ADDIS ABBABA UNIVERSITY
CHOLEGE OF HEALTH SCEINCES
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DEPARTMENT OF MEDICAL BIOCHEMISTRY

ESTIMATION OF SERUM HIGH SENSITIVITY C-REACTIVE PROTEIN AND SERUM LIPID PROFILE AMONG HYPERTENSIVE PATIENTS: A CROSS SECTIONAL STUDY AT JIGJIGA, KARAMARA GENERAL HOSPITAL, SOMALI REGIONAL STATE OF ETHIOPIA.

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This is to certify that the thesis prepared by Mohamed Ali Sugal , entitled “Estimation of serum high sensitivity C-reactive proteins and Serum Lipid profiles among Hypertensive patients”: A Cross Sectional Study at Jigjiga, Karamara General Hospital, Somali Regional State of Ethiopia, and submitted in partial fulfillment of the requirements for the degree of Master of Science in Medical Biochemistry complies with the regulations of the University and meets the accepted standards with respect to the originality and quality.

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Table of Contents

LIST OF TABLES

List of figures

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Abbreviations/acronym

ABCA1:	ATP Binding Cassette A1
BMI:	Body Mass Index
BP:	Blood Pressure
CHD:	Coronary heart disease
CVD:	Cardiovascular Disease
EDTA:	Ethylene diamine tetra acetic acid
HDL-C:	High Density Lipoprotein Cholesterol
HSCRP:	High sensitivity C -reactive protein
HTN:	Hypertension
IL-6:	Interleukins- 6
JNC:	Joint National Committee
LDL-C:	Low Density Lipoprotein Cholesterol
MCP-1:	Monocyte chemotactic protein-1
NO:	Nitric oxide
ROS:	Reactive oxygen species
TC:	Total cholesterol
TG:	Triglycerides
TPA:	Tissue Plasminogen activator
TPI:	Tissue Plasminogen inhibitor
VCAM-1:	Vascular cell Adhesion molecules
VLDL:	Very low Density Lipoproteins
WHR:	Waist to hip ratio

ABSTRACT

Introduction: Hypertension and dyslipidemia are the two most important public health anxieties in developing countries and one of the major risk factors for cardiovascular diseases. It has been reported that hypertension is in part an inflammatory disorder, and hypertensive patients have been reported for elevated levels of high-sensitivity C-reactive protein (hsCRP). Therefore, the present study is focused to estimate serum high sensitivity C-reactive protein and serum lipid profiles in hypertensive patients at Karamara General Hospital, Jigjiga Somali Regional State of Ethiopia.

Methodology: Comparative case-study was conducted from November 2017 to April 2018. A total of 100 participants, 57 hypertensive patients and 43 normal controls were recruited. Data were collected on socio-demographic factors, anthropometric measurements, blood pressure, high sensitivity C-reactive protein and lipid profiles.

Result: The serum levels of high sensitivity C-reactive protein, were significantly higher than their respective cut-off values in hypertensive patients compared to normal controls ($p<0.001$). Serum triglycerides and total cholesterol were significantly higher in hypertensive patients than in normal controls ($p<0.05$). However, the mean of low density lipoprotein and high density lipoprotein showed significantly no difference in both hypertensive and normal control participants. High sensitivity C-reactive protein was positively correlated with triglycerides, total cholesterol, and inversely correlated with serum high density lipoproteins.

Conclusion: Our study finding may conclude that hypertensive patients in the study area have elevated high sensitivity C-reactive protein, triglycerides and total cholesterol, which may synergize in accelerating other cardiovascular diseases. Our finding may help future strategies for preventing both hypertension and dyslipidimia through proper life style change or Medical management or by the combination of both. High sensitivity C-reactive protein estimation may be recommended in evaluation of all hypertensive patients and preserve the Cardiovascular diseases.

Key words: Hypertension, HSCRP, Lipid profiles, and Anthropometric indicators.

1. Introduction

1.1. Background

Hypertension is clinically defined a state in which systolic blood pressure (SBP) is or above 140 mmHg and diastolic blood pressure (DBP) of 90 mmHg or above as shown by us eighth joint committee on detection, Evaluation and treatment of hypertension (JNC 8). Blood pressure values increases with age and mostly elevated blood pressure (BP) is commonly seen in Elderly people. It is estimated that more than 26% of the population are with hypertension worldwide. Hypertension affects approximately 25% of the adult American population (James *et al*., 2014).

Although, different risk factors have been identified for the development of hypertension (Whelton *et al*., 2002), its pathophysiologic etiology is still not fully understood in most (90%) patients (Essential or primary hypertension). This form of hypertension cannot be cured, but it can be treated or controlled. However, a small percentage of patients have a specific cause for their hypertension (10%) i.e. secondary hypertension. There are many potential secondary causes that either are concurrent medical conditions or are endogenously induced. If the cause can be identified, hypertension in these patients can potentially be cured (Dipiro *et al*., 2014).

Blood pressure of individuals can be classified into four categories: normal, pre-hypertension, stage 1, stage 2 hypertension. Pre-hypertension is not considered as a disease, but it is a designated chosen to identify individuals at high risk developing the disease or those who are likely to progress to stage 1 or stage 2 hypertension, so that both clinicians and patients are informed to this risk and encouraged to intervene and prevent or delay the disease from emerging. Classification of Blood Pressure in adults (18 years and above) is based on the average of two or more properly measured blood pressure readings from two or more clinical visits (James *et al*., 2014) (**Table 1**).

Table 1: Classification of blood pressure for adults (>18 years old) (James *et al*., 2014)

Classification	Systolic BP(in mmHg)	Diastolic BP(in mmHg)
Normal	<120	and < 80
Pre-hypertension	120-139	or 80-89
Stage 1 hypertension	140-159	or 90-99
Stage 2 hypertension	≥160	≥100

Hypertension is recognized as the "silent killer" because it typically has no warning signs or symptoms, and many people do not know they have it. Frequently, the only sign of essential hypertension is elevated blood Pressure (BP) (James *et al.,* 2014).

Different factors such as; environmental, genetic, psychosocial and inflammatory factors have been associated in the development of hypertension (Tomson and Lip, 2005). Hypertension and vascular disorders is indicated as an inflammatory disease. Inflammation of the arterial wall is associated in the development of endothelial dysfunction, which leads to hypertension (Kuklinska *et al.*, 2009).

Many recent guidelines on the diagnosis and management of hypertension focus that total CVD risk should be quantified so that the type and intensity of treatment can be tailored to the degree of overall risk rather than the level of blood pressure elevation alone. This approach maximizes the cost effectiveness of hypertension management. The starting point of this therapeutic approach is the search for, and identification of the various CVD risk factors (WHO, 2003). Hypertension is also one of the major manifestations of the group of clinical abnormalities that characterize metabolic syndrome found in 30 to 40% of hypertensive individuals (Marchi-Alves *et al*., 2012).

1.2. Literature review

1.2.1. Anthropometric indicators in relation to hypertension

As reported by several epidemiological studies from different populations there is a significant association between different anthropometric indicators and blood pressure levels (Olatunbosun *et al*., 2000, Bose *et al*., 2003, Shanthirani *et al*., 2003). Some anthropometric indexes or measures, like body mass index (BMI), and other measures of body fat distribution have been utilized in most of the studies to analyze the relation between cardiovascular risk factors and adiposity (Guagnano *et al*., 2001, Sargeant *et al*., 2002, Belahsen *et al*., 2004).

In addition, the amount of abdominal fat plays an important role in the relationship between BP and its metabolic correlates. Insulin resistance with the helper hyperinsulinemia may be the intermediate link in the association of central obesity with elevated BP. In support of this hypothesis, both central obesity and hypertension are frequently accompanied by hyper-insulinemia, glucose intolerance, and elevated levels of triglyceride (Siani *et al*., 2002, Huxley, *et al*., 2010).

Plethoras of studies have shown direct relationships between anthropometric measures and the risk of cardiovascular disease (Olatunbosun *et al*., 2000, Yekeen *et al*., 2003, (Huxley, *et al*., 2010). These associations between body fatness using different indexes have been consistently observed, but remain poorly understood and the mechanistic explanations for the phenomenon are still being debated and no biological model of the process has been established (John, 2009).

The anthropometry, and blood pressure relationship in Ethiopian subjects is not well known, while no data seems to be available on the relationship between body-fat distribution and the risk of hypertension in the same population.

1.2.2. Serum lipid profiles in relation to hypertension

Different factors increase the risk of developing hypertension, and cardiovascular disease. Elevated blood pressure (BP) is mostly regarded as the most significant underplaying cause of cardiovascular disease in the world. It is mostly related to other cardiovascular factors such as diabetes, obesity and dyslipidemia. Among this risk factors and the resulting endothelial dysfunction may play a role in the cause of hypertension (Oparil *et al*., 2003). Evidences indicate that hypertension play the same patho-physiology with cardiovascular disease (CVD). Similarly, dyslipidemia, which is strong predictors of Cardio vascular disease (CVD), can also be an important predictor of hypertension (Halperin *et al*., 2006).

