuals with an increased risk of CVDs, access to NCD treatment, and basic health measures in all primary health care facilities are essential(23). However, many markers, such as carotid ultrasound, pulse-wave velocity, and echocardiography require specialized equipment and skilled personnel, which are not practical in primary health care systems. Therefore, inter-arm BP difference (IABPD) may be one of the cardiovascular risk markers that can easily be measured clinically without additional equipment and appear acceptable to patients. However, no longer attention was given previously to IABPD(5).

If IABPD is not detected, it leads to an error in the diagnosis and management of hypertension, consequently putting the individuals at future CVD risk through suboptimal control of HTN. Furthermore, a 10-mmHg difference in SBP between arms has been associated with cardiovascular risk factors. The detection of significant IABPD may serve as a simple cost-effective tool in primary health care to identify patients who may benefit from further screening for cardiovascular diseases (14). Studies have shown an increase in the prevalence of inter-arm BP variations in hypertensive patients(3,24).

IABPD is related to subclavian artery stenosis, atherosclerosis, and left ventricular hypertrophy. Furthermore, an increased systolic IABPD is linked to a 1.6 fold higher risk of cardiovascular morbidity and mortality(25). Significant IABPD has a significant impact on the prevalence of CVD. Study participants with substantial IABPD were more likely to suffer from CAD and cerebrovascular disease with a relative risk of 1.4 and 1.5 respectively. These finding indicate the correlation between significant inter-arm BP difference and a 10-year cardiovascular risk score. However, there are no evidence-based interventions based on inter-arm BP differences to reduce the risk of cardiovascular events(10,26).

The prevalence of IABPD is higher in hypertensive and known cardiovascular disease patients (5,27). It increases with increasing severity of HTN(14). A study done in the UK revealed that IABPD can predict an increased risk of cardiovascular events over 10 years in people with HTN(28). A study conducted in Korea found that hypertensive subjects had a higher SIABPD (43.6 %) than normotensive subjects (8.8%)(29). According to a Chinese study, the prevalence of abnormal IABPD in the general population was 14.3%, while in hypertensive people was 19.4%(30).

In Ethiopia, 37–78% of hypertension patients were unaware of their BP status. The reasons for this could be the asymptomatic nature of HTN (the silent killer), poor screening(21). Significantly large IABPD has been considered as a marker for the diagnosis of peripheral artery disease. However, the clinical significance of IABPD has not been elucidated. Furthermore, clinical guidance for the management of patients with a large IABPD has not yet been established. Therefore, early detection of IABPD beyond the normal level may be useful to prevent the progression of atherosclerosis and reduce cardiovascular morbidity and mortality(26).

Hypertension guidelines have recommended the measurement of BP in both arms at the initial visit (15–18). However, such guidelines have been ignored practically(31). In general, studies revealed that detecting inter-arm BP differences prevents misdiagnosis and mismanagement of HTN. In addition, studies in developed countries showed the association of IABPD with cardiovascular and all-cause mortality, and also its association with CVD risks. However, scarce data is found to date regarding IABPD in Africa despite HTN being a serious public health problem especially, in low-income countries. In our country Ethiopia, no published data on the prevalence of IABPD and its associated factors. In this regard, this study aimed to determine the magnitude of inter-arm BP difference and its associated factors.

1.3 Significance of the study

The result of this study will provide information on the importance of inter-arm blood pressure difference, which will be useful in the implementation of preventive measures to reduce CVD risk. This study will determine the magnitude of inter-arm blood pressure differences and its associated factors. The findings of this study will directly benefit patients with hypertension to know their inter-arm BP difference status and future risk of CVD in a cost-effective way. It will also enable health care providers to accurately diagnose hypertension and to easily detect individuals with increased risk of cardiovascular disease without additional instruments. Moreover, it will serve as the baseline information for future researchers who are interested in this area of study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of inter-arm blood pressure difference

Inter-arm BP differences are defined as the absolute variations or differences in average blood pressure between the right and left arm(26). A few mmHg of variation in BP between the arms is normal, but more than 10 mmHg difference can considerably increase the risk of cardiovascular events(5). There are different causes for IABPD; anatomical as well as pathological. However, the cause of IABPD has not been known clearly. Anatomically, it has been proposed that angulation of the left subclavian artery's origin relative to the right cause higher turbulence, facilitating unequal atherosclerosis development. Pathologically, the most common cause of symptomatic upper limb ischemia, where IABPD is significant, is atherosclerosis, which is associated with PAD(10). Atherosclerosis causes a decrease in blood flow to the lower limbs and an increase in arterial wall stiffness, resulting in a decrease in an ankle-brachial index and arterial distensibility, as well as left ventricular hypertrophy (LVH). LVH, on the other hand, reduces cardiac output, exacerbates the inadequacy of blood circulation in the extremities, hastening the progression of PAD, and increasing the frequency of IABPD. Atherosclerosis and LVH could explain the association between IABPD and poor cardiovascular outcomes(19). Site-specific atherogenesis might be due to uncontrolled hypertension and subsequently, raise the IABPD(32).

Uneven arterial stiffness could also contribute to an inter-arm difference in blood pressure and explain its association with elevated cardiovascular risk. The research shown above explains the link between an inter-arm difference in blood pressure and vascular diseases, as well as how to recognize it as a sign of increased cardiovascular risk(10). IABPD can occur in younger people when a muscle compresses an artery feeding the arm, or when an anatomical abnormality prevents smooth blood flow through an artery. In older persons, IABPD is mostly caused by a blockage induced by atherosclerosis. As a result, recognizing a variation in blood pressure between the arms is crucial for future cardiovascular risk assessment(5). Clinicians should consider the risk of developing atherosclerotic cardiovascular diseases when they encounter patients with an IABPD of > 10 mm Hg(33).

2.2 Pathogenesis of inter-arm blood pressure difference in Hypertension

Hypertension is an elevated state of BP ≥140/90, which is the major modifiable risk factor for CVDs. If hypertension is left untreated, it can lead to a problem termed hypertension-mediated organ

damage (HMOD). HMOD is defined as the alteration in structure or function of the arterial vasculature and/or the organs it supplies that is caused by raised blood pressure(17). Untreated hypertension complicates end organs including the brain, heart, eyes, kidneys, central and peripheral arteries(22). The effects of hypertension on the arteries are atherosclerotic plaque/stenosis, large arterial stiffening, and intima-media thickness (IMT) (17). These structural changes in the arteries (stenosis and arterial stiffness) were the proposed causes of interarm BP difference(9). In addition, carotid intima-media thickness was positively and statistically significantly correlated with systolic inter-arm BP difference(19). Therefore, structural alterations and diffuse stiffening in arteries as a result of hypertension might be the possible mechanism for higher IABPD in hypertensive patients(34).

2.3 prevalence of inter-arm blood pressure difference (IABPD)

Studies reported a varying prevalence of IABPD in general populations in different countries. Accordingly, the prevalence of SIABPD in the general population was reported as 23.1% in Israel(35), 23.4% in Korea (36), 38% in British (37), and 34% in France (38). The prevalence of diastolic IABPD in the general population was 17 % in Israel (35) and 19.3% in Ireland(39).

The inter-arm blood pressure difference is more common in hypertensive and known cardiovascular disease patients (27). With the increasing severity of hypertension, the proportion of significant IABPD rises. Systolic and diastolic IABPD were high in respondents with HTN (31.3%&20.9%) than that of non-hypertensive respondents (18%& 12%) respectively(14). A study done in Korea showed that hypertensive respondents had significantly higher SIABPD (43.6 %) than normotensive subjects (8.8%)(29). According to a Chinese study, the prevalence of abnormal IAD in the general population was 14.3%, while the prevalence of abnormal IABPD in hypertensive patients was 19.4%(30). The prevalence of systolic IABPD among hypertensive patients was 58% in India(5), 26% & 8.7% in the UK (40,41), and 18.2% in the USA (42), 13.5% in Mexico(43).

The prevalence of DIABPD among hypertensive patients was reported as follows; 2.8% in the USA (42), 6% in the UK (41), and 5.4% in Mexico(43). Studies conducted in India(5,12,44) respectively reported the prevalence of SIABPD among non-hypertensive participants as 40%, 15.4%, and 51%. A study in the USA showed 14% of non-hypertensive participants had SIABPD(42). The prevalence of DIABPD among non-hypertensive respondents was 1.7% in India (44) and 3.8% in Mexico (43).

2.4 Factors associated with inter-arm blood pressure differences

2.4.1 Socio-demographic factors

Aging may be the cause for arterial calcification, which leads to arterial stiffness that may differ between arms. furthermore, IABPD could occur at any time with aging and may worsen due to the progression of atherosclerosis (34).

Studies have shown that as people get older, their arterial elasticity declines, and their peripheral vascular resistance rises, both of which are linked to atherosclerosis. This could explain why abnormal IABPD is more prevalent among the elderly population (5,35) A study showed that age was not significantly associated with IABPD(14). According to a study conducted in China, the prevalence of aberrant IABPD in blood pressure varies significantly by age, with older adults having a higher prevalence. A multivariate logistic regression analysis revealed that being over 45 years old was associated with a considerably greater prevalence of IABPD. Age and ethnicity were found to be common risk factors for IABPD. The prevalence of IAD did not differ significantly based on gender. The prevalence of IAD did not differ significantly based on gender(30). A study in Japan showed that age was associated with SIABPD among hypertensive patients(45).

2.4.2 Hypertension-related factors

Inter-arm BP discrepancies had been linked to a delay in HTN diagnosis and poor control of it. As a result, an unnoticed variation could lower the prevalence of hypertension, exposing people to further risk who are already at high cardiovascular risk. A positive significant correlation was found between IABPD & HTN in multivariate logistic regression analysis(46). A study done in the UK revealed that IABPD can predict an increased risk of cardiovascular events and all-cause mortality over 10 years in people with hypertension(28). Research findings demonstrated a higher prevalence of IABPD in hypertensive and known cardiovascular disease patients(27). The proportion of significant IABPD increases with the increasing severity of hypertension(14).

Systolic BP was associated with SIABPD in studies done in China (20) and Korea(47). DBP was associated with DIABPD in studies employed in Korea (33,47). Risk factors for atherosclerotic diseases such as age, SBP, and DM are determinants of high systolic IABPD, which is consistent with the most cause of vascular stenosis, atherosclerosis (38). It is well known that atherosclerotic plaques appear in specific localized tracts of the arteries and it is also likely that arterial stiffening might be localized, being more accentuated in one arm because of anatomical reasons(34). Sustained elevated BP compromises the vascular bed and causes arterial stiffness as a result of

damage to the elastic fibers, thus reflecting a possible justification for the occurrence of IABPD in these high cardiovascular risk individuals (48).

2.4.3 Diabetes mellitus

IABPD is highly prevalent in patients with diabetes, is associated with vascular damage(34). A study conducted in Japan showed that IABPD might be a novel risk marker for subclinical atherosclerosis in patients with type 2 DM(45). Studies conducted in Korea (29), Nigeria (14), and France (38) discovered the association of DM with SIABPD. DM was associated with diastolic IABPD in a study conducted in Nigeria (14). So, it should be considered as a surrogate marker for vascular complications in patients with DM (49). DM is a well-known risk factor for CVD; they both share conditions such as subclinical atherosclerosis for which interarm BP difference may be a predictive factor(41). IABPD is frequently reported in patients with DM (50). The possible mechanism might be due to structural alterations in the large arteries as a result of diabetes and hypertension. Duration of diabetes may be the possible factor that causes calcification of arteries, resulting in arterial stiffness that differs between upper arms and arterial stiffness has been proposed as one of the causes of inter-arm BP difference (9,34).

2.4.4 Ankle-brachial index (ABI)

The lower ankle-brachial index (ABI) is associated with the incidence of cardiovascular disease and PAD(20). The ABI and IABPD may be essential in identifying systemic atherosclerosis. Therefore, abnormal IABPD and ABI, are linked together with both atherosclerotic risk factors and imminent cardiovascular disease events(51). ABI is a broadly accepted screening tool for detecting the presence of PAD. It is a simple, non-invasive and cost-effective assessment tool for patients with intermittent claudication(52). A Study in Taiwan shows that ABI was significantly associated with an IABPD of 10 mmHg or more. Hence, atherosclerosis might represent a causal intermediary between a large interarm SBP difference and poor cardiovascular outcomes (53,54).

ABI was one of the factors for IABPD in addition to other factors as shown by a study done in China(30). Another study in China has presented that ABI <0.9 was linked to systolic inter-arm BP difference of ≥ 10mmHg(55). IAD may be due to PAD predicting a higher risk of CVD in the future(56). The study conducted in Japan showed the significant association of IABPD with atherosclerosis markers, including ABI(45). In general ABI <0.9 was one of the factors associated significantly with systolic IABPD in studies conducted in France(38), Japan(45), China(54), and

UAS(57). The possible pathophysiological mechanism might be IABPD beyond the physiologic difference is considered as a marker for atherosclerosis(45). Atherosclerosis decreases the blood perfusion to the lower extremities and an increase in arterial wall stiffness, contributing to decreasing ankle-brachial index and arterial distensibility, and then finally progressed to left ventricular hypertrophy. On the reverse, left ventricular hypertrophy decreases the cardiac output, which further exacerbates deficiency of blood perfusion to extremities and enhances the progression of peripheral arterial disease, and increased systolic interarm blood pressure difference (19).

