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Assessment of Cardiometabolic Risks and Associated Factors among Ethiopian Public Health Institute Staff Members

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A Master's thesis submitted to, School of Graduate Studies, Addis Ababa University, Department of Biochemistry, College of Health Sciences, in partial fulfillment of the requirements for Degree of "Master of Science in Medical Biochemistry.

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This is to certify that the thesis work prepared by Zeleke Geto, entitled with:-"**Assessment of Cardiometabolic Risks and Associated Factors among Ethiopian Public Health Institute Staff Members**" and Submitted in partial fulfillment of the requirements for the degree "Master of Science in Medical Biochemistry" in the department of Biochemistry complies with regulations of the university and meets the accepted standards with respect to originality and quality.

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Abstract

Background: - Non communicable diseases are increasingly becoming the global cause of premature death encompassing cardiovascular diseases, cancer, respiratory diseases and diabetes mellitus. Cardiovascular diseases are the major cause of death accounting about nearly half from all deaths by non-communicable diseases as a result of increasing cardiometabolic risks such as insulin resistance, impaired glucose intolerance, dyslipidemia, hypertension and central obesity.

Objective: -Was to assess the magnitude and associated risk factors for cardiometabolic risks among Ethiopian Public Health Institute staffs.

Methodology: - Cross section study design was conducted from January to October 2018 on Ethiopian Public Health Institute staff members using WHO Non-Communicable Diseases (NCD) step survey instrument version 3.1.2008. A total of 450 study participants were involved in this study. The data collection tools were questionnaires, physical measurement and biochemical analysis. The questionnaire was modified with expanded and optional questions like chat chewing to suit local needs. Biochemical analysis were done using COBAS 6000 analyzer. SPSS version 20 was used for statistical data analysis. Ethical clearance was obtained from EPHI Institutional review board (EPHI-IRB) and Addis Ababa University Biochemistry Department ethics and research committee (DRERC).

Results: - The prevalence of metabolic syndrome was 124/450 (27.6%). Prevalence of central obesity, low HDL and hypertension were 80.2%, 41.3% and 23.6% respectively. Likewise, only 24% of the study participants were free from any components of metabolic syndrome and about 40% of the participants had at least two and above components used in metabolic syndrome.

Conclusion: Prevalence of metabolic syndrome was significant in studied population which increases morbidity and premature mortality with CVD and Type 2 DM. Metabolic syndrome will lead to increased cardiometabolic risks causing death from CVD and Type 2 DM. Interventions focused on life style change, nutritional elements and physical activities and early screening are recommended to overcome the disease burden.

Key words Metabolic Syndrome, Cardiometabolic Risk, CVD, Type 2 DM, Hypertension, Hyperglycemia, Dyslipidemia, Central Obesity.

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Abbreviations

AACE	American Association of Clinical Endocrinologists
AHA	American Heart Association
ASCVD	Arteriosclerotic Cardio Vascular Disease
BMI	Body Mass Index
BP	Blood Pressure
CE	Cholesterol Esterase
CMRs	Cardio metabolic Risks
CVDs	Cardio Vascular Diseases
DBP	Diastolic Blood Pressure
EGIR	European Group for the study of Insulin Resistance
EPHI	Ethiopian Public Health Institute
ENAO	Ethiopian National Accreditation Office
FFA	Free Fatty Acid
HDL	High Density Lipoprotein
HL	Hepatic Lipase
hs-CRP	High Sensitive C-Reactive Protein
IDF	International Diabetes Federation
IGT	Impaired Glucose Tolerance
IRB	Institutional Review Board
ISO	International Standard Organization
LDH	Lactate Dehydrogenate
LDL	Low Density lipoprotein
LPL	Lipoprotein Lipase
MetS	Metabolic Syndrome
NCD	Non Communicable Diseases
NCEP ATP	National Cholesterol Education panel Adult Treatment Program
OGTT	Oral Glucose Tolerance Test
OR	Odds Ratio
RAAS	Rennin Angiotensin Aldosterol System
SD	Standard Deviation
SBP	Systolic Blood Pressure
SNS	Sympathetic Nervous System
T2D	Type 2 Diabetes
TG	Triglyceride
VLDL	Very Low Density Lipoprotein
WHO	World Health Organization

1 INTRODUCTION

Non communicable diseases (NCDs) are increasingly becoming the leading causes of morbidity and mortality involving every country in the Globe (Ekpenyong *et al*., 2012). The leading NCDs encompass collections of illness including cardiovascular diseases (CVDs), diabetes mellitus type 2, chronic obstructive lung disease, and cancer. These NCDs shared common and key modifiable behavioral risk factors like unhealthy diet, lack of physical activity, use of alcohol, tobacco which in turn lead to clinical disorders like overweight/obesity, raised blood pressure, raised cholesterol, and finally chronic disease (WHO, 2017). These risk factors have showed clustering, and synergizing effect through time and associated with higher prevalence of NCDs including cardiovascular diseases and related mortality (Kaukua *et al*., 2001, Alzeidan *et al*., 2016). According to the 2017 report of World Health Organization (WHO), NCDs such as CVDs, cancer, diabetes and chronic respiratory diseases are the global leading causes of deaths and are responsible for about 70% of all deaths in the worldwide (WHO, 2017). From 36 million annual NCD deaths Cardiovascular diseases primarily accounted for (17.5 million of total NCD deaths), followed by cancers (8.2million of the NCD deaths), respiratory diseases (4.0 million of the NCD deaths) and diabetes mellitus (1.5million of the NCD deaths) (Mendis, 2014). Globally cardiovascular diseases being the largest contributor to global mortality, accounting for nearly half of 36 million annual NCDs deaths and produces massive health and economic burdens (Benziger *et al*., 2016).

Cardiometabolic syndrome is combination of metabolic dysfunctions including insulin resistance, impaired glucose intolerance, dyslipidemia, hypertension and central obesity which are associated with an increased risk of cardiovascular diseases (CVDs) and type 2 diabetes (Ash-Bernal and Peterson, 2006). Cardiometabolic syndrome is also called insulin resistance syndrome which is triggered mainly by insulin resistance leading to a series of events like; obesity, hypertension, dyslipidemia and hyperglycemia or it is cluster of risk factors to cause the morbidity and mortality with cardiovascular diseases and type 2 diabetes mellitus **(**Kelli *et al*., 2015, von Bibra *et al*., 2016)**.** This complex cardiometabolic disorder has increasingly become a major worldwide public health problems, because of its association with increased risk of type 2 diabetes mellitus, atherosclerotic

cardiovascular disease and all causes mortality (Ala'a *et al*., 2012). With the rise of cardiometabolic risks such as obesity, hyperglycemia, hypertension and dyslipidemia; cardiovascular diseases become the leading causes of premature mortality (Carney *et al*., 2016). In addition high rates of smoking, alcohol consumption, poor diet and limited physical activities are risk factors for cardiovascular diseases (Vancampfort *et al*., 2011, Krishnadas *et a*l., 2012). Cardiovascular diseases which accounts for one-half all NCD deaths in the world and are nearly also 70% cause of deaths in low and middle income countries (Benziger *et al.*, 2016).

These metabolic syndromes were characterized by different criteria according to different guidelines. However these criteria do not fully predicted and difficult to recognize in single clinical setting. Therefore, structured lifestyle interventions are required to adequately treat cardiometabolic syndrome and reduce residual CVDs caused mortality. Timely diagnosis of cardiometabolic risk factors helps to identify individuals at high risk for CVD and T2D and to initiate preventive strategies before end-organ damage occurs (Sperling *et al*., 2015).

1.1. Literature review

1.1.1 Metabolic Syndrome

Metabolic syndrome is the major and increasing public health problem and clinical challenge worldwide with increasing of urbanization, excess energy intake, increasing obesity and sedentary life style (Kaur, 2014b). Metabolic syndrome is defined by combinations of interconnected physiological, biochemical, clinical and metabolic factors that directly increase the risk of arteriosclerosis cardiovascular disease (ASCVDs), type 2 diabetes mellitus and all are the related causes of mortality (Nazare et al., 2018, Kaur, 2014b). The components of syndrome related to arteriosclerotic and type 2 diabetes mellitus risks include abdominal obesity, atherogenic dyslipidemia, elevated blood pressure, insulin resistance with or without glucose intolerance, proinflammatory state, and prothrombotic state (Sperling *et al*., 2015). Synergistic effects of each inter-related components had paramount contribution to the risks of cardiovascular diseases, in addition of their independent effects **(**Mottillo *et al*., 2010, Ala'a *et al*., 2012, Sperling *et al*., 2015). Insulin resistance in liver results in impaired glucose output and fatty acid metabolism

leading to increased triglyceride content and VLDL secretion from liver (Meigs *et al*., 2015).The risks of developing cardiovascular diseases increases rapidly with an increasing number of metabolic syndrome components. Male having greater than or equal to three risk factors and female greater than or equal to two risk factors for female are more vulnerable to develop CVD as compared to those without any risk factors of metabolic syndrome (Girman et al., 2005). Metabolic syndrome is a cluster components for the development of cardiovascular diseases and type 2 diabetes, which is responsible for a 2.5-fold increased cardiovascular mortality and a 5-fold higher risk of developing diabetes (Moreira *et al*., 2014).

The Pathophysiology of metabolic syndrome is complex with insulin resistance and abnormal regulation of lipid metabolism playing central role in its progression (Ranasinghe *et al.*, 2017). Genetic predisposition is a factor for metabolic syndrome and the prevalence depends on ethnic groups and the overall prevalence among young adults becomes 4.8-7% from pooled data analysis (Nolan et al., 2017). The prevalence in United State (US) adults was increased from 1988 to 2012 for every socio-demographic group; by 2012, more than 25% of all US adults met the definition and criteria for metabolic syndrome agreed to jointly by several international organizations (Moore *et al*., 2017, Falkner and Cossrow, 2014). The prevalence in urban population of Brazilian is also found 22.7% which is being influenced by age, body mass index, educational levels, physical activity, and leading to a higher prevalence of cardiovascular complications (Moreira *et al*., 2014).

The pathogenesis of metabolic syndrome is complex and so far incompletely understood but the interaction of obesity, sedentary life style, dietary, environmental and genetic factors are known to contribute to the development(Ala'a *et al*., 2012). Even if metabolic syndrome is multifactorial in its origin pathogenesis is underlined by two tightly intertwined conditions obesity and insulin resistance. These conditions together can lead to dyslipidemia, hypertension and impaired fasting blood glucose or diabetes, the most dangerous risk factors for development of cardiovascular diseases (CVDs) and type 2 diabetes mellitus (T2DM) (Kaur, 2014b).

Different organizations and experts had proposed defining criteria for metabolic syndrome considering to the higher risk of developing CVDs and type 2 Diabetes. These experts develop consensus definitions based on evidence- based outcomes with their similar focus on basic criteria as obesity, dyslipidemia, hyperglycemia and hypertension substantial difference remained concerning the insulin resistance (Alberti *et al*., 2005).

1.1.2 Definitions of Metabolic Syndrome

The World Health Organization (WHO) definition developed in 1998, accounting insulin resistance as absolute requirement for defining metabolic syndrome. Insulin resistance could be measured impaired fasting glucose above predetermined cutoff value of 100 mg/dL or impaired glucose tolerance (IGT) defined as glucose level above cutoff value commonly 140 mg/dL for 120 minutes after ingestion of 75 grams of glucose. Elevated homeostatic model assessment for insulin resistance (HOMA-IR) value can also be used as evidence of insulin resistance (Alberti and Zimmet, 1998).

After a year of WHO definition, European group for the study of insulin resistance (EGIR) proposed of modification. Like the WHO, the EGIR insulin resistance defined by fasting insulin value greater than the 75^{th} percentile plus two other factors among abdominal obesity, hypertension, raised blood glucose and elevated triglycerides and/or reduced HDL (Balkau, 1999).

The National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) in 2001 developed definition for metabolic syndrome presented with the presence of any three or more of the five criteria. This guideline the most broadly and commonly used as a result of simple and easy to remember with readily accessible laboratory tests for physicians (Grundy *et al*., 2002).

In 2005 the International Diabetes Federation (IDF) published a new metabolic syndrome defining criteria as central obesity as essential component. Ethnicity and sex specific based waist circumference (WC) value was suggested to identify central obesity The NCEP ATP III and IDF criteria were the most due to the higher operating easiness of the obtained clinical and lab data **(**Paula *et al*., 2010). Table 1 summarizes the four commonly used definitions of metabolic syndrome.

Table 1 Diagnostic criteria for Metabolic Syndrome used in the study. Addis Ababa, Ethiopia, 2018.

	NCEP ATP III (2001)	WHO (1998)	EGIR (1999)	IDF
Absolutely required	None	Insulin resistance (IFG,IGT T2DM or other evidence of IR	Hyperinsulinemia* (Plasma insulin >75th percentile)	Central obesity (WC$^{€}$ ≥94cm (M), ≥80cm (F)
Criteria	Any three of the five criteria listed below	IR or diabetes plus two of the five criteria listed below	Hyperinsulinemia plus any two of the four criteria listed below	Obesity plus two of the four criteria listed below
Obesity	WC >90/80 M/F	WHtR >0.90 (M), >0.85 (F)or BMI >30kg/m^2	WC >94cm (M), >80cm (F)	Central obesity already required
Hyperglycemia	Fasting Glucose >100mg/dl or on Rx	Insulin resistance already required	Insulin resistance already required	Fasting Glucose >100 mg/dl
Dyslipidemia	TG≥150mg/dl or Rx	TG≥150mg/dl or HDL<35/39mg/dl (M/F)	TG≥177mg/dl or HDL <39 mg/dl	TG≥150mg/dl or Rx
Dyslipidemia (second separate criteria)	HDL <40mg/dl (M) <50mg/dl (F)			HDL <40mg/dl (M) <50mg/dl (F)
Hypertension	>130/85mmHg or Rx	≥140/90mmHg or Rx	≥140/90mmHg or Rx	>130/85mmHg or Rx
Other Criteria		Microalbuminuria$^{£}$		

IGT, Impaired Glucose Tolerance, IFG, Impaired fasting Glucose, IR, Insulin Resistance, T2DM, Type 2 Diabetes Mellitus, Rx, Pharmacological Treatment, WHtR, Waist to Height Ratio

$^{£}$Urinary Albumin excretion of ≥20ug/min or Albumin Creatinine ratio of ≥30mg/g

*Reliable only in patients with T2DM

€Criteria for central obesity (WC) are specific for each population

1.1.3 Epidemiology of Metabolic syndrome

The incidence of metabolic syndrome often increases parallel to the incidence of obesity and type 2 diabetes (one of the outcome of metabolic syndrome) (Saklayen, 2018). According to the global survey of obesity in 195 countries done in 2015 showed about 604 million adults and 108 million children were obese. The prevalence of obesity was increasing in most countries and doubled in 73 other countries since 1980 (Afshin *et al*., 2017). Even though different criteria are used to define metabolic syndrome and variable population distribution made hard to measure, the global prevalence can be estimated to be about one quarter of the world population which is near to one billion are now affected by metabolic syndrome (Saklayen, 2018).The prevalence is increasing in developed and developing countries with a range of 20% to 45%(de Carvalho Vidigal *et al*., 2015, Engin, 2017, Houti *et al*., 2016, Sirdah *et al*., 2011).The worldwide prevalence of metabolic syndrome in adult population is also increasing with an estimated prevalence of 20%-25% which increases lifelong burden of cardiovascular diseases (Nolan *et al*., 2017).

The recent study in Ethiopia among public employees in Mekele town showed a prevalence of 40% metabolic syndrome (Gebremariam *et al*., 2018). Physical inactivity, smoking family history of diabetes, obesity and sedentary lifestyle all influence the prevalence of the metabolic syndrome (Kolovou *et al*., 2007, Herath *et al*., 2018).

1.1.4 Pathogenesis of Metabolic Syndrome

Different researchers have proposed that different reasons for metabolic syndrome to occur. However, central obesity and insulin resistance play central role in pathophysiology of metabolic syndrome (Ren *et al*., 2018). The metabolic syndrome is a complex pathophysiologic state that originates primarily from an imbalance of calorie intake and energy expenditure but also affected by genetic/epigenetic make up of individual, predominance of sedentary lifestyle over physical activity, and other factors like quality and composition of food and composition of gut microbes (Saklayen, 2018). The adipose tissue in addition of being inert energy storage deposit, adipocytes are now known to be metabolically active secreting hormones affecting appetite, satiety and energy metabolism of the body. The adipocyte hormone leptin suppresses appetite and adiponectin has

opposite effect of increases insulin resistance (Adamczak and Wiecek, 2013). In addition of central obesity and insulin resistance which are interrelated factors, low levels of high-density lipoprotein (HDL), elevated levels of triglycerides, elevated blood pressure, and a pro-inflammatory, pro-thrombotic environment can occur together to promote development of type 2 diabetes and cardiovascular diseases (Mazloomzadeh et al., 2018).