Biochemically, complexes of variable proteins and lipid compositions called lipoproteins are responsible for transport of lipids throughout the body. The plasma lipoproteins are spherical Macro-molecular substances made up of lipids and specific proteins called apo-lipoproteins or apo-proteins. The lipoprotein complexes include high-density lipoproteins (HDL), low-density lipoproteins (LDL), very-low-density lipoproteins (VLDL), and chylomicrons (CM). The complexes play key roles in maintaining their component lipids soluble while they transport them in the blood and providing an efficient mechanism for transporting their lipid contents to (and from) the body tissues. In humans, the transport system is less efficient than in other animals and, as a consequence, humans are vulnerable to gradual deposition of lipid substances (dyslipidemia) especially cholesterol in body tissues. This is a potentially life-threatening occurrence when the lipid deposition contributes to plaque formation, causing the narrowing of blood vessels (atherosclerosis) (Harvey and Ferrier, 2011).

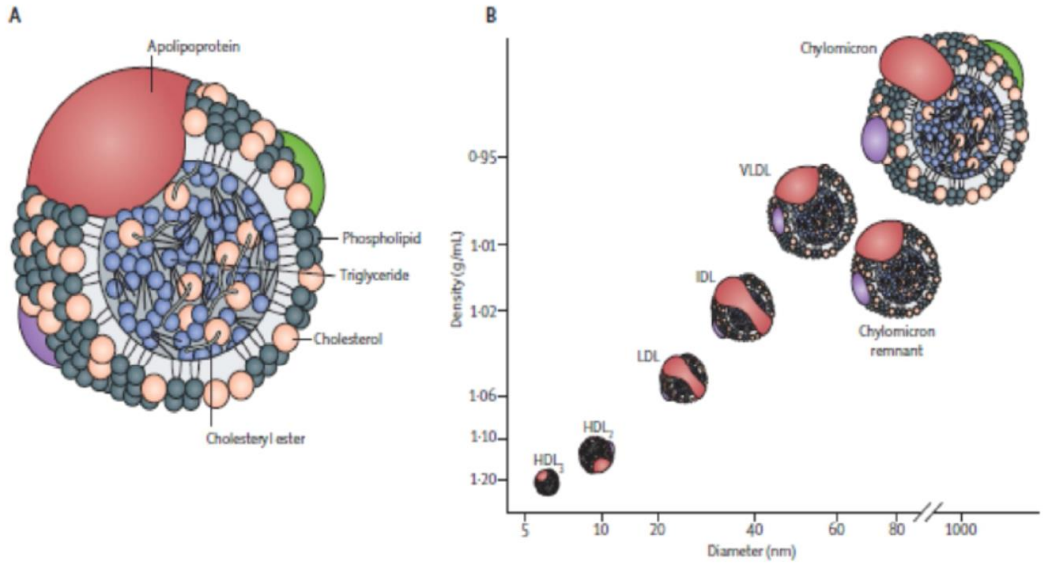

Figure 1: Showing structure and densities of lipoproteins in the blood from Braun Wald's Heart Disease: (Mann *et al.*, 2015).

Low density lipoprotein (LDL) particles, associated with the Apo-lipoprotein molecule Apo-lipoprotein B-100, contain much less triacylglycerol than their VLDL predecessors, and have a high concentration of cholesterol and cholesteryl esters. The primary function of LDL particles is to provide cholesterol to the peripheral tissues where they are internalized through the LDL receptor by receptor-mediated endocytosis. Genetic defects that result in loss of function of LDL receptor cause inherited hyperlipidemias (Mooradian, 2009, Harvey and Ferrier, 2011).

High density lipoprotein (HDL-C) contains Apo-lipoprotein A-1. Formation of HDL occurs in the liver and intestine, which both synthesize and secrete Apo A-I. Shortly after secretion as a lipid poor protein, Apo A-I interacts with the cholesterol–phospholipid transporter ABCA1 (ATP Binding Cassette A1) expressed by hepatocytes and enterocytes to acquire lipids, thereby generating a nascent HDL particle (Grummer and Carroll, 1988).

Serum lipid profiles are measured for cardiovascular risk prediction and have now become almost a routine test. The test includes four basic parameters: total cholesterol (TC), triglycerides (TG), HDL-cholesterol and LDL-cholesterol. Worldwide, there is broad variation in serum lipid profile patterns among different population groups. Increased serum levels of TC, TG, and

decreased serum HDL level are known to be associated with major risk factors for CVD. There is a strong relationship between TC concentrations and CVD events (Choudhury *et al.*, 2014).

Plethora of studies have prospectively examined if increased lipid levels are correlated with afterward development of hypertension in middle age adults. In most studies, high-density lipoprotein cholesterol (HDL-C) levels show an independent and inverse relation with the development of hypertension (Halperin *et al.,* 2006, Simone *et al*., 2006, Laaksonen *et al*., 2008). Increased triglycerides levels (Laaksonen *et al.,* 2008), higher total cholesterol (TC) (Sesso *et al*., 2005) and none increased HDL-C have been found to be associated with an increased risk of hypertension in some studies, but not in all (Simone *et al*., 2006).

1.2.3. Serum high sensitivity C-reactive protein with respect to hypertension

Hypertension is major independent risk factors for progress of atherosclerosis and multiple cardiovascular diseases in the globe (Robert *et al*., 2011). C-reactive protein (CRP) is defined as an acute phase reactant produced in the liver by stimulation of interleukin-6. The beginning and advancement of hypertension might be played a key role by vascular inflammation, which can be due to elevated levels of inflammatory markers such as interleukins-6, tumor necrosis factor-α, and C-reactive proteins in hypertensive patients (Dawri *et al.,* 2014).

Both increased levels of CRP and blood pressure might be indicated as risk factors of cardiovascular disease, in spite of the great number of factors and related conditions with cardiovascular disease. C-reactive proteins are not merely considered as a marker or athero-thrombosis process, but also can be mediators of this mechanism. It is shown that, C-reactive protein as predictors of future cardiovascular diseases (Yousuf *et al*., 2013).

Although, C-reactive protein may acts as a mediator of atherosclerotic plaque formation through its role in inhibition of proteins that mediate the complement. It is indicated that, when CRP levels are elevated, deregulation of the equilibrium between coagulation and fibrinolysis can occur. The concentration of tissue plasminogen activator (tPA), responsible for lysing coagulates at the vessel wall, and increases plasminogen activator inhibition (PAI-1) concentrations, which inhibits the fibrinolysis process can be due to reduced CRP. Therefore, this facilitates formation

of thrombi on the endothelial wall, which also increases the risk of cardiovascular events (Teixeira *et al.*, 2014).

The most important characteristics are that the biomarker has an independent predictive potential, being called hsCRP (Cozlea *et al.*, 2013). Serum hsCRP above 3.0 mg/L is considered as cardiovascular prognostic marker in clinical use. Therefore reduction of CRP values for medical treatment can decrease the progress of cardiovascular problems (Cortez and muxfeldt, 2016).

1.2. Statement of the problem

Cardiovascular diseases (CVD), including hypertension is increasing worldwide. High blood pressure is the major global concern. In 2008, according to WHO the global prevalence of hypertension in adults aged 25 years and more were around 40% which is higher in African region. In 2000, about 1 billion people (26.4%) of adults were estimated to have hypertension worldwide and this is likely to increase to over 1.5 billion by 2025 as a result of aging population in many developed countries, and an increasing incidence of hypertension in developing countries (Cornier *et al*., 2008).

Epidemiologically in Ethiopia it is approximately estimated that around 35.2% of population are suffering from problems of hypertension (WHO, 2011). The prevalence of hypertension in Ethiopia was (19.6%) as reported by systematic meta-analysis (Kibret and Mesfin, 2015). The prevalence of hypertension in Jigjiga town was 13.3% as reported by (Seifu *et al*., 2017).

Several risk factors (modifiable and non-modifiable) may play a role in the progression of hypertension (Leone, 2011). In an investigation on the different genetic and environmental risk factors of hypertension studies showed that age, sex, hyperlipidemia, diabetes, alcohol consumption, high Body Mass Index (BMI), sodium intake and others were associated with hypertension. An excessive daily intake of saturated fats, cholesterol, and subsequent disturbance of lipid profiles leading to hypertriglyceridemia and hypercholesterolemia are associated with obesity and, consequently, hypertension (Kotsis *et al*., 2010).

Hypertension and dyslipidemia, co-existing in 15 to 31%, are the two major risk factors for CVDs and account for more than 80% of deaths and disability in low and middle income countries (Reddy, 2004). These risk factors have an adverse effect on the vascular endothelium, which results in enhanced atherosclerosis resulting in CVD (Dalal *et al*., 2012). Abnormalities in some of the serum lipid profiles levels can be recognized as major modifiable CVD risk factor and has been identified as a risk factor for essential hypertension giving rise to the term dyslipidemic hypertension (Halperin *et al*., 2006).

Systemic hypertension is an independent risk factor for cardiovascular mortality and morbidity and maybe associated with injury or dysfunction of different systems known as hypertensive target organ damage. High sensitivity C-reactive protein, an indicator of systemic inflammation, can be associated with increased risk of CHD. Previous work studies have shown that CRP levels were well known to be higher in patients with hypertension. Elevated levels of CRP can be associated with future advance of hypertension in healthy women & men (Seyfeli *et al*., 2016).