2.4.5 Obesity

According to a study conducted in India, those who were obese/overweight had a considerably higher probability of developing DIABPD than people with a normal BMI(5). Obesity measures such as highest BMI, and WC were significantly associated with IABPD with RR of 2.38, and 2.68, respectively. In comparison to the group with low IABPD, the group with high IABPD had higher adiposity, with the majority of the participants being women, and they had less physical activity(58). Hypertension and obesity, in addition to the other risk variables, were linked to SIABPD(27,57). Obesity is linked to increased blood viscosity, which raises the rheological component of peripheral resistance and contributes to obesity-related changes in arterial blood pressure(59).

Through this mechanism, the risk of IAD in BP was 1.4 -fold higher in the obese group than that in the normal population(30). According to a study conducted in Korea, individuals with severe SIAD had higher BMI than patients without it(26). Study participants with a BMI of 30 were more likely to develop SIABPD with an OR of 1.4(1.21, 1.65, p=0.00) in a study done in China(30). Obesity parameters BMI and waist circumference were correlated with DIABPD in a study conducted in Korea (47). BMI was associated with SIABPD in studies conducted in China(55), Korea (47), and the USA (60).

2.4.6 Dyslipidemia

Dyslipidemia is one of the important risk factors for cardiovascular diseases. Patients with SIABPD had increased total cholesterol, and LDL(25). A study done in China shows that obesity and hyperlipidemia were associated with a higher risk of abnormal inter-arm BP difference (30). A study done in Korea showed total cholesterol was significantly associated with DIABPD among hypertensive patients(26). According to a Japanese study, IABPD is linked to arteriosclerosis risks such as HTN, hypercholesterolemia, obesity, and metabolic abnormalities. On multivariate logistic

regression, hypercholesterolemia was an independent risk for an inter-arm difference of 10 mmHg(61). Atherosclerotic changes in blood vessels may be the cause for inter-arm BP difference(26) and elevated total cholesterol causes a buildup of fatty plaques in arteries which leads to atherosclerosis (62).

2.4.7 Family history of hypertension

A study in India showed that having SIABPD ≥10 mmHg was related to a family history of hypertension(27). Young adults with major cardiovascular and metabolic diseases in their families have a greater risk of arterial stiffness. Furthermore, they had thickened intima-media layers in their carotid artery(63). This leads to an inter-arm BP difference. Various studies have confirmed an increased risk of hypertension with a positive history of CVD among their family members. Thus, the occurrence of an IABPD may be positively associated with the existence of CVD in the family(44,64).

2.4.8 Framingham cardiovascular risk score

Significant IABPD had a significant impact on the prevalence of cardiovascular diseases. The group with substantial IAD was more likely to have coronary artery disease and cerebrovascular disease. This study result supports the link between substantial IABPD and a 10-year increase in cardiovascular risk. When systolic IABPD is taken into account, the precision of cardiovascular risk prediction is improved when compared to utilizing the Framingham score alone. Significant systolic IABPD was associated with FRS and the presence of cardiovascular disease in hypertensive patients. These results suggest that systolic IABPD can be used as an additional parameter to predict future cardiovascular events in patients undergoing treatment for HTN(26). The independent cross-sectional relationship of systolic IAD with FRS was confirmed by a large multivariable analysis(9).

2.4.9 Behavioral factors

According to WHO the most important behavioral risk factors of cardiovascular diseases are unhealthy diet, physical inactivity, tobacco use, and harmful use of alcohol(23). Researchers in the United States found an association between IABPD and behavioral factors such as smoking and excessive alcohol use (39). According to a study conducted in India, smokers had a considerably higher risk of developing interarm blood pressure differences than nonsmokers. Similar findings were discovered in the case of alcoholism(5). Smoking was the most common risk factor for IABPD(30). Chewing Khat could significantly affect CVS by enhancing catecholamine release, HR,

BP, and inducing coronary vasospasm(65). Amphetamine-like compounds are found in the leaves of the Khat plant which are implicated in the development of hypertension(66). However, no studies have assessed the association of Khat with interarm blood pressure difference.

Regular physical activity prevents or delays the development of high blood pressure, and exercise reduces blood pressure in people with hypertension. Physical activity can also lower blood cholesterol levels which then decrease the risk of developing CVD(67). In comparison to the group with low IABPD, the group with high IABPD had higher adiposity, and they had less physical activity(58).

2.5 Conceptual framework

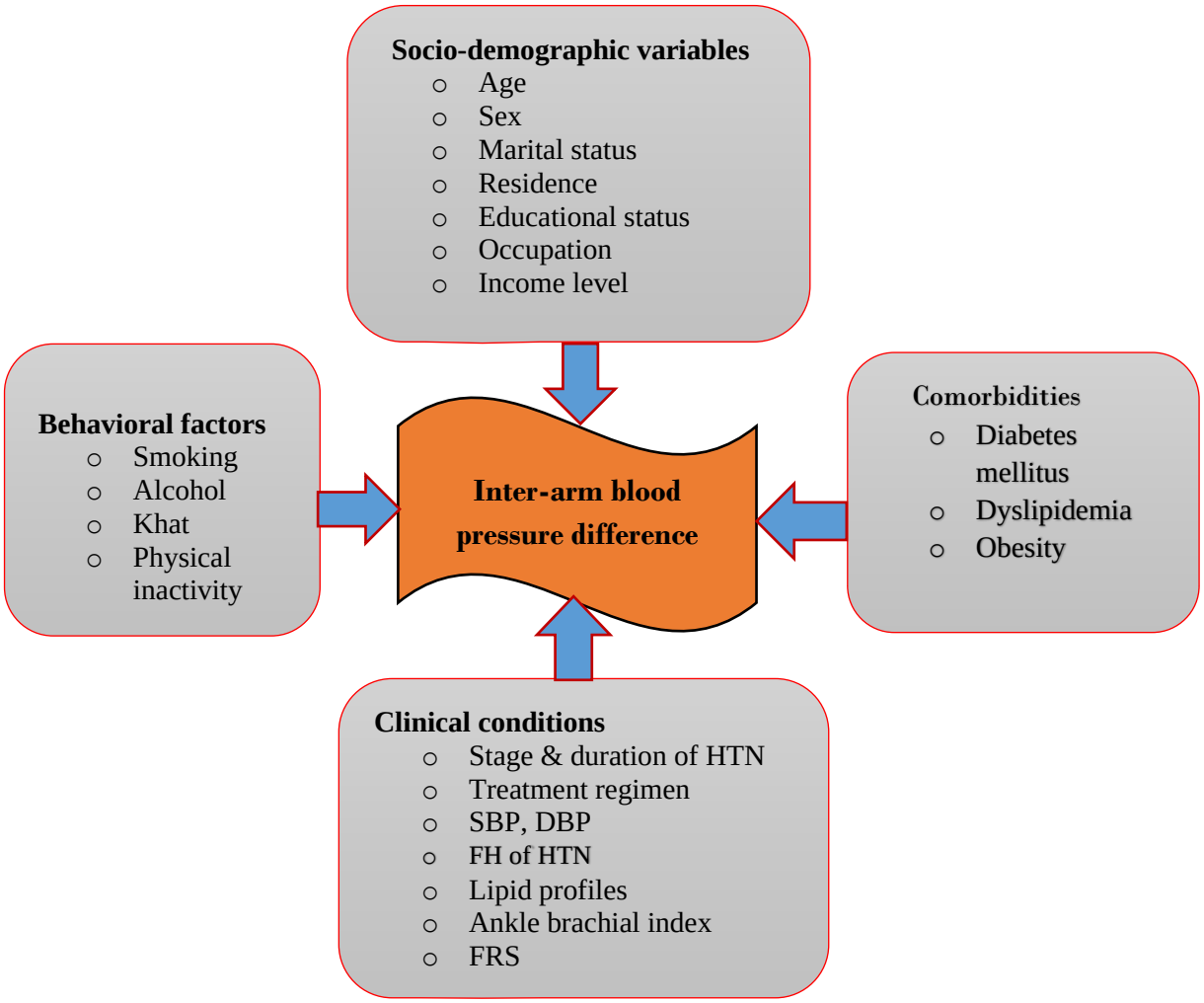

Figure 1: Conceptual framework for the factors associated with Inter-Arm BP difference adapted from different literature.

CHAPTER THREE: OBJECTIVES

3.1 General Objective:

To assess Inter-arm blood pressure difference and its associated factors among hypertensive patients at Jimma Medical Center, Jimma, Southwest Ethiopia, 2021.

3.2 Specific Objectives:

i. To determine the prevalence of inter-arm blood pressure difference in hypertensive and non-hypertensive respondents
ii. To identify factors associated with inter-arm blood pressure difference among hypertensive patients

CHAPTER FOUR: MATERIALS AND METHODS

4.1 Study area and period

The study was conducted at Jimma Medical Center, Jimma, Ethiopia. It is located 352 km southwest of Addis Ababa, which is the capital city of Ethiopia. JMC is the only teaching and referral hospital in Jimma town, southwest Ethiopia. The hospital gives health services at an inpatient and outpatient level as a referral hospital with a catchment population of 15 million. Chronic follow-up clinic is one of the health services providing units of JMC for chronic disease follow up including hypertension. There were 3,500 patients in the chronic disease follow-up clinic at Jimma medical center, from this 29.5% were hypertensive patients. The study was done at JMC, from October 1 to November 30, 2021.

4.2 Study design

An institution-based comparative cross-sectional study design was utilized.

4.3 population

4.3.1 Source population

For hypertensive group: all known hypertensive patients on follow-up at Jimma Medical Center

For comparison group: age-sex matched non-hypertensive (i.e attendants) who had attended JMC

4.3.2 Study Population

For hypertensive group: all selected known hypertensive patients visited chronic follow-up clinic of JMC during the study period and fulfilled the inclusion criteria

For comparison group: age-sex matched respondents without hypertension who had attended JMC during the study period

4.4 illegibility criteria

4.4.1 Inclusion Criteria

Hypertensive group:

- ✓ Hypertensive Patients on follow up
- ✓ Aged 20 years & above and who gave consent to participate in the study

Comparison group: Any age-sex matched attendants without hypertension

4.4.2 Exclusion Criteria

For study group:

Subjects <20 years of age, known heart failure, CAD, stroke, and chronic renal failure, Patients with one arm & upper limb deformity, newly diagnosed hypertensive patients who were not registered, severe illness, and pregnant women were excluded from the study.

For comparison group:

All the conditions which excluded the study groups from the study also excluded the comparison group from the study.

4.5 Sample size determination

The sample size was determined by using Sample size for comparison between two population proportion formulas by considering the following assumptions: 95% Confidence interval and 80% power. The sample size was determined equally by taking one to one ratio between the two groups.

$$\boldsymbol{n(each\ group) = \frac{(p_1 q_1 + p_2 q_2)\left(Z1 - \frac{\alpha}{2} + Z1 - \beta\right)^2}{(p1 - p2)^2}}$$

Where: -

p1 = proportion of outcome in study group

p2 = proportion of outcome in comparison group

q1 = (1-p1)

q2 = (1-p2)

Z (1-α/2) = 1.96 = value of the standard normal distribution corresponding to a significance level of α (1.96 for a 2-sided test at the 0.05 level).

Z (1-β) = 0.84 = value of the standard normal distribution corresponding to the desired level of power (0.84 for a power of 80%).

A study conducted in Nigeria shows 35.7% of respondents with hypertension had systolic IABPD ≥10 mmHg, whereas 18% of patients without hypertension had systolic IABPD of ≥10 mmHg(14). The calculated sample size after adding a 10% non-response rate was 104 for each group. Therefore, the total sample size was 208 (104 hypertensive and 104 non-hypertensive).

4.6 Sampling technique

Comparison group:

Respondents were selected from the study population by using a purposive sampling technique until the required number was achieved.

Study group:

Respondents were selected from the chronic disease follow-up clinic of JMC during the study period by systematic random sampling technique. First, K was determined by dividing the estimated number of hypertensive patients in two months by the sample size i.e K= 560/104 which was approximately five. Then, the first participant from five hypertensive patients was selected randomly by lottery method. Thereafter, every 5^{th} hypertensive patient was recruited until the required sample size was achieved.

Five hundred sixty (560) was the estimated number of hypertensive patients visiting chronic follow-up OPD in two months. Chronic follow-up clinic had two consecutive days (every Wednesday and Thursday) follow-up per week for hypertensive patients with a regular appointment, for drug refill and further checkup. About 20-25 hypertensive patients visited the clinic within these days and besides these follow-up days, 6-10 hypertensive patients visited the chronic clinic on other days of the week (preliminary Hospital study).

4.7 Data Collection tools and procedure

Data were collected by using a semi-structured interviewer-administered questionnaire, physical measurement, and laboratory investigation. The data were collected by two experienced clinical nurses and one laboratory professional. It contains socio-demographic characteristics, behavioral factors, clinical conditions, co-morbidities, and laboratory parameters such as lipid profile and blood glucose level. In addition, the data contain the Framingham cardiovascular risk score.