1.1.4.1 Obesity

Obesity is the most prevalent and considered as the 21st century epidemics, nutritional disorder in developed and developing countries that is associated with increased cardiometabolic risks (Ala'a *et al*., 2012). Obesity is defined as a disproportionate body weight for height with an excessive accumulation of adipose tissue that is usually accompanied by mild, chronic, systemic inflammation. Fat deposition in obesity resulted from an imbalance between caloric intake and energy expenditure. Accordingly low physical activity (sedentary life style) and over consumption of high energy yielding foods above the needs of an individual results in fat depositions leading to obesity (Sellayah *et al*., 2014). Obesity is associated with the development of type 2 diabetes mellitus, cardiovascular diseases, some types of cancer and other adverse pathological conditions. Some of these co-morbidities are considered as features of the commonly named metabolic syndrome, a prevalent risk factor for cardiovascular disease and type 2 diabetes mellitus (González-Muniesa et al., 2017b). Based on the position fat accumulation in which they are found adipose tissue in the body are classified as visceral adipose tissue, found in intra-abdominal (mainly mesenteric, perirenal and pericardial adipose tissue) and subcutaneous adipose tissue (Rosen and Spiegelman, 2014, Shulman, 2014). Visceral fat area correlated with obesity-associated cardiovascular risks, but cardiovascular risks did not increase with the increase of subcutaneous fat (Ortega *et al*., 2016). Obesity is a major cause of cardiovascular and kidney diseases through different mechanism like hypertension, dyslipidemia, impaired glucose intolerance and inflammation(González-Muniesa et al., 2017b)

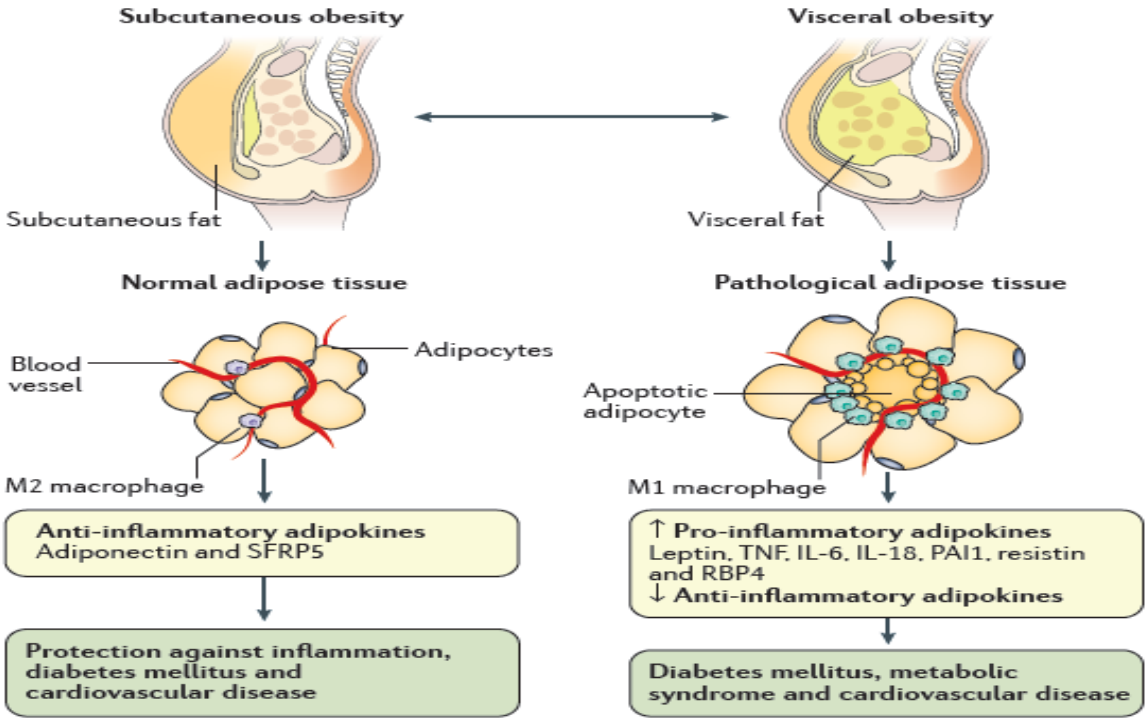


Figure 1 Pathological Changes in Adipose Tissue

Depending the location of obesity can be visceral which is associated with cardiovascular risks while subcutaneous obesity did not increase cardiovascular risks. Adipocytes in subcutaneous fat might function with expected release of anti-inflammatory adipokines , whereas adipocytes in visceral fat obesity increase the release of pro-inflammatory adipokines and suppress the secretion of anti-inflammatory adipocytokines to create low grade inflammation leading to systemic metabolic impairment. Adipocyte necrosis created with visceral fat results abnormal oxygen tension to recruiting macrophages around dead cells.PAI1, prothrombin activator inhibitor 1; RBP4, retinol-bindingprotein 4; SFRP5, secreted frizzled-related protein 5; TNF, tumour necrosis factor(González-Muniesa et al., 2017a).

1.1.4.2 Hyperglycemia

Hyperglycemia describes as condition of raised blood glucose that is caused by defects in insulin secretion and decreased tissue sensitivity to the action of insulin, leading to a compensatory increase in insulin secretion (hyperinsulinemia) (Artunc *et al*., 2016). Insulin resistance has been shown to occur in the classical insulin-responsive organs (liver, skeletal muscle and white adipose tissue), particularly in association with obesity and the metabolic syndrome(Zheng *et al*., 2017). Insulin is secreted from β-cells of pancreas normally to reduce glucose output by the liver and increases glucose uptake by skeletal muscle and adipose tissue. However when the feedback loops between insulin action and insulin secretion do not function properly, glucose production in the liver was increased and glucose uptake by insulin sensitive tissue (skeletal muscle and adipose tissue) have been decreased (Zheng *et al*., 2017, Balagopal *et al*., 2011). Impaired insulin action due to insulin resistance or β-cells dysfunction results in metabolic defects in major insulin sensitive tissue leading hyperglycemia and hyperlipidemia which produces several other pathophysiologic conditions in different organs. Dyslipidemia resulted from insulin resistance characterized by increased triglyceride, low HDL and abnormal structure of LDL (sdLDL) have atherogenic properties (Corbatón-Anchuelo *et al*., 2013). Small dense LDL are susceptible for oxidation and easily penetrate to arterial wall with stronger attachment. Oxidized sdLDL also acquire new properties that recognized by immune cells as foreign which attracts biological responses like leukocytes. Leukocytes ingest oxidized lipoproteins to produce foam cells finally resulted in atherosclerotic plaque (Dokken, 2008). The chronic state of continues hyperglycemia called Diabetes mellitus was raising in prevalence throughout the Globe because of life style change, environmental and genetic factors are responsible (Laakso and Kuusisto, 2014). The pathophysiologic crosstalk between different organs has adverse effect on cardiovascular systems (Artunc *et al*., 2016). Insulin resistance in target cells shows attenuated response to insulin, which results in hyperinsulinemia in compensation to affect organ cross talk and promote organ dysfunction and diseases (Roth *et al*., 2017). Insulin resistance in adipose tissue, skeletal muscle and liver resulted in insulin signaling to cause hyperglycemia and hyperinsulinemia which inappropriately activated renin angiotensin system and oxidative stress in kidney (Stefan *et al*., 2014).

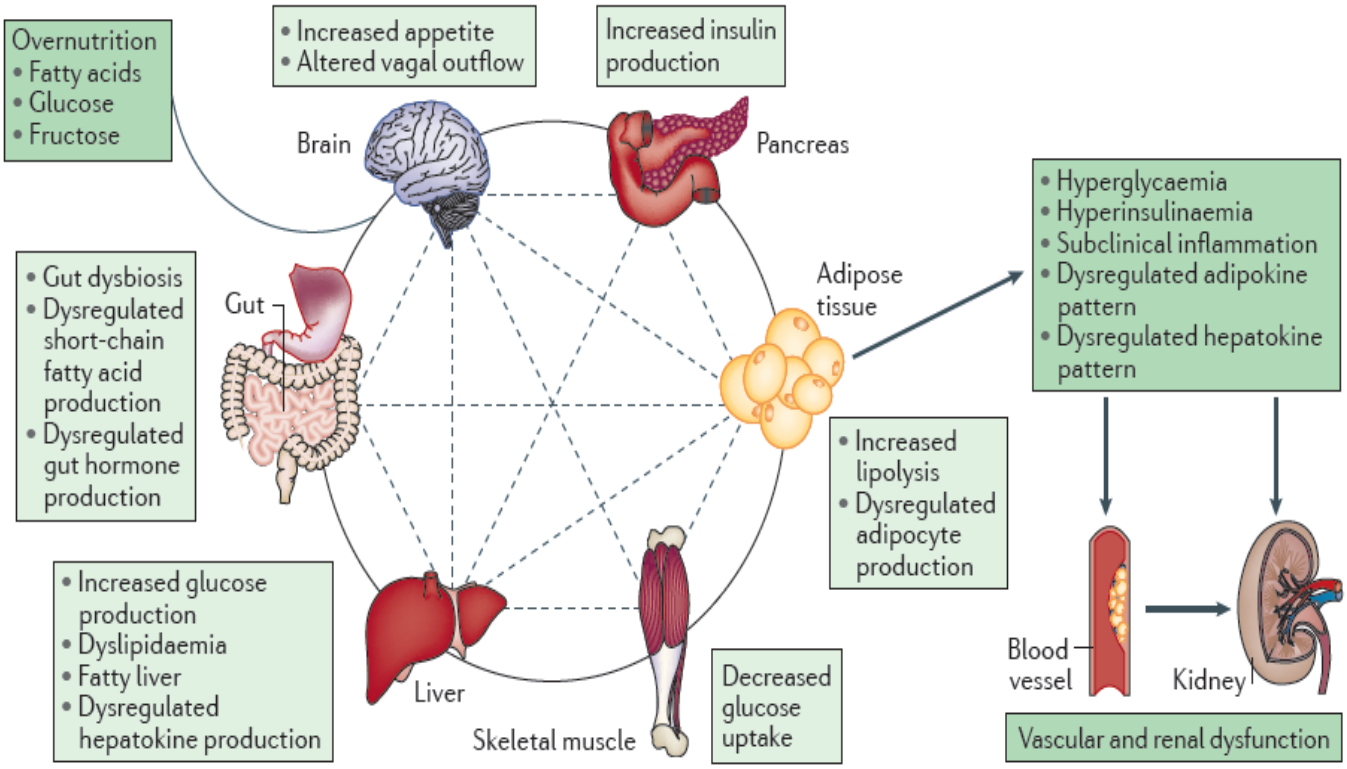


Figure 2Organ Cross Talk in Obesity

Insulin has metabolic effects on the liver, adipose tissue and skeletal muscle and non-classical effects on other organs, including the brain, gut, pancreas, vasculature and kidney. These effects are impaired in the insulin-resistant state, resulting in hyperglycemia and hyperlipidemia, which trigger several other pathophysiologic conditions in these organs. Furthermore, hyperglycemia and hyperlipidemia induce dysregulated adipokine and hepatokine production, hyperinsulinemia and subclinical inflammation. These effects together with gut dysbiosis lead to a pathophysiological organ crosstalk that has an adverse impact on cardiovascular and renal systems(Artunc *et al*., 2016).

1.1.4.3 Hypertension

The cause of hypertension in Metabolic Syndrome is multifactorial and likely includes all the elements of the syndrome, including obesity, insulin resistance, and dyslipidemia. The co-existence of hypertension and metabolic syndrome components in an individual potentiate one another leading to synergistic effect that increases the development of total CVDs risks (Osuji and Omejua, 2012, Tachebele *et al*., 2014). Obese individuals who are metabolically active and under healthy condition shows higher cardiometabolic risks including hypertension (Shah *et al*., 2015). Obesity is associated with increased extracellular volume expansion and increased tissue blood flow which increases venous

return to the heart and cardiac output (Brunner *et al*., 2015, Hall. *et al*., 2018). Some of the increased tissue blood flow is due to secondary growth of these tissues as body weight and metabolic demands of these tissues increase (Hall *et al*., 2015). Even if the exact mechanism of obesity hypertension is under investigation; however ,activation of the renin angiotensin aldosterone system RAAS and sympathetic nervous system (SNS) and physical compression of the kidneys may contribute to impaired renal-pressure natriuresis and increased renal sodium re-absorption leading to increased blood pressure (Hall. *et al*., 2018, Redon *et al*., 2009). Insulin resistance or hyperinsulinemia as well contribute for the development of hypertension by activation of sympathetic nervous system (SNS) leading to increase renal sodium retention, increase cardiac output and the arteries respond to vasoconstriction. Insulin resistance also tends to lose the vasodilatory effect of insulin (Redon *et al*., 2009).

1.1.4.4 Dyslipidemia

Lipid abnormalities called combined dyslipidemia that are characterized by low levels of high density lipoprotein cholesterol (HDL-C), high levels of triglycerides and increased number of small dense low density lipoprotein (sdLDL-C) particles which are more atherogenic (Kavey, 2015, Raal, 2009). Combined dyslipidemia is primarily explained by an increase VLDL driven by increased delivery of FFA to the liver with subsequent increased synthesis of triglyceride and apolipoprotein B100 as a result of insulin resistance in liver, skeletal muscle and adipose tissue (Bremer *et al*., 2012). Insulin resistance in adipocytes characterized by lack of inhibition of hormone sensitive lipase leads to increase release of FFA and activation of lipoprotein lipase which favors accumulation of VLDL particles (Nor *et al*., 2016). Decrease in the number of HDL-C is favored by chemical transformation of cholesterol ester to VLDL in exchange of triglycerides leading to activation of hepatic lipase to metabolize HDL triglyceride creating altered smaller and denser HDL particles which becomes readily cleared from plasma or excreted via the kidney, resulting in lower circulating HDL-C levels(McCrindle, 2018). In another process small dense LDL particles are produced by Cholesterol ester transfer protein-mediated exchange of triglyceride from VLDL particles with cholesterol ester from LDL particles results in a triglyceride enriched LDL particle which are not capable and less readily

cleared by LDL receptors, leading to a more prolonged circulation time and greater accumulation(Wang and Peng, 2011). The accumulated LDL particles are more susceptible to oxidation in the formation of foam cells leading to endothelial cell dysfunction initiating and drive atherosclerosis (Burns *et al*., 2012, McCrindle, 2018).

Lack of sensitivity of the metabolically active adipocytes to insulin and acylation stimulate protein and results in increased release of circulating free fatty acids. These contribute excessive substrate for triglyceride production; stimulate production of apolipoprotein B in the liver, which are then incorporated into an increased production of triglyceride-enriched VLDL particles. Triglyceride from VLDL is exchanged with cholesterol esters from both LDL and HDL particles, a process mediated by cholesterol ester transfer protein. Hepatic lipase metabolizes the triglyceride content of both HDL and LDL, resulting in smaller, denser particles. For LDL, this results in a more atherogenic particle, and for HDL, these results in increased catabolism and clearance (Mudd *et al*., 2007).

1.1.5 Cardiometabolic Risks

The contributing factors to increase the risk of cardiovascular and metabolic diseases were frequently clustered together called metabolic syndrome (Mottillo *et al*., 2010). In addition the metabolic syndrome has been linked to increased CVDs, and mortality risks concomitantly increases with the number metabolic syndrome risk factors (Repas, 2007). The clinical definitions of metabolic syndrome do not include all components that lead to increased cardiovascular diseases known as cardiometabolic risks (Skodvin, 2015, Lender and Sysko, 2006). In addition to metabolic syndromes risk factors, including abdominal obesity, dyslipidemia, elevated blood pressure, insulin resistance, low levels of high-density lipoprotein (HDL) cholesterol and elevated levels of triglycerides, there are also the modifiable risk factors (traditional risk factors) age, sex, family history and smoking with emerging factors especially inflammatory state and pro-thrombotic profile that are the building blocks of "Global Cardiometabolic Risks" (CMR) (Ala'a et al., 2012, Leiter et al., 2011b).

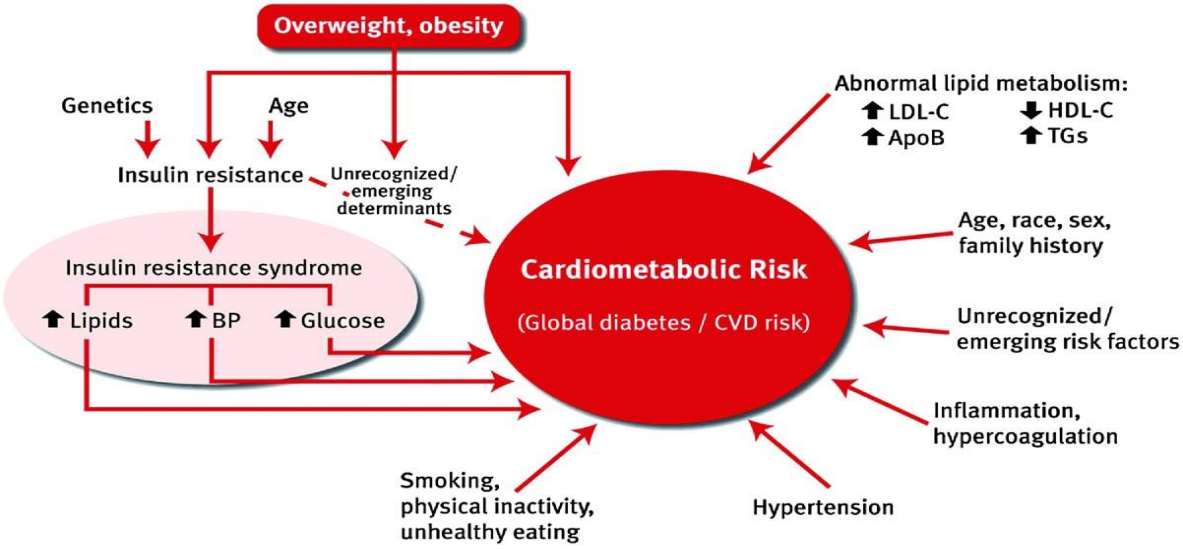


Figure 3 Traditional and Emerging CVDs Markers that contribute to Global Cardio Metabolic Risks

Cardiometabolic risks leading to T2DM and CVDs consisting Insulin Resistance caused by overweight/ Obesity especially central obesity together with genetics and aging producing dyslipidemia, hypertension and hyperglycemia. These cluster conditions or in isolation leads to Cardiometabolic risks. They also exacerbated by physical inactivity and smoking. Apo B, apolipoprotein B; BP, blood pressure; CVD, cardiovascular disease; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TGs, triglycerides(Leiter et al., 2011a).

Cardiometabolic risk factor entails alterations of the overall increasing risk of cardiovascular diseases and metabolic disturbances. Overweight and obesity are associated with an altered metabolic state, which increases the risk of cardiovascular disease and a reduced life expectancy (Skodvin, 2015). Cardiometabolic risks also include all the risk factors for CVDs and diabetes, including the traditional risk factors and the more novel or emerging risk factors (e.g., pro-thrombotic profile, inflammatory state).

Cardiometabolic risks cannot defined only by components of metabolic syndrome. It is defined as cluster of risk factors associated with metabolic syndrome as well as elevated LDL, raised cholesterol, smoking alcohol consumption and inflammatory markers (Lalan *et al*., 2018).

1.2. Significance of the Study

Currently non communicable diseases including cardiovascular diseases, cancer, diabetes and respiratory diseases are increasing like an epidemic in the world with the highest burden in middle and low income countries as a result of behavioral and life style changes. Cardiometabolic diseases are the foremost causes of deaths in the globe and can be present long before becoming clinically apparent. A premature death from all non-communicable diseases finally converges to the cardiovascular deaths. Cardiovascular diseases causes' death before it was diagnosed and recognized clinically.

Cardiovascular disease includes a constellation of risk factors such as central obesity, high blood pressure, insulin resistance, abnormal cholesterol levels. These risk factors collectively increase the utilization of expensive healthcare resources. Assessment of accurate predictors of disease and risk factors have a particular importance for early detection and or prevention of morbidity. These risk factors are increasing due to different reasons such as sedentary life style, aging, urbanization, increasing prevalence of obesity, smoking and drinking in the world and alarmingly in Ethiopia. These risk factors are more commonly practiced in urbanization area with sedentary life style follower populations like government institution staffs which they expend more working times by sitting. Ethiopian Public Health Institute (EPHI) is one of the government institutes whose staffs expend their working time with less physical activity according to the nature of their jobs. However there is limited evidence about the magnitude and types of cardiometabolic diseases risks in Ethiopia which initiates us to assess the cardiometabolic risks and associated factors in adult civil servant populations. Knowing the risk factors and avoiding them is so important for and it is the way to prevent deaths from cardiovascular diseases.