Dyslipidemia and arterial hypertension can cause vascular damage and progressive loss of endothelial protective functions, thereby increasing oxidative stress and inflammation. Cytokines and factors, such as; Interleukin-6 (IL-6) and tumor necrosis factor alpha (TNF-α) respectively, are released by the endothelium, stimulating adhesion molecules and increasing vascular risk. Increased IL-6 and CRP levels can cause endothelial nitric oxide synthase (eNOS), facilitating thrombi formation and, consequently, increasing the risk of cardiovascular events (Teixeira *et al*., 2014).

Different studies have been conducted on serum high sensitivity C-reactive protein and serum lipid profiles in hypertensive patients in different societies. There is no ample data on the condition in Africa especially Ethiopia. To the best of my knowledge, there are no reports done on the estimation of high sensitivity C-reactive protein and lipid profiles in hypertensive patients particularly in the study area. Little is known about the anthropometry, lipid profiles and high sensitivity C-reactive protein parameters to blood pressure relationship in Ethiopian subjects, while no data seems to be available on the relationship between body-fat distribution and the risk of hypertension in the same population.

Globally there is broad variation in lipid profiles, and C-reactive protein patterns among different societies. Therefore, evaluation and monitoring of modifiable risk factors can be beneficial to reduce CVD morbidity and mortality. The present study will evaluate and examine the association between serum high sensitivity C-reactive protein to serum lipid profiles and other associated risk factors in hypertension at Karamara General Hospital, Jigjiga Ethiopia, and give recommendations so as to decrease progression of CVD morbidities and mortalities.

1.3. Significance of the study

Cardiovascular diseases including hypertension is the primary cause of disability and death worldwide, and a great majority of CVDs are associated with dyslipidemia. The problem is disturbing and causing a major concern in resource limited countries like Ethiopia. Unfortunately, due to low socio-economic status and other factors; patients come to health facilities at advanced stage of cardiovascular diseases (CVD) including hypertension in Ethiopia. Therefore, evaluating and examining serum high-sensitivity C-reactive protein, and serum lipid profiles and other associated risk factors in patients with hypertension in our setup will significantly be important to help shape clinical as well as public health care of the patients and the population at large. In addition, the results obtained from this study is expected to pave the way for further related studies to be broadly and extensively done.

1.4. Hypothesis

Null hypothesis: There is no difference in mean values of Serum levels of high sensitivity C-reactive protein (hsCRP) and Serum lipid profile between hypertensive patients and normal control participants.

Alternative hypothesis: There is difference in mean values of Serum levels of high sensitivity C-reactive protein (hsCRP) and Serum lipid profile between hypertensive patients and normal control participants.

2. OBJECTIVES

2.1. General objectives

- To evaluate the relationship between serum high sensitivity C-reactive proteins and serum lipid profiles among hypertensive patients.

2.1. Specific objectives

- To compare anthropometric parameters in hypertensive patients with normal control participants.
- To compare levels of serum lipid profiles and high sensitivity C-reactive protein in hypertensive patients and normal control participants.
- To evaluate levels of serum high sensitivity C-reactive protein and serum lipid profile in stage 1 and stage 2 hypertensive patients.
- To assess the correlation between socio-demographic profiles, anthropometric parameters with dependent variables in hypertensive patients and normal control participants.
- To assess correlation between serum high sensitivity C-reactive proteins in stage 1, stage 2 and hypertensive male and female patients.

2. Materials and methods

2.1. Study area and period

The study was conducted from November 2017 to April 2018 at Karamara General Hospital, Jigjiga Ethiopia. Jigjiga is the capital city of Somali regional state of Ethiopia, located 628 km to east of Addis Ababa.

2.2. Study design

Comparative case control study was conducted to estimate serum high sensitivity C-reactive protein and serum lipid profiles among hypertensive patients at Karamara General Hospital, Jigjiga, Ethiopia

3.3. Population

3.3.1. Source population

The Source of population was all hypertensive patients who visit Karamara General Hospital of Jigjiga, Ethiopia, during the study period.

3.3.2. Study population

The study population was hypertensive patients attending Karamara General Hospital, during data collection period

3.3.3. Eligibility Criteria

3.3.3.1. Inclusion Criteria

Hypertensive patients who were attending at the OPD of the hospital during data collection period were included.

3.3.3.2. Exclusion Criteria

- Age (less than 18 years and greater than 70 years on both genders
- Auto immune diseases
- Tuberculosis patients
- Liver diseased

- Pregnancy hypertension
- Renal diseased
- Inflammatory disease

3.4. Sample size determination and sampling method

The size of study participants that were recruited into the research was calculated using G* power version 3.1 software by selecting t-test of means. Sample size was calculated by considering alpha= 0.05, power (1- β) = 0.8 (80%) and effect size (d) = 0.5. the total sample size became 102. The number of participants enrolled into the study was 100 (57 hypertensive patients and 43 normal health controls)

Purposive sampling technique was used to include all hypertensive patients during the study period. There was a well-structured questionnaire (annexure) which was used to select appropriate study participant, record clinical and socio-demographic data. These study 100 participants (57 hypertensive patients and 43 normal controls) were recruited, respectively.

3.5. Variables

3.5.1. Dependent variables

- Serum triglyceride concentration (TG).
- Serum total cholesterol concentration (TC).
- High density lipoprotein (HDL) cholesterol concentration.
- Low density lipoprotein (LDL) cholesterol concentration.
- Serum high-sensitivity C-reactive protein concentration (hsCRP).

3.5.2. Independent variables

- Age groups
- Sex
- Socio- demographic factors
- Family history of hypertension
- Anthropometric indicators

3.6.1. Blood sample and data collection

3.6.1.1. Data collection procedure

After a brief explanation, the study participants had been asked for their consent to be interviewed and to give sample of blood. 5ml of blood was withdrawn from the study participants, who had fasted overnight (9-12 hours), by qualified health care professionals in the Hospital for the immediate laboratory analysis. In addition, the questionnaire was filled by face to face interview and some anthropometric parameters like; Waist circumference (WC), hip circumference (HC), waist to hip ratio (WHR) and blood pressure (BP) (two consecutive readings) were also assessed and measured side by side as well.

3.6.1.2. Blood samples

A total of 100 blood samples were collected. Among the 100, 57 were hypertensive (37 males and 20 females) and 43 normal volunteers (20 males and 23 females). Volumes of 5ml of blood were collected using serum separator tube (SST). Samples were allowed to stand for 30 minutes to allow complete clotting and clot retraction. The blood samples were centrifuged at 4000 rpm for five minutes then serum samples were harvested into Eppendorf tube. Then, it was stored in -80^{o}c deep freezer until the analysis.

The serum extracted was then used to determine the levels of serum (High-sensitivity C-reactive protein (hsCRP), triglycerides (TG), total cholesterol (TC), and high density lipoprotein (HDL)-cholesterol. LDL-cholesterol was calculated using the Friedewald formula (Friedewald *et al*., 1972).

3.7. Anthropometric Measurement Procedures

3.7.1. Body mass index

Different anthropometric measurements were performed which includes; weight, height, blood pressure, hip circumference (HC) and waist circumference (WC). The weight of every study participants was measured using a standard balance, and the height was also measured by using a height measuring device attached to the balance. Body Mass Index (BMI) was then calculated from the body weight (kg) and height (meter) as follows: BMI = Weight (in kg) / (Height in m) ^{2}

Using the (WHO, 2008), classification five categories of BMI can be identified as follows: underweight, <18.5 kg/m2; normal, >18.5-24.9 kg/m2; overweight, >25.0-29.9 kg/m2; and obesity, 30.0-34.9 or 35.0- 39.9, extreme obesity > 40.0 kg/m2.

3.7.2. Waist to hip circumference ratio

Waist and hip circumference were measured using standard measuring tape to the nearest 0.5cm. The tape measure was stretched around the abdomen at the level mid way between the lowest rib margin and iliac crest. Hips were measured at the levels of widest diameters around the buttocks-the widest level around the trochanter in a horizontal plane (John, 2009).

Waist to hip ratio (WHR) was calculated by dividing waist circumference by hip circumference (Tambe *et al*., 2010). The cut-off point considered for waist circumference (WC) was >80cm for females and >90cm for males to define overweight, the cut-off taken for waist to hip ratio was >0.8 cm for females and >0.9cm for males as per the criterion of the WHO in the year 2008.

3.7.3. Blood pressure

Blood pressure was measured with a mercury sphygmomanometer. Measurements were made to the nearest 2mmHg, in the sitting position with the arm supported, and repeated after 5 minutes' rest, if the first recording is high. The cut-off points for elevated BP were SBP of 140mmHg or above and DBP of 90mmHg or above (James *et al*., 2014).