Interviewer-administered questionnaire adapted from WHO STEPS wise approach to surveillance of NCD risk factors was used to collect socio-demographic characteristics, behavioral factors, clinical conditions, and co-morbidities. Physical activity was assessed using a questionnaire adapted from the global physical activity questionnaire section of the STEPS instrument(68).

Physical measurements such as BP, ABI (ankle-brachial index), and anthropometric parameters were obtained according to standard procedures. In addition, laboratory investigation was performed to collect biochemical parameters such as lipid profile and blood glucose level.

Covid-19 prevention measures such as the use of personal protective equipment and social distancing were taken during data collection to prevent the transmission of infection. Participants were briefly informed that their participation in this study was based on their interest and they had full right to refuse or participate in the study at any time. They were also informed that their refusal doesn't affect the service that they would get from Hospital in any way. Written informed consent was taken from each participant before data collection.

Blood pressure measurement

The Blood pressure was measured after the participants rested for 5 minutes by a digital automatic blood pressure measuring device (Omron Model-HEM-7121-E, Japan). The Blood pressure was measured in a separate room in a sitting position with back and arm supported, leg uncrossed, feet flat on the floor, and mid-arm at the level of the heart. The data collectors make sure that an appropriately sized cuff was used and took the measurement only after the study participants were comfortable and relaxed. Data collectors palpated the brachial artery pulse and then placed the center of the cuff's bladder on the region where pulsation was palpated. After placing the lower end of the cuff 2 cm above the antecubital fossa, BP was measured three times on both the right and left arm sequentially within two minutes gap between measurements, and the average was used for analysis.

The average BP for each arm was used to calculate the inter-arm BP difference. Systolic inter-arm BP difference is the absolute difference between the average right and left arm SBP. Similarly, diastolic inter-arm BP difference is the absolute difference between average right and left arm DBP. BP difference of ≥10 mmHg was considered significant. To reduce bias, the same instrument and personnel were used to measure BP in both arms. To minimize diurnal variations, readings were taken at the same time of the day for both study groups (hypertensive & non-hypertensive) (16,69).

Ankle-brachial index (ABI) measurement

Measurement of ABI was done in participants who refrained from smoking, caffeine, and exercise 30 minutes before the examination. It was measured in a supine position after 5 minutes of rest with head and heels supported well. The appropriately sized cuff was placed around the ankle with the

lower part of the cuff 2 cm above the medial malleolus. BP was measured three times at posterior tibial arteries in the ankle using digital BP apparatus (Omron Model-HEM-7121-E, Japan)(70). Then, ABI was calculated by taking the ratio of ankle systolic BP to the higher upper arm systolic BP. ABI was performed both on the right and left ankle and the lower of the two ankles was taken as respondent's ABI(57). ABI $\leq$ 0.9 was considered abnormal or having a peripheral arterial disease(71).

Anthropometric measurements

Body weight was measured to the nearest 0.1kg using a portable weight scale machine. Participants were barefoot and wearing light clothing. Height was measured in meters, standing upright on a flat surface by using a stadiometer. Keeping the heels, shoulder, and back of the head touching a flat surface. BMI was calculated as body weight in kg divided by the square of body height (in m)(44). Waist circumference was measured in cm at the level of the iliac crest using a non-elastic tape measure(72).

Biochemical parameters

For biochemical investigation, 5ml of venous blood was collected from study subjects before the physical examination. Whole blood was collected with a plane vacutainer test tube. Before centrifugation, the whole blood was applied to the test strip to measure the random blood glucose level (RBS). RBS was measured by a blood glucose meter device (CareSens^{TM} N Eco Model-GM01WAA, Korea). Then, the remaining whole blood waited 30 minutes to clot. After clotting, it was centrifuged with 3000 revolutions per minute for 4-5 minutes to separate serum. The serum obtained was stored at 4^0 C until it was analyzed for lipid profiles. The lipid profiles including total cholesterol (TC), triglyceride (TG),), high-density lipoprotein cholesterol (HDL-c), and low-density lipoprotein cholesterol (LDL-c) were analyzed using an automatic chemistry analyzer machine (Cobas, Hitachi 6000, German)(73).

Assessment of Framingham cardiovascular risk score

Framingham risk score (FRS) was determined to estimate the patient's 10-year cardiovascular risk based on age, sex, smoking status, SBP, HDL, and total cholesterol (TC) levels(74). FRS is a gender-specific algorithm used to estimate the 10-year cardiovascular risk of an individual. Scores were given for each of the above risk factors based on cutoff points. Giving of scores and calculation of FRS in % from total points is gender-specific. The cutoffs used for the calculation of FRS were as follows:

Age: 20-34, 35-39, 40-44, 45-49, 50-59, 60-64, 65-69, 70-74, and 75-79; **sex**: male or female; **TC**: < 160, 160-199, 200-239, 240-279, and ≥ 280 mg/dL; **HDL-C**: < 40, 40-49, 50-59 and ≥ 60 mg/dl; **smoking status**: smoker, non-smoker, and **SBP**: < 120, 120-129, 130-139, 140-159, and ≥ 160 mmHg. FRS in percentage (probability of developing cardiovascular disease in ten years) was calculated by adding the total points and it was categorized as < 10%(low risk), 10-20% (intermediate-risk), and > 20% (high risk)(75).

4.8 Study variables

4.8.1 Dependent variable

- Inter-arm blood pressure difference
  i. Systolic inter-arm blood pressure difference
  ii. Diastolic inter-arm blood pressure difference

4.8.2 Independent variables

- **Socio-demographic characteristics**: age, sex, educational status, ethnicity, occupation, monthly income, marital status, religion, and residence.
- **Clinical conditions**: stage, duration & treatment of hypertension, SBP, DBP, and Ankle-brachial index
- **Clinical comorbidities**: Diabetes mellitus, dyslipidemia, obesity, and family history of hypertension.
- **Behavioral factors**: Smoking, Alcohol, Khat, and physical activity.
- **Cardiovascular risk marker:** Framingham risk score

4.9 Operational definition

Non-hypertensive: an individual who had no previous history of hypertension, was not treated for HTN, and/or his average BP was < 140/90 during the data collection period.

Elevated systolic IABPD: is defined as ≥10 mmHg difference in average SBP between the right and left arm(44).

Elevated diastolic IABPD: is defined as ≥10 mmHg difference in average DBP between the right and left arm(44).

ABI: was calculated by taking the ratio of systolic BP in the ankle with SBP in the upper arm. ABI of ≤ 0.90 was considered abnormal or having PAD(71).

Abnormal waist circumference: was described as WC >94 cm for men and >80 cm for women (72).

Dyslipidemia: was determined by having one of the following four lipid profile abnormalities: TC >240 mg/dL, TG >200 mg/dL, LDL-c > 160 mg/dL, and HDL-c < 40 mg/dL(74).

Severe illness: Any acute or chronic illness condition that prevents the respondent from giving the needed information and performing study procedures on them.

Current chewers: study participants who were chewing Khat within 30 days before the study.

Current alcohol user: study participants who were drinking any alcohol within 30 days before the study.

Current smoker: respondents who had smoked cigarettes within 30 days before the study(76).

Vigorous-intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate, and **moderate-intensity activities** are activities that require moderate physical effort and cause small increases in breathing or heart rate(77).

4.10 Data analysis procedure

The data were double-checked for completeness daily during data collection. The data were coded, cleaned, and entered into Epi data version 4.6.0.5 statistical software, and exported to SPSS version 26 for analysis. Continuous variables were summarized as mean and standard deviation, whereas the categorical variables were presented as numbers and percentages. Comparisons were done for different variables between two groups (hypertensive & non-hypertensive) using a student **t**-test for continuous variables, and by using a chi-square test for categorical variables. Correlation between inter-arm blood pressure difference and FRS was done by Pearson correlation. Bivariable and multivariable binary logistic regression analysis was used to identify factors associated with inter-arm blood pressure difference. P-value <0.05 was considered significant for statistical analysis.

4.11 Data Quality management

The pre-test was done in 5% of the sample size out of the study area, which was in Shenen Gibe Hospital and further modification was done on the questionnaire accordingly. The data collection (i.e filling questionnaires, doing procedures, and taking blood) was done by two experienced nurses with close follow-up to increase reliability and efficiency. The data collectors were trained on the tool and method of data collection, and techniques of all-important measurements.

The data collectors were supervised and the collected data were checked for completeness, consistency, and any missing data by the principal investigator regularly. Instruments were calibrated after each measurement. Standard laboratory procedures were followed to assure the quality of laboratory investigation results. The laboratory investigation was done by an experienced laboratory professional. The questionnaire was translated to Afaan Oromo and Amharic, then again translated back to English to check its consistency.

4.12 Ethical consideration

The study was carried out after obtaining ethical clearance from the Institutional Review Board (IRB) of Jimma University, Institute of Health. A formal letter was written to all concerned bodies and permission was secured at all levels.

A cooperation letter was obtained from Jimma University and sent to the medical director office of JMC and the coordinator office of chronic disease follow-up clinic of JMC before the actual data collection. Written informed consent was obtained from each study participant after the purpose of the study was briefly informed for them before the data collection. They had been told that they could withdraw from the study at any time. The novel COVID-19 transmission prevention measures/ precautions recommended by WHO were taken to prevent the risk of infection transmission. The information provided from participants was kept in a highly confidential manner and their personal information and identifiers were not disclosed on the questionnaire and anywhere in the document.

4.13 Dissemination plan

The result of this study will be presented to the department of biomedical science as a thesis defense and, different workshops and seminars. Copy of the document will be submitted to the department of biomedical sciences of Jimma University, JU postgraduate program coordinating office, and chronic follow-up clinic of JMC. Finally, the possible effort will be made for publication in an international scientific journal.

CHAPTER FIVE: RESULT

5.1 Socio-demographic and behavioral characteristics of study participants

A total of two hundred two (202) study participants with an equal proportion of hypertensive patients and non-hypertensive controls (101 each) were involved in the study with a response rate of 97.1%. The male sex comprised 51.5% of the study participants both in hypertensive patients and non-hypertensive respondents.

The mean age of the hypertensive and non-hypertensive control group was 53.32±13.92 (mean ±SD) and 52.62 ±13.61(mean ±SD) years respectively. Most of the study participants were found in the age category of 45-54(27.2%). The majority of the respondents 128(63.4%) were Oromo in their ethnic group and Around half of the respondents (51.5%) were Muslims, followed by orthodox (27.7%). Almost two-thirds of the study participants (63.4%) were living in the urban area. From the total study participants, the proportion of respondents who were married was 64.9%.

Out of the hypertensive respondents, 18.8% and 21.8% of participants were current alcohol users and current smokers respectively whereas 22.8% and 13.9% of non-hypertensive respondents were current alcohol users and smokers respectively. In addition, 37.6% of hypertensive patients and 44.6% of the non-hypertensive respondents were current Khat chewers (**Table 1**).

In general, there were no significant differences between the two study groups (hypertensive patients and non-hypertensive controls) regarding the socio-demographic and behavioral factors (**Table 1**).

Table 1: Socio-demographic and behavioral characteristics of respondents at JMC, Ethiopia 2021.

Variable	Category	Study groups (N=202)			
		HTN N (%)	Controls N (%)	Total N (%)	P Value
Age	Mean ±SD	53.32±13 .92	52.62 ±13.61	52.97±13.73	.721[t]
	<45	23 (22.8)	25(24.8)	48(23.8)	
	45-54	28 (27.7)	27(26.7)	55(27.2)	.615
	55-64	22(21.9)	28(27.7)	50(24.8)	
	≥65	28 (27.7)	21(20.8)	49(24.3)	
Sex	Male	52(51.5)	52(51.5)	104(51.5)	1
	Female	49(48.5)	49(48.5)	98(48.5)	
Marital status	Married	64(63.4)	67(66.3)	131(64.9)	
	Single	19(18.8)	17(16.8)	36(17.8)	.901
	Others[a]	18(17.8)	17(16.8)	35(17.3)	
Residence	Urban	67(66.3)	61(60.4)	128(63.4)	.381
	Rural	34 (33.7)	40(39.6)	74(36.6)	
Educational status	Illiterate	44 (43.5)	32(31.6)	76(37.6)	
	Primary	26 (25.7)	29 (28.7)	55(27.2)	
	Secondary	17 (16.8)	26(25.7)	43(21.3)	.256
	College &above	14 (13.9)	14(13.9)	28(13.9)	
Ethnicity	Oromo	58 (57.4)	70(69.3)	128(63.4)	.281
	Amhara	17 (16.8)	8(7.9)	25(12.4)	
	Gurage	8 (7.9)	5(5)	13(6.4)	
	Dawro	7 (6.9)	7(6.9)	14(6.9)	
	Others[b]	11(10.9)	11(10.9)	22(10.9)	
Religion	Muslim	51(50.5)	53(52.5)	104(51.5)	.696
	Orthodox	29(28.7)	27(26.7)	56(27.7)	
	Protestant	10(9.9)	8(7.9)	18(8.9)	
	Others[c]	11(10.9)	13(12.8)	25(12.4)	
Occupation	Farmer	18(17.8)	24(23.8)	42(20.8)	
	Housewife	24(23.8)	28(27.7)	52(25.7)	
	Merchant	17(16.8)	14(13.9)	31(15.3)	.716
	Gov't employee	27(26.7)	22(21.8)	49(24.3)	
	Others[d]	15(14.9)	13(12.9)	28(13.9)	
Monthly income	≤500	24(23.8)	20(19.8)	44(21.9)	.900
	501-1000	21(20.8)	24(23.8)	45(22.3)	
	1001-2000	23(22.8)	24(23.8)	47(23.3)	
	>2000	33(32.7)	33(32.7)	66(32.7)	
Current alcohol user	Yes	19(18.8)	23(22.8)	42(20.8)	.488
	No	82(81.2)	78(77.2)	160(79.2)	
Current Smoking	Yes	22(21.8)	14(13.9)	36(17.8)	.141
	No	79(78.2)	87(86.1)	166(82.2)	
Currently chewing Khat	Yes	38(37.6)	45(44.6)	83(41.1)	.317
	No	63(62.4)	56(55.4)	119(58.9)	
Physical activity	Yes	35(34.7)	28(27.7)	63(31.2)	.288
	No	66(65.3)	73(72.3)	139(68.8)	

Notes: [a]divorced, Widowed. [b]Yem. [c]Catholic, Wakefata, joba. [d]Private work, unemployed. t= independent t-test, SD= standard deviation, HTN=hypertension. N (%) =number (percent).