1.3. Statement of the Problem

Non communicable Diseases now days are the first killer globally with no country untouched (Ekpenyong *et al*. 2012). The prevalence is increasing and expected to rise in the future if interventions not effective. The priority of NCDs in Low and middle Income countries is also predominated and covered with the greatest burden of communicable, nutritional and maternal epidemic(Islam *et al*., 2014). NCDs mortality converges to the CVDs and stroke which have multiple risk factors including behavioral, biological and environmental factors(Aikins *et al*., 2014). CVDs are the number one cause of death globally in which more people die annually from CVDs than from any other cause. An estimated 17.7 million people died from CVDs in 2015, representing 31% of all global deaths from which about 82% premature deaths occurred in low and middle income countries (Sacco *et al*., 2016;Maledis *et al*., 2015). Most cardiovascular diseases can be prevented by addressing behavioral risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity and harmful use of alcohol using population-wide strategies**(**Moreira *et al*., 2014).People with cardiovascular disease or who are at high cardiovascular risk (due to the presence of one or more risk factors such as hypertension, diabetes, hyperlipidemia or already established disease) need early detection and management using counseling and medicines, as appropriate (Leiter *et al*., 2011a).

Assessing these cardiometabolic risks in general population used to reduce the incidence and prevalence of risk factors by implementing population-wide policies to reduce behavioral risk factors, including harmful use of alcohol, physical inactivity, overweight, obesity and high salt intake.

1.4. Hypothesis

Null Hypothesis: - There is no association of socio-demographic, behavioral and clinical factors with metabolic syndrome and components of cardiometabolic risks.

Alternate Hypothesis: - Socio-demographic, behavioral and clinical factors have associations with metabolic syndrome and components of cardiometabolic risks.

2. OBJECTIVES

2.1. General Objective

To assess the magnitude and associated risk factors for cardiometabolic Risks among Ethiopian Public Health Institute staffs.

2.2. Specific Objectives

- To estimate the magnitude of behavioral and biological risk factors for cardiometabolic Risks.
- To determine the level of blood glucose, systolic & diastolic blood pressure.
- To determine the prevalence of central obesity
- To estimate the prevalence of dyslipidemia among the staff members
- To identify the associated factors for metabolic syndrome

3. MATERIALS AND METHODOLOGY

3.1. Study population and area

The study was conducted in Ethiopian Public Health Institute located in Addis Ababa, Ethiopia. The source population of the study were all staff members of Ethiopian Public Health Institute and the study population were all volunteer staff members of Ethiopian Public Health Institute.

3.2. Study design and period

Cross sectional study was conducted using WHO stepwise survey from January 2018 to October 2018.

3.3. Inclusion and Exclusion criteria

Inclusion criteria

- All staff members of Ethiopian Public Health Institute of age 18-69 years

Exclusion criteria

- Staff members of pregnant female

3.4. Sample size

The sample size was determined using single population formula for estimating single population proportion from the infinite population. The formula for calculating the sample size (n) would be:

$$n^* = \frac{(z\alpha/2)^2 P(1-P)}{d^2}$$

Considering the following assumptions:

P= assumed the highest population proportion prevalence of metabolic syndrome in Ethiopian adults 40%(Gebremariam *et al*., 2018)

Margin of error = 0.03(3%), and Non-response rate= 10%

Where:

n*= sample size from the infinite population

z (a/2) = Z-score at 95% confidence interval = 1.96;

P= 40% = 0.40 (positive prevalence); 1-P=Q= 0.60 (negative prevalence)

d= marginal error=0.03 (3%)

$$n^* = \frac{(1.96)^2 0.40\ (0.60)}{(0.03)^2}$$

$$= 1024$$

But our source population was finite with total staff members in EPHI is (N=816) so we have used the finite population correction formula(Arya *et al*., 2012)

$$n = \frac{N\ (z^2)\ P\ (1-P)}{d^2(N-1)+(z^2)P\ (1-P)}$$

$$n = 454$$

Therefore our minimum sample size was 454 which were selected based on voluntarism

3.5. Variables

Dependent variable

Serum Glucose, Lipoproteins, Cholesterol, Triglycerides, hs-CRP (High sensitive CRP)

Independent variables

Socio demographic- Age, Sex, educational level, income per month, systolic blood pressure, diastolic blood pressure, height, weight, BMI, waist circumference

Behavioral- Alcohol consumption, physical inactivity, low fruit and vegetable intake, Cigarette smoking, Khat chewing

Co-morbid conditions-Hypertension, diabetes, dyslipidemia, obesity.

3.6. Data collection

3.6.1. Questionnaire

A questionnaire was specifically developed per sample size, which helps to either including or excluding from the study. The questionnaire includes the question that assess the socio demographic characteristic such as Age, Sex, educational level, income per month, and co-morbidities, WHO identified risk factors of NCDs with expanded and optional questions to suit local needs also include in the question. The questionnaire also contains behavioral risk factors like tobacco use, alcohol consumption, Khat chewing, fruits and vegetable intake and physical activity (WHO, 2015).

3.6.2. Blood Pressure Measurement

Blood pressure and heart rate measurements were taken three times on the right arm of the survey participants in a sitting position, using a Boso-Medicus Uno instrument with a universal cuff and automatic blood pressure and heart rate monitor. The mean of three measurements was taken for analysis. The measurements were taken after the participant had rested for 15 minutes, and each with three minutes of rest between the measurements (maximum deviation of cuff pressure measurement ± 3 mmHg).

3.6.3. Anthropometric Measurement

Physical measurements such as weight, height, waist circumference, hip circumference and blood pressure were taken using standardized methods and adjusted equipment. Weight was measured in kilogram with light cloths and no wearing of shoes, the participants height was measured in centimeter using height board with no shoes wearing and in upright position then BMI and Waist to height ratio (WHtR) was calculated to determine the obesity status. BMI measures body weight and height, and calculates with (Body weight (kg)/ Body height (m^2). Normal BMI <=25 kg/m^2, Overweight BMI= 24.99-30 kg/m^2, Obese BMI= >=30 kg/m^2.

Waist circumference was measured in centimeter at the narrowest point between the lower costal border and the iliac crest with a constant tension tape and measurement of blood pressure at the midpoint of the lift arm after participants rest for at least five minutes or 30 minutes for those who took hot drinks like coffee with three blood pressure readings was taken for all participants then the mean blood pressure value was taken.

3.6.4. Assessing Physical Activity

According to WHO STEPS, physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity was categorized into vigorous and moderate and sedentary (low) activity.

A vigorous-intensity activity was defined as any activity that causes large increase in breathing or heart rate, if continued for at least 10 minutes (e.g. running, carrying or lifting heavy loads, digging or construction work) at least for three days per week.

Moderate-intensity activity was defined as any activity that causes small increase in breathing or heart rate, if continued for at least 10 minutes (brisk walking or carrying light loads). Or Three or more days of vigorous intensity activity of at least 20 minutes per day; or five or more days of moderate-intensity activity or walking for at least 30 minutes per day. Physical activity related to work, transportation and leisure time was assessed in terms of minutes that caused them breathless or feel palpitation.

Low level physical activity involves a person not meeting any of the above-mentioned criteria for the moderate- or high-level categories

3.6.5. Blood sample collection and processing

About 5mLof blood sample was collected following minimum of eight hour fasting or early in the morning before breakfast with standardize serum separator tube from each participant by trained laboratory technologist. The process of blood sample collection is through aseptic/sterile technique. Serum was obtained from collected blood sample by centrifugation at 3000 rpm for 7 minutes using Rotanta 960 centrifuge in thermo stable condition after 30 minutes of collection. Separated serum sample was transferred immediately to National References Laboratory for Clinical Chemistry, Ethiopian Public Health Institute (EPHI) for analysis or stored at 2-8 ^{0}c until analysis was done.

3.6.6. Biochemical analysis

Laboratory tests were performed for blood glucose, total cholesterol, triglyceride, LDL-cholesterol, HDL- cholesterol and hsCRP using COBAS 6000 (Roche Diagnostics GmbH, Mannheim, Germany) clinical chemistry analyzer. All these tests were done the next day of after STEPS 1 and 2 data collections with minimum 8 hours fasting. Laboratory test results were assessed and categorized according to the definition.

3.6.6.1. Glucose estimation

Glucose: - Glucose is the major carbohydrate present in the peripheral blood. Oxidation of glucose is the major source of cellular energy in the body. Glucose derived from dietary sources and is converted to glycogen for storage in the liver or to fatty acids for storage in adipose tissue. The concentration of glucose in blood is controlled within narrow limits by many hormones, the most important of which are produced by the pancreas.

Test principle: - Enzymatic reference method with hexokinase (Roche Diagnostics Corporation, 2016)

Hexokinase catalyzes the phosphorylation of glucose toglucose-6-phosphate by ATP.

$$\text{Glucose} + \text{ATP} \xrightarrow{\text{HK}} \text{G-6-P} + \text{ADP}$$

Glucose-6-phosphate is oxidized by Glucose-6-phosphate Dehydrogenase (G-6PDH) in the presence of NADP to produce gluconate-6-phosphate. The rate of NADPH formation during the reaction is directly proportional to the glucose concentration and is measured photometrically at 700/340nm wave length.

$$\text{G-6P} + \text{NADP}^+ \xrightarrow{\text{G-6-PDH}} \text{Gluconate-6-P} + \text{NADPH} + \text{H}^+$$

3.6.6.2. Total Cholesterol Estimation

Cholesterol: Cholesterol is a steroid with a secondary hydroxyl group in the C3 position. It is synthesized in many types of tissue, but particularly in the liver and intestinal wall. Approximately three quarters of cholesterol are newly synthesized and a quarter originates from dietary intake. Cholesterol assays are used for screening for atherosclerotic risk and in the diagnosis and treatment of disorders involving elevated cholesterol levels as well as lipid and lipoprotein metabolic disorders.

Principle: Enzymatic, colorimetric method

Cholesterol esters are cleaved by the action of cholesterol esterase (CE) to yield free cholesterol and fatty acids. Cholesterol oxidase (CHOD) then catalyzes the oxidation of cholesterol to cholest-4-en-3-one and hydrogen peroxide. In the presence of peroxidase (POD), the hydrogen peroxide formed effects the oxidative coupling of phenol and 4-aminoantipyrine to form a red Quinone-imine dye (Roche Diagnostics Corporation, 2016).

$$\text{Cholesterol esters} + H_2O \xrightarrow{\text{CE}} \text{cholesterol} + \text{RCOOH}$$

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

$$2\ H_2O_2 + \text{4-AAP} \xrightarrow{\text{POD}} \text{Phenol Quinone-imine dye} + 4H_2O$$

The color intensity of the dye formed is directly proportional to the cholesterol concentration. It was determined by measuring the increase in absorbance at 512 nm with COBAS 6000/c501 module instrument spectroscopically.

3.6.6.3. Triglyceride Estimation

Triglycerides: Triglycerides are esters of the tri-hydric alcohol glycerol with 3 long-chain fatty acids. They are partly synthesized in the liver and partly ingested in food. The determination of triglycerides is utilized in the diagnosis and treatment of patients having diabetes mellitus, nephrosis, liver obstruction, lipid metabolism disorders and numerous other endocrine diseases (Nordestgaard and Varbo, 2014).

Enzymatic colorimetric principle

The method is based on hydrolysis of triglyceride using lipoprotein lipase (LPL) to glycerol followed by oxidation to dihydroxyacetone phosphate and hydrogen peroxide. The hydrogen peroxide produced then reacts with 4-aminophenazone and 4-chlorophenol under the catalytic action of peroxidase to form a red dye which is directly proportional to concentration of triglyceride measured photometrically 700/705nm wavelength (Roche, 2017)

$$\text{Triglyceride} + 3\,H_2O \xrightarrow{\text{LPL}} \text{Glycerol} + 3\,\text{RCOOH}$$

$$\text{Glycerol} + \text{ATP} \xrightarrow[Mg^{2+}]{\text{GK}} \text{Glycerol-3- Phosphate} + \text{ADP}$$

$$\text{Glycerol-3-phosphat} + O_2 \xrightarrow{\text{GPO}} \text{Dihydroxyacetone phosphate} + H_2O_2$$

$$H_2O_2 + \text{4-aminophenazone} + \text{4-chlorophenol} \longrightarrow \text{4-(p-benzoquinone-monoimino)- phenazone} + 2H_2O + HCL$$

3.6.6.4. HDL-cholesterol Estimation

High density lipoproteins (HDL) - Cholesterol: (HDL) are responsible for the reverse transport of cholesterol from the peripheral cells to the liver. Here, cholesterol is transformed to bile acids which are excreted into the intestine via the biliary tract. Monitoring of HDL‑cholesterol in serum is of clinical importance since an inverse correlation exists between serum HDL-cholesterol concentrations and the risk of atherosclerotic disease. Elevated HDL-cholesterol concentrations are protective against coronary heart disease, while reduced HDL‑cholesterol concentrations, particularly in conjunction with elevated triglycerides, increase the cardiovascular risk. Strategies have emerged to increase the level of HDL‑cholesterol to treat cardiovascular disease (Roche Diagnostics Corporation, 2017).

Principle: - The cholesterol concentration of HDL cholesterol is determined enzymatically by cholesterol esterase (CHER) and cholesterol oxidase (CHOD). Cholesterol esters are broken down quantitatively into free cholesterol and fatty acids by cholesterol esterase. In the presence of oxygen, cholesterol is oxidized by cholesterol oxidaseto Δ4-cholestenone and hydrogen peroxide. The color intensity of the blue quinoneimine dye formed is directly proportional to the HDL-cholesterol concentration. It was determined by measuring the increase in absorbance at 583 nm (Roche Diagnostics Corporation, 2017).

$$\text{HDL-Cholesterol esters} + H_2O \xrightarrow{\text{CHER}} \text{HDL-cholesterol} + \text{RCOOH}$$

$$\text{HDL-cholesterol} + O_2 \xrightarrow{\text{CHOD}} \Delta^4\text{-cholestenone} + H_2O_2$$

$$2H_2O_2 + \text{4-amino- antipyrine} + \text{EMSE} + H + H2O \xrightarrow{\text{Peroxidase}} \text{colored pigment} + 5H_2O$$

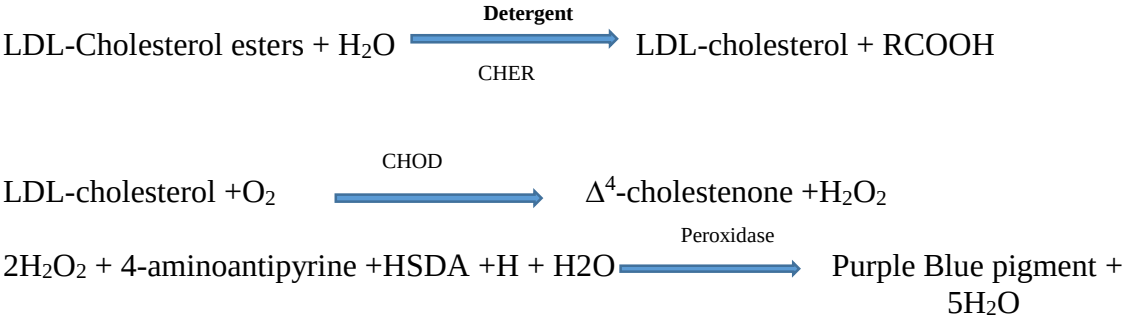
3.6.6.5. LDL –cholesterol estimation

Low Density Lipoproteins (LDL):- play a key role in causing and influencing the progression of atherosclerosis and, in particular, coronary sclerosis. The LDLs are derived from VLDLs (Very Low Density Lipoproteins) rich in triglycerides by the action of various lipolytic enzymes and are synthesized in the liver. The elimination of LDL from plasma

takes place mainly by liver parenchymal cells via specific LDL receptors. Elevated LDL concentrations in blood and an increase in their residence time coupled with an increase in the biological modification rate results in the destruction of the endothelial function and a higher LDL-cholesterol uptake in the monocyte/macrophage system as well as by smooth muscle cells in vessel walls. The majority of cholesterol stored in atherosclerotic plaques originates from LDL. The LDL-cholesterol value is the most powerful clinical predictor among all of the single parameters with respect to coronary atherosclerosis (Roche Diagnostics Corporation, 2016)

Principle: -Homogeneous enzymatic colorimetric assay

Miscellaneous component of LDL- cholesterol is removed by using detergent and cholesterol ester is broken down to free cholesterol and fatty acids by cholesterol esterase. In the presence of oxygen cholesterol is oxidized by cholesterol oxidase to Δ4-cholestenone and hydrogen peroxide. Hydrogen peroxide in the presence of peroxidase reacts with 4- aminoantipyrine to produced purple dye which is directly proportional to the concentration of LDL cholesterol measured photometrically at 585nm (Roche Diagnostics Corporation, 2016)



3.6.6.6. High sensitive C-reactive protein (hsCRP) Estimation

High sensitive C-reactive protein (hsCRP); -Measurement of CRP is used for the detection and evaluation of inflammatory disorders and associated diseases, infection and tissue injury. Highly sensitive CRP measurement of may also be used as an aid in the assessment of the risk of future coronary heart disease. When used together with other laboratory evaluation methods of acute coronary syndromes, it may also be an additional independent indicator of recurrent event prognosis in patients with stable coronary disease or acute coronary syndrome.

Test principle: - Particle enhanced immunoturbidimetric assay.

Human CRP agglutinates with latex particles coated with monoclonal anti-CRP antibodies. The precipitate was determined turbidimetrically (Roche Diagnostics Corporation, 2017)

3.7. Data quality assurance

For each phase of the study design, data quality control techniques were practical. The questionnaire was prepared by English version and translated to local language (Amharic). Data were collected digitally using personal digital assistants (PDAs). The data collectors were professional laboratory technologists and nurses under the close supervision of investigators and were trained before data collection. The training sessions were covered every detail of the study and the full range of skills involved in the study and addresses the objectives of the study. Blood sample collection was done through standardized, calibrated, and sterile technique. Questionnaire pretest was done prior to the concrete data collection process is being started to check the reliability of the data and to increase the quality of the data. Data collected in PDAs was transferred to central server using internet file streaming system (IFSS) and was exported to Microsoft Excel to personal computer for analysis. The biochemical tests were analyzed on calibrated COBAS 6000 instrument after internal quality control (IQC) was done. The tests were done by well trained and experienced professionals with strictly followed SOP. The laboratory was received accreditation certificate with ISO 15189 standard from Ethiopian National Accreditation Office (ENAO) on May 2017. Manual double entry of biochemical tests results of were done to minimize errors.

Table 2 Components and steps of variable in data collection used in the study. Addis Ababa, Ethiopia, 2018.