3.8. Test principle of laboratory analytes

3.8.1. Serum total cholesterol concentration

A commercial kit developed by Coxon and Schaffer was used to estimate serum total cholesterol concentration (Coxon and Schaffer, 1971). Cholesterol is measured enzymatically in serum or plasma in a series of coupled reactions that hydrolyze cholesteryl esters and oxidize the 3-OH group of cholesterol. One of the reactions by products, H_2O_2 is measured quantitatively in a peroxidase catalyzed reaction that produces a color. Absorbance is measured at 500 nm. The color intensity is proportional to cholesterol concentration. The reaction sequence is as follows:

Cholesteryl ester + H_2O $\xrightarrow{\text{cholesterol ester hydrolase}}$ cholesterol + fatty acid

Cholesterol + O_2 $\xrightarrow{\text{cholesterol oxidase}}$ cholest- 4-en-3-one + H_2O_2

$2H_2O_2$+4-aminophenazone $\xrightarrow{\text{phenolperoxidase}}$ 4-(p-benzoquinone-monoimino) -phenazone+4H2O.

- Desirable or normal cholesterol levels were considered to be those below 200 mg/dL, and it is considered abnormally elevated levels of cholesterol to be those 200 mg/dL or above.

3.8.2. Serum triglyceride (TG) concentration

A commercial kit developed from Cromatest® Cholesterol MR, Linear chemicals SL, Barcelona, Spain was used to estimate serum triglyceride concentration (Allain *et al.,* 1974). Triglycerides are measured enzymatically in serum or plasma using a series of coupled reactions in which triglycerides are hydrolyzed to produce glycerol. Glycerol is then oxidized using glycerol oxidase, and H_2O_2, one of the reaction products, is measured as described above for cholesterol. Absorbance is measured at 500 nm. The reaction sequence is as follows:

a. Triglycerides + 3H2O $\xrightarrow{\text{lipase}}$ glycerol + fatty acids

b. Glycerol + ATP $\xrightarrow{\text{glycerokinase}}$ glycerol-3-phosphate + ADP

c. Glycerol-3-phosphate + O2 $\xrightarrow{\text{glycerophosphate oxidase}}$ dihydroxyacetone phosphate + H2O2

d. H2O2 + 4-aminophenazone+4-chlorophenol $\xrightarrow{\text{peroxidase}}$ 4-(p-benzoquinone-monoimino)- phenazone +2H2O+HCl**.**

❖ Desirable or normal fasting triglyceride levels are considered to be those below 200 mg/dL, and increased range 200 mg/dL or above.

3.8.3. Serum high density lipoprotein (HDL) cholesterol concentration

A commercial kit developed from Cromatest® Cholesterol MR, Linear chemicals SL, Barcelona, Spain was used to estimate serum triglyceride concentration. HDL was measured directly in serum. The basic principle of the method is as follows. The apoB containing lipoproteins in the specimen are reacted with a blocking reagent that renders them non-reactive with the enzymatic cholesterol reagent under conditions of the assay. The apoB containing lipoproteins are thus effectively excluded from the assay and only HDL-C is detected under the assay conditions. The method uses sulfated alpha-cyclodextrin in the presence of Mg+2, which forms complexes with apoB containing lipoproteins, and polyethylene glycol-coupled cholesteryl esterase and cholesterol oxidase for the HDL-C measurement. Absorbance was measured at 600 nm. The reaction principles are as follows:

a. ApoB containing lipoproteins + α-cyclodextrin + Mg+2 + dextran SO4 $\longrightarrow$ soluble non -reactive complexes with apoB-containing lipoproteins.

b. HDL-cholesteryl esters $\xrightarrow{\text{PEG-cholesteryl esterase}}$ HDL-unesterified cholesterol + Fatty acid.

c. Un esterified chol + O2 $\xrightarrow{\text{PEG-cholesterol oxidase}}$ cholestenone + H2O2.

d. H2O2 + 5-aminophenazone + N-ethyl-N-(3-methylphenyl)-N'succinyl ethylene diamine + H2O + H+ $\xrightarrow{\text{peroxidase}}$ qunoneimine dye + H2O.

- A low HDL-cholesterol concentration is considered to be a value below **40 mg/dL**. HDL-cholesterol values are also used in the calculation of LDL-cholesterol (as shown below).

3.8.4. Serum Low density lipoprotein (LDL) cholesterol concentration

Mostly of the circulating cholesterol is found in three major lipoprotein fractions: very low density lipoproteins (VLDL), LDL and HDL. Total cholesterol = VLDL-cholesterol + LDL-cholesterol+HDL-cholesterol. LDL-cholesterol is calculated from measured values of total cholesterol, triglycerides and HDL-cholesterol according to the relationship: LDL-cholesterol = Total cholesterol - HDL-cholesterol – (TG/5) Where TG/5 is an estimate of VLDL-cholesterol and all values are expressed in mg/dL.

- Desirable levels of LDL-cholesterol are those below100 mg/dL in adults and 100mg/dL or above are considered to be elevated.

3.8.5. Serum high sensitivity C-reactive protein concentration

A commercial kit developed by chromatest@ CRP-latex, linear chemical, S.L.U, founded by 1994 in Barcelona, Spain was used to estimate serum C- reactive protein concentration (CRP). C-reactive protein in measured enzymatically in serum, the assay was performed by testing a suspension of latex particles coated with anti-human CRP antibodies against unknown serum. Using semi-quantitative CRP test kit. Six specimens were prepared and diluted serially using normal saline (0.86mg/dl), each sample were added one drop of Blood. The highest dilution which shows clear cut agglutination with 2 minutes indicates the CRP titer. The approximate hsCRP concentration can be obtained with multiplying titer by sensitivity of the test (0.4) mg/dl. The presence of a visible agglutination indicates an increase of the CRP level above the upper limit of the reference interval in the sample tested. The reaction sequence is as follows:

C- reactive protein in sample $\xrightarrow[\text{Detergent/ Buffer}]{\text{R1}}$ C- reactive protein solution

C- reactive protein in solution $\xrightarrow[\text{Latex coated with monoclonal antibodies}]{\text{R2}}$ CRP and Antibody particles complex

- Low: hsCRP level under 1.0 mg/L, average: between 1.0-3.0 mg/L and elevated hsCRP is considered to be: those above 3.0 mg/L for adults (Zangana, 2016).

3.9. Data quality control and management

- All standards operating procedures (SOPS) was applied during collection of sample from the study participants.
- There was a well-prepared data collection questionnaire to assess participant's demographic information.
- All the laboratory procedures were handled by professional laboratory technologists.
- All the tests were standardized and automated.

3.10. Data processing and software used in statistical analysis

All the data were checked for completeness and cleaning, processing and analysis of the data obtained from laboratory analyses of the blood samples and questionnaires was performed by coding and entering the data into Epi-Data statistical software (version 3.5.1, 2008) and then exported the entered data to SPSS software (version 22.0, 2013, America) for statistical analysis. Descriptive analysis, Pearson correlation, independent sample T-test, continuous variables were presented as mean±standard deviation and were compared using the student t-test for groups. All the data were expressed in mean±SD and $P<0.05$ at 95% confidential level was considered as a statistically significant in all the analytes.

3.11. Ethical consideration

The Ethical clearance was obtained from Biochemistry Department College of Health Sciences Addis Ababa University with protocol number 09/17 and meeting number DRERC 02/17. Furthermore, Collaboration letter for data collection was also obtained from Karamara General Hospital. The objective of the study was briefly clarified and explained for each participant, before enrolling any of the eligible study participants. Samples and data were collected after informed consent had been obtained from the study participants. Confidentiality, accountability and academic honesty was maintained throughout the study (see annexure). The findings of the study will be disseminated for health care professionals and other concerned bodies for better care of the hypertensive patients than ever.

3.12. Operational definition

High sensitivity C-reactive protein: is an indicator used for patients to measure increased risk of cardiovascular disease. Now a day it becomes a usual diagnostic tool for inflammatory and vascular diseases.

Anthropometric indicators: parameters for the measurement of the human body and its individual parts thereby yielding a quantitative index of their variability. They include age, height, weight, body mass index, waist circumference, waist to hip ratio etc.

Stage I hypertension: is a state in which systolic blood pressure is raised 140mmHg or above and diastolic blood pressure of 90 mmHg or above.

Stage II hypertension: is a state in which systolic blood pressure is raised 160 mmHg or above and diastolic blood pressure of 100 mmHg or above.

4. RESULTS

4.1. Socio-demographic characteristics

The present study recruited 100 study participants. Among the 100, 57 were hypertensive (37 were male and 20 were females) and 43 normal volunteers (20 males and 23 females). The majority of hypertensive patients (61.4%) were found within in the age group of 40-59 years. Among the 57 hypertensive patients, 27 (47.4%) of the males and 18 (41.9%) of the females were living in urban areas, whereas the remaining patients were living in rural areas. Most of the hypertensive males and females were married, and 50% were illiterate. Among the 37 hypertensive male patients 15 had history of cigarette smoking and 5 of them were alcohol users, and 28 of them were khat chewers (**Table 2**).

Table 2: Socio-demographic characteristics of male and female study participants.