5.2 Clinical characteristics of study participants

The mean SBP among the hypertensive and healthy control group was 141.37 ± 21.75 and 115.45 ±13.60 whereas mean DBP was 93.98 ±21.07 and 79.36 ±7.54 respectively. Thirty-one (30.7%) of hypertensive patients and 11(10.9%) of non-hypertensive controls have a family history of HTN respectively. Most of the non-hypertensive respondents 54(53.5%) and 39(38.6%) of hypertensive patients were found in the normal BMI range (18.5-24.9) and their respective mean BMI was 22.23 ± 3.77 and 25.33 ± 4.51.

Around forty percent (39.6%) of hypertensive and nineteen (18.8%) of non-hypertensive controls had abnormal waist circumference respectively. Out of hypertensive participants, 20.8% of them had comorbid diabetes, whereas 6.9% of non-hypertensive control groups had DM. Dyslipidemia was found in 42.6% of hypertensive and 14.9% of non-hypertensive groups. The Mean of total cholesterol among hypertensive and non-hypertensive control was 190.26 ±56.00 and 166.72 ±40.45 respectively. Abnormal ABI was found in 39.6% of hypertensive and 15.8% of non-hypertensive respondents.

The mean FRS was 10.66 ±5.91 and 7.23 ±4.27 respectively in the hypertensive and non-hypertensive control groups. Most of the study participants, 63.4% of the hypertensive group and 78.2% of the comparison group were found at Framingham risk score of <10% (i.e the low-risk category) (**Table 2**).

In general, there was a significant difference between the hypertensive and non-hypertensive participants concerning clinical characteristics (**Table 2**).

Table 2: Clinical characteristics of study participants at JMC, Jimma, Ethiopia, 2021

		Study groups		
Variable	Category	HTN group (101)	Control group (101)	P value
SBP	Mean ±SD	141.37 ±21.75	115.45 ±13.60	< .001[t]
DBP	Mean ±SD	93.98 ±21.07	79.36 ±7.54	< .001[t]
FH of HTN	Yes	31(30.7)	11(10.9)	.001[x2]
	No	70 (69.3)	90(89.1)	
BMI	Mean ±SD	25.33 ±4.51	22.23 ±3.77	< .001[t]
	<18.5	8(7.9)	15(14.9)	
	18.5-24.9	39(38.6)	54(53.5)	.015[x2]
	25-29.9	32(31.7)	21(20.8)	
	≥30	22(21.8)	11(10.9)	
WC	Normal	61(60.4)	82(81.2)	.001[x2]
	Abnormal	40(39.6)	19(18.8)	
DM	Yes	21(20.8)	7(6.9)	.004[x2]
	No	80(79.2)	94(93.1)	
RBS	<200	83(82.2)	94(93.1)	.019[x2]
	≥200	18(17.8)	7(6.9)	
TC	Mean ±SD	190.26 ±56.00	166.721 ±40.45	.001[t]
TG	Mean ±SD	165.85±81.65	139.23±93.54	.032[t]
HDL	Mean ±SD	37.36 ±9.10	44.08 ±7.44	< .001[t]
LDL	Mean ±SD	104.48±29.77	86.373 ±19.99	< .001[t]
Dyslipidemia	Yes	43(42.6)	15(14.9)	
	No	58(57.4)	86 (85.1)	< .001[x2]
ABI	≤0.9	40(39.6)	16 (15.8)	
	>0.9	61(60.4)	85(84.2)	< .001[x2]
FRS	Mean ±SD	10.66 ±5.91	7.23 ±4.27	< .001[t]
	<10	64(63.4)	79 (78.2)	
	10-20	28(27.7)	19 (18.8)	.043[x2]
	>20	9(8.9)	3 (3.0)	

Note: t= independent t-test, x^2=chi square test, SD= standard deviation, BMI= body mass index, FRS= Framingham risk score, ABI=ankle brachial index, RBS= Random blood sugar, LDL=low density lipoprotein, HDL= high density lipoprotein, TG =triglyceride, TC= total cholesterol, FH of HTN= family history of hypertension. Waist circumference normal <94cm for males and <80cm for females and abnormal one is >94cm for males and >80cm for females. N (%) = number (percent).

The mean duration of hypertension among hypertensive patients was 5.38 ±4.45. Around sixty percent (59.4%) and forty-seven percent (46.5%) of hypertensive participants use diuretics & CCB respectively. ACE inhibitors were used by 56.4% of hypertensive patients. Out of 101 hypertensive respondents, 38.6% of them were found in the controlled stage of HTN whereas 51.5% and 9.9% of them were in stage I & stage II respectively (**Table 3**).

Table 3: Hypertension-related variables among hypertensive patients at JMC, Jimma, Ethiopia 2021.

Variable	**Category**		
HTN duration	Mean ±SD		5.38 ±4.45
Stage of hypertension	Normal/controlled		39 (38.6%)
	Stage I		52 (51.5%)
	Stage II		10 (9.9%)
Treatment regimen	CCB	Yes	47 (46.5%)
		No	54 (53.5%)
	Diuretics	Yes	60 (59.4%)
		No	41 (40.6%)
	ACEI	Yes	57 (56.4%)
		No	44 (43.6%)
	ARB	Yes	30 (29.7%)
		No	71 (70.3%)
	BB	Yes	22 (21.8%)
		No	79 (78.2%)

Note: SD= standard deviation, CCB=calcium channel blocker, ACEI= angiotensin-converting enzyme inhibitors, ARB= angiotensin receptor blocker, BB= beta blocker, controlled= BP <140/90, stage I =BP of 140/90 -160/110, stage II= BP ≥160/110

In this study, the mean systolic and diastolic BP were significantly (P <.001) higher on the right arm of the study participants. The analysis was done by paired t-test (**Table 4**).

Table 4: Comparison of BP between the right and left arm among study participants at JMC, Ethiopia, 2021.

Blood pressure	Mean ± SD	P value
Right SBP	125.12 ± 20.39	<.001*
Left SBP	121.83 ± 20.02	
Right DBP	84.04 ± 14.63	<.001*
Left DBP	81.61 ± 13.20	

Note: * = statistically significant

5.3 Prevalence of Inter-Arm BP Difference among Study Participants

The overall prevalence of systolic IABPD ≥10 mmHg was 26.2% [95% CI: 19.8, 32.2], and diastolic IABPD was 12.9% [95% CI: 8.4, 17.8] (Figure 2). The mean SIABPD was 8.21 ±6.96 for the hypertensive group and 5.83 ±4.20 for non-hypertensive control groups. There was a significant mean difference in SIABPD between the two study groups (P = 0.004). The prevalence of SIABPD of ≥10 mmHg was 32.7% [95% CI: 22.8, 42.6] in hypertensive patients and 19.8% [95% CI: 11.9, 27.7] in non-hypertensive control groups. There was a significant difference between the two study groups in the prevalence of SIABPD (P = .038) (**Table 5**).

There was a significant mean difference (p = .020) in DIABPD between study groups. The mean DIABPD was 6.08 ± 5.47 for the hypertensive group and 4.54 ± 3.69 for non-hypertensive control groups. Diastolic IABPD ≥10 mmHg was present in 17.8% [95% CI: 10.9, 25.7] and 7.9% [95% CI: 3.0, 13.9] of hypertensive and non-hypertensive controls respectively. There was a significant difference between study groups in the prevalence of DIABPD ≥10 mmHg (P = .036) (**Table 5**).

Table 5: Comparison of IABPD between study groups at JMC, Jimma, Ethiopia, 2021.

		Study groups (N=101 each)		
Variable	**category**	HTN group % [95% CI]	Control group % (95% CI)	**P-value**
SIABPD	Mean ±SD	8.21 ± 6.96 [6.85, 9.64]	5.83 ± 4.200 [5.07,6.72]	.004[t]
(mmHg)	<10	67.3%	80.2%	
	≥10	32.7% [22.8, 42.6]	19.8% [11.9, 27.7]	.038[x2]
DIABPD	Mean ±SD	6.08 ± 5.47 [5.06,7.11]	4.54 ± 3.687 [3.91,5.26]	.020[t]
(mmHg)	<10	82.2%	92.1%	
	≥10	17.8% [10.9, 25.7]	7.9% [3.0, 13.9]	.036[x2]

Note: t = independent t-test, **x^2 =** chi square test, SIABPD = systolic inter-arm BP difference, DIABPD = diastolic inter-arm BP difference, % [95% CI] = percentage (95% confidence interval).

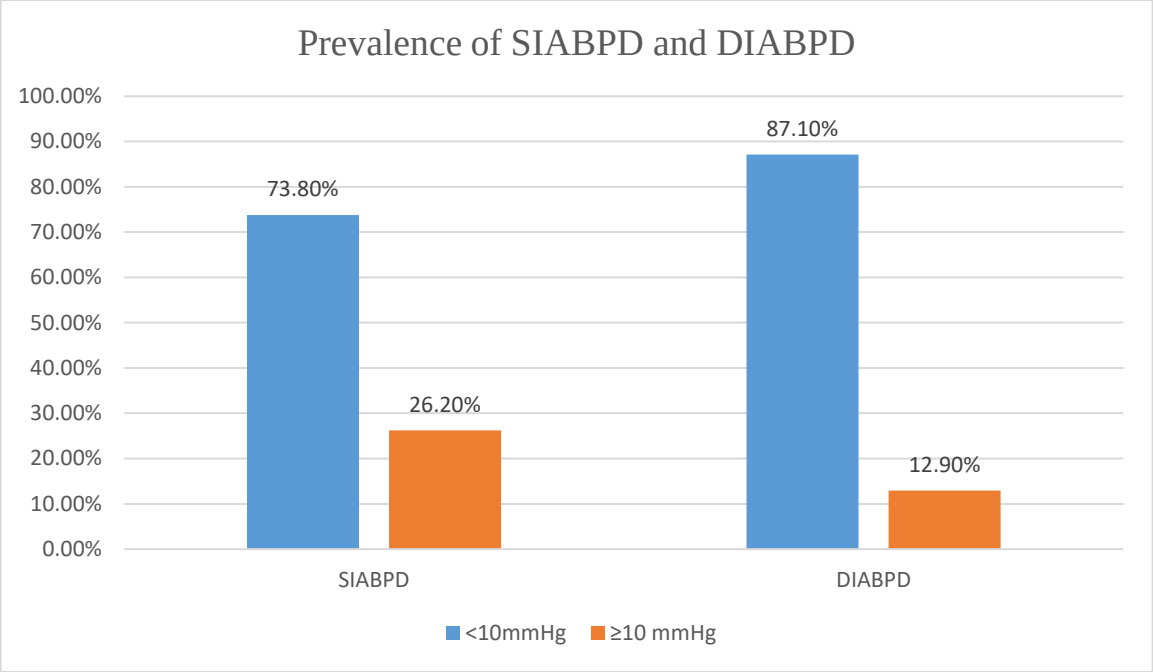

Figure 2: Overall prevalence of SIABPD and DIABPD in study participants at JMC, Jimma, Ethiopia, 2021

Both systolic and diastolic IABPD was found in 10% of hypertensive and 3% of non-hypertensive study participants **(Figure 3)**.