Steps	Core	Expanded	Remark
Step1: Behavioral	Basic demographic information, including age, sex, literacy, and highest level of education.	Expanded demographic information including years at school, marital status, household income	Khat consumption included in the core data set since khat is a major risk factor of country specific problem
	Tobacco use, alcohol consumption, fruit and vegetable consumption, physical activity	Smokeless tobacco use, Past 7 days drinking, Oil and fat consumption, History of blood pressure, treatment for raised blood pressure, History of diabetes, treatment for diabetes Khat consumption	
Step2: Physical measurement	Weight and height, waist circumference, blood pressure	Hip circumference	
Step3: Biochemical measurement	Fasting blood sugar, total cholesterol,	HDL-cholesterol LDL-Cholesterol fasting triglycerides LDH and hsCRP	

3.8. Data processing and analysis

After data was collected and analysed by well-trained health professionals, statistical data analysis was conducted using statistical package for the social science (SPSS) version 20 software. The data contains response from questionnaires, physical measurement, and biochemical measurement. Descriptive data analyses were presented in tables and/or graphs with means, proportions and frequency distributions. Bivariate and multivariate logistic regression analysis were used to determine the potential determinants of risk factors with cardiometabolic syndromes. Chi-Square test was used to indicate the strength of association with their 95% CI upper and lower limit interval to indicate the significance association or P-value of <0.05 at 95% confidence level was considered to be statistical significance in all analysis.

3.9. Ethical consideration

To conduct the research, ethical approval was obtained from EPHI IRB with meeting number 018 and protocol number EPHI-IRB-082-2018 and from Addis Ababa University Biochemistry Department ethics and research committee (DRERC) with protocol number M.Sc. 11/18 and meeting number DRERC 08/18. Informed consent was obtained from the participants before running the questions and blood sample collection. All the principles of ethics such as informed consent, confidentiality, and privacy was retained and data collection was conducted without personal identifier or using codes. All study participants were read and signed on the informed consent, but if the study participants are illiterate the data collector was read and took the sign or thump impression when they agreed.

3.10. Dissemination of the Result

The result will be submitted to Ethiopian Public Health Institute and Addis Ababa University, School of Medicine. In addition, the results will be disseminated through publication in peer reviewed local or international reputable journals.

4. RESULTS

4.1. Sociodemographic Characteristics

A total of 450 study participants were recruited in this study, of whom 232/450 (51.6%) were males. The mean age in year ±SD of study participant was 36.5 ±10 years and 41.3% were in the age range of 29-38 years. About 220/450 (48.9%) study participants attend their education up to College/University level. The marital status of the Participants were 295/450 (58.9%) married and 156/450 (34.7%) were never married (Table 8). Regarding monthly income of the study participants 107/450 (23.8%) had a monthly income of <1500 Ethiopian birr, 117/450 (26%) had 1500- 3173 Ethiopian birr and 118/450 (26.2%) had > 6677 Ethiopian birr.

Table 3 Socio demographic Characteristics of study participant stratified by sex, EPHI, Ethiopia, Addis Ababa, 2018 (n=450)

Characteristics		Total	Sex	
			Male N (%)	Female N (%)
Study Participant n (%)		450	232 (51.6)	218 (48.4)
Mean age y (SD)		36.5 (10)	38 (10)	35 (10)
Age of Respondent	18-28	21.6	(34)35.1	(63)64.9
	29-38	41.3	(107)57.5	(79)42.5
	39-48	21.3	(52)54.2	(44)45.8
	49-58	12.2	(29)52.7	(26)47.3
	59-69	3.6	(10)62.5	(6)37.5
Marital Status	Never married	34.7	(73)46.8	(83)53.2
	Married	58.9	(156)58.8	(109)41.1
	Separated/Divorced/Widowed	6.4	(3)10.3	(26)89.7
Level of Educational Status	Less than Primary School	6.9	(9)29	(22)71
	Primary School Completed	10.7	(21)43.8	(27)56.2
	Secondary School Completed	14.4	(24)36.9	(41)63.1
	College/University Completed	48.9	(114)51.8	(106)48.2
	Post Graduate Degree	19.1	(64)74.4	(22)25.6
Quartile of Income per Month	Quartile1	23.8	(27)25.2	(80)74.8
	Quartile2	26	(50)42.7	(67)57.3
	Quartile3	24	(72)66.7	(36)33.3
	Quartile4	26.2	(83)70.3	(35)29.7

Quartile 1 = <1500 Birr, Quartile 2 = 1500-3173 birr, Quartile 3= 3174-6676 birr Quartile 4 = >6677 birr

4.2. Behavioral, Clinical and Biochemical Characteristic of Study Subjects

From the total study participants 19/450 (4.2%) were smoking tobacco products at the time of study, while 26/450 (5.8%) were previous smokers. In addition, 18/19(95%) of the current smokers at the time of study were found to be male. Similarly, 19/450 (4.2%) study participants were chewing Khat at the time of study while 52/450(11.6%) of the study participants had stopped chewing Khat. About 350/450 (66.7%) participants were consumed alcohol in the past 30 days prior to the study with the proportion of males was 172/300 (57.3%). The proportion of study participants who consumed fruit and vegetable for five and more days per a week were 36/450 (8%) and about 35/450 (78%) were consumed fruit and vegetable for less than three days a week. About 448/450 (99.6%) of the study participants consumed less than five servings of fruit and vegetable daily. About only 21/450 (4.8%) participants did not meet WHO recommendation on physical activity for health. Male study participants were greater in meeting WHO recommendation of physical activity for health.

Among the study participants about 31/450 (7%) were found to be obese based on their BMI (≥30kg/m^2) and (167/450) 37% were overweight with a BMI (25-30kg/m^2). Among all study participants about 106/450 (23.6%) had raised blood pressure (mean SBP=156 mmHg and mean DBP=99mmHg) and 11/450 (2.4%) were Diabetes, of whom 8/11 (72.7%) were male. About 127/450 (28.2%) respondents had raised fasting cholesterol (>200 mg/dl) and 186/450 (41.3%) of the participants had low HDL (40mg/dL for males and <50 mg/dL for females) of whom 95/186 (51.1%) were females. High level of fasting triglycerides was found among male study participants 71/87 (81.6%) (TG>150mg/dL), from a total of 87/450 (19.3%) who had raised fasting triglyceride. We was also found that 117/450 (25.1%) of the participants had high LDL (> 130mg/dL) and 326/450 (72.4%) of the study participants had raised hsCRP (>2mg/L). About 80.2% of the study participants had central obesity which was defined by waist circumference >94cm for males and 80cm for females based on IDF criteria. (Table 8).

Table 4 Prevalence of Behavioral Clinical and Biological Characteristics of study Participant, EPHI, Addis Ababa, Ethiopia, 2018 (n=450)

Characteristics		% of Total	Sex	
			Male n (%)	Female n (%)
Smocking Status	Never Smoke	90	190 (46.9)	215 (53.1)
	Current Smoker	4.2	18 (94.7)	1 (5.3)
	Previous Smoker	5.8	24 (92.3)	2 (7.7)
Alcohol Drinking Status of Respondent	No	33.3	60(40)	90(60)
	Yes	66.7	172(57.3)	128(43.7)
Physical activity level (WHO Recommendation)	Vigorous	29.6	74(55.6)	59(44.4)
	Moderate	65.6	149(50.5)	146(49.5)
	Low	4.8	9(40.9)	13(59.1)
Khat Chewing Status of Respondent	Never Chewed	84.2	166(43.8)	213(56.2)
	Current Chewer	4.2	(19)100	0(0)
	Previous Chewer	11.6	47(90.4)	5(9.6)
Days of fruit & Vegetable Intake per Week (WHO Recommendation)	>=5	8	18(50)	18(50)
	3-5	14	31(49.2)	32(50.8)
	<3	78	183(52.1)	168(47.9)
Serving of Fruit and Vegetable per day (WHO) recommendation	>=5	0.4	1(50)	1(50)
	<5	99.6	231(51.6)	217(48.4)
Body Mass Index (BMI*)	Normal	56	128(50.8)	124 (49.2)
	Overweight	37.1	97(58.1)	70(41.9)
	Obese	6.9	7(22.6)	24(77.4)
Blood Pressure	Normal	76.4	172(50)	172(50)
	Hypertensive	23.6	60(56.6)	46(43.4)
Lipid Profiles	Cholesterol <200	71.8	158(48.9)	165(51.1)
	Cholesterol >=200	28.2	74(58.3)	53(41.7)
	Triglyceride <150	80.7	161(44.4)	202(55.6)
	Triglyceride >=150	19.3	71(81.6)	16 (18.4)
	Normal HDL	58.7	141(53.4)	123(46.6)
	Low HDL	41.3	91(48.9)	95(51.1)
	Normal LDL(<130)	74.9	166(49.3)	171(50.7)
	High LDL (>130)	25.1	66(58.4)	47(41.6)
Blood Glucose	Normal	97.6	224(51)	215(49)
	Hyperglycemia	2.4	8(72.7)	3(27.3)
hsCRP	<2mg/L	27.6	68(54.8)	56(45.2)
	>=2mg/L	72.4	164(50.3)	162(49.7)
Dyslipidemia Based on NCEP-ATPII	Normal	50.4	113(49.8)	114(50.2)
	Dyslipidemia	49.6	119(53.4)	104(46.6)
Central Obesity (CO) based on IDF	Normal	19.8	28(31.5)	61(68.5)
	Obese	80.2	204(56.5)	157(43.5)

*Abbreviations:- *BMI- Body Mass Index, hsCRP- High sensitive C-reactive protein, LDL- Low density Lipoprotein, HDL- High Density Lipoprotein, HDL low <40/50mg/dl (M/F) CO (central Obesity Waist Circumference >=94/80cm Male/Female);*

4.3. Prevalence and Risk Factors for Blood Pressure, Blood Glucose, Lipid Profile Abnormalities and Central Obesity

Among the study participants the prevalence of hypertension, diabetes, dyslipidemia and central obesity were 106/450 (23.6%), 11/450 (2.4%), 223/450 (49.6%) and 361/450 (80.2%) respectively. The prevalence of hypertension and diabetes were highest in the age group of 58-69 years which was 10/16 (62.5%) and 12.5% respectively. The prevalence of hypertension and diabetes in male study participants were 60/232 (26%) and 8/232 (4.3%) respectively. A proportion of hypertensive in previous smokers and Khat chewer were 10/26 (38.5%) and 14/52 (26.9%) respectively. While the proportion of diabetes in smokers and Khat chewers at the time of study were 3/19 (15.8%) and 1/19 (5.3%) respectively when compared with those who never smoked cigarettes and chewed Khat. We found that hypertension and diabetes among the participants who consumed alcohol was 83/300 (27.7%) and 10/300 (3.3%) respectively.

The study also showed that dyslipidemia in previous smoker, Khat chewer and low level physical activities were 15/26 (57.7%), 30/52 (57.7%) and 12/22 (54.5%) respectively. In obesity class based on BMI, the prevalent of hypertension in obese was 18/21 (58.1%) and the prevalent in obese was 92/320 (28.8%) based on WHtR. While the prevalence of diabetes in overweight and obese based on BMI was (2.4%) and (9.7%) respectively. Participants with hyperglycemia had 7/11 (63.6%) prevalence of hypertension. The study showed that Dyslipidemia was prevalent in overweight 102/167 (61.1%), obese 17/31 (54.8%) and had raised hsCRP 174/324 (53.4%).

From those participants who had central obesity (80.2%) based on IDF criteria, all participants with 59-69 years age group had central obesity. Male participants had prevalence of central obesity 204/232 (87.9%). (Table 9)

Table 5 Prevalence of Blood pressure, Blood Glucose, Lipid Profiles abnormalities and central obesity of Study Participants at EPHI, Addis Ababa Ethiopia, 2018 (n=450)

Characteristics		Blood Pressure n (%)		Blood Glucose n (%)		Lipid Profiles n (%)		Central Obesity by IDF n (%)	
		Normal	HTN	Normal	DM	Normal	Dyslipidemia	Normal	Obese
Sex	Male	172 (74.1)	60 (25.9)	224(96.6)	8(3.4)	113(48.7)	119(51.3)	28(12.1)	204(87.9)
	Female	172(78.9)	46(21.1)	215(98.6)	3(1.4)	114(52.3)	104(47.7)	61(28)	157(72)
Age	18-28	88(90.7)	9(9.3)	97(100)	0(0)	51(52.6)	46(47.4)	48(49.5)	49(50.5)
	29-38	162(87.1)	24(12.9)	185(99.5)	1(0.5)	98(52.7)	88(47.3)	29(15.6)	157(84.4)
	39-48	57(59.4)	39(40.6)	93(96.9)	3(3.1)	38(39.6)	58(60.4)	7(7.3)	89(92.7)
	49-58	31(56.4)	24(43.6)	50(90.1)	5(9.1)	29(52.7)	26(47.3)	5(9.1)	50(91.9)
	59-69	6(37.5)	10(62.5)	14(87.5)	2(12.5)	11(68.8)	5(32.2)	0(0)	16(100)
Smocking Status	Never Smoked	314(77.5)	91(22.5)	398(98.3)	7(1.7)	203(50.1)	202(49.9)	86(21.2)	319(78.8)
	Current Smoker	14(73.7)	5(26.3)	16(84.2)	3(15.8)	13(68.4)	6(31.6)	1(5.3)	18(94.7)
	Previous Smoker	16(61.5)	10(38.5)	25(96.2)	1(3.8)	11(42.3)	15(57.7)	2(7.7)	24(92.3)
Alcohol consumption	No	127(84.7)	23(15.3)	149(99.3)	1(0.7)	76(50.7)	74(49.3)	42(28)	108(72)
	Yes	217(72.3)	83(27.7)	290(96.7)	10(3.3)	151(50.3)	149(49.7)	47(15.7)	253(84.3)
Physical activity level	Vigorous	97(72.9)	36(27.1)	131(98.5)	2(1.5)	68(51.1)	65(48.9)	19(14.3)	114(83.7)
	Moderate	232(78.6)	63(21.4)	286(96.9)	9(3.1)	149(50.5)	146(49.5)	62(21)	233(79)
	Low	15(68.2)	7(31.8)	22(100)	0(0)	10(45.5)	12(54.5)	8(36.4)	14(63.6)
Khat Chewing Status of Respondent	Never Chewer	289(76.3)	90(23.7)	371(97.9)	8(2.1)	196(51.7)	183(48.3)	79(20.8)	300(79.2)
	Current Chewer	17(89.5)	2(10.5)	18(94.7)	1(5.3)	9(47.4)	10(52.6)	3(15.8)	16(84.2)
	Previous Chewer	38(73.1)	14(26.9)	50(96.2)	2(3.8)	22(42.3)	30(57.7)	7(13.5)	45(86.5)
Days of fruit & Vegetable Intake per Week	>=5	29(80.6)	7(19.4)	35(97.2)	1(2.8)	17(47.2)	19(52.8)	8(22.2)	28(77.8)
	3-5	44(69.8)	19(30.2)	61(96.8)	2(3.2)	32(50.8)	31(49.2)	17(27)	46(73)
	<3	271(77.2)	80(22.8)	343(97.7)	8(2.3)	178(50.7)	173(49.3)	64(18.2)	287(81.8)
Body Mass Index (BMI)	Normal	206(81.7)	46(18.3)	248(98.4)	4(1.6)	148(58.7)	104(41.3)	79(31.3)	173(68.7)
	Overweight	125(74.9)	42(25.1)	163(97.6)	4(2.4)	65(38.9)	102(61.1)	9(5.4)	158(94.6)
	Obese	13(41.9)	18(58.1)	28(90.3)	3(9.7)	14(45.2)	17(54.8)	1(3.2)	30(96.8)
WHtR	Normal	116(89.2)	14(10.8)	129(99.2)	1(0.8)	85(65.4)	45(34.6)	84(64.6)	46(35.4)
	Obese	228(71.2)	92(28.8)	310(96.9)	10(3.1)	142(44.4)	178(55.6)	5(1.6)	315(98.4)
hsCRP (mg/L)	<2 mg/L	108(87.1)	16(12.9)	122(98.4)	2(1.6)	75(60.5)	49(39.5)	42(33.9)	82(66.1)
	>=2 mg/L	236(72.4)	90(27.6)	317(97.2)	9(2.8)	152(46.6)	174(53.4)	47(14.4)	279(85.6)
Raised Blood Pressure	Normal	NA	NA	340(98.8)	4(1.2)	173(50.3)	171(49.7)	70(26.1)	198(73.9)
	Hypertensive	NA	NA	99(93.4)	7(6.6)	54(50.9)	52(49.1)	19(10.4)	163(89.6)
Raised Blood Glucose	Normal	340(77.4)	99(22.6)	NA	NA	220(50.1)	219(49.9)	86(21.1)	321(78.9)
	Hyperglycemia	4(36.4)	7(63.6)	NA	NA	7(63.6)	4(36.4)	3(7)	40(93)
Lipid Profile	Normal	173(76.2)	54(23.8)	220(96.9)	7(3.1)	NA	NA	56(24.7)	171(75.30
	Dyslipidemia	171(76.7)	52(23.3)	219(98.2)	4(1.8)	NA	NA	33(14.8)	190(85.2)
Central Obesity by IDF	Normal	70(78.7)	19(21.3)	88(98.9)	1(1.1	56(62.9)	33(37.1)	NA	NA
	Obese	198(54.8)	163(45.2)	351(97.2)	10(2.8)	171(47.4)	190(52.6)	NA	NA

4.4. Lipid Profile Abnormalities

The prevalence of Low HDL was high in all age groups. Among those study Participants who had low HDL females were more predominant. Furthermore, hypertriglyceridemia was most prevalent among both female and male study participants with age ranging from 59-69 years. Hypercholesterolemia was the second most prevalent lipid abnormality in all age groups and both sexes.