Variables		Males (N=57)		Females (N=43)	
		Normal (n=20) N%	Hypertensive (n=37) N%	Normal (N=23) N%	Hypertensive (n=20) N%
Age (years)		49.55±11.29	48.78±10.9	54.51±9.06	47.05±12.26
Marital status	Married	18 (31.6)	35 (61.5)	20 (46.5)	15 (34.9)
	Single	2 (3.5)	2 (3.5)	3 (7)	5 (11.6)
Educational Level	Illiterate	18 (31.6)	28 (49.1)	15 (34.9)	13 (30.2)
	Up to 12	2 (3.5)	9 (15.8)	8 (18.6)	7 (16.3)
Residence	Urban	17 (29.8)	27 (47.4)	20 (46.5)	18 (41.9)
	Rural	3 (5.3)	10 (17.4)	3 (7)	2 (4.6)
Physical exercise	Yes	5 (8.8)	12 (21)	4 (9.3)	5 (11.6)
	No	15 (26.3)	25 (43.9)	19 (33)	15 (34.9)
Cigarette smoking	Yes	8 (14)	15 (26.3)	nil	nil
	No	12 (21)	22 (38.6)	23 (53.5)	20 (46.5)
Khat chewing	yes	12 (21)	28 (29.1)	nil	Nil
	No	8 (14)	9 (15.8)	23 (40.3)	20 (46.5)
Family history of HTN	yes	nil	26 (45.6)	nil	12 (27.9)
	No	20(35)	11 (19.3)	23(53.5)	8 (18.6)
Income (Birr)	< 2000	12(21)	19 (43.8)	11 (58.1)	17 (39.5)
	>2000	8 (14)	18 (31.6)	12 (27.9)	8(7)
Alcohol use	Yes	1 (1.75)	5 (8.8)	nil	nil
	No	19 (33)	32 (56.1)	23 (53.5)	20 (46.5)

Abbreviation: HTN = hypertension

4.2. Anthropometric characteristics of the study participants

The levels of BMI, WHR, SBP, DBP, and duration of Hypertension are indicated below. Among the anthropometric indictors BMI was significant higher in the male and female hypertensive patients. The elevated WHR (waist/hip circumference) was observed in male and female patients (>0.9 for males and >0.8 for females). The SBP were recorded high in both male and female patients (140 mmHg or above), and diastolic BP was high also high in male and female patients (90 mmHg or above).

Table 3: Anthropometric indicators of male and female study participants

Characteristics		Males (N=57)		Females (N=43)	
		Normal (N=20) N%	Hypertensive (N= 37) N%	Normal (N=23)N%	Hypertensive (N=20) N%
BMI (kg/m2)		23.57±2.376	25.05±2.728	23.95±3.187	25.50±3.306
	<25	12 (21)	21(36.8)	17 (39.5)	nil
	25-30	8 (14)	14(28)	6 (13.9)	15 (34.9)
	>30	nil	nil	nil	5 (11.6)
WHR (cm)		0.775±0.0639	0.922±0.712	0.770±0.0765	0.905±0.153
	<cut-off	15 (26.3)	12(31.6)	19 (44.2)	2 (4.6)
	>cut-off	5 (8.8)	25 (33)	4 (9.3)	18 (41.9)
BP mmHg	SBP	104.50±12.8	148.92±11.73	105.50±8.87	149.13±9.960
	DBP	73.00±8.645	89.73±11.17	71.00.±6.959	90.50±12.106
Duration of HTN	<1 years	nil	12 (21)	nil	12 (27.9)
	1-5 years	nil	20 (35)	nil	11 (25.6)
	>5 years	nil	2 (3.5)	nil	3 (7)

Abbreviations: HTN= hypertension**;** BP= blood pressure; BMI= Body mass index; WHR= Waist-to hip ratio; SBP= Systolic blood pressure; DBP=Diastolic blood pressure.

4.3. Levels of serum lipid profiles and serum high sensitivity C-reactive proteins in the study participants

The serum levels of triglycerides, LDL-cholesterol, HDL-cholesterol, total cholesterol and high sensitivity C-reactive protein was indicated below. Among this lipid profiles, the levels of TG ($p<0.001$) and total cholesterol ($p<0.009$ in male and $P<0.007$ in females) were elevated in the hypertensive patients. However the LDL-cholesterol and HDL-cholesterol did not showing significant difference in both male and female patients. The hsCRP was recorded high in both male and female patients ($p<0.001$).

Table 4: Levels of serum lipid profiles and Serum high-sensitivity C-reactive protein in the study participants.

Variables	Males (N=57)			Females (N=43)		
	Normal (N=20)	Hypertensive (N=37)	P-value	Normal (N=23)	Hypertensive (N=20)	P-value
TG	91.30±31.593	195.92±109.915	0.001	94.09±31.969	190.75±99.59	0.001
LDL-C	77.51±23.298	80.80±33.780	0.700	78.86±32.892	108±42.575	0.520
HDL-C	47.95±12.614	46.78±13.701	0.526	49.40±9.566	47.95±12.24	0.556
TC	140.60±38.32	189.08±39.525	0.009	147.05±38.45	197.52±51.90	0.007
HSCRP	1.80±0.696	2.97±1.040	0.001	1.70±0.571	3.45±0.912	0.001

Abbreviations: TG= triglycerides**;** LDL-C= low density lipoprotein cholesterol; HDL-C= high density lipoprotein cholesterol; TC=total cholesterol; HSCRP=high-sensitivity C-reactive proteins.

The table 5 below shows that comparison of serum lipid profile levels and serum hsCRP in the stage 1 and stage 2 hypertensive patients (both male and female). Among the parameters the elevated levels of triglycerides (TG), total cholesterol (TC), and high sensitivity C-reactive proteins (hsCRP) were observed in male and female stage 2 hypertensive patients. However, LDL-Cholesterol and HDL-cholesterol did not bringing any significant changes in stage 1 and stage 2 hypertensive patients.

Table 5: Levels of lipid profiles and high sensitivity C-reactive protein for stage 1 and stage 2 hypertensive patients.

Variable	Males(N=37)			Females (N=20)		
	Stage 1 HTN (N=21)	Stage 2 HTN (N=16)	P-value	Stage1 HTN (N=12)	Stage 2 HTN (N=8)	P-value
TG	149.56±217.13	198.57±117.2	0.035*	119.75±40.27	217.13±135.7	0.017*
LDL-C	78.30±30.625	83.31±33.556	0.639	101.35±48.67	119.48±40.55	0.396
HDL-C	48.33±11.280	44.56±11.581	0.765	49.63±7.050	47.00±13.725	0.271
TC	126.2±39.447	187±199.25	0.030*	170.92±58.58	199.25±49.2	0.030*
HSCRP	2.86±0.910	3.56±0.964	0.001*	3.45±0.688	3.75±0.707	0.001*

*P<0.05 is statistically significant

Among the 57 hypertensive patients in the male hypertensive patients 23 of them had elevated level of TG (above 200 mg/dL); 29 of them had elevated level of TC (above 200 mg/dL); 20 of them had high level of LDL-C (above 100 mg/dL); 27 of them had elevated HSCRP (above 3mg/L) and 6 of them decreased level of HDL-C were observed in the present study (below 40 mg/dL). Among the female hypertensive patients 16 had elevated levels of TG (above 200mg/dL); and 12 of them had high levels of TC (above 200mg/dL); 17 of them had elevated levels of LDL-C (above 100mg/dL) (**Figure 3**).

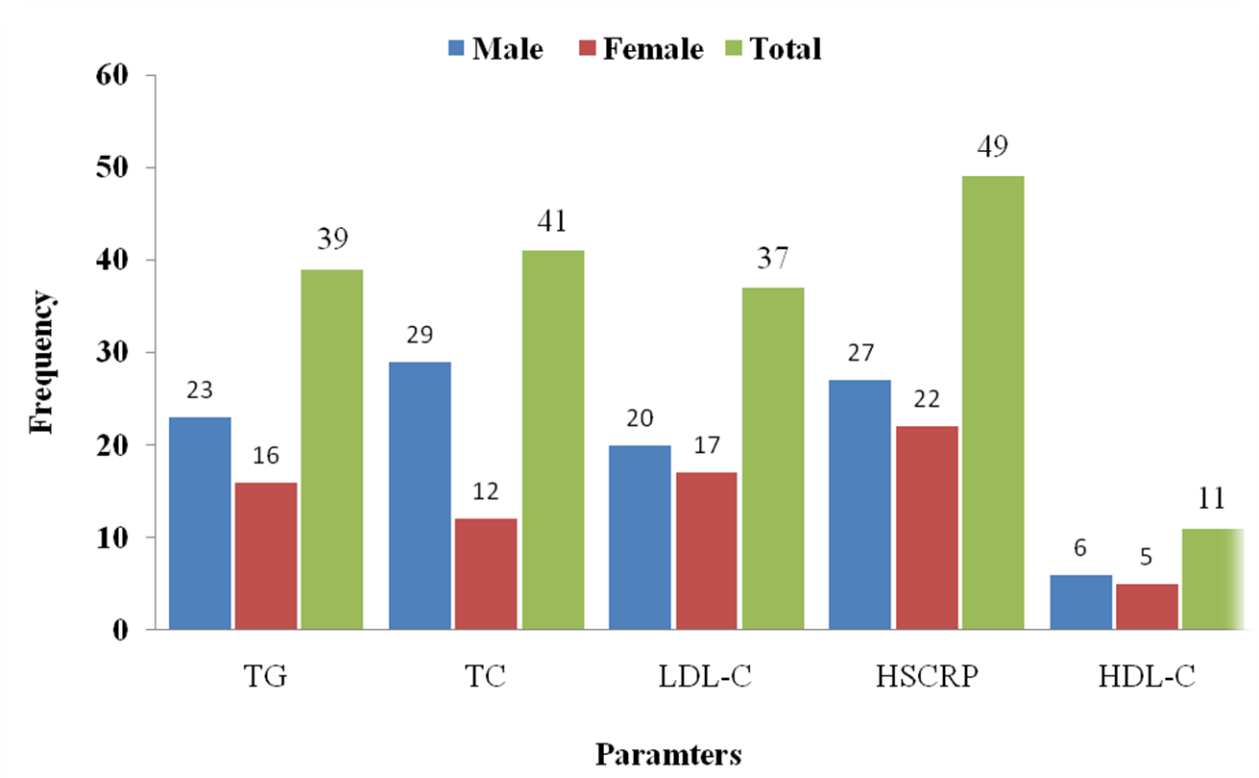

Figure 2: Hypertensive patients having abnormal levels of lipid profiles and high sensitivity C-reactive proteins stratified by sex.