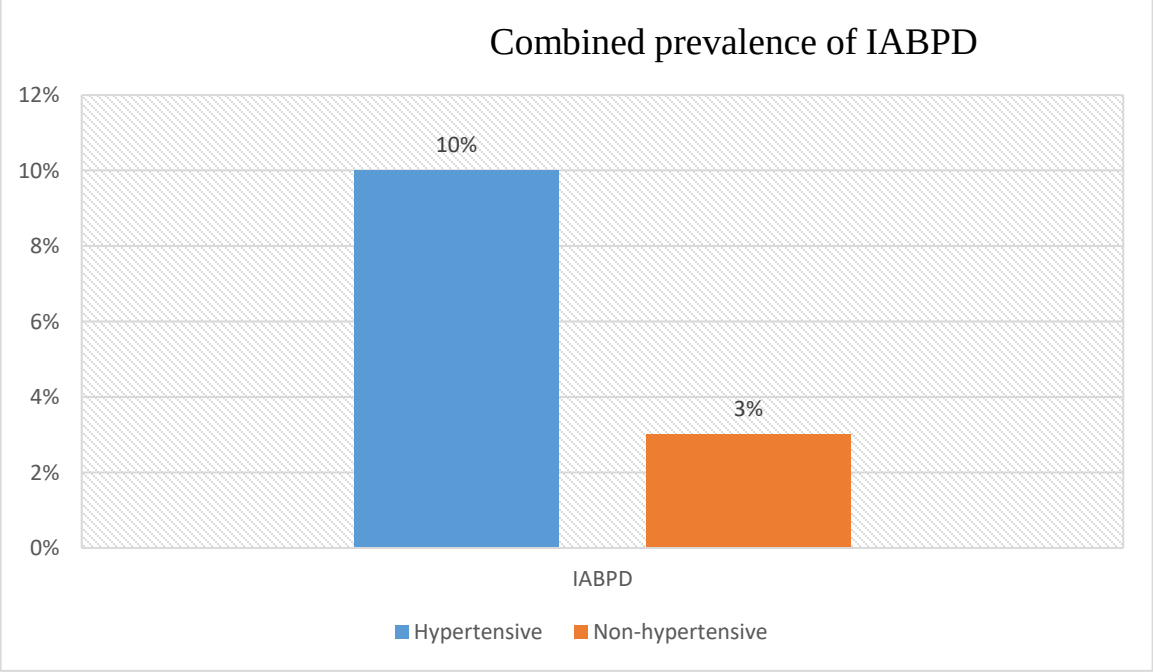

Figure 3:Combined prevalence of IABPD in study respondents at JMC, Jimma, Ethiopia, 2021

5.4 Factors associated with Inter-arm blood pressure difference

The variables associated with systolic IABPD in bivariable logistic regression in hypertensive patients at p-value < 0.25 were age, duration of HTN, stage of HTN, family history of hypertension, diabetes mellitus, dyslipidemia, SBP, DBP, BMI, waist circumference, total cholesterol, and ABI (ankle-brachial index). On the other hand, variables associated with diastolic IABPD in bivariable analysis at p-value < 0.25 in hypertensive patients were DM, duration of HTN, family history of HTN, SBP, DBP, total cholesterol, BMI, ABI, and waist circumference. Hence, these variables were entered into multivariable logistic regression analysis.

The Hosmer and Lemeshow goodness of fit test gave a p-value of 0.455 and 0.217 respectively for SIABPD & DIABPD, indicating evidence of model fitness. Multicollinearity diagnostic test was done to check multicollinearity assumption between the predictor variables and there was no multicollinearity with variable inflation factor (VIF) of <10 and tolerance of >0.1 respectively. Multivariable logistic binary regression analysis was done using the backward likelihood ratio method to explore the independent predictors of systolic and diastolic IABPD among hypertensive patients at a p-value < 0.05.

Systolic BP was one of the factors significantly associated with systolic inter-arm BP difference (SIABPD). One mmHg increase in SBP increases the likelihood of having SIABPD by 4.2% [AOR = 1.042; 95% CI: 1.012, 1.073), p = 0.005] controlling for all other factors in the model. The other independent predictor variable was BMI; hypertensive clients with BMI of 25-29.9 kg/m^2 were 5.84 times more likely to have SIABPD as compared to those with normal BMI [AOR = 5.842; 95% CI: 1.206, 28.292, p = 0.028] and participants with BMI ≥ 30kg/m^2 were 7.55 times more likely to develop SIABPD ≥10 mmHg as compared to those with normal BMI [AOR = 7.546; 95% CI: 1.533, 37.140, p = 0.013] controlled for other variables in the multivariable logistic regression analysis.

Hypertensive respondents whose ABI was ≤ 0.9 were 4.23 times more likely to have SIABPD than those who had ABI >0.9 [AOR = 4.233; 95% CI: 1.309,13.689, p = 0.016]. Finally, hypertensive patients who had co-morbid DM were 4.12 times more likely to develop SIABPD as compared to non-diabetics [AOR = 4.109; 95% CI: 1.165, 14.490, p = 0.028] provided other predictors remained constant (**Table 6**).

Duration of HTN, family history of HTN, DM, SBP, DBP, BMI, waist circumference, total cholesterol, and ABI were the candidate variables entered to multivariable logistic analysis for

DIABPD (i.e another outcome variable). From these variables; DM, waist circumference, DBP, and total cholesterol were significantly associated with DIABPD among hypertensive patients. The likelihood of having DIABPD was 5.13 times higher in hypertensive patients with diabetes than without diabetes [AOR= 5.127, 95% CI (1.467, 17.916), p=0.010].

Hypertensive patients with abnormal waist circumference (WC >80 & 94cm for females and males respectively) were 4.01 times more likely to develop DIABPD than those having normal waist circumference [AOR=4.008, 95% CI (1.120, 14.337), p=0.033]. The likelihood of developing diastolic inter-arm BP difference among hypertensive patients increased by 2.8% for a 1mmHg increase in DBP [AOR=1.028, 95% CI 1.001, 1.056, P=0.043] other factors remained the same. The odds of having DIABPD among hypertensive patients increase by 1.1% for 1mg/dl increase in total cholesterol [AOR=1.011, 95% CI 1.001, 1.020, P=0.033] adjusted for other variables (**Table 7**).

Table 6: Factors Associated with SIABP Among Hypertensive Patients at JMC, Ethiopia, 2021

Variable	Category	SIABPD (mmHg)		Bivariable Analysis		Multivariable Analysis	
		<10	≥10	P-value	COR (95% CI)	P-value	AOR (95% CI)
Age	<45	19	4		1		1
	45-54	21	7	.513	1.583(.400, 6.270)	.405	2.149(.354,13.031
	55-64	15	7	.266	2.217(.545, 9.013)	.402	2.406(.308,18.788
	≥65	13	15	.011	5.481(1.480,20.297)	.207	3.27(.519, 20.622)
SBP	Mean ±SD	135.04±19.6	154.42±20.33	< .001	1.048(1.023,1.073)	.005**	**1.042**(1.012, 1.073)
DBP	Mean ±SD	90.46 ±18.75	101.2±23.89	.019	1.025(1.004, 1.046)	.548	1.009(.981, 1.037)
HTN duration	Mean ±SD	4.79 ± 3.684	6.58 ± 5.59	.071	1.093(.992, 1.203)	.151	1.127(.957, 1.326)
Stage of HTN	Controlled	31	8		1		1
	Stage I	33	19	.102	2.231(.854, 5.830)	.756	1.267(.284, 5.640)
	Stage II	4	6	.020	5.813(1.317, 25.658)	.481	2.094(.268, 16.386)
FH of HTN	Yes	17	14	.078	2.211(.915, 5.340)	.678	1.332(.344, 5.161)
	No	51	19		1		1
DM	Yes	7	14	< .001	6.421(2.262,18.225)	.028**	**4.109** (1.165, 14.490)
	No	61	19		1		1
BMI	18.5-24.9	34	5		1		1
	<18.5	5	3	.002	3.562(1.085, 11.695)	.122	5.358
	25-29.9	21	11	< .001	11.900(3.312, 42.757)	.028**	5.842 (1.206, 28.292)
	≥30	8	14	.107	4.080(.737, 22.597)	.013**	7.546(1.533, 37.140)
WC	Normal	50	11	< .001	1	.347	1
	Abnormal	18	22		5.556(2.254, 13.694)		1.888(.503, 7.088)
TC	Mean ± SD	179.46 ±41.38	212.53 ±73.87	.009	1.011(1.003, 1.019)	.752	1.002(.991, 1.013)
Dyslipidemia	Yes	26	17	.207	1.716(.741, 3.975)	.263	1.950(.606, 6.271)
	No	42	16		1		1
ABI	≤0.9	15	25	<.001	11.042(4.140,29.45)	.016**	**4.233**(1.309,13.689)
	>0.9	53	8		1		1

Notes: **Statistically significant. SIABPD= systolic inter-arm BP difference, AOR= adjusted odds ratio; COR= crude odds ratio; CI=confidence interval; 1= reference, SD= standard deviation, ABI= ankle-brachial index, FH of HTN= family history of hypertension, TC= total cholesterol, Waist circumference abnormal >94cm for males and >80cm for females, N (%) = number (percent).

Table 7: Factors Associated with DIABPD Among Hypertensive Patients at JMC, Jimma, Ethiopia 2021

Variable	Category	**DIABPD** (mmHg)		**Bivariable Analysis**		**Multivariable Analysis**	
		<10	≥10	P-value	COR (95% CI)	P-value	AOR (95% CI)
SBP	Mean ±SD	138.91±21.33	152.72±20.60	.018	1.030(1.005, 1.056)	.960	1.001 (.966, 1.037)
DBP	Mean ±SD	91.25 ±18.97	106.56 ±25.95	.008	1.034(1.009, 1.059)	.043**	**1.028** (1.001, 1.056)
HTN duration	Mean ±SD	5.13 ± 3.77	6.50 ±4.78	.246	1.063(.959, 1.178)	.948	1.004 (.884, 1.141)
FH of HTN	Yes	22	9	.056	2.773(.976, 7.881)	.796	1.199 (.305, 4.715)
	No	61	9		1		1
DM	Yes	12	9	.002	5.917(1.954, 17.919)	.010**	**5.127** (1.467, 17.916)
	No	71	9		1		1
BMI	18.5-24.9	34	5		1		1
	<18.5	6	2	.387	2.267(.355, 14.493)	.839	.752(.048, 11.817)
	25-29.9	27	5	.736	1.259(.330, 4.802)	.867	1.282 (.071, 23.256)
	≥30	16	6	.167	2.550(.676, 9.615)	.970	1.055 (.066, 16.810)
WC	Normal	56	5		1		1
	Abnormal	27	13	.003	5.393(1.744, 16.677)	.033**	**4.008** (1.120, 14.337)
TC	Mean ± SD	182.51± 53.673	226.01±53.93	.006	1.012(1.004, 1.021)	.033**	**1.011** (1.001, 1.020)
ABI	≤0.9	27	13	.003	5.393 (1.744, 16.677)	.691	1.372 (.289, 6.516)
	>0.9	56	5		1		1

Notes: ** Statistically significant. DIABPD= diastolic inter-arm blood pressure difference AOR= adjusted odds ratio; COR= crude odds ratio; CI= confidence interval; 1= reference. ABI= ankle brachial index, TC=

total cholesterol, FH= family history of hypertension, WC= waist circumference, WC abnormal >94cm for males and >80cm for females. N (%) = number (percent).

The factors associated with systolic IABPD in Bivariable logistic regression among non-hypertensive respondents were BMI, SBP, and ABI. Hence, they were entered to multivariable logistic regression analysis and ABI was significantly associated with SIABPD among non-hypertensive participants. Non-hypertensive individuals with ABI ≤ 0.9 were 3.62 times more likely to have SIABPD than those who had ABI > 0.9 [AOR = 3.615; 95% CI: 1.080,12.095, p = 0.037] (**Table 8**).

Table 8:Factors associated with SIABPD among non-hypertensive respondents at JMC, Ethiopia, 2021

Variable	Category	SIABPD (mmHg)		Bivariable Analysis		Multivariable Analysis	
		<10	≥10	P-value	COR (95% CI)	P-value	AOR (95% CI)
SBP	Mean ±SD	113.87±11.45	118.80±17.39	.132	1.03(.991,1.070)	.082	1.036(0.996, 1.079)
BMI	18.5-24.9	46	8		1		1
	<18.5	13	2	.885	.885(.167, 4.687)	.980	1.023(.169, 6.196)
	25-29.9	13	8	.032	3.538(1.112, 11.257)	.056	3.240(0.969, 10.836)
	≥30	9	2	.778	1.278(.232, 7.038)	.473	1.919(.324, 11.371)
ABI	≤0.9	10	6	.061	3.043(.951, 9.737)	**.037***	**3.615**(1.080,12.095)
	>0.9	71	14		1		1

Notes: ** Statistically significant. SIABPD= systolic inter-arm BP difference AOR= adjusted odds ratio; COR= crude odds ratio; CI= confidence interval; 1= reference. ABI= ankle brachial index,

Diastolic BP, waist circumference, and total cholesterol were factors associated with DIABPD in bivariable analysis in non-hypertensive participants. So, they were the candidate variables for multivariable logistic regression analysis. However, none of them were significantly associated with DIABPD (**Table 9**).