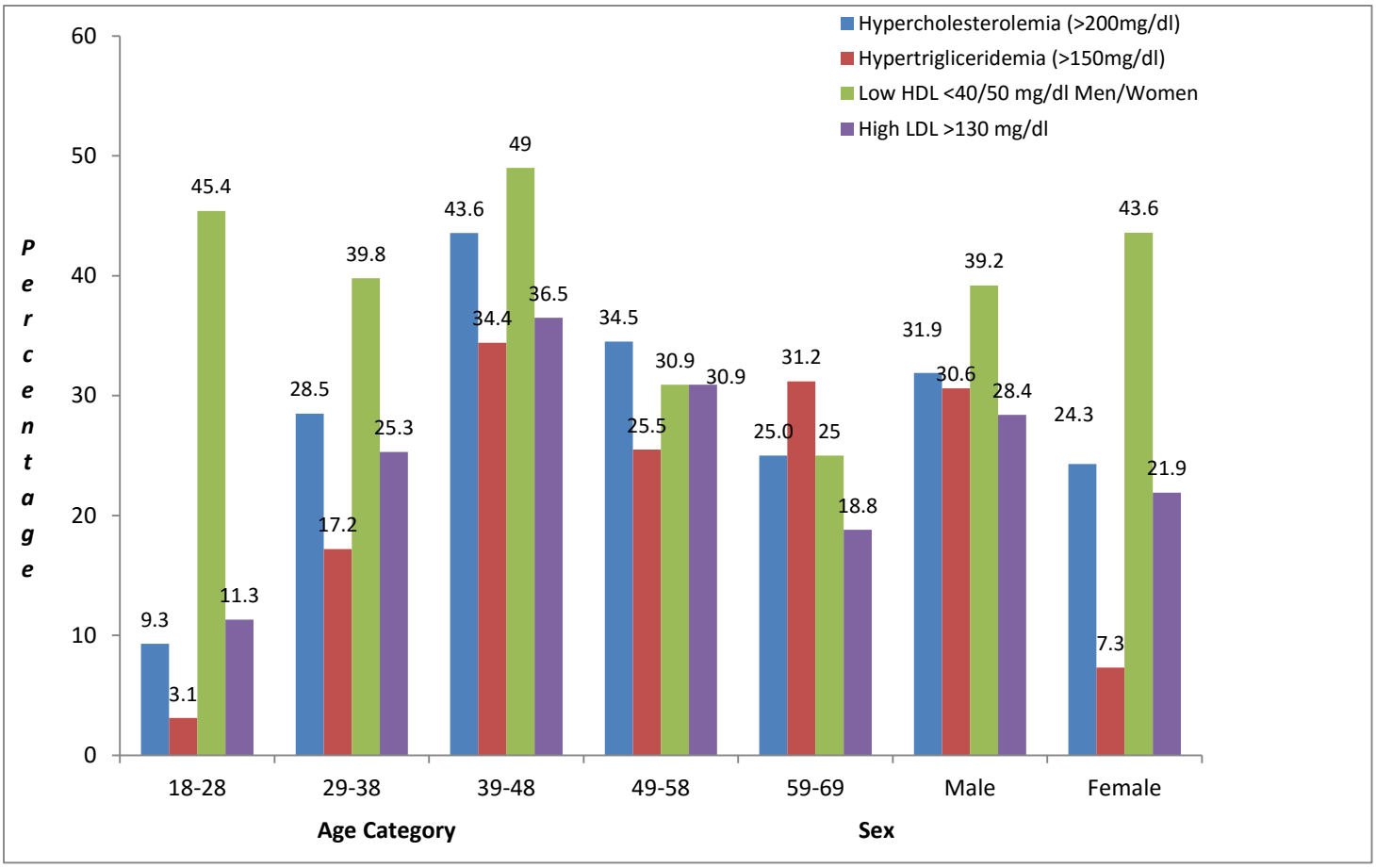


Figure 4 Proportion of Lipid Profiles Abnormalities with Age and Sex of study Participants at EPHI, Addis Ababa, Ethiopia, 2018 (n=450)

4.5. Association of risk factors with Raised (blood Pressure, Blood Glucose), Dyslipidemia and Central Obesity.

The prevalence of hypertension was statistically significant in the age groups of 39-48 years (OR=4.27, (95% CI; 1.8-10.31)), 49-58 years (OR= 4.53, (95% CI; 1.77-11.6)) and 59-69 years (OR= 8.62, (95% CI; 2.36-31.5)). It was seen that the prevalence of being hypertension in the age group 59-69 years was eight times higher when it was compared with 18-28 years age group. However, there was no statistically significant difference in sex, smoking status, and physical activity, Khat chewing, days of fruit and vegetable intake and lipid profile abnormalities.

Raised fasting blood glucose had no significant association with sex, alcohol consumption, Khat use, physical activity, raised WHtR, raised hsCRP and dyslipidemia. Following adjustment for confounding factors with multiple logistic regressions, the study showed that, hyperglycemia was significantly associated with current smokers with (OR= 10.34, (95% CI; 2.2-48.7)) in which current smokers had ten times more diabetes than study participants who never smoke in their life time. Being hypertensive showed nearly five times risk of developing hyperglycemia after adjusting the confounders in multi logistic regression model analysis with (OR=4.8, (95% CI; 1.24-18.62)).

Overweight based on BMI and raised WHtR had a significant association with dyslipidemia in multilogistic regression model with OR as follows overweight (OR=1.68, (95% CI; 1.07-2.63)) and raised WHtR (OR= 1.74, (95% CI; 1.07-2.81)).

Based on IDF definition of central obesity, expressed with raised waist circumference had significant association with age categories 29-38 years, 39-48 years and 49-58 years of age with (OR=3.33, (95% CI; 1.78-6.27)), (OR=5.16 (95% CI; 2.0-13.3)) and (OR=4.12 (95% CI; 1.32-12.85)) respectively. Overweight (OR=4.87 (95% CI; 2.23-10.6)) Obesity (OR= 9.29 (95% CI; 1.07-80.7)) and raised WHtR (OR=312 (95% CI; 78-1245)) had significant association with central obesity based on IDF criteria after adjusting the confounders in multilogistic regression model (Table 10).

Table 6 Bivariate and multivariate analyses of demographic and clinical risk factors for raised blood pressure, raised blood sugar, dyslipidemia and central obesity of study subjects. EPHI, Ethiopia, Addis Ababa, 2018 (n=450)

Characteristics		Raised Blood Pressure		Raised Blood Glucose		Dyslipidemia		Central Obesity based on IDF	
		COR[1] (95% CI)	AOR[2] (95% CI)	COR[1] (95% CI)	AOR[2] (95% CI)	COR[1] (95% CI)	AOR[2] (95% CI)	COR[1] (95% CI)	AOR[2] (95% CI)
Sex	Male	1.00	-	1.00	-	1.00	-	1.00	1.00
	Female	0.77(0.5-1.20)	-	0.39(0.10-1.49)	-	0.87(0.6-1.25)	-	0.35(0.22-0.58)	0.38(0.21-0.68)*
Age	18-28	1.00	1.00		-	1.00	-	1.00	1.00
	29-38	1.45(0.65-3.25)	1.11(0.48-2.58)		-	1.0(0.61-1.63)	-	5.30(3.02-9.30)	3.33(1.78-6.27)*
	39-48	6.69(3.01-14.85)	4.27(1.8-10.13)*		-	1.69(0.96-3.0)	-	12.45(5.24-29.62)	5.16(2.0-13.3)*
	49-58	7.57(3.18-18.04)	4.53(1.77-11.6)*		-	1.0(0.51-1.93)	-	9.8(3.6-26.7)	4.12(1.32-12.85)*
	59-69	16.3(4.8-55.34)	8.62(2.36-31.5)*		-	0.50(0.16-1.56)	-	-	-
Smocking Status	Never Smoked	1.00	-	1.00	1.00	1.00	-	1.00	-
	Current Smoker	1.23(0.43-3.51)	-	10.66(2.51-45)	10.34(2.2-48.7)*	0.46(0.17-1.24)	-	4.85(0.64-36.9)	-
	Previous Smoker	2.16(0.95-4.92)	-	2.27(0.27-19.2)	1.74(0.2-15.42)	1.37(0.62-3.06)	-	3.23(0.75-13.96)	-
Alcohol Drinking Status	No	1.00	1.00	1.00	-	1.00	-	1.00	-
	Yes	0.47(0.28-0.79)	1.68(0.96-2.93)	5.14(0.65-40.5)	-	1.01(0.68-1.5)	-	2.09(1.30-3.36)	-
Physical activity level (WHO Recommendation)	Vigorous	1.00	-	1.00	-	1.00	-	1.00	1.00
	Moderate	0.73(0.46-1.17)	-	2.06(0.44-9.67)	-	1.03(0.68-1.54)	-	0.63(0.36-1.1)	0.68(0.35-1.31)
	Low	1.23(0.47-3.33)	-	0.00(0.00)	-	1.25(0.51-3.11)	-	0.29(0.11-0.79)	0.21(0.06-0.77)
Khat Chewing Status of Respondent	Never Chewer	1.00	-	1.00	-	1.00	-	1.00	-
	Current Chewer	0.38(0.09-1.67)	-	2.58(0.31-21.7)	-	1.19(0.47-2.99)	-	1.4(0.4-4.94)	-
	Previous Chewer	1.18(0.61-2.28)	-	1.85(0.38-8.98)	-	1.46(0.81-2.62)	-	1.69(0.73-3.89)	-
Days of fruit & Vegetable Intake per Week (WHO Recommendation)	>=5	1.00	-	1.00	-	1.00	-	1.00	-
	3-5	1.8(0.67-4.79)	-	1.15(0.1-13.11)	-	0.87(0.38-1.97)	-	0.77(0.29-2.02)	-
	<3	1.22(0.52-2.9)	-	0.82(0.1-6.72)	-	0.87(0.44-1.73)	-	1.28(0.56-2.94)	-
Body Mass Index (BMI)	Normal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Overweight	1.51(0.94-2.42)	0.86(0.50-1.50)	1.52(0.37-6.17)	1.31(0.31-5.52)	2.23(1.5-3.33)	1.68(1.07-2.63)*	8.01(3.89-16.5)	4.87(2.23-10.6)*
	Obese	6.2(2.84-13.55)	2.31(0.95-5.59)	6.64(1.41-31.2)	3.18(0.57-17.8)	1.73(0.82-3.66)	1.25(0.57-2.74)	13.4(1.84-102)	9.29(1.07-80.71)*
WHtR	Normal (<0.5)	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00
	Obese (>=0.5)	3.34(1.83-6.12)	1.66(0.81-3.40)	4.16(0.53-32.8)	-	2.37(1.55-3.62)	1.74(1.07-2.81)*	115(44-298)	312(78-1245)*
hsCRP (mg/L)	<2 mg/L	1.00	1.00	1.00	-	1.00	1.00	1.00	-
	<=2 mg/L	2.57(1.44-4.59)	1.56(0.82-2.98)	1.73(0.37-8.1)	-	1.75(1.15-2.67)	1.33(0.85-2.1)	3.04(1.88-4.93)	-
Raised Blood Pressure (>=140/90 mmHg)	Normal	NA	NA	1.00	1.00	1.00	-	1.00	-
	Hypertension	NA	NA	6.10(1.72-20.9)	4.8(1.24-18.62)*	0.97(0.63-1.51)	-	4.43(1.98-9.91)	-
Raised Blood Glucose Level (>=126mg/dl)	Normal	1.00	1.00	NA	NA	1.00	-	1.00	-
	Hyperglycemia	6.01(1.72-20.95)	2.20(0.56-8.61)	NA	NA	0.57(0.17-1.99)	-	2.51(0.32-19.85)	-
Lipid Profile	Normal	1.00	-	1.00	-	NA	NA	1.00	-
	Dyslipidemia	0.97(0.63-1.51)	-	0.57(0.17-1.99)	-	NA	NA	1.89(1.17-3.04)	-

BMI= Body mass Index, WHtR= Waist to Height Ratio, Dyslipidemia= Triglyceride >=150 mg/dl and HDL <=40/50 mg/dl for Male/Female according to IDF/NCEP ATP III

****significant during multi logistic analysis***

4.6. Proportions of Metabolic syndromes

From a total of study participants (124/450) 27.6% had metabolic syndrome based on IDF criteria while (75/450) 16.7% had metabolic syndrome based on NCEP ATP III. Metabolic syndrome based on both IDF and NCEP criteria was high in male participants (83/232) 35.8% and (45/232) 19.4% respectively. The study also showed that the prevalence of metabolic syndrome was increased with increasing age and out of participants in age group of 59-69 years (10/16) 62.5% had metabolic syndrome based on IDF. In every age group and in male study participants metabolic syndrome was higher based on IDF criteria as compared to NCEP ATPII (Figure 8).

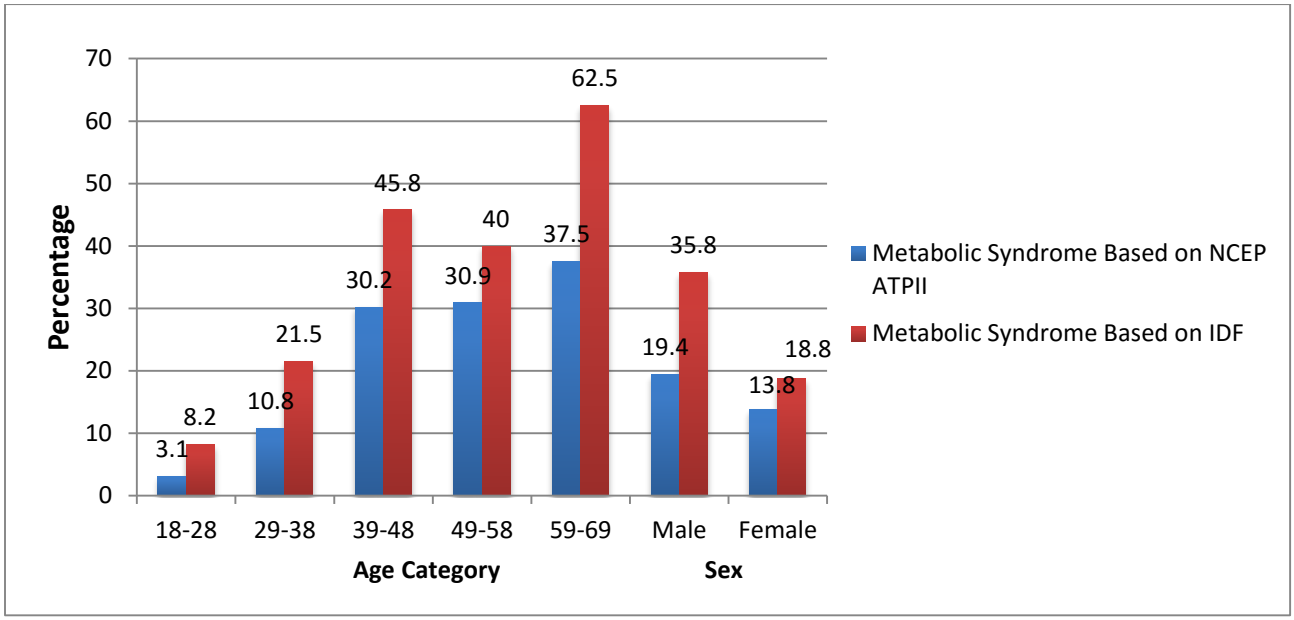


Figure 5 Proportions of Metabolic Syndrome Based on NCEP ATP III and IDF criteria stratified by Age Group and Sex of Participants EPHI, Addis Ababa, Ethiopia, 2018.

4.7. Risk factors for metabolic syndrome

Male, older age, overweight, raised blood glucose, raised blood pressure and dyslipidemia were shown to be a significant risk factors for metabolic syndrome (Table 12). Compared to males being, females were protective with (OR= 0.32, (95% CI: 0.16-0.64)). Study participants with age groups 39-48, 49-58, 59-69 and overweight were individual predictors for metabolic syndrome with (OR = 5.38, (1.72-16.8)), (OR =4.0, (1.09-14.7)), (OR= 81.2(9.4-669)) and (OR= 4.67, (95% CI 2.27-17.6)) was the risk factor for metabolic syndrome respectively. From our research result raised (blood pressure, blood glucose) and dyslipidemia were significant risk factors for metabolic syndrome with OR= 28 (95% CI; 9.46-86.9), OR= 126 (95% CI; 6.7-2374) and OR= 210 (95% CI; 52-849) respectively. Statistical significance association was not observed in Smoking, alcohol consumption, physical activity, serving of fruit and vegetable and raised hsCRP for metabolic syndrome. Almost similar results were observed using ATP III criteria on significance of risk factors for metabolic syndrome. Central obesity was the constant component for IDF criteria while according to ATP III criteria it was statistically significant risk factor for metabolic syndrome with (OR= 9.56 (95% CI; 4.11-22.3)). Regarding sex difference there was no statistical association for metabolic syndrome whether the participant was male or female (Table 11).

Table 7 Bivariate and Multivariate analyses of risk factor components for Metabolic Syndrome of study subjects. EPHI, Addis Ababa, Ethiopia, 2018 (n=450)

Characteristics		MS- IDF		MS- NCEP ATP IIII	
		COR (95% CI)	AOR (95% CI)	COR (95% CI)	AOR (95% CI)
Sex	Male	1.00	1.00	1.00	-
	Female	0.42(0.27-0.64)	0.32(0.16-0.64)*	0.66(0.4-1.09)	-
Age of Respondents	18-28	1.00	1.00	1.00	1.00
	29-38	3.05(1.36-6.81)	2.1(0.74-5.95)	3.78(1.09-13.0)	1.24(0.48-7.6)
	39-48	9.41(4.12-21.5)	5.38(1.72-16.8)*	13.6(3.97-46.4)	3.84(0.79-18.8)
	49-58	7.42(3.0-18.29)	4.0(1.09-14.7)*	14(3.88-50.4)	3.3(0.6-18.05)
	59-69	18.5(5.34-64.3)	81.2(9.4-669)*	18.8(4.06-86.9)	15(1.74-129)*
Smocking Status	Never Smoke	1.00	1.00	1.00	-
	Current Smoker	1.69(0.65-4.4)	1.46(0.15-14)	2.55(0.94-6.97)	-
	Previous Smoker	2.89(1.3-6.44)	0.88(0.23-3.38)	2.04(0.82-5.05)	-
Alcohol Drinking Status of Respondent	No	1.00	1.00	1.00	-
	Yes	1.72(1.08-2.74)	1.28(0.62-2.63)	1.72(0.97-3.04)	-
Physical activity level (WHO Recommendation)	Vigorous	1.00	-	1.00	-
	Moderate	0.93(0.59-1.47)	-	0.84(0.49-1.44)	-
	Low	0.94(0.34-2.58)	-	1.34(0.45-3.98)	-
Khat Chewing Status of Respondent	Never Chewed	1.00	-	1.00	1.00
	Current Chewer	1.32(0.49-3.58)	-	1.51(0.48-4.7)	1.41(0.21-9.3)
	Previous Chewer	1.79(0.98-3.28)	-	2.08(1.06-4.08)	1.66(0.66-4.58)
Serving of Fruit and Vegetable per day (WHO) recommendation	>=5	1.00	-	-	-
	<5	0.38(0.02-6.1)	-	-	-
Body Mass Index (BMI)	Normal	1.00	1.00	1.00	1.00
	Overweight	4.0(2.77-7.0)	4.67(2.27-9.6)*	9.04(4.65-17.6)	5.28(2.12-13.7)*
	Obese	5.45(2.48-11.9)	2.2(0.6-8.05)	11(4.3-28.1)	1.75(0.49-6.21)
Blood Pressure	Normal	1.00	1.00	1.00	1.00
	Hypertensive	6.05(3.77-9.7)	28(9.46-86.9)*	3.75(2.22-6.32)	4.55(1.88-11.01)*
Blood Glucose	Normal	1.00	1.00	1.00	1.00
	Hyperglycemia	28.5(3.61-225)	126(6.7-2374)*	9.55(2.72-33.5)	41.5(4.75-362.9)*
hsCRP	<2mg/L	1.00	1.00	1.00	1.00
	>=2mg/L	3.34(1.88-5.93)	2.18(0.88-5.39)	6.51(2.56-16.54)	3.73(0.93-14.9)
Dyslipidemia Based on NCEP-ATPII	Normal	1.00	1.00	1.00	1.00
	Dyslipidemia	14.8(8.12-27)	210(52-849)*	13.9(6.2-30.8)	85.5(21.9-332)*
Waist Circumference	Normal	NA	NA	1.00	1.00
	Centrally Obese	NA	NA	7.05(4.09-12.16	9.56(4.11-22.3)*

MS-IDF=metabolic syndrome based on IDF (Waist Circumference >=94/80cm plus any two of the following 1) raised blood pressure >=130/85, 2) raised fasting blood glucose>=100mg/dl, 3) Fasting triglyceride >=150mg/dl and 4) HDL <40/50 for Male/Female. MS-NCEP ATPII Metabolic Syndrome based on ATP III defined by any three of the following 1) waist circumference ≥ 102/88 male/female 2) Hypertriglyceridemia: serum TG ≥ 150 mg/dl, 3)Low HDL-C < 40/50mg/dl male/female, 4) Hypertension: SBP ≥ 130 mmHg or DBP ≥ 85 mmHg and 5) Fasting plasma glucose ≥ 110 mg/dl

****significant during multi logistic analysis***

4.8. Summary of Combined Cardiometabolic risk Factors

Among the total study participants only (109/450) 24.2% had no risk factors for cardiometabolic diseases with greater proportions of male participants 65/109 (59.6%) than to females 44/109 (40.4%) based on NCEP ATP III criteria. As shown in the (Figure 2) more than three risk factors were three times more prevalent in male participants 10/13 (79.6%) than to female 3/13 (23.1%), having crude percentage of 13/450 (2.9%). Most of the study participants 341/450 (75.8%), at least had one risk factor for metabolic syndrome and cardiometabolic risks. About 189/450 (42%) of the study participants had two or more risk factors with balanced proportions between male (49%) and female (51%) (Figure 9).