4.4. Correlation between Socio-demographic profiles, anthropometrics parameters with lipid profiles in hypertensive patients

Bivarate Pearson correlation showed that among the socio-demographic profiles, age was positively correlated with hypertension, TC, LDL-cholesterol, and inversely correlated with TG and HDL-C. Cigarette smoking was positively correlated with TC and LDL-C. The SBP was positively correlated with TG and TC and inversely correlated with LDL-C and HDL-C. The DBP was positively correlated with TG and LDL-C (Table 6 and 7).

Body mass index (BMI) was positively correlated with TG, TC, and LDL-cholesterol, and inversely correlated with HDL-cholesterol. Waist to hip ratio (WHR) was positively correlated with TG and TC and inversely correlated with LDL-cholesterol and HDL-cholesterol (**Table 6 and 7**).

Table 6: Correlation between socio-demographic characteristics, anthropometric indicator with Triglycerides and High density lipoproteins in the study participants.

Variables	TG				HDL-C			
	HTN		N		HTN		N	
	r- value	p-value	r-value	p-value	r-value	P-value	r-value	p-value
Age	-0.017	0.023	0.080	0.649	-0.090	0.508	0.071	0.649
Smoking	-0.060	0.658	0.483	0.110	-0.041	0.763	0.812	0.037
SBP	0.143	0.288	0.245	0.113	-0.051	0.705	0.366	0.016
DBP	0.026	0.023	0.117	0.453	-0.217	0.024	0.221	0.145
BMI	0.131	0.064	-0.199	0.200	-0.034	0.012	-0.051	0.747
WHR	0.228	0.289	0.289	0.089	-0.112	0.406	0.055	0.406

Abbreviation: H= hypertension; N= normal

Table 7: Correlation between socio-demographic characteristics, anthropometric parameters with Total cholesterol, and Low density lipoproteins in the study participants.

Variables	TC				LDL-C			
	HTN		N		HTN		N	
	R-value	P-value	R-value	P-value	R-value	P-value	R-value	P-value
Age	0.385	0.067	0.108	0.490	0.205	0.467	0.154	0.323
Smoking	0.146	0.736	0.612	-0.080	0.647	-0.041	-0.064	0.069
SBP	0.227	0.006	-0.475	0.187	0.092	0.498	0.461	0.498
DBP	0.002	0.042	0.205	0.187	0.061	0.145	0.111	0.032
BMI	0.476	0.425	-0.085	0.587	0.120	0.145	0.047	0.765
WHR	0.144	0.286	0.185	0.478	-0.043	0.282	0.162	0.752

P. value of <0.05 is statistically significant

4.5. Correlation between serum high sensitivity C-reactive proteins with serum lipid profiles and anthropometric indicators in the hypertensive patients

High-sensitivity C-reactive protein was positively associated with age, BMI, SBP, WHR, TG, TC, LDL-cholesterol, and inversely correlated with HDL-cholesterol in hypertensive male and female hypertensive patients (**Figure 4**).

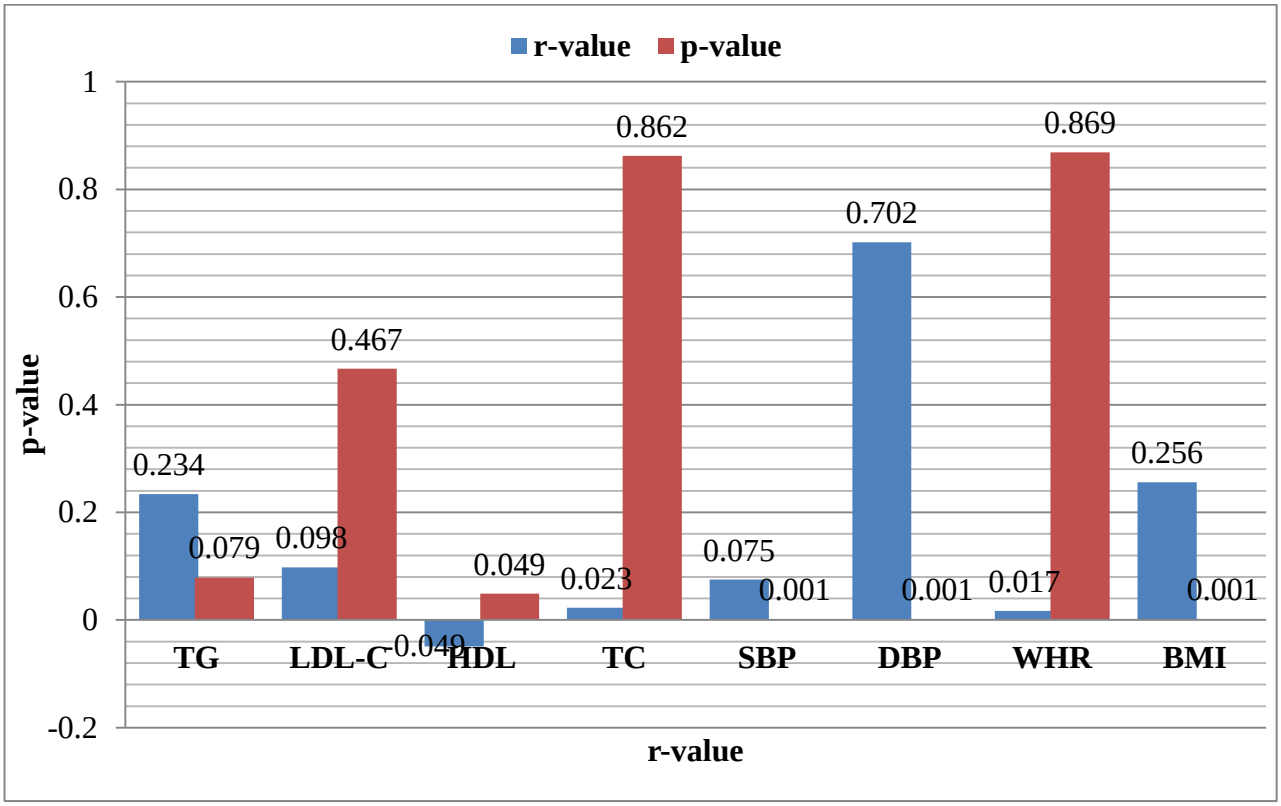

Figure 4: Correlation between high sensitivity C-reactive protein with lipid profiles in the hypertensive patients.

When compare stage 1 hypertensive patients' high sensitivity C-reactive protein with stage 2 patients. The results show positively correlation with SBP, DBP, BMI, WHR, TG, TC and LDL-C, with hsCRP, however, inversely correlated with and HDL-C (**Table 8**).

Table 8: Correlation of high sensitivity C-reactive protein with anthropometrics and lipid profiles in stage 1 and 2 hypertensive male and female patients.

Variables	**Male stage 1 and 2 HTN**		**Female stage 1 and 2 HTN**	
	r-value	p-value	r-value	p-value
AGE	0.031	0.854	0.027	0.423
SB	0.194	0.057	0.111	0.051
DBP	0.709	0.001	0.526	0.001
BMI	0.235	0.161	0.538	0.027
WHR	0.127	0.405	0.276	0.746
TG	0.163	0.035	0.356	0.017
HDL-C	-0.049	0.065	-0.132	0.021
TC	0.163	0.774	0.374	0.114
LDL-C	0.049	0.631	0.149	0.396

5. DISCUSSION

Currently, cardiovascular diseases, including hypertension are the leading global cause of death. According to WHO in 2008, the global prevalence of hypertension in adults aged 25 years and more was around 40% which is higher in African region. In 2000, about 1 billion people (26.4%) of adults were estimated to have hypertension worldwide and this is likely to increase to over 1.5 billion by 2025 as a result of aging population in many developed countries, and an increasing incidence of hypertension in developing countries (Cornier *et al*., 2008). In Ethiopia it is currently indicated prevalence of hypertension was around 19.6%) as Reported by systematic meta-analysis (Kibret and Mesfin, 2015). Therefore, an early biomarker for diagnosis, prognosis and a potential treatment target for hypertension and other cardiovascular diseases are required.