Table 9: Factors associated with DIABPD among non-hypertensives at JMC, Jimma, Ethiopia, 2021

Variable	Category	**DIABPD** (mmHg)		**Bivariable Analysis**		**Multivariable Analysis**	
		<10	≥10	P-value	COR (95% CI)	P-value	AOR (95% CI)
DBP	Mean ±SD	79.46 ±7.44	84.03 ±3.586	.099	1.119 (0.979, 1.278)	.074	1.150 (.986, 1.345)
WC	Normal Abnormal	77 16	5 3	.174	1 2.887 (0.626, 13.326)	.299	1 2.337 (.471, 11.604)
TC	Mean ± SD	162.645 ±39.122	186.175± 54.472	.125	1.014 (.996, 1.033)	.078	1.017 (.998, 1.036)

Notes: ** Statistically significant. DIABPD= diastolic inter-arm BP difference AOR= adjusted odds ratio; COR= crude odds ratio; CI= confidence interval; 1= reference. TC= total cholesterol, WC= waist circumference, WC abnormal >94cm for males and >80cm for females.

5.5 Correlation of Inter-arm BP difference and Framingham risk score

In this study there was a statistically significant positive correlation between systolic IABPD and Framingham risk score (FRS); However, there was no statistically significant correlation between DIABPD and FRS. The analysis was done by the Pearson correlation test (**Table 10**).

Table 10: Correlation of inter-arm BP difference with FRS among study participants at JMC, Jimma, Ethiopia, 2021.

Variable	**SIAD in mmHg**		**DIAD in mmHg**	
	r value	p value	r value	P value
FRS in %	0.529	<0.001*	0.130	0.066

Note: *statistically significant, FRS= Framingham risk score, SIABPD = systolic inter-arm difference in BP, DIABPD= diastolic inter-arm difference in BP, r = Pearson's correlation coefficient.

CHAPTER SIX: DISCUSSION

This research is the first study in Ethiopia, which tried to offer insight on the prevalence of inter-arm BP difference and its associated factors among hypertensive patients. The prevalence of IABPD was significantly higher in hypertensive groups than the non-hypertensive control groups which might be due to arterial stiffness, which occurs as a result of structural changes in large arteries by elevated blood pressure(34).

The overall prevalence of SIABPD among study participants (total population) was found to be 26.2% [95% CI: 19.8, 32.2]. This result was in line with other studies conducted so far. It was in line with studies done in Israel (23.1%) (35), in Korea (23%) (29) & (23.4%) (36), and Nigeria (24.2%) (14). However, the finding of the current study was lower than studies done in British (38%) (37), Ireland 40.3% (39), France 34% (38), and India 43.5% (5). The possible reason for such discrepancies might be the difference in socio-demographic characteristics, study population, sample size, study design, the apparatus, and the number of times BP was measured. In contrast, it was higher than studies conducted in China 13.9% &14.3%(1,30). The differences were might be due to study populations, and the method used to measure BP (sequential or simultaneous).

The overall prevalence of DIABPD among study participants was 12.9% [95% CI: 8.4, 17.8]. This result was similar to a study done in Israel 17% (35). However, the result of this study was lower than studies done in Ireland 19.3%(39), and Nigeria 18.8%(14). These might be due to socio-demographic characteristics, sample size, and the number of times BP was measured. On the other hand, the finding of this study was higher than studies conducted in China 4.4%(1), and Korea 3.02%(49). Justification for such variations might be study population, clinical status, and the method used to measure BP.

Magnitude of SIABP among hypertensive patients was 32.7% [95% CI: 22.8, 42.6]. This result was consistent with other studies conducted in UK 26%(41), Nigeria 35.7%(14), and India 31%(19). However, it was lower than studies done in Korea (43.6%)(29) and India 58%(5). These might be due to socio-demographic cxcs, sample size, and the number of BP measurements. In contrast, our study finding was higher than studies done in China (19.4%)(30), the USA (18.2%)(42), and Mexico (13.5%)(43). Clinical status, and the method used (i.e sequential or simultaneous) to measure IABPD were the possible justifications for the discrepancies.

DIABPD was found in 17.8% [95% CI: 10.9, 25.7] of hypertensive patients. It was in line with a study done in Nigeria which reported 20.9%(14). The finding of the current study was higher than studies conducted in the USA (2.8%) (42), UK (6%) (41), and Mexico (5.4%)(43). Such discrepancy might be due to differences in co-morbid disease status, and the method used to measure IABPD.

The prevalence of SIABPD among non-hypertensive groups was 19.8% [95% CI: 11.9, 27.7]. This result was similar to other studies conducted previously. Accordingly, studies conducted in India 15.4%(44), USA 14%(42), Nigeria 18%(14), China 14.3%(30), and Mexico 18.7%(43). However, the result of our study was lower than three studies done in India 29%(27), 40%(5), and 46%(12). The possible reason for the differences might be socio-demographic characteristics, the clinical status of respondents (such as those who had CVD were included in some of them), sample size, and the number of BP measures. On the other hand, our study finding was higher than other studies done in Korea (8.8%)(29), and the UK (7.6%)(40). These differences were might be due to clinical status, and the method used to measure BP (sequential method was used in this study).

The magnitude of DIABPD among non-hypertensive respondents was 7.9% [95% CI: 3.0, 13.9]. This result was consistent with studies in Mexico (3.8%) (43), and Nigeria (12%) (14). However, this finding was higher than studies conducted in the USA (2.5%)(42) and, India (1.7%)(44). The justification for such discrepancy might be due to differences in study design, clinical status (due to high mean BMI), and the method used.

In this study, the mean systolic and diastolic BP were significantly ($P < .001$) higher on the right arm. This finding was supported by other studies conducted in India (12,27), Nigeria(14), and Korea (37). In contrast to this, SBP was significantly higher on the left arm in a study done in China (20). A systematic review in the UK found that there was no clear evidence in favor of a higher BP on the right arm than the left arm(78). Therefore, the findings that BP is frequently higher in one arm had no clinical significance because there is still a chance of having a higher BP in any of the arms (14). BP should be checked in both arms without choosing which arm to measure is a key part of cardiovascular risk assessment to detect and manage elevated BP(2). Hence, the probability of having a higher blood pressure in either of the arms further justifies the recommendation of guidelines, which states BP should be measured in both the right and left arm at the initial visit (15–18).

In this study, DM was significantly associated with SIABPD in hypertensive patients. Other studies conducted in Korea (29), Nigeria (14), and France(38) supported this association. DM was also one of the independent predictors of DIABPD which was in line with other studies in Nigeria (14), and Korea (47). A study in Japan showed that Patients with significant SIABPD and DIABPD were more likely to have diabetes and suggested that IABPD might be a novel risk marker for subclinical atherosclerosis in DM patients (45). A study done in Korea suggested systolic IABPD could be considered a surrogate marker for vascular complications of type 2 DM (49). The possible explanation might be due to structural alterations in the large arteries as a result of diabetes and hypertension. Duration of diabetes may be the possible factor that causes calcification of arteries, resulting in arterial stiffness that differs between upper arms and arterial stiffness has been proposed as one of the causes of inter-arm BP difference (9,34).

Systolic BP was one of the independent predictors of SIABPD in multivariable logistic analysis in hypertensive patients. This was consistent with several other studies. Accordingly, it was similar to studies done in France (38), Japan (45), Italy (34), China (20), and others (26,29,33). In addition, DBP was significantly associated with DIABPD in this study, which was similar to other studies conducted in Korea (33,47). Sustained elevated BP compromises the vascular bed and causes arterial stiffness as a result of damage to the elastic fibers, thus reflecting a possible justification for the occurrence of IABPD in these high cardiovascular risk individuals (48).

ABI was one of the independent predictors of systolic inter-arm BP difference among hypertensive patients. This was consistent with other studies conducted in China (30,55), France (38), Japan (45), and UAS(57). In addition, lower ABI (≤ 0.9) was significantly associated with SIABPD in non-hypertensive respondents. This was supported by a study done in China in which ABI was associated with SIABPD after excluding hypertensive patients(55). A possible pathophysiological mechanism might be IABPD beyond physiologic difference is considered as a marker for atherosclerosis(45). Atherosclerosis decreases the blood perfusion to the lower extremities and an increase in arterial wall stiffness, contributing to decreasing ABI and arterial distensibility, and then finally progressed to left ventricular hypertrophy. On the reverse, left ventricular hypertrophy decreases the cardiac output, which further exacerbates deficiency of blood perfusion to extremities and enhances the progression of peripheral arterial disease, and increased systolic interarm blood pressure difference(19).

BMI was independently associated with SIABPD in multivariable logistic analysis in hypertensive patients. This finding was supported by other studies done in Korea (36), China(55), the USA (60), and others (26,47). In addition, in this study waist circumference was one of the significantly associated factors for DIABPD. Studies conducted in Korea (47) and the USA (58) supported this finding. A study in India found that people who were obese/overweight were significantly at risk of having DIABPD (5). A study in the United States showed respondents with high IABPD had more adiposity than those with low IAD in BP. Being in the highest category of adiposity measure doubled, tripled, or quadrupled the risk of having high IABPD compared to the lowest category(58).

The possible explanation might be obese people are more likely to have hypertension as well. Obesity is linked to increased blood viscosity, which raises peripheral resistance and contributes to obesity-related arterial blood pressure changes (59). Therefore, the risk of inter-arm BP difference was higher in obese individuals through this mechanism(30).

Total cholesterol was significantly associated with DIABPD among hypertensive patients in this study, which is similar to a study conducted in Korea (26). Atherosclerotic changes in blood vessels may be the cause for inter-arm BP difference(26) and elevated total cholesterol causes a buildup of fatty plaques in arteries which leads to atherosclerosis (62). Therefore, this might be the possible justification for the association of elevated total cholesterol with DIABPD.

In this study, there was a statistically significant positive correlation between systolic IABPD and Framingham risk score (FRS) ($r=0.529$, $p < .001$). The finding of the current study was supported by other studies conducted in Korea (26,33) and the UK(9). Therefore, the correlation between SIABPD and FRS suggests that systolic inter-arm blood pressure difference may predict the future cardiovascular disease risk.

Limitation of study

i. Inability to establish a cause and effect relationship due to cross-sectional study design.
ii. This study was a single-center study. Thus it doesn't represent general population
iii. Arterial imaging such as pulse wave velocity was not performed to see whether the study participants had arterial problems (i.e arterial stiffness).
iv. Respondents with chronic diseases such as heart disease and chronic renal failure were excluded by history without doing investigations due to financial constraints.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The prevalence of systolic and diastolic inter-arm BP difference among hypertensive patients was significantly higher than that of non-hypertensive control groups.

The factors significantly associated with systolic IABPD in hypertensive patients in multivariable logistic analysis were systolic BP, diabetes mellitus, BMI, and ABI (ankle-brachial index). The factors independently associated with diastolic IABPD among hypertensive respondents were DM, waist circumference, diastolic BP, and total cholesterol. Hence, hypertensive patients who had comorbid DM, obesity, PAD (which was determined by ABI ≤ 0.9), and elevated total cholesterol should be further investigated for inter-arm blood pressure differences.

Systolic inter-arm blood pressure difference was significantly correlated with Framingham cardiovascular risk score (FRS), which is one of the standard cardiovascular risk assessment tools. Therefore, additional studies are required to verify that systolic inter-arm blood pressure differences may predict future cardiovascular risk.

7.2. Recommendation

For Federal Ministry of Health of Ethiopia:

- To integrate dual-arm blood pressure measurement as a routine clinical in every health care system including primary health care.
- To encourage large-scale longitudinal studies to clarify the clinical significance of inter-arm blood pressure difference.

For Jimma university medical center:

- Health care providers should measure blood pressure in both arms and make it a part of routine clinical practice.
- Physicians should further investigate Hypertensive patients with an inter-arm blood pressure difference of ≥10 mmHg.

For researchers:

- Better to do further study with relatively strong study designs like cohort to explore the prevalence of Inter-arm blood pressure difference and its associated factors

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Annex I: Informed Consent

How are you! My name is_____ I am working as a data collector for study conducted by Mr. Hassen Chakisso. He is a postgraduate student of Jimma University in the Department of Biomedical Sciences, and now, he is on research with the title of assessment of interarm blood pressure difference and its associated factors among hypertensive patients at JMC. So, for this research now I am a data collector and you are selected to participate in this study. Therefore, your participation in this study is critical for assessing inter-arm BP differences and associated factors. So, we kindly request you participate in this study. However, your participation in this study is based on your interest and you have full right to refuse at any time. Your refusal doesn't affect the service that you will get from Hospital in any way. The interview will take around 25 minutes. By going through the study, you will know your BP status, inter-arm BP difference, lipid profile, blood sugar level, and other anthropometric parameters of yourself. Moreover, you will know your Framingham ten-year CVD risk score and will be linked to the cardiac clinic if further investigation is needed.

The following are information, that will help you to decide whether to participate or not in this study.

Objective of the study: the objective of this study is to assess inter-arm BP differences and associated factors among hypertensive patients at JMC, southwest, Ethiopia.

Procedures to be carried on: you will be asked some questions related to Inter-arm BP difference and associated factors. Also, some physical measurements and a blood sample will be taken.

Risk: there is no risk related to this studies' procedure.

Expected benefit: this study ensures whether there is a significant inter-arm BP difference and what are the associated factors to it to recommend to responsible bodies for developing preventive measures. If there is a significant inter-arm BP difference, you will be linked to respective bodies for further investigation. Therefore, you will be benefited from the results obtained.

Termination of study: you have full right to withdraw from the study at any time.