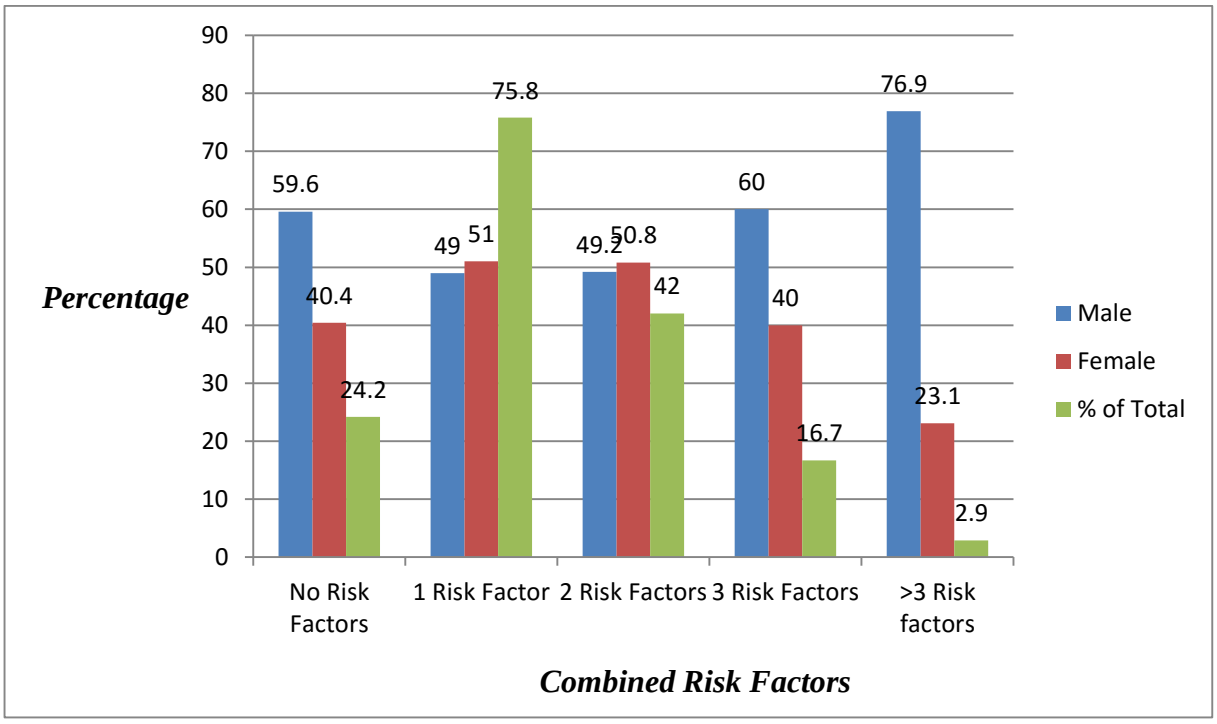


Figure 6 Summary of Combined Risk Factors by Sex of Study Participant based on ATP III definition, EPHI, Addis Ababa, Ethiopia, 2018 (n=450)

5. DISCUSSION

Metabolic syndrome is constellation of risk factors associated with a 5 fold increase in incidence of Type 2 diabetes and 2-3 fold increase in the incidence of CVD (Alberti *et al*., 2009). For this study, metabolic syndrome was defined according to the criteria of National Cholesterol Education Program Adult Treatment Panel II (NCEP ATP III) and International Diabetes Federation (IDF) (Expert Panel on Detection, 2001, Alberti *et al*., 2006). According to these criteria the definition of metabolic syndrome in general is constellation of 1) Abdominal (central) Obesity, 2) High triglyceride, 3) low HDL, 4) Elevated blood pressure and 5) elevated fasting blood glucose.

Ethiopian Public Health Institute had 816 permanent and contract staffs members, in which 450 study participants 232/450 (51.6%) males were recruited for our study. Within the study population 29-38 years age group (41.3%) were the dominant one. The average age of the study participants was 36.5 ±10 years and 48.9% of the study participants were married. The educational status which reflects about the lifestyle of the participant, nearly half of the study participants complete their education to college/university level. In our study population comparable proportion was observed in monthly income between <1500, 1501- 3173, 3174- 6676 and >6676 Ethiopian birr. When we compare our study participant to other studies done in Ethiopia, larger sample size was used by (Tran *et al*., 2011) among working adults in Addis Ababa (n=1935), (Gebremariam *et al*., 2018) among public employees in northern Ethiopia Mekele town (n=1380), (Mossie and Mezgebu, 2016) among Jimma town population (n=1316) and (Tefera *et al*., 2015) among adults residing in Gilgel Gibe field research center (n=4273). Our study was done on one institution based participants while other studies was from different public institutions and residents in nearby the study area.

The prevalence of current smoker (4.2%) and Khat chewer (4.2%) was almost similar with result of national survey conducted in Ethiopia in 2015 by (EPHI, 2016). However our research result prevalence of tobacco smoking status at the time of study (4.2%) was higher than that found in Northern Ethiopia (2.2%), but it was lower as compared to studies by *Alemseged et al. (2012)* in Gilgel Gibe research center southwest Ethiopia (9.3%), by *(*Mossie and Mezgebu, 2016*)* among adults residing in Jimma town (7%) and by *(*Tran *et al*., 2011*)* among working adults in Addis Ababa (7.2%). This may due to environmental and socio-cultural difference among study participants. Current smoking status was more prevalent among males compared to females which is consistent with other findings (Mossie and Mezgebu, 2016**,** Gebremariam *et al*., 2018, Alemseged *et al*., 2012, Tran et al., 2011). This study revealed that the proportion of fruit and vegetable intake less than five serving on average per day was (99.6%) and physically inactive (4.8%), which was comparable with Ethiopian national survey 2015 (EPHI, 2016) 97.6% and

5.8% respectively. Our study also revealed that the prevalence of fruit and vegetable in take less than five serving in average per week (0.4%) was comparable with the study conducted by Gebremariam *et al*. 2018 in northern Ethiopia, Mekele which was (0.3%). However the prevalence of fruit and vegetable intake below adequate level (below five serving per day) in our study (99.6%) was much higher as compared to the study done by (Alemseged *et al*., 2012) which was (27%). One possible reason contributing for such difference may be due to the production and accessibility of fruit and vegetable is better in this area. Among the total study participant 21/450 (4.8%) had low level of physical activity which was higher in females 13/21 (59.1%). This isin line with the study done (Alemseged *et al*., 2012) among adults residing in Gilgel Gibe Field Research Center which stated that females had higher prevalence of low level physical activity. This is may be due to the nature of work activities in the institute and use of transportation among female participants because of high burden in their house.

The prevalence of alcohol consumption in this study was about 300/450 (66.7%), which is higher than that reported among adults living at Gilgel Gibe Field Research Center (GGFRC) of Jimma University (7.1%) (Alemseged et al., 2012) and national survey conducted in Ethiopia in 2015 (40.7%) but it was comparable (52.1%) reported by (Mossie and Mezgebu, 2016) among adult population residing in Jimma town. This may be due to sample size and types of study participants together with sociocultural and religious difference. Our result was also consistent with the national survey Ethiopia of 2015 in which the prevalence of alcohol consumption was more frequent in males than females (WHO, 2015). This may be due to the difference in lifestyle as men compared to women usually go out for recreation and have better opportunity to drink alcohol.

Regarding anthropometric measurement, obesity based on BMI, about 44% of study population were overweight/obese, in which 6.9% were obese and 37.1% were overweight. This finding was higher than other findings conducted in Ethiopia national survey (1.2% obese and 5.2% overweight), northern Ethiopia Mekele (4.1% obese and 26% overweight) and Northwest Ethiopia Jimma obese 67/1316 (5.1%) and overweight 137/1316 (10.4%). This makes the participants may be more vulnerable to metabolic syndrome which results morbidity and mortality with CVD and type 2 diabetes (Gebreyes *et al*., 2018, Gebremariam *et al*., 2018, Mossie and Mezgebu, 2016). The possible explanation for higher prevalence of overweight/obesity in our study may be due the difference in physical activity, sample size, sedentary behavior and lifestyle.

Hypertension the second most common criteria for metabolic syndrome with frequency of 106/450 (23.6%) and was higher than those reported in earlier studies conducted in Ethiopia 15.8% (95% CI: 14.4-16.9) in Ethiopian 2015 national survey, 300/3221 (9.3%) at Gilgel Gibe field research center and 20% in male and 14% in female among working adults in Addis Ababa

(Gebreyes *et al*., 2018, Alemseged *et al*., 2012, Tran *et al*., 2011). Possible explanation for higher prevalence of hypertension in our study may be due to alcohol consumption behavior of our study participants was more prevalent as compared to other studies. It is evident that appropriate interventions for hazardous alcohol use could lower blood pressure level (Rehm *et al*., 2017). The prevalence of hypertension was also higher when compared to other study done in, Angola (140/781) 17.9%) among workers in private tertiary center , but lower in comparisons with studies done in Eastern Ethiopia among adults lived in Jigijiga city 138/487 (28.3%), Nigeria Lagos 368/964 (38.2%) among urban slum dwellers and in Ghana 146/264 (55.3%) among urban & rural adults in the Keta Municipality (Paquissi *et al*., 2016, Daniel *et al*., 2013, Atinyi *et al*., 2017, Asresahegn *et al*., 2017). The possible explanation for the disparities of hypertension prevalence among different studies was due to family history, sociodemographic, attitude, and awareness and residence difference of study participant. Sampling methods may be also the possible reason for the difference since we had used homologous type population. After adjusting for confounders the prevalence of hypertension was higher with increasing age was statistically significant in the age groups 39-48, 49-58 and 59-69 years with (OR=4.27; (95% CI= 1.8-10.13)), (OR=4.53; (95%CI= 1.77-11.6)) and (OR=8.62; (95% CI= 2.36-31.5)) respectively. This result was consistent with studies done by (Alemseged *et al*., 2012) and (Tesfaye *et al*., 2009).

The result of our research showed that the prevalence of Diabetes Mellitus was 11/450 (2.4%) that is exactly the same with the study done among adult in rural Koladiba town northwest Ethiopia (Worede et al., 2017). Our result was slightly similar with the 2010 global estimate of the prevalence of Diabetes in Ethiopian population (2.0%) (Shaw *et al*., 2010) and study done in South Western Nigeria population that found prevalence of Diabetes Mellitus was (2.5%) (Oladapo *et al*., 2010). However our result was lower when compared with the Ethiopian national crude prevalence rate (3.2%) (Gebreyes *et al*., 2018) and study done in Northern Ethiopia among public employees (10.1%) (Gebremariam *et al*., 2018). This may be because in our study we had used only fasting blood glucose to define the prevalence of diabetes but the study done by (Gebremariam et al., 2018) used combination of FBG and HgA1c, which results in observed prevalence difference.

Dyslipidemia especially low HDL levels 186/450 (41.3%) was common occurrence in our study participants next to central obesity 361/450 (80.2%) based on IDF metabolic syndrome criteria. The prevalence of low HDL in our study was in line with study done by Maritinez Torres and his colleagues among Colombian college students (40.3%), by Oladapo and his colleagues among rural Southwestern Nigerian population (43.1%) and with study done among Saudi University employee (36.8%) (Martínez-Torres *et al*., 2017, Amin *et al*., 2014, Oladapo *et al*., 2010). The similarity of this result may be explained with the mean age group of study participants in Saudi Arabia University employee was 40.4±9.8 years which was comparable to our study mean age

(36.5±10) years and also volunteering based sampling method was used which was similar with our study. On the contrary higher prevalence of low HDL was observed in Ethiopian national survey 2015 (68%) and among public employees in northern Ethiopia (71.3%) (Gebremariam *et al*., 2018, Gebreyes *et al*., 2018). Environmental factors, physical activity status, nutrient intake and sample size and age of study participants may be used as part of explanation for this difference.

Regarding the prevalence of hypertriglyceridemia in our study (19.3%), nearly the same result was reported in Ethiopian national survey. But higher prevalence was found in the following studies Northern Ethiopia (55%) by *Gebremariam et al.,* Saudi University Employee (36.1%) by Amin *et al.,* and among Jordanian adults (50.2%) by *Obeidat et al.(*Obeidat *et al., 2015,* Amin *et al., 2014,* Gebremariam *et al., 2018).* Dietary, level of physical activity, lifestyle difference, and level of awareness may be part of possible explanation for this hypertriglyceridemia.

Abdominal obesity drives development of cardiometabolic risks through altered secretion of adipocyte-derived active substances called adipokines, including free fatty acids, adiponectin, interleukin-6, tumor necrosis factor alpha, and plasminogen activator inhibitor-1, and through exacerbation of insulin resistance and associated cardiometabolic risk factors(Farzadfar *et al*., 2011). In the present study we demonstrated that elevation of waist circumference based on IDF criteria was the most prevalent criteria, with a total frequency of 80.2%, 87.9% and 72% among males and females respectively that was the superior component to yield larger metabolic syndrome prevalence. This result was higher than the community based study done among Andean highlanders (75.9%) (Herrera-Enriquez and Narvaez-Guerra, 2017) and study done in South African Asian Indians who found a prevalence of (73.1%) even though harmonized criteria was used (Prakaschandra and Naidoo, 2017). This is may be due difference in sample size, level of physical activity difference, and dietary intake difference. With respect to sex- difference, it is noted that males had higher frequency of central obesity (87.9%). The reason for this difference may be majority (65%) of female participants were younger as compared to (35%) male and central obesity increases with increasing age. We also found that old age, overweight and obesity were the significant predictors of central obesity. This was supported with the study done (Schousboe *et al*., 2018)

The higher prevalence of central obesity, low HDL, hypertension and raised triglyceride in study population results higher prevalence of metabolic syndrome with only 24% were free from any one of the components and 2.9% had four and five components. The standard percentage of the population free from any components of metabolic syndrome was higher as compared to Central America population based study in Honduras 21.1%, Nicaragua 19.4%, and Costa Rica 9%

(Wong-McClure *et al*., 2015**)**. This can be attributed to differences in life style choices and dietary habits as most of the studies were carried out in the USA and none in Eastern Africa.

The prevalence of increased hsCRP above 2mg/L cut off was 72.6% which indicates systemic inflammation which is considered to be an essential factor in development of atherosclerosis cardiovascular diseases by stimulating plaque formation (McCormack and Allan, 2010). Our result was higher than the study done among Jamaican adults (Bennett *et al*., 2014) which showed that the prevalence of hs-CRP was 15%. This higher difference may be due to restriction of participant's age at which the above study focuses only 18-20 years. High prevalence of central obesity in our study may possibly attributed to the higher prevalence of hsCRP. This was also supported by article review done (Shrivastava *et al*., 2015) which showed that Central obesity expressed by increases cholesterol and triglycerides with the release of oxidized lipoproteins and inflammatory cytokines leads to increment of hs-CRP.

Findings from this study showed that prevalence metabolic syndrome among staff members of EPHI was 16.7% using NCEP ATP III criteria, while the IDF criteria yielded higher prevalence of 27.6%. This higher prevalence of metabolic syndrome based on IDF criteria was due to higher prevalence of central obesity which is one of the pre-request criterion for defining the metabolic syndrome. Our result was fairly comparable to study conducted in systematic review of Madagascar (27.7%), Nigeria (28.1%), Spain (24.3%), South Asia (29.8%), and Australia (30.7%) based on IDF criteria (Aryal and Wasti, 2016, Kingue *et al*., 2017, Oguoma *et al*., 2015, Cameron *et al*., 2007, Corbatón-Anchuelo *et al*., 2013). The prevalence of metabolic syndrome in our study was less than from other studies conducted in Kenya among urban population (34.6%), Nigeria among apparently healthy adults in Ogun state (36.8%), among Turkey adults (44%), among Jourdan adults (51%) (Kaduka et al., 2012, Adeyemi et al., 2017, Gundogan et al., 2013, Obeidat et al., 2015). Differences in the age of study subjects, sample size, socioeconomic status, residence & life style, dietary intake and physical activity may contribute to the different prevalence of metabolic syndrome in these different studies.

High prevalence of metabolic syndrome has been linked to urbanization, westernization, nutritional and epidemiological transition (Owolabi *et al*., 2017). Our result was also lower than the recent study conducted in Northern Ethiopia involving public employees in Mekele found a prevalence of metabolic syndrome to be 40% using IDF criteria (Gebremariam *et al*., 2018). The explanation for this discordant may be due to environmental and sampling methods in which we had used non-random sampling. However the finding in this study was higher than other community based studies conducted among working adults in Addis Ababa Ethiopia (17.9% using IDF criteria and 12.5% using ATP criteria), in Jimma town (16.7%) using IDF criteria) and community based study conducted in Ethiopia in 2015 (4.8%) (Tran *et al*., 2011, Mossie and

Mezgebu, 2016, WHO, 2015). Our result also showed higher prevalence from studies conducted among adults in rural area of West China (10.8%) and study conducted among health professionals in Brazil (4.5%), (Zhao *et al*., 2014, de Carvalho Vidigal *et al*., 2015). This could be as a result of differences in socio-economic backgrounds, lifestyle variations and difference in ethnicity.