In our present's study the majority of the hypertensive patients were found within in the age group of 40-59 years. This is in line with the previous studies done both in developed and developing countries which consistently reported that age is associated with hypertension (Idemudia and Ugwuja, 2008, Forhand *et al*., 2014).

In addition, the present study revealed that age was positively correlated with serum, LDL-cholesterol and total cholesterol in the hypertensive patients. This finding agreed with the previous studies of, Osuji *et al*., (2012), Prabhanjan *et al*., (2014), which showed that as we age, there is a natural tendency for the blood pressure to rise which could be because of an increase in stiffness of the arteries in the vasculature as well as endothelial atherosclerotic changes.

In our present's study, body mass index (BMI) and waist to hip ratio (WHR) were significantly higher in hypertensive patients, than normal controls. This finding lined with study done by (Osuji *et al*., 2012).

An increased waist circumference ratio was most likely associated with elevated risk factors because of its relation with visceral fat accumulation, and the mechanism may involve excess exposure of the liver to fatty acids and release of detrimental adipocytokines and lower levels of Beneficial adipocytokines and these have multiple detrimental effects, including pro-inflammatory damage, altered signaling pathways and reactive oxygen species production, on

beta cells and other tissues resulting in disease states like hypertension and diabetes (Dalton *et al*., 2003).

In addition, the accumulation of visceral fat may bring about an increase in sympathetic over activity which is associated with insulin resistance and hence increasing the activity of the reninangiotensin- aldosterone system as visceral adipocytes increase angiotensinogen secretion as compared to the subcutaneous fat (Lee *et al*., 2006). Mechanical effect could also be exerted by the accumulation of visceral fat resulting in renal compression and promoting a rise in arterial blood pressure (Hall *et al*., 2003).

In our study associated BMI, WHR and lipid profiles in hypertensive patients. Our finding agreed with previous study of, Lorenzo et al., (2016), that showed, there was positive correlation between BMI with TG, TC and inverse relation with LDL-C and HDL-C. However, WHR was positively correlated with TG, LDL-C and TC; and HDL-C is inversely associated. This can be explained that central obesity is directly related to visceral adiposity which is an indicator of unfavorable metabolic changes. These effects can influence atherogenic development and hypertension, as well as causing alterations such as insulin resistance, glucose intolerance, and hypertriglyceridemia (Krause *et al*., 2007).

The results of present' study revealed the average levels of triglycerides and total cholesterol in hypertensive patients were higher than their respective cut-off values than in normal controls. However, we did not find any significant difference according to LDL-C and HDL-C. The result of present finding is lined with previous study done by (Rekha and Prasad *et al*., 2016).

Therefore, abnormalities in total cholesterol and triglycerides may play a central role in endothelial functional abnormality which is important in the pathogenesis of atherosclerosis, thrombosis, insulin resistance as well hypertension. Abnormally elevated total cholesterol level is considered to be risk factors for developing macro-vascular complications like Coronary Heart Disease (CHD), stroke and hypertension (Albucher *et al.,* 2000).

In our current study, hypertensive patients had higher levels of hsCRP than healthy controls. This shows that inflammation might be associated with hypertension; this finding agreed with different studies of, Tolmay *et al.*, 2012, Zangana, 2016, and Suthahar *et al.,* 2018, those found a positive relation between increasing levels of hs-CRP and risk of developing hypertension.

Generally vascular inflammation may be promoted by abnormally elevated levels of blood pressure. Increased expression of soluble intercellular adhesion molecule- 1(sICAM-1) and vascular cell adhesion molecule-1(VCAM-1) by endothelial cells and also up regulate the secretion of monocyte chemo-attractant protein-1 (MCP-1) that promote monocyte adhesion to endothelium (Zangana, 2016), therefore increased production of contracting factors, like; oxygen-derived free radicals and oxidized low density lipoprotein (ox-LDL), a marker of oxidative stress, could play an important role in the development of hypertension (Kuklinska *et al.,* 2009).

As current study revealed hsCRP was positively correlated with BMI and WHR. This correlation between hsCRP and BMI is consistent with the recent studies that revealed chronic inflammatory state is associated with obesity and may induce insulin resistance and endothelial dysfunction, further leading to CVD (Kamath *et al*., 2015).

In our study an increasing SBP is associated with hsCRP**;** this independent risk factor may suggest that hsCRP as a valuable marker to predict future cardiovascular diseases in hypertension. This finding agreed with different studies of Kamath *et al.,* 2015; Vukovic–Dejanovic *et al.*, 2015; and Cortez and Muxfeldt, 2016.

Correspondingly, SBP and DBP were higher in stage 2 hypertensive patients than stage 1 hypertensive patients. This result was lined with previously reported by Nayak et al., (2016), which showed that blood pressure may have a continuous and consistent relationship with the risk of cardiovascular events, the higher the BP, the higher the chance of CVD.

In our present finding hsCRP was higher in stage 2 hypertensive patients compared to stage 1. This finding was lined with studies done by, Aslam et al., (2014), which showed that higher hsCRP in stage 2 hypertension compared to stage 1 hypertension.

In our finding shows that, there was positive association between TG, TC and LDL-C with hsCRP in stage 1 and 2 hypertensive patients. However, HDL-C was inversely correlated. This finding agreed with study done by (Zangana, 2016).

The findings of our study, therefore may suggest estimation of CRP levels as an essential or potential tool for early identification of individuals at risk for cardiovascular diseases. Since both elevated hsCRP and hypertension are independent determinants of cardiovascular risk, the finding of this study may provide a rationale for pharmacotherapy, in a broader subset of people with hypertension. Since the people with hypertension may be at a greater CV risk than previously appreciated due to elevated CRP levels, hence plans targeted to lower hsCRP levels may potentially provide increased clinical benefits.

6. CONCLUSIONS

- Our present finding indicates that, there were significantly higher mean levels of serum high sensitivity C-reactive protein, total cholesterol and Triglycerides and statistically no significant difference in serum concentration of LDL-cholesterol and HDL-cholesterol in hypertensive patients compared to those of normal controls.
- The effect of the significant changes in high sensitivity C-reactive protein, Triglycerides, and total cholesterol as obtained in this study, may suggest that inflammation might be associated with hypertensive patients.
- Our findings may help to develop future strategies for preventing both hypertension and dyslipidemia through proper lifestyle changes or medical management or by the combination of both.
- Therefore, measurement of high-sensitivity C-reactive protein at regular intervals may be done for butter prevention and management of cardiovascular diseases and stroke.

7. STRENGTHS AND LIMITATIONS OF THE STUDY

7.1. Strength of the study

- The strength of the study includes several demographic, clinical and anthropometric parameters claimed to be associated with the variables under study.
- It is expected that assessment of serum high-sensitivity C-reactive protein may favorably alter therapeutics indices of the patients.
- Therefore, this study is expected to provide the baseline information for use of hsCRP in hypertensive patients of Ethiopia.

7.2. Limitation of Study

- The limitation of the study was the study area; it was conducted in only one hospital due to this the sample size was small. Using such number of participants, it may be difficult to represent the whole hypertensive patients in Ethiopia.
- In addition, the study could not compare the effect of high sensitivity C-reactive protein variations among those who have both Hypertension and Diabetics.
- Lack of ample previous study findings limited the comparison of these study findings with other findings in similar hospitals in Ethiopia.

8. RECOMMENDATIONS

- Further studies could be conducted with larger sample size and incorporating more hospitals as well as using more robust study designs such as case control and cohort study to establish the causality of the association between hypertension and high sensitively C-reactive protein and their implications on the management of hypertensive patients.
- Nutritional factors and dietary habits should be assessed in further studies.
- There should be better public health education as well as clinical care of the hypertensive patients for better management of blood pressure and lipid abnormalities as well as overweight and obesity.
- Further study should be conducted to see correlation of high-sensitivity C-reactive protein for diagnosis of individuals at risk for development of hypertension and eventually cardiovascular diseases.
- Further molecular studies could also be directed so as to investigate the genetic basis of the high prevalence of high-sensitivity C-reactive protein and lipid abnormalities in the hypertensive patients.
- There should be timely evaluation of high- sensitivity C-reactive protein and lipid profile of the patients and prescription of drugs whenever indicated so as to prevent cardiovascular problems.

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10. Annexes

10.1. Questionnaires (English)

Dear participants, you are kindly requested to give correct information accordingly. Please check all the information shown below to insure it is accuracy. Thank you for your participation.