Privacy and Confidentiality: The information you provided will be kept in a highly confidential manner and your personal information and identifiers will not be disclosed on the questionnaire and anywhere in the document. An identification code will be given to you, so no one can know your personal information. If you want to know your result you can check it by using your code number.

Person to contact: If you have any questions, please feel free to ask at any time. If you want to ask a further clarification on the study you can contact Mr. Hassen Chakisso, the principal investigator of this study at any time.

Tel phone number: +251925656706

Email address: hassenchakiso@gmail.com

Consent form

The investigator has explained information briefly about the study to me. I understood the objective of the study. The information given will serve only for this study, not for any other purpose. It has also been briefly explained to me that I have the right to stop participation at any time and there is nothing I will lose if I refuse to participate. I agree to participate in the study and I approve my agreement with my signature.

Code no_____

Signature of study participant _____

Name of data collector_____ Signature _____

Date of data collection _____ / _____ / _____

(DD/ Month/ Year)

Annex II: Questionnaire (English)

PART I: Questions related to Socio-demographic characteristics of the respondents

No	Questions	Response categories	Remark
01	Sex of respondent	1. Male 2. Female	
02	Age of respondent	_____ (In year)	
03	What is your Marital status	1. Single/never married 2. Married 3. Others	
04	Where is your residence?	1. Urban 2. Rural	
05	What is your educational status?	1. Illiterate 3. Primary 4 Secondary 5. College and above	
06	What is your Ethnicity?	1. Oromo 2. Amhara 3. Gurage 4. Dawuro 5. Other	
07	What is your religion?	1. Orthodox. 2. Muslim 3. Protestant 4. Catholic 5.Others, specify_____	
08	Occupational status of the respondent	1. Farmer 2. Housewife 3. Merchant 4. Gov't employee 5. Other, specify_____	
09	What is your monthly income	_____ (ETB)	
Part II: Questions related to clinical conditions/ comorbidities of the respondent			
No	**Questions**		**Responses**
01	Do you have a history of chronic illnesses like hypertension or DM?		1. Yes 2. No
02	If yes to question no 01 for how long it was since diagnosis?		_____ years
03	In the past two weeks, have you been treated for HTN?		1. Yes 2. No
04.	If yes to Question no 03, what medications do you use?		1. CCB 2. ACE inhibitors 3.Thiazide diuretics 4. ARB 5. Beta blockers
05	For how long have you used medication for Hypertension?		_____years
	Does your doctor has ever taken your BP in both your right and left arm?		1. Yes 2. No

06	Do you have a family history of hypertension?	1. Yes 2. No
07	Do you have a history of DM?	1. Yes 2. No
08	Do you have frequent hungry, thirst, and urination?	1. Yes 2. No
09	In the past two weeks, have you been treated for raised cholesterol with drugs?	1. Yes 2. No

Part III: Questions related to behavioral factors of the study participants

Tobacco use practice

No	**Questions**	**Responses**	Remarks
01	Do you have a history of smoking cigarettes?	1. Yes 2. No	
02	If yes to 01 how long since you start Smoking?	_____years	
03	If yes to 01, how often do you smoke?	1. Daily 2. 3 times per week 3. Once a week 4. Once a month	
04	On average, how many packets of cigarettes do you smoke each day/week?	_____packs	
05	Do you currently smoke tobacco products?	1. yes 2. No	

Alcohol use practice

No	Questions	Responses	Remarks
01	Do you have a history of alcohol drinking?	1. Yes 2. No	
02	How often have you had at least one standard alcoholic beverage?	1. Daily 2. 3 times per week 3. Once a week 4. Once a month	
03	On average, how many standard drinks do you consume on a single drinking occasion?	_____Drinks	
05	Do you drink alcohol currently?	1. yes 2. No	

Khat Chewing practice

No	Questions	Responses	Remark
01	Do you chew Khat?	1. Yes 2. No	
02	If yes, how often do you chew Khat?	1. Daily base 2. 3 times per week 3. Once a week 4. Once a month	
03	Do you currently chew Khat?	1. Yes 2. No	

Physical activity-related questions

No	Questions	Responses	Remark
01	Do you do any intensity physical activities that increase breathing or HR for at least 10 minutes continuously?	1. Yes 2. No	
02	In a typical week, on how many days do you do these vigorous/ moderate-intensity physical activities?	_____days	
03	How much time do you spend doing any intensity physical activities on a typical day?	_____/_____ Hrs/min	

Part IV Physical examination measurements

Blood Pressure in mmHg	Reading 1	Reading 2	Reading 3	Average	IABPD
1.Rt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SIAD_____ DIAD_____
2. Lt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	
Ankle-brachial index	Average higher leg SBP (Rt/Lt) _____		Average higher arm SBP (Rt/Lt) _____		ABI _____
Anthropometric parameters	Weight (_____) kg Height (_____) m Body mass index (BMI) (_____) Kg/m^2 Waist Circumference (_____) cm				

PART V: Laboratory investigation results

Biochemical parameters	Total cholesterol	HDL cholesterol	LDL cholesterol	Triglycerides	RBS
	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl

PART VI: Ten-year cardiovascular risk score through Framingham risk score

Framingham risk score (FRS) calculation =_____%

Annex III: Questionnaire (Oromic Version)

Odeeffannoo Waliigalaa

Akkam nagaa jirtuu? Ani maqaan koo _____yoon ta'u, barataa maastarsii (digrii lammaffaa) yuunivarsitiii Jimmaa kan ta'e Hasan Caakkisootiif odeeffannoo funaanaadha. Qoranichi waa'ee garaagarumma dhiibbaa dhiigaa irree lamaan jidduu jiru fi wantoota isaan

walqabatanii jiraniiti. Kanaafuu qorannoo kanaaf ragaa funaanaan ykn walitti qabaan jira. Yoo eeyyamamoo taatan gaafiiwwan tokko tokko wantoota garaagarumma dhiibbaa dhiigaa irree keessan lamaan jidduu jiruun walqabatan isin gaafachuu fi qorannoo qaama keessani fi dhiiga keessan fudhaachuu barbaada. Gaafii fi deebii isin wajjiin taasisu hanga daqiiqaa 25 fudhachuu danda'a. Qorannoo kanaan garaagarumma dhiibbaa dhiigaa irree keessan lamman gidduu jiru, dhiibbaa dhiigaa keessan, hamma shukkaara dhiiga keessani, fi wantoota birooo ulfaatina, hamma cooma isin qabdanii kkf ni beektu. Qorannoo kannaf hirmaachuun keessan wantoota dhibee oneetifi dhiibbaa dhiigaatiif sababa tahan addaan baasanii beekuuf ummata hospitaala kanaatiifi ummata magaala Jimmaatiif baayee barbaachisaa. Garuu hirmaannaan keessan fedhii keessaniin kan murtaayee fi hirmmachuu diduuf mirga guutuu qabdu. Hirmaachuu diduu keessaniif tajaajila hospitaala kanarraa kanaan dura argattan irraa wanta isin jalaa hir'isu hin qabu.

Ragaan isin nuuf kennitan icciiti cimaadhaan kan eeggamuufi wanti eenyuummaa keessan ibsu gaafi fi deebii kanarratt hin ibsamne. Dhumarratti ragaa qorannoo keessanii beekuu yoo barbaaddan koodii icciiti isiniif kenninuun beekuu dandeessu. Namoonni hundinuu kan raga isinirra funaananiifi qorannoo dhiigaakeesani kan labooratoritti dalagan eenyumma keessan beekuu hin dandahan.

Gaafii fi deebii taasisuuf eeyyamamoodha? Eeyyan Lakki

Guca walii galtee

Haaluma ragaa funaanaan waa'ee qorannichaa naaf ibseen kaayyoo qorannichaa hubadheera. Mirga yeoo kamuu hirmachuu fi diduus akkan qabu akkasumas waan dideef wal'aansa koorra wanti ga'u akka hin jires hubadheera. Haaluma kanaan qoranicharratti fedhii kootiin hirmaachuuf walii galuu mallatoo kootiin nan mirkaneessa.

Lakk. koodii _____

Mallattoo hrmaataa _____

Maqaa ragaa funaanaa _____ Mallattoo _____

Guyyaa ragaan itti funaanamu---------/----------/----------

Gaafii:

PART I: Gaafii waayee hawaasummaa Hirmaatootaa ilaalchisee

Lakk.	Gaafii	Deebii	Yaada
01	Saala	1. Dhiira 2. Dhalaa	
02	Umrii	_____ (Waggaadhaan)	
03	Gaa'ila	1. Hin fuune/hin heerumne 2. Fuudheera ykn heerumera 3. Hiikera/gargar baheera 4.Abbaan manaa / haati mana koo du'aan boqotabiiru	
04	Eessa jiraattu?	1.Magaala 2.Baadiyyaa	
05	Barumsa hanga meeqaa barattaniirtu?	1. Barumsa idilee kan hin baratin 2. sadarkaa tokkoffaa(1-8) 3. Sadarkaa lammaffa(9-12) 4. kolleejjii fi isaa ol	
06	Sabni keessan maali??	1. Oromoo 2. Amaara 3. Guraage 4. Dawuro 6. Kan biro	
07	Amantiin keessan maali?	1. Ortodoksii. 2. Muslima 3. Protestantii 4. Catolikii 5. Kan biroo,_____	
08	Hojiin keessan maali?	1.Qotee bulaa 2. Haadha manaa 3. Daldalaa 4.Hojjataa mootumma 5. Hojjataa guyyaa 6. Kan biroo_____	
09	Galiin ji'aan argattan meeqa?	_____ (ETB)	

Part II: Gaafii waayee Fayyaa qaamaa fi dhukkuboota biro ilaalchisee		
01.	Kanaan dura dhibbewwan tutturoo kan akka dhibee dhiibba dhiigaatiin qabamtanii beektuu?	1. Eeyyen 2. Lakki
02.	Yoo gaafii tokkoffaaf deebiin eeyyan tahe,hanga yoomiitt erga qoratamtanii?	_____Waggadhaan

03.	Toban darban lamaaf qoricha dhiibbaa dhiiga kan doktoraan ykn ogeessa fayyaa biroon ajajame fudhattaniirtuu?	1. Eeyyen 2. Lakki
04	Yoo gaafii tokoffaf deebiin eeyyan tahe qoricha gosa kami fudhattan?	1. CCB 2. ACE inhibitors 3. Thiazide diuretics 4.Angiotensin receptor blockers 5. Beta blockers
05	Hanga yoomiitt fudhattan qoricha dhiibba dhiigaa?	_____/_____Baatii/Waggaa
	Doktorri keessan dhiibba dhiigaa irree mirgaa moo bitaarra fudhata?	1.Eeyyee 2. Lakki
06	Maatii keessan keessa namni dhiibbaa dhiigaa qabu jiraa?	1. Eeyyen 2. Lakki
07	Shukaara qabamtanii beektuu?	1. Eeyyen 2. Lakki
08		
09	Torban darban lamaan, Kollestioolii qoricha hir'isu fudhattanii jirtuu?	1. Eeyyen 2. Lakki

Part III: Gaafii waayee amala araadaa fi naamusaa ilaalchisee

Araada tamboo xuuxuu ykn aarsuu

Lakk	Gaafii	Deebii	Yaada
01	Kanaan dura araada tamboo xuuxuu ykn aarsuu qabduu?	1. Eeyyen 2. Lakki	
02	Deebiin eeyyan yoo tahe, hangam ture erga jalqabdanii?	**_____waggaadhaan**	
03	Deebiin eeyyan yoo tahe, si'a meeqa aarsitu?	1. Guyyaa guyyaan 2. Torbaniitt al-sadi 3.Torbaanitt al-tokko 4. Ji'atti al-tokko	
04	Jidduugaleessaan siigaara paakkeettii meeqa guyyatti ykn toraabitt aarsitu ykn xuuxxu	_____paakkettii	
05	Amma araada tamboo xuuxuu qabduu?	1. Eeyyen 2. Lakki	

Gaafii waayee Araada dhuugaatii fayyadamuu

Lack.	Gaafii	Deebii	Yaada
01	Kanaan dura dhuugaatii dhugdanii beektuu?	**1.** Eeyyen 2. Lakki	
02	Si'a meeqa yoo xiqqaate dhugaati sadarkaa isaa eeggate fayyadamtu?	1. Guyyaa guyyaan 2. Torbaniitt al-sadi 3.Torbaanitt al-tokko 4. Ji'atti al-tokko	

03 04	Jidduu galeessan dhugaatii sadarkaa isaa eeggate si'a tokko fayyadamtu? Amma dhugaatii fayyaamtuu?	**_____Dhugaatii** 1. Eyyen 2. Lakki	
Araada jimaa fayyadamuu			
Lakk.	Gaafii	Deebii	**Yaada**
01	Kanaan dura Jimaa qamaatuu?	1. Eeyyen 2. Lakki	
02	Deebiin 1ffaa Eeyyan yoo tahe si'a meeqa fayyadamtu?	1. Guyyaa guyyaan 2. Torbaniitt al-sadi 3.Torbaanitt al-tokko 4. Ji'atti al-tokko	
03	Amma Jimaa qamaatuu?	1. Eeyyen 2. Lakki	
Gaafii shaakkallii qaamaa ilaalchisee			
Lakk.	Gaafii	Deebii	**Yaada**
01	Shaakkallii qaamaa hargansuu keessan dabalu yookiin dhahanna onnee keessanii dabaluu yoo xiqaate daqiiqaa 10 dalagdanii beektuu ?	1. Eeyyen 2. Lakki	
02	Torabanitt al-meeqa shaakalli qaama hojjattan?	_____guyyatti	
03	Guyyatti Shaakkallii qaamaa sa'aa meeqaaf hojjattu?	_____/_____sa'aa/daqiiqaa	