The result also showed that the prevalence of metabolic syndrome was 35.8% in males and 18.8% in females based on IDF criteria. This was in line with the study reported by (Martínez-Torres *et al*., 2017*)* in Colombia who observe that the prevalence of metabolic syndrome in male was three times higher than in female. The possible explanation for higher prevalence of metabolic syndrome in males than female participants was because of majority of female participant were younger as compared to male. The other possible explanation for higher metabolic syndrome prevalence in males was because of central obesity which was more prevalent in male (72%) than female (28%). However our result was contradicted with the study done by Mossie and Mezgebu, *(*2016*)* who found that there was greater occurrence of metabolic syndrome in female. This may be due to female study participants in our study were younger whom they are less susceptible for metabolic syndrome. Our result finding also showed that prevalence metabolic syndrome was high in older age. Increasing age group from 39-48, 49-58 and 59-69 years was significantly associated with metabolic syndrome which showed that (OR=5.38(95% CI; 1.72-16.8)), (OR= 4.0(95% CI; 1.09-14.7)) and (OR= 81.2(95% CI; 9.4-669)) respectively. This is in line with studies reported by (Mossie and Mezgebu, 2016, Kaur, 2014a). This is because aging is characterized by a progressive deterioration in physiological functions and metabolic process that generate reactive oxygen species as by product of biological oxidation. The oxidative damage of reactive oxygen species induces cellular dysfunction playing an important role in many pathological conditions like chronic low level inflammation induced metabolic syndrome (Francesca *et al*., 2015).

The predisposing factors for having metabolic syndrome include being overweight (OR=4.67, (95% CI; 2.27-9.6)), having raised blood pressure (OR= 28, (95% CI; 9.46-86.9)), raised fasting blood glucose (OR= 126, (95% CI; 6.7-2374)) and dyslipidemia (OR= 210, (95% CI; 52-849)). This was in line with reports done by (Martínez-Torres *et al*., 2017, Mossie and Mezgebu, 2016, Kaur, 2014a). Overweight characterized by unbalanced energy intake and expenditure which could results continues raised blood glucose level (Laakso and Kuusisto, 2014, Wagner *et al*., 2012). This further results hypersecretion of insulin leading to insulin resistance over time. Once insulin resistance occurs in different target organs metabolic process dysregulation will be initiated such as lipid profile abnormalities, endothelial dysfunction and inflammatory reactions (González-Muniesa *et al*., 2017a, Adamczak and Wiecek, 2013).

Three fourth of the participants had at least one components of metabolic syndrome. This result revealed that characteristics including smoking habit, alcohol consumption. Physical activity and serving of fruit and vegetables per week were not individual predictors for metabolic syndrome. Even though the study participants were not apparently healthy, our result was consistent with the finding from Hawassa University Hospital and Jimma health center among peoples living with HIV/AIDS (Bosho *et al*., 2018, Tesfaye *et al*., 2014). The study done by *Owolabi* and his colleagues among adults attending healthcare in Eastern Cape South Africa contradicts our finding. They found that smoking, alcohol use, fruit and vegetable consumption were the statistically significant factors for metabolic syndrome (Owolabi *et al*., 2017). Finding from *Owolabi et al*. stated that it was opposed with other studies which have reported a lower prevalence of metabolic syndrome in association with fruit and vegetable consumption (Folchetti *et al*., 2014). The discordant with smoking and alcohol use might be because of the amount and type of alcohol and smoking products taken by the study populations. However sex, age, BMI, raised blood pressure, raised blood glucose, dyslipidemia and raised hsCRP had statistically significance with metabolic syndrome in bivariate analysis. After adjusting confounders in logistic regression only age, BMI, raised blood glucose, raised blood pressure and dyslipidemia were independent predictors for metabolic syndrome. This was also in line with the study done by *Salas et al.* among Mexican adult population and among Brazilian health professionals (Salas *et al*., 2014, de Carvalho Vidigal *et al*., 2015).

In general prevalence of central obesity expressed as increased waist circumference was the most common abnormality, followed by low HDL and raised Blood pressure were in accordance with many researchers(Obeidat *et al*., 2015, Nalado *et al*., 2015, el Bilbeisi *et al*., 2017). It is assumed that the modern luxurious life style lies behind abdominal obesity and dyslipidemia being the most common components of metabolic syndrome (Mabry R *et al*., 2010).The high prevalence of abdominal/central obesity, low HDL and raised blood pressure emphasizes the susceptibility of the study population to CVD and Type 2 DM especially in older age. Controlling weight and body fat with physical activity and more adequate diet were important in reducing the risk of CVD (Ntandou *et al*., 2009). The prevalence also has been linked to urbanization, westernization, nutritional and epidemiological transition and this calls for urgent action by the policy makers and health managers to further emphasize the need for routine screening for all the components of Metabolic syndrome.

6. CONCLUSION

From this study, it is possible to conclude the followings; the prevalence of metabolic syndrome and its components were significantly high among study population. Central obesity, followed by dyslipidemia and hypertension were the most frequent components of metabolic syndrome. The prevalence of hypertension was found substantial as compared to the national survey report. Being male, over 39 years old, overweight, raised blood pressure, raised fasting blood glucose and dyslipidemia were significantly associated with metabolic syndrome. Only 24% of the study participant were free from any risk factors for metabolic syndrome. About 16.7% of the study participants had ≥ 3 risk factors based on NCEP ATP III defining criteria.

7. RECOMMALEDATIONS

These findings from our study will be beneficial as an input for policy makers, researchers and for the community in design and implementation of interventions for the prevention and control of cardiometabolic risks.

Further study will be done using more appropriate study design to show clear picture of risk factors in apparently healthy populations. This study will also give baseline information to other public and private organizations to wake up on screening schedule for their staffs for chronic diseases.

Modifying the life style like limiting consumption of alcohol, avoiding tobacco use, and avoid chewing of Khat with promoting fruit and vegetable intake and increasing efforts to physical activity will be important components in preventing and controlling metabolic syndrome. Bringing awareness on health risks of behavioral factors and strengthen early detection and treatment of components of metabolic syndrome may be warranted in employees of public sectors like EPHI.

8. STRENGTH AND LIMITATION OF THE STUDY

The study can express its strength as, it includes several demographic, behavioral, clinical, and anthropometric and biochemical parameters claimed to be associated with the variables under study. In addition it was assured that biochemical analysis was done in the laboratory that are implementing laboratory quality management system and became accredited by Ethiopian National Accreditation Office (ENAO) in accordance with the requirements of ISO/IEC 15189:2012 for technical competency. This data has limitation associated with cross-sectional study design and non-random sampling technique. Some questions used in data collections of the study were mainly subjective in nature and couldn't show the exact status especially physical activity, fruit and vegetable intake. In addition study findings may not generalized for to a broader Ethiopian population since our study participants were employee of Ethiopian public Health Institute.

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Annex I Participant Information sheet

Information sheet for the participants of the study entitled assessment of cardiometabolic risks and associated factors among Ethiopian public health institute (EPHI) staff members.

Addis Ababa University, school of medicine, department of biochemistry

Principal investigator: Zeleke Geto

Advisors:

Dr. Daniel Seifu

Dr. Maria T/Mariam

Mr. Abebe Bekele

Name of sponsor: Ethiopian public health institute and Addis Ababa University

You are invited to participate in a study to the assessment of cardiometabolic risks and major risk factors for chronic non-communicable diseases. Risk factors for these diseases include: Tobacco use such as smoking, high rates of alcohol consumption, Low intake of fruit and vegetables, Lack of exercise, Raised blood pressure, Raised blood sugar, Obesity and High levels of fat in the blood. You are selected as a candidate for this study because you met the criteria for inclusion as a participant.

For the purpose of this study, the participants will be asked to provide 5 ml whole blood sample from the vein. This is the same procedure that the participant would undergo under normal circumstances. These samples will be used for the same tests that the participants would require under normal circumstances, and no participant will be subjected to any test he/she would not normally undergo as part of his/her required medical care. However, the samples taken for the purposes of the study will not be identified with the participant's name, and no information regarding the participant's sample will be used for any purpose other than the specific objective of the study. During the process of drawing blood for the purpose of performing the laboratory tests in question, the participant will feel a small amount of temporary discomfort.

This study will alert health workers and decision makers to take appropriate measures to treat, prevent and control CVDs. The study will help to alert individuals to prevent and treat before the disease appears through avoiding risk factors. The study can also build capacity in cardiometabolic syndrome research and will provide baseline information for further studies on the prevalence and risk factors for CVDs. However, the investigators cannot promise or guarantee that the participant will directly receive any benefit of the study.

Any information that is obtained in this study regarding the participants will be kept completely confidential. By agreeing to participate in this study, the participant agrees to allow the investigators to use any results obtained through the use of the participant's blood sample for

publication or discussion in any national or international forum. By disseminating the results of this study, the investigators will be able to make research reports available at all levels of care. In any publication where the results of the study appear, the information will be disseminated in such a way that the participant is not identified.

The decision not to participate in this study will not in any way harm the future relationship between you and the organization or individual. In agreeing to participate in this study the participant remains free to terminate his/her participation at any time and without any consequence. We, the investigators, encourage the participant to ask any questions regarding the study that he/she might have at this time.

Annex II Informed Consent Form

Introduction: This form describes what participation in the survey of NCD risk factor assessment among staff members of EPHI members.

Title of Survey: Survey is on risk factors of chronic Non-communicable Disease (NCDs and prevalence of selected non communicable disease.

Risk factors for these CVDs include:

- Tobacco use such as smoking
- High rates of alcohol consumption
- Low intake of fruit and vegetables
- Lack of exercise
- Raised blood pressure
- Raised blood sugar
- Obesity
- High levels of fat in the blood.

Data Collection methods: We will collect information from volunteer 816 study participants of EPHI staff members

Information will be gathered through:

- Step 1- A face to face interview which will ask about lifestyle, behaviors and risk factors and medical problems
- Step 2- Measurements of height, weight, waist& blood pressure.
- Step 3- Blood sampling to test for conditions like diabetes (high blood sugar) and dyslipidemia by cholesterol, triglyceride, HDL and LDL levels in the blood

The table below shows each of the steps involved. You will be given time to consider your participation.

Step	Action
1	We will describe the study in detail
2	You may ask any questions you and the child may have
3	We will ask you to sign consent form
4	You will be asked to agree for the participation in step 1. This will involve survey team ask you confidential questions about your: ➢ Age ➢ Education ➢ Employment and income ➢ Tobacco and alcohol use ➢ Fruit and vegetable intake ➢ Physical activity ➢ History of diabetes and or raised blood pressure

5	You will then be asked to agree for step 2. This will involve survey team taking some simple measurements: ➢ Height ➢ Weight ➢ Waist and hip circumference ➢ Blood pressure and heart arte
6	You may also be asked to participate in steps 3. This will involve survey team taking a small amount of blood to test for sugar and fat levels in your blood. This may cause temporary discomfort to you but will not harm you in any other way

Timeframe It is estimated that step 1, 2 and 3 of the survey will take approximately 1 hour.

Benefits: - It will benefit EPHI staff members through early identification of risk factors for CVDs for which they will be advised for further clinical follow up.

Your rights It is your right to:

- Decline from taking part in the study
- Withdraw from the study at any time
- Decline to answer any question in the interview that you do not wish to answer.

Confidentiality Your participation and data provided will be completely confidential. Your name will not be used in any report of the study

Results: The results of this study will be used to help plan strategies in reducing the risk factors that contribute to CVDs

Ethical approval: This study will be received ethical approval from the Addis Ababa University and IRB of Ethiopian Public Health Institute.

Dear study participant

Voluntary participation: -your participation is voluntary and you can withdraw from the study after having agreed to participate. You are free to refuse to answer any question that is asked in the questionnaire.

Read to study participant		Interviewer	
Agreed		Refused	

Name of study participant _____ Sign _____

Witness: _____ Sign _____

አባሪ III: - ተላላፊ ያልሆኑ በሽታዎች አጋላጭ የሆኑ ሁኔታዎች ጥናት የተሳታፊዎች መረጃ ቅጽ

መግቢያ፡

ይህ ቅፅ በኢንስቲዩቱ ለሚካሄደው ተላላፊ ላልሆኑ በሽታዎች አጋላጭ ሁኔታዎች ጥናት እና ተሳትፎ ምን እንደሚመስል ይገልጻል፡፡

የጥናቱርዕስ፡-

የዚህጥናትርእስሥርየሰደዱተላላፊያልሆኑበሽታዎችአጋላጭሁኔታዎችእናሥርጭትለተመረጡተላላፊላልሆነበሽታዎችየሚልነው፡፡

የጥናቱዓላማ፡-

ተላላፊያልሆኑበሽታዎችማለትበበሽታአምጭተህዋጽኦየማይመጡበሽታዎችማለትናቸው፡፡ ይህጥናትበኢስቲትዩቱየህብረተሰብክፍሎችያለውንተላላፊያልሆኑበሽታዎችስርጭትእናዋነኛ አጋላጭሁኔታዎችንያጠናል፡፡

ለነዚህበሽታዎችአጋላጭሁኔታዎች

- ትምባሆመጠቀምልክእንደማጨስ
- በከፍተኛሁኔታአልኮልመውሰድ /መጠጣት/
- አትክልትናፍራፍሬበዝቅተኛሁኔታመውሰድ
- በቂ የሰውነት እንቅስቃሴአለማድረግ
- የደምውስጥስኳርመጠንከፍማለት
- ጤናማያልሆነውፍረት
- ከፍተኛየሆነየደምውስጥቅባት

የመረጃአሰባሰብዘዴ ፡-

መረጃው 816ከሚሆኑተሳታፊዎችይሰበሰባል፡፡

መረጃውየሚሰበሰበውም፡-

- ደረጃ -1 ፡-ከተሳታፊዎችጋርፊትለፊት የሚደረግመጠይቅሲሆንየአኗኗርሁኔታንባህልንአጋላጭሁኔታዎችንእናችግሮችንይይዛል፡፡
- ደረጃ -2 ፡- የቁመትክብደትየወገብእናየደምግፊትመለካትንያካትታል፡፡
- ደረጃ -3 ፡-የደምናሙናለስኳርበሽታእናየደምውስጥቅባትመጠንለመመርመርመዋሀድን ይይዛል፡

ምንምንነገሮችተካተዋል፡- የሚቀጥለውሠንጠረዥሁሉንምያካተቱትንደረጃዎችያሳያል፡፡ ተሳታፊዎችንለማሰብጊዜይሠጠዋል፡፡

ደረጃ	ድርጊት
1	ስለጥናቱገለፃእናደርግልዎታለን፡
2	ጥያቄካለወትማንኛውንምጥያቄይጠይቃለ፡፡
3	በፈቃደኝነትስምምነትቅጽላይእንዲፈርሙእንጠየቅዎታለን፡፡
4	ደረጃ 1 ላይተሳታፊእንዲሆኑይጠየቃለ፡፡ ይህም የኢትዮጵያሕብረተሰብጤናኢንስታትዩትሠራተኛሚስጥራዊነቱንበጠበቀመልኩ - ዕድሜ - የትምህርትሁኔታ - ቅጥርእናገቢ - ትምባሆእናአልኮልመጠቀም - ፍራፍሬእናቅጠላቅጠልአመጋገብ - የአካልእንቅስቃሴ

	☛የሥኳርበሽታእናየደምግፊትከፍታታሪክ ☛የአዕምሮደህንነትሥነወሲብእናሥነተዋልዶጤናነክመጠይቅይጠይቅዎታል
5	ከዚህቀጥሎደረጃሁለትላይእንዲሳተፉይጠየቃሉ ፡፡ ይኸምየኢትዮጵያሕብረተሰብጤናኢንስቲትዩትሠራተኛእንዲሰራ ☛ቁመት ☛ክብደት ☛የወገብእናየዳሌዙሪያ ☛የደምግፊትእናየልብምትይለካል
6	ደረጃሶስትላይተሳታፊእንዲሆኑሊጠየቁይችላሉ፡፡ ይኸምየኢትዮጵያ የሕብተሰብጤናኢንስቲትዩትሰራተኛመጠኑትንሽየሆነደምከግራእጅክንድየደምስርዎይወስዳል፡፡ ደሙምለስኳርመጠንእናየደምውስጥቅባቶችንየጉበትናኩላሊትጤንነትለመመርመርይውላል ፡፡ ይኸምጊዜያዊየሆነአለመመቻቸትስሜትሊያስከትልብዎይችላልነገርግንበእርስዎላይምንምዓይነትየተለየጉዳትአያመጣም፡፡

የጥናቱደረጃ 1 እና 2 እና 3 ክፍሎችአንድሰአትአካባቢእንደሚወስድይገመታል፡

<u>የማህበረሰብጥቅሞች፡-</u>

የዚህጥናትውጤትየጤናሁኔታዎንበቅዱሚያእንዲያዉቁስርለሰደዱተላላፊ ያልሆኑ በሽታዎችአጋላጭሁኔታዎችለመቀነስየሚደረጉጥረቶችለማገዝእናየህብረተሰብጤናፕሮግራሞችንለማጎልበትያግዛል፡፡

ከዚህበተጨማሪይህጥናትተላላፊያልሆኑበሽታዎችጋርበተያያዘየሚሠጠውአገልግሎት የተሻለእንዲሆንያልማል፡፡

<u>የእርስዎመብቶች፡-</u>

እርስዎቀጥሎየተዘረዘሩትመብቶችአለዎት

☛የጥናቱተሳታፊየመሆንየመግለፅ

☛በማንኛውምሰዓትየማቋረጥ

☛መጠይቁበሚካሄድበትወቅትመመለስያልፈለጉትንጥያቄያለመመለስ

<u>ምስጢራዊነት፡-</u>

☛ስምናእናአድራሻይሰጡናልከዚያምጥናቱከተካሄደበኋላአስፈላጊሆኖከተገኘግንኙነትይ ደረግበታል፡፡

☛ተሳትፎናየሰጡትመረጃሙሉበሙሉምስጢራዊነው፡፡

☛በሚወጣውማንኛውምሪፖርትላይየእርስዎንስምአንጠቀምም፡፡

<u>ውጤቶች፡-</u>

የዚሕጥናትውጤትበኢንስቲትዩቱማህበረሰብውስጥሥርለሠደዱበሽታዎችአጋላጭየሆኑ ሁኔታዎችንለመቀነስየሚዘጋጁስትራቴጂዎችንለማቀድያግዛል፡፡

<u>የጥናቱንስነምግባራዊነትሥለማፅደቅ፡-</u>

ይህጥናትየኢትዮጵያ

የሕብረተሰብጤናኢንስቲትዩትየምርምርስነምግብገምጋሚኮሚቴፀድቆፈቃድአግኝተዋል፡፡

ውድተሳታፊ

<u>በፈቃደኝነትላይየተመሠረተተሣትፎ፡-</u>

ተሳትፎዎበፈቃደኝነትላይየተመሰረተነው፡፡

ተሣታፊለመሆንከተስማሙበኋላምማቋረጥይቻላሉ፡፡

በመጠይቁላይበሚጠየቁትላይእናመመለስለማይፈልጉትጥያቄአለመመለስይችላሉ።።
ስለዚህጥናትጥያቄካለወትየኢስቲትዩቱየምርምር ስነምግባር ሀላፊስምና አድራሻእንደሚከተለውነው
ደ/ር ጌታቸዉአዲስ