I. Personal socio demographic, anthropometric and clinical information.

Card no _____

1. Age (in years) _____
2. Gender Male ☐ Female ☐
3. Educational status: Illiterate ☐
   Up to Secondary school ☐
   University degree ☐
4. Marital status Single ☐
   Married ☐
   Divorced ☐
   Widowed ☐
5. Income <2000birr ☐
   2000-5000 birr ☐
   > 5000 birr ☐
6. Regular physical activity Yes ☐ No ☐
7. Residential area Urban ☐ Rural ☐
8. Height (m) _____
9. Weight (in Kg) _____
10. Body Mass Index (kg/ m2) _____
11. Waist circumference (cm) _____
12. Hip circumference (cm) _____

13. Waist-to-hip ratio_____

14. Alcohol consumption: yes ☐ No ☐

15. If yes, how many liters _____

16. Smoking: Yes ☐ No ☐

17. Family history of hypertension: Yes ☐ No ☐

18. Duration of hypertension: < 1 year ☐

1-5 years ☐

>5 years ☐

18. Measurement of blood pressure (mmHg) _____

19. Salt consumption Yes ☐ No ☐

20. Khat chewing Yes ☐ No ☐

10.2. Participants Information sheet (English version)

Hello, welcomes to Hospital how are you? _____ My name is? _____

I came from _____

This is an interview to be done with you for a study that is being conducted at Addis Ababa University, College of Health Science, and School of Medicine Department of Medical Biochemistry. You are kindly requested to participate in this research project as volunteer study participants. Read carefully the information provided in this sheet carefully and then respond freely to in interview questions.

Research project: Estimation of Serum high sensitivity C-reactive protein and Serum lipid profiles in hypertensive patients at Karamara General Hospital.

Sponsoring organization: Addis Ababa University, College of Health Science, Department of Medical Biochemistry.

Principal investigator: Mohamed Ali (BSC, MSc candidate in Medical Biochemistry).

Advisors: Gnana Sekaran (PhD), Dr Daniel Seifu (PhD).

Objectives of research project

This information sheet is prepared by investigator and advisors at Addis Ababa University for the project with the objectives of Estimations of serum high sensitivity C- reactive proteins and lipid profiles in hypertensive patients.

Study procedures

You will be asked kindly if you are volunteer to participate in this project. If you agree the investigator or a health worker will give you verbal or in written information about the study.

The health professionals will ask you same interview equations about your health status and take few drop of blood for your finger as a sample for laboratory examination that are important for the study.

Discomfort, Risk and benefits

The discomfort and risk of participating this are very minimal with minor pain around injected areas following blood drawing which relieves after same time. The blood will be drown by licensed health care professionals in the hospital, and proper concentration will be given. The most appropriate sterilized blood collection materials will be used. You will not be paid for any direct incentives or your participation in this study. Only the diagnostic laboratory examination will be covered by the project. Besides, the results obtained from the study will be beneficial and serve you as a base line data. In addition, the result of the study will be important for the better prevention and care of hypertension patients than before. You are also benefiting the hypertensive patients and the community at large in this condition.

Confidentiality

All the pieces of data about the patient will be kept secretly. The records concerning participants are to be used only for this project. The information will not be revealed to anyone except the physician and principal investigator. At any time you have full freedom of asking any questions regarding to this study. Your decision will not affect your right to get proper health care.

Contact information: If you have any questions contact me on: Mohamed Ali, Tell: no 0915101472.

10.3. Informed consent (English version)

Addis Ababa University, School of Graduate Studies, College of Health sciences, Department of Medical Biochemistry consent form for the participation of the study subjects in the research project.

Name of the study participants _____

Code number _____

I have been clearly informed about the research project that it aims to estimate serum high sensitivity c-reactive proteins and lipid profile among hypertensive patients. The objectives of the research project have been clearly explained to me and I have been told that the results obtained from me will help the community as well as for better management of the disease.

I have been informed also the confidentiality of this research project. Moreover, I have been well informed of my right to keep hold of information decline to cooperate and make myself with draw from the study. Therefore, with full understanding of the importance of the study, I agreed voluntarily to participate and provide the sample required for the study.

I _____hereby give my consent for providing the request information and blood Sample as the doctor find best for me.

Signature:_____Date: _____

10.4. Appendix: Somali Language translated Questionnaire

Ka qayb qatayaasha sharafta leh waxaa si naxariisle la idiinka codsanayaa inaad bixisaan war bixan saxa sida ugu wanagsan. Waad ku mahadsantihiin ka qayb galkiina.

I. Dadka, dhaqan shaqsiyeed, cabirada jidhka iyo macluumadka caafimadka

1. Card no _____
2. Dada _____
3. Jinsiga Lab ☐ Dhadig ☐
4. Heerka waxbarashada Waxba aan qorin ☐
   Ilaa dugsi sare ☐
   Heer jamacadeed ☐
5. Xalada guurka Guursaday ☐
   Lafuray ☐
   Aan gursan ☐
   Carmal ☐
6. Dakhli < 2000 birr ☐
   2000-5000 ☐
   5000 birr ☐
7. Masamaysaa jimicsi joogto ah Haa ☐ Maya ☐
8. Goobta degananshaha Miyi ☐ Magalo ☐
9. Cabirka Dhararka (M) _____
10. Cabirka Miisanka (kg) _____
11. Cabirka culayska oo loo qaybshay dhararka oo labo jibaran (kg/m2) _____
12. Cabirka dhexda (cm) _____
13. Cabirka misigta (cm) _____
14. Cabirka dhexda oo loo qaybshay cabirka misigta (cm) _____
15. Ma is Isticmashaa khamrida Haa ☐ Maya ☐

16. Haday haa tahay? imisa liter _____

17. Ma cabtaa Sigarka Haa ☐ Maya ☐

18. Qoyskiina cid leh dhiigkar ma jirtaa Haa ☐ Maya ☐

19. Imisa sano ayuu ku hayay dhiigkarku < 1 sano ☐

1-5 sano ☐

>5 sano ☐

20. Cabirka heerka dhiiga (mmHg) _____

21. Isticmaalka milixda Haa ☐ Maya ☐

22. Cunida qaadka Haa ☐ Maya ☐

10.5. Participants Information sheet (Somali version)

Introduction

Haye, ku soo dhawoow cusbitalka, see tahay? _____ Magacaygu waa _____ Waxaan ka imid ahay _____

Waxaan Kula yeelanayaa waraysi kaas oo lagu samaynayay jaamacada Addis Ababa waaxda culuumta caafimaadka. Waxaa si naxariisle la idiinka codsanayaa inaad ka qaybqaadataan mashruuca cilmibaadistan si mudodawacnimo ah. Akhri si daxaderleh warbixintan hoos ku xusan kana jawaab bixi si ekhtiyar ah su,aalaha waraysiga ah.

Mashruuca cilmibaadhista: qiyaasida serum high sensitivity C- reactive protein and serum lipid profiles bukaanada dhiigkarka qaba.

Hayada maalgelinaysa: Addis Ababa university Department of Medical Biochemistry, College of health science.

Cida masuul ka ah baaritaankan: Mohamed Ali (BSC, MSc candidate in Medical Biochemistry).

Advisorada: Gnana Sekaran (PhD), Dr Daniel Seifu (PhD).

Ujeedada mashruuca cilmibaadhista

Warbixinta waraaqda hoosku xusan waxaa diyaariyay baaraha iyo lataliyayasha Jaamacada Addis Ababa ee mashruucan oo ay ujeedadiisu tahay qiyaasida serum high sensitivity C-reactive proteins iyo seum lipid profileska bukaanada dhiigkarka qaba.

Hababka baaritaanka

Waxaa si naxariisleh lagaga codsanayaa hadii aad ka qaybqaadanayso si mudadawacnimo ah mashruucan. Hadii aad ogolatay shaqalaha caafimaadka ayaa ku siini ama kuu sheegi warbixin ku saabsan baaristan. Xirfadlayaasha caafimaadka ayaa ku waydiini suaalo ku saabsan xaaladada caafimaada waxayna kaa qaadayaan waxoogaa dhiig ah fartaada si loogu baro shaybaadhka taas oo waxtar u leh cilmi baaristan.

10.6. Informed consent (Somali version).

Foomka ogolaanshaha ka qaybqaatayasha mashruuca cilmibaadhista ee Jaamacada Adis Ababa, waaxda Caafimaadka, qayb waaxeed ka Biochemistariga.

Magaca ka qaybqaataha cilmibaadhista _____

Namberka kaarka_____

Waxaa si cad la iigu wargeliyay mashruuca cilmi baadhista oo ay ujeedadiisu tahay si loo cabiro dhiiga c-reactive borotinka iyo lipid profile ka ee dadka dhiigarku hayo. Ujeedada cilmibaadhistan Waa la ii sharaxay aniga, waxaa kaloo la ii sheegay natiijada la helo inay waxtar u leedahay bulshada si si wanaagsan loogu xakameeyo cudurkan dhiigkarka.

Waxaa kale oo la igu wargaliyay kalsooniada mashruucan cilmibaarista ah. Intaas waxaa dheer waxaa kaloo si wanaagsan la iigu wargaliyay xuquuqda aan u leeyahay inaan iska diidi karo inaan ka qayb qaato baadhistan. Sidaas darted, anigoo si buuxda u fahmay faaiidada cilmibaadhistan, waxaan si mudadawacnimo ah uga qaybqaadanayaaa oon walibana bixinayaa dhiiga la iga baahanyahay cilmi baadhistani.

Anigoo ah_____waxan halkan u joogaa inaan siiyo si ogolaansho ah codsiga dhiiga sida uu dakhtarku iga qaadayo.

Saxeexa: _____Taarikhda: _____