Part IV: Physical examination measurements

Blood Pressure in mmHg	Reading 1	Reading 2	Reading 3	Average	IABPD
1.Rt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SIAD__ ____ DIAD_ ____
2. Lt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	
Ankle-brachial index	Average higher leg SBP (Rt/Lt) _____		Average higher arm SBP (Rt/Lt) _____		ABI _____
Anthropometric parameters	Weight (_____) kg Height (_____) m Body mass index (BMI) (_____) Kg/m^2 Waist Circumference (_____) cm				

PART V: Laboratory investigation results

Biochemical parameters	Total Chol	HDL chol	LDL chol	Triglycerides	RBS
	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl

PART VI: Ten-year cardiovascular risk score through Framingham risk score

*Framingham risk score (FRS) calculation =*_____%

Annex IV: Questionnaire (Amharic Version)

አባሪ ii - መረጃ ሰጪ ስምምነት

እንዴት ናችሁ! ስሜ _____ አሁን በሀሰን ጫኪሶ ለምሰራው ምርምር መረጃ እየሰበሰብኩ ነው ። እሱ የጅማ ዩኒቨርስቲ ፊዚዮሎጂ ትምህርት ክፍል የድህረ ምረቃ ተማሪ ነው። በ ሁለት እጆች መካከል ያለውን የደም ግፊት እና ተያያዥ መንሳኤዎች በምለው ርእስ ምርምር በደም ግፊት ታካሚዎች ላይ እያደረገ ነው ። ስለዚህ ፣ ለዚህ ምርምር አሁን በጂማ ዩኒቨርሲቲ የሕክምና ማዕከል ውስጥ በደም ግፊት ታካሚዎች ላይ መረጃ እየሰበሰበ ነው ። እርስዎ ፈቃደኛ ከሆኑ ፣ በ ሁለት እጆች የደም ግፊት ልዩነት ጋር የተያያዙ አንዳንድ ጥያቄዎችን እጠይቃለው። አንዳንድ አካላዊ ምርመራ እና የደም ናሙና እወስዳለሁ። ቃለ ምልልሱ ወደ 25 ደቂቃዎች አካባቢ ይወስዳል። በጥናቱ መጨረሻ የእርስዎን -የሁለት እጅ የደም ግፊት ልዩነት ፣ የኮሌስትሮል መጠን፣ የደም ግፊት ፣ የደም ስኳር መጠን ፣ ሲስቶልክ የደም ግፊት ከቁርጭምጭሚት ወደ ክንድ ያለዉን ክፍልፋይ እና ሌሎች የሰውነት ስብጥር መለኪያዎችን ያውቃሉ። በእኔ ጥናት ውስጥ የእርስዎ ተሳትፎ ለሁለት እጅ የደም ግፊት ልዩነት እና ተያያዥ ነገሮችን ለማጥናት በጣም ወሳኝ ነው። ይሁን እንጅ ፣ በጥናቴ ውስጥ የእርስዎ ተሳትፎ በፍላጎትዎ ላይ የተመሠረተ እና እምቢ የማለት ሙሉ መብት አለዎት። እምቢታዎ በማንኛውም መንገድ ከሆስፒታል በሚያገኙት አገልግሎትዎ ላይ ተጽዕኖ አያሳድርም።

የሰጡት መረጃ በከፍተኛ ሚስጥራዊነት ይያዛል ፣ እና ማንኛውም የግል መለያዎችዎ በመጠይቁ ላይ አይሰፍሩም። የእርስዎን ውጤት ማወቅ የሚፈልጉ ከሆነ የሚሰጥዎትን የሚስጥር ኮድ ቁጥር በመጠቀም የራስዎን ውጤት መመልከት ይችላሉ። የላቦራቶሪ ውጤቱን የሚተነትኑ ባለሙያዎች ራሱ የእርስዎን የግል መለያዎችን ማዎቅ አይችሉም።

መጠይቁን ለመቀጠል ፈቃደኛ ንዎት? አዎ ☐ ☐

የስምምነት ቅጽ:

መረጃ ሰብሳቢው ስለ ጥናቱ ዓላማ በደንብ አስረድቶኛል። በጥናቱ ላይ የመሳተፍና ያለመሳተፍ ሙሉ መብት እንዳለኝ ነግሮኛል፣ እናም በፈለግኩት ግዜ ማኮም እና እምቢ ካልኩኝም በማገኘው አገልግሎት ላይ ምንም ተጽኖ እንደሌለው አስረድቶኛል። በጥናቱ ላይ ለመሳተፍ ፍቃደኛ ነኝ። ፍቃደኝነቴን በፍርማዬ አረጋግጣለው።

የተሳታፊው ፍርማ_____

መረጃ ሰብሳቢ ስምና ፍርማ_____

መረጃ የሰበሰበበት ቀን ___ / ___ / ____ (ቀን / ወር / ዓመት) መለያ ቁጥር ____

አባሪ III - መጠይቅ

ክፍል I- ከማህበራዊ-ስነሕዝብ ባህሪያት ጋር የተያያዙ ጥያቄዎች

ቁጥር	ጥያቄዎች	ምላሽ	
01	ጾታ	1. ወንድ 2. ሴት	
02	ዕድሜ	_____ (በዓመት)	
03	የጋብቻ ሁኔታዎ	1. ያላገባ/ች 2. ያገባ/ች 3. ሌላ	
04	የመኖሪያዎ ቦታ	1. ከተማ 2. ገጠር	
05	የ ትምህርት ደረጃ	1 መደበኛ ትምህርት ያልተማረ/ች 2. የመጀመሪያ ደረጃ 3 ሁለተኛ ደረጃ 4. ኮሌጅ እና ከዛ በላይ	
06	ብሄር	1. ኦሮሞ 2. አማራ 3. ጉራጌ 4. ዳውሮ 5. ሌላ	
07	ሃይማኖት	1. ኦርቶዶክስ 2. ሙስሊም 3. ፕሮቴስታንት 4. ካቶሊክ 5. ሌላ ፣ ይግለፅ ___	
08	የስራ ሁኔታ	1. ገበሬ 2. የቤት እምቤት 3. ነጋዴ 4. የመንግስት ሰራተኛ 5. ሌላ ፣ ይግለፅ ____	
09	ወርሃዊ ገቢ	_____(በኢትዮጵያ ብር)	

ክፍል II - ከደም ግፊት እና ተዛማጅ በሽታዎች ጋር ተያያዥ ጥያቄዎች

01.	ደም ግፊት እና ስካር በሽታ አለብዎት?	1. አዎ 2. አይደለም
02.	በምርመራ ከታዎቀ ጊዜ ጀምሮ ለደም ግፊቱ ምን ያህል ጊዜ ሆኖታል?	_____ ዓመታት
03.	ባለፉት ሁለት ሳምንታት ውስጥ ለደም ግፊት መድኃኒቶችን ወስደዋል?	1. አዎ 2. አይደለም
04	ለጥያቄ ቁጥር 03 አዎ ከሆነ ምን ዓይነት መድሃኒት ይዎስዱ ነበር?	1. CCB 2. ACEI 3. Thizide diuretics 4. ARB 5. BB
05	ለደም ግፊት መድሃኒት ከጀመሩ ምን ያህል ጊዜ ሆነ?	____/____ ዓመት
	በማንኛውም ጊዜ ሐኪሙ ወይም ሌላ የጤና ባለሙያ ደም ግፊትዎን በሁለቱም ክንድ ወስዷ ያውቃል?	1.አዎ 2. አይደለም
06	ከቤተሰብ የደም ግፊት ያለው አለ?	1. አዎ 2. አይደለም
07	ከዚህ በፍት ስካር በሽታ አለብዎት?	1. አዎ 2. አይደለም
08	ከፍተኛ የሆነ የረሃብ፤ ጥማት እና ቶሎቶሎ የመሽናት ባህሪ አለብዎት?	1. አዎ 2. አይደለም

09	ባለፉት ሁለት ሳምንታት ውስጥ የኮሌስትሮል መጠን የሚቀንስ መድሃኒት ይዎስዱ ነበር?		
ክፍል III - ከጥናት ተሳታፊዎች ስነ_ባህሪ ጋር ተያያዥ ጥያቄዎች			
ከትንባሆ አጠቃቀም ጋር ተያያዥ ጥያቄዎች			
ቁጥር	ጥያቄዎች	ምላሽ	አስትያያት
01	ሲጋራ ኣጭሰህ ታዉቃለህ/ሽ?	1. አው 2. አይደለም	
02	ለ 1ኛ ጥያቄ መልስዎ አዎ ከሆነ, ምን ያህል ጊዜ ያጨሳሉ?	1. በየቀኑ 2. በሳምንት 3 ጊዜ 3. በሳምንት አንድ ጊዜ 4. በወር አንድ ጊዜ	
03	በኣማካይ በየቀኑ/በሳምንት ስንት ሲጋራዎችን ያጨሳሉ?	_____ፓኮ	
04	በአሁኑ ጊዜ ትንባሆ/ሲጋራ ያጨሳሉ?	1.አው 2. አይደለም	
ከአልኮል አጠቃቀም ጋር ተዛማጅ ጥያቄዎች			
ቁጥር	ጥያቄዎች	ምላሽ	አስትያያት
01	የአልኮል መጠጥ ጠጥተው ያዉቃሉ?	1. አዎ 2. አይደለም	
02	በምን ያህል ጊዜ ነው ቢያንስ አንድ መደበኛ የአልኮል መጠጥ የምትዎስደው?	1. በየቀኑ 2. በሳምንት 3 ጊዜ 3. በሳምንት አንድ ጊዜ 4. በወር አንድ ጊዜ	
03	በአንድ የመጠጫ ጊዜ ምን ያህል መደበኛ የአልኮል መጠጥ ነው የምትዎስደው በአማካይ?	_____መጠጥ	
05	በአሁኑ ጊዜ አልኮል ይጠጣሉ?	1. አው 2. አይደለም	
ከጫት ጋር የተያያዙ ጥያቄዎች			
ቁጥር	ጥያቄዎች	ምላሽ	አስትያያት
01	ጫት ቅመህ ታውቃለህ/ሽ?	1. አው 2. አይደለም	
02	ለ1ኛ ጥያቄ መልስዎ አዎ ከሆነ ጫት ምን ያህል ጊዜ ትቅማለህ/ሽ?	1 በየዕለቱ 2. በሳምንት 3 ጊዜ 3. በሳምንት አንድ ጊዜ 4. በወር አንድ ጊዜ	
03	በአሁኑ ጊዜ ጫት ትቅማለህ/ሽ?	1. አው 2. አይደለም	
ከአካላዊ እንቅስቃሴ ጋር ተዛመጅ ጥያቄዎች			
ቁጥር	ጥያቄዎች	ምላሽ	አስትያያት
01	ትንፋሽ ወይስ የልብ ምትን የሚጨምሩ የአካል እንቅስቃሴዎችን ያለማቋረጥ ቢያንስ ለ 10 ደቂቃ ያህል ይሰራሉ?	**1.** አው 2. አይደለም	

02	በተለመደው ሳምንት, ስንት ቀን የአካል እንቅስቃሴዎችን ይሰራሉ?	_____ቀናት	
03	በእስፖርት ቀን የአካል እንቅስቃሴዎችን እየሰሩ ምን ያህል ጊዜ ያሳልፋሉ?	___/__ሰዐት/ደቂቃ	

Part IV: Physical examination measurements

Blood Pressure in mmHg	Reading 1	Reading 2	Reading 3	Average	IABPD
1.Rt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____ DBP_____	SIAD_____ DIAD_____
2. Lt arm Blood Pressure	SBP_____ DBP_____	SBP_____ DBP_____	SBP_____DBP_____	SBP_____ DBP_____	
Ankle-brachial index	Average higher leg SBP (Rt/Lt) _____		Average higher arm SBP (Rt/Lt) _____		ABI _____
Anthropometric parameters	Weight (_____) kg Height (_____) m Body mass index (BMI) (_____) Kg/m^2 Waist Circumference (_____) cm				

PART V: Laboratory investigation results

	Total Chol	HDL chol	LDL chol	Triglycerides	RBS
Biochemical parameters	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl	_____mg/dl

PART VI: Ten-year cardiovascular risk score through Framingham risk score

*Framingham risk score (FRS) calculation =*_____%

Annex VI: Declaration

Assurance of principal investigator

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.

Name: _____

Signature: _____

Name of the institution: _____

Date of submission: _____

This thesis has been submitted with my approval as a university advisor

Name and signature of the first advisor

_____

_____

Name and signature of the second advisor

_____

_____

Approval of the internal examiner

Name and signature of the internal examiner

_____

_____