ሞባይል------ +251 944123110

<u>የተሳትፎስምምነት</u>፡-

በዚህየስምምነትቅፅላይመፈረመዎየሚያመለክሰተውበጥናቱምንእንደሚጠበቅበትየገባ ወትመሆኑንእናለመሳተፍፈቃደኛመሆኑንነው።።

የተሳታፊው/ዋ ተነቧል	**ቃለመጠይቅአድራጊ**	
ተስማምተዋል	**አልተስማሙም**	

ስም_____**ፊርማ** _____

ምስክር_____**ፊርማ** ----------

Annex IV Questioner English Version

Participant Identification Number ⌊_⌋⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋

Ethiopia STEPS survey questionnaire on Risk Factors for chronic Non-Communicable Diseases and Prevalence of selected NCDs, 2018
The Ethiopian Public Health Institute

Survey Information		
Location and Date	**Response**	**Code**
EA ID	⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋	I1
EA name		I2
Interviewer ID	⌊_⌋⌊_⌋⌊_⌋	I3
Date of completion of the instrumalet	⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋⌊_⌋ dd mm year	I4
Consent, Interview Language and Name	**Response**	**Code**
Consent has been read and obtained	Yes 1 No 2 If NO, END	I5
Interview Language *[Insert Language]*	English 1 Amharic 2	I6
Time of interview (24 hour clock)	⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	I7

Step 1 Demographic Information

CORE: Demographic Information

Question	Response	Code
Sex (Record Male / Female as observed)	Male 1 Female 2	C1
What is your date of birth? Don't Know 77 77 7777	⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋⌊_⌋ If known, Go to C4 dd mm year	C2
How old are you?	Years ⌊_⌋⌊_⌋	C3
In total, how many years have you spent at school and in full-time study (excluding pre-school)?	Years ⌊_⌋⌊_⌋	C4

EXPANDED: Demographic Information

What is the highest level of education you have completed?	No formal schooling 1 Less than primary school 2 Primary school completed 3 Secondary school completed 4 College/University completed 6 Post graduate degree 7 Refused 88	C5
What is your [insert relevant ethnic group / racial group / cultural subgroup / others]background?	Oromo 1 Amhara 2 Tigray 3 Somali 4 Wolayita 5 Sidama 6 Guragie 7	C6

	Hadiya	8	
	Kembata	9	
	Keficho	10	
	Others	11	
	Refused	88	
What is your marital status?	Never married	1	C7
	Currently married	2	
	Separated	3	
	Divorced	4	
	Widowed	5	
	Cohabitating	6	
	Refused	88	
In which Directorate are you working? (USE SHOWCARD)	Health system	1	C8
	TB/HIV	2	
	Food Science & Nutrition	3	
	Human resource	4	
	Technology transfer	5	
	Plan, Evaluation & Monitoring	6	
	Bacteriology parasitology& zoonosis	7	
	PHEM	8	
	Sex	9	
	Regional Laboratory Capacity building	10	
	Traditional & Modern Medicine	11	
	Finance & Procuremalet	12	
	Scientific & Ethical Review Office	13	
	Public Relation Office	14	
	Public Health Training Center	15	
	General Service	16	
	Audit & Inspection	17	
	Reform and Good Governance	18	
	Others	19	
	Refused	88	
Are you holding a permanent or temporary position in the institute?	Permanent	1	C8A
	Temporary	2	
	NA	3	
How many people older than 15 years, including yourself, live in your household?	Number of people	⌊__⌋⌊__⌋	C9

Question	Response	Code
Taking the past year, can you tell me what the average earnings of the household have been? (RECORD ONLY ONE, NOT ALL 3)	Per week └┴┴┴┴┴┴┴┘ Go to T1	C10a
	OR per month └┴┴┴┴┴┴┴┘ Go to T1	C10b
	OR per year └┴┴┴┴┴┴┴┘ Go to T1	C10c
	Refused 88	C10d
If you don't know the amount, can you give anestimate of the annual household income if I read some options to you? Is it [INSERT QUINTILE VALUES IN LOCAL CURRENCY] (READ OPTIONS)	≤ Quintile (Q) 1 1 More than Q 1, ≤ Q 2 2 More than Q 2, ≤ Q 3 3 More than Q 3, ≤ Q 4 4 More than Q 4 5 Don't Know 77 Refused 88	C11

Step 1 Behavioural Measuremalets

CORE: Tobacco Use

Now I am going to ask you some questions about tobacco use.

Question	Response	Code
Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes? (USE SHOWCARD)	Yes 1 No 2 If No, go to T8	T1
Do you currently smoke tobacco products daily?	Yes 1 No 2	T2
How old were you when you first started smoking?	Age (years) Don't know 77 └┴┘ If Known, go to T5a/T5aw	T3
Do you remember how long ago it was? (RECORD ONLY 1, NOT ALL 3)	In Years └┴┘ If Known, go to T5a/T5aw	T4a
	OR in Months └┴┘ If Known, go to T5a/T5aw	T4b
	OR in Weeks └┴┘	T4c
On average, how many of the following products do you smoke each day/week? (IF LESS THAN DAILY, RECORD WEEKLY)	DAILY↓ WEEKLY↓	
	Manufactured cigarettes └┴┴┘ └┴┴┘	T5a/T5aw
	Hand-rolled cigarettes └┴┴┘ └┴┴┘	T5b/T5bw
	Pipes full of tobacco └┴┴┘ └┴┴┘	T5c/T5cw

(RECORD FOR EACH TYPE, USE SHOWCARD) Don't Know 7777	Number of Shisha sessions	⌊_⌋⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋	T5e/T5ew
	Other	⌊_⌋⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋ If Other, go to T5other, else go to T6	T5f/T5fw
	Other (please specify):	⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋⌊_⌋	T5other/ T5otherw
During the past 12 months, have you tried to stop smoking?	Yes No	1 2	T6
During any visit to a doctor or other health worker in the past 12 months, were you advised to quit smoking tobacco?	Yes No No visit during the past 12 months	1 If T2=Yes, go to T12; if T2=No, goto T9 2 If T2=Yes, go to T12; if T2=No, go to T9 3 If T2=Yes, go to T12; if T2=No, go to T9	T7
In the past, did you eversmoke any tobacco products? (USE SHOWCARD)	Yes No	1 2 If No, go to T12	T8
In the past, did you ever smoke daily?	Yes No	1 If T1=Yes, go to T12, else go to T10 2If T1=Yes, go to T12, else go to T10	T9

Question	Response		Code
How old were you when you stopped smoking?	Age (years) Don't Know 77	⌊_⌋⌊_⌋ If Known, go to T12	T10
How long ago did you stop smoking?	Years ago	⌊_⌋⌊_⌋ If Known, go to T12	T11a
	OR Months ago	⌊_⌋⌊_⌋ If Known, go to T12	T11b
(RECORD ONLY 1, NOT ALL 3) Don't Know 77	OR Weeks ago	⌊_⌋⌊_⌋	T11c
Do you currently use any smokeless tobacco products such as [snuff, chewing tobacco, betel]? (USE SHOWCARD)	Yes No	1 2 If No, go to T15	T12
Do you currently use smokeless tobacco products daily?	Yes No	1 2 If No, go to T14aw	T13
On average, how many times a day/week do you use …. (IF LESS THAN DAILY, RECORD WEEKLY)		DAILY↓ WEEKLY↓	
	Snuff, by mouth	⌊_⌋⌊_⌋⌊_⌋ ⌊_⌋⌊_⌋⌊_⌋	T14a/ T14aw

(RECORD FOR EACH TYPE, USE SHOWCARD) Don't Know 7777	Snuff, by nose	└┴┴┴┴┘ └┴┴┴┴┘	T14b/ T14bw
	Chewing tobacco	└┴┴┴┴┘ └┴┴┴┴┘	T14c/ T14cw
	Gaya	└┴┴┴┴┘ └┴┴┴┴┘	T14d/ T14dw
	Other	└┴┴┴┴┘ └┴┴┴┴┘ | f Other, go to T14other, if T13=No, go to T16, else go to T17	T14e/ T14ew
	Other (please specify):	└┴┴┴┴┴┴┘ If T13=No, go to T16, else go to T17	T14other/ T14otherw
In the past, did you ever use smokeless tobacco products such as [snuff, chewing tobacco, or betel]?	Yes No	1 2If No, go to T17	T15
In the past, did you ever use smokeless tobacco products such as [snuff, chewing tobacco, or betel]daily?	Yes No	1 2	T16
During the past 30 days, did someone smoke in your home?	Yes No	1 2	T17
During the past 30 days, did someone smoke in closed areas in your workplace (in the building, in a work area or a specific office)?	Yes No Don't work in a closed area	1 2 3	T18

Tobacco Policy			
You have been asked questions on tobacco consumption before. The next questions ask about tobacco control policies. They include questions on your exposure to the media and advertisemalet, on cigarette promotions, health warnings and cigarette purchases			
Question	Response		Code
During the past 30 days, have you noticed information about the dangers of smoking cigarettes or that encourages quitting through the following media?			
Newspapers or magazines	Yes No Don't know	1 2 77	TP1a
Television	Yes No Don't know	1 2 77	TP1b

Radio	Yes No Don't know	1 2 77	TP1c
During the past 30 days, have you noticed any advertisemalets or signs promoting cigarettes in stores where cigarettes are sold?	Yes No Don't know	1 2 77	TP2
During the past 30 days, have you noticed any of the following types of cigarette promotions?			
Free samples of cigarettes	Yes No Don't know	1 2 77	TP3a
Cigarettes at sale prices	Yes No Don't know	1 2 77	TP3b
Coupons for cigarettes	Yes No Don't know	1 2 77	TP3c
Free gifts or special discount offers on other products when buying cigarettes	Yes No Don't know	1 2 77	TP3d
Clothing or other items with a cigarettebrand name or logo	Yes No Don't know	1 2 77	TP3e
Cigarette promotions in the mail	Yes No Don't know	1 2 77	TP3f
The next questions TP4 – TP7 are administered to current smokers only.			
During the past 30 days, did you notice any health warnings on cigarette packages?	Yes No Did not see any cigarette packages Don't know	1 2 If no, go to TP6 3 If "did not see any cigarette packages", go to TP6 77If Don't know, go to TP6	TP4
During the past 30 days, have warning labels on cigarette packages led you to think about quitting?	Yes No Don't know	1 2 77	TP5
The last time you bought manufactured cigarettes for yourself, how many cigarettes did you buy in total?	Number of cigarettes Don't know or Don't smoke or purchase manuf. cigarettes 7777	☐☐☐☐ If "Don't know or don't smoke or purchase manuf. cig.", end section	TP6
In total, how much money did you pay for this purchase? (DIGITS TO BE ADAPTED TO Ethiopian	Amount Don't know Refused	 7777 8888	TP7

CORE: Alcohol Consumption		
The next questions ask about the consumption of alcohol.		
Question	**Response**	**Code**
Have you ever consumed any alcohol such beer, Tella, Bordie, Tej, Arake, wine, spirits (beherawi, ye bale zaf,)? (USE SHOWCARD OR SHOW EXAMPLES)	Yes 1 No 2 If No, go to A16	A1
Have you consumed any alcohol within the past 12 months?	Yes 1 If Yes, go to A4 No 2	A2
Have you stopped drinking due to health reasons, such as a negative impact on your health or on the advice of your doctor or other health worker?	Yes 1 If Yes, go to A16 No 2 If No, go to A16	A3
During the past 12 months, how frequently have you had at least one standard alcoholic drink? (READ RESPONSES, USE SHOWCARD)	Daily 1 5-6 days per week 2 3-4 days per week 3 1-2 days per week 4 1-3 days per month 5 Less than once a month 6	A4
Have you consumed any alcohol within the past 30 days?	Yes 1 No 2 If No, go to A13	A5
During the past 30 days, on how many occasions did you have at least one standard alcoholic drink?	Number Don't know 77 ⌊__⌋⌊__⌋	A6
During the past 30 days, when you drank alcohol, how many standarddrinks on average did you have during one drinking occasion? (USE SHOWCARD)	Number Don't know 77 ⌊__⌋⌊__⌋	A7
During the past 30 days, what was the largest number of standard drinks you had on a single occasion, counting all types of alcoholic drinks together?	Largest number Don't Know 77 ⌊__⌋⌊__⌋	A8
During the past 30 days, how many times did you have six or more standard drinks in a single drinking occasion?	Number of times Don't Know 77 ⌊__⌋⌊__⌋	A9
During each of the past 7 days, how many standard drinks did you have each day?	Monday ⌊__⌋⌊__⌋	A10a
	Tuesday ⌊__⌋⌊__⌋	A10b
	Wednesday ⌊__⌋⌊__⌋	A10c

(USE SHOWCARD) Don't Know 77	Thursday ⌊_⌋⌊_⌋ Friday ⌊_⌋⌊_⌋ Saturday ⌊_⌋⌊_⌋ Sunday ⌊_⌋⌊_⌋	A10d A10e A10f A10g
During the past 30 days, when you consumed an alcoholic drink, how often was it with meals? Please do not count snacks.	Usually with meals 1 Sometimes with meals 2 Rarely with meals 3 Never with meals 4	X6
I have just asked you about your consumption of alcohol during the past 7 days. The questions were about alcohol in general, while the next questions refer to your consumption of homebrewed alcohol, alcohol brought over the border/from another country, any alcohol not intended for drinking or other untaxed alcohol. Please only think about these types of alcohol when answering the next questions.		
Question	Response	Code
During the past 7 days, did you consume any homebrewed alcohol, any alcohol brought over the border/from another country, any alcohol not intended for drinking or other untaxed alcohol? [AMALED ACCORDING TO LOCAL CONTEXT]	Yes 1 No 2 If No, go to A13	A11
On average, how many standard drinks of the following did you consume during the past 7 days? [INSERT COUNTRY-SPECIFIC EXAMPLES] (USE SHOWCARD) Don't Know 77	Homebrewed spirits, e.g. moonshine ⌊_⌋⌊_⌋ Homebrewed beer or wine, e.g. beer, palm or fruit wine ⌊_⌋⌊_⌋ Alcohol brought over the border/from another country ⌊_⌋⌊_⌋ Alcohol not intended for drinking, e.g. alcohol-based medicines, perfumes, after shaves ⌊_⌋⌊_⌋ Other untaxed alcohol in the country ⌊_⌋⌊_⌋	A12a A12b A12c A12d A12e
During the past 12 months, how often have you found that you were not able to stop drinking once you had started?	Daily or almost daily 1 Weekly 2 Monthly 3 Less than monthly 4 Never 5	A13
	Daily or almost daily 1	

During the past 12 months, how often have you failed to do what was normally expected from you because of drinking?	Weekly Monthly Less than monthly Never	2 3 4 5	A14
During the past 12 months, how often have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Daily or almost daily Weekly Monthly Less than monthly Never	1 2 3 4 5	A15
During the past 12 months, have you had family problems or problems with your partner due to someone else's drinking?	Yes, more than monthly Yes, monthly Yes, several times but less than monthly Yes, once or twice No	1 2 3 4 5	A16

Diet

The next questions ask about the fruits and vegetables that you usually eat. I have a nutrition card here that shows you some examples of local fruits and vegetables. Each picture represents the size of a serving. As you answer these questions please think of a typical week in the last year.

Question	Response	Code
In a typical week, on how many days do you eat fruit? (USE SHOWCARD)	Number of days ⌊_⌋⌊_⌋ If Zero days, go to D3 Don't Know 77	D1
How many servings of fruit do you eat on one of those days? (USE SHOWCARD)	Number of servings ⌊_⌋⌊_⌋ Don't Know 77	D2
In a typical week, on how many days do you eat vegetables?(USE SHOWCARD)	Number of days ⌊_⌋⌊_⌋ If Zero days, go to D5 Don't Know 77	D3
How many servings of vegetables do you eat on one of those days? (USE SHOWCARD)	Number of servings ⌊_⌋⌊_⌋ Don't know 77	D4

Dietary salt

With the next questions, we would like to learn more about salt in your diet. Dietary salt includes ordinary table salt, unrefined salt such as sea salt, iodized salt, salty stock cubes and powders, and salty sauces such as soya sauce or fish sauce (see showcard). The following questions are on adding salt to the food right before you eat it, on how food is prepared in your home, on eating processed foods that are high in salt such as [insert country specific examples], and questions on controlling your salt intake. Please answer the questions even if you consider yourself to eat a diet low in salt.

How often do you add salt or a salty sauce such as soya sauce to your food right before you eat it or as you are eating it? (SELECT ONLY ONE)	Always Often Sometimes Rarely Never Don't know	1 2 3 4 5 77	D5
How often is salt, salty seasoning or a salty sauce added in cooking or preparing foods in your household?	Always Often Sometimes Rarely Never Don't know	1 2 3 4 5 77	D6
How often do you eat processed food high in salt? By processed food high in salt, I mean foods that have been altered from their natural state, such as packaged salty snacks, canned salty food including pickles and preserves, salty food prepared at a fast food restaurant, cheese, bacon and processed meat [add country specific examples].	Always Often Sometimes Rarely Never Don't know	1 2 3 4 5 77	D7
How much salt or salty sauce do you think you consume?	Far too much Too much Just the right amount	1 2 3	D8

	Too little	4	
	Far too little	5	
	Don't know	77	

Diet

Question	Response		Code
How important to you is lowering the salt in your diet?	Very important	1	D9
	Somewhat important	2	
	Not at all important	3	
	Don't know	77	
Do you think that too much salt or salty sauce in your diet could cause a health problem?	Yes	1	D10
	No	2	
	Don't know	77	

Do you do any of the following on a regular basis to control your salt intake?
(RECORD FOR EACH)

Limit consumption of processed foods	Yes	1		D11a
	No	2		
Look at the salt or sodium content on food labels	Yes	1		D11b
	No	2		
Buy low salt/sodium alternatives	Yes	1		D11c
	No	2		
Use spices other than salt when cooking	Yes	1		D11d
	No	2		
Avoid eating foods prepared outside of a home	Yes	1		D11e
	No	2		
Do other things specifically to control your salt intake	Yes	1	If Yes, go to D11other	D11f
	No	2		
Other (please specify)	|_|_|_|_|_|_|_|_|			D11other

The next questions ask about the oil or fat that is most often used for meal preparation in your household, and about meals that you eat outside a home.

What type of oil or fat is most often used for meal preparation in your household?	Vegetable oil	1		D12
	Homemade oil product	2		
	Butter	3		
	Margarine	4		
(USE SHOWCARD)	Solid fats	8		
(SELECT ONLY ONE)	Other	5	If Other, go to D12 other	
	None in particular	6		
	None used	7		

	Don't know 77	
	Other ⌊_⌊_⌊_⌊_⌊_⌊_⌊_⌊_⌋	D12other
On average, how many meals per week do you eat that were not prepared at a home? By meal, I mean breakfast, lunch and dinner.	Number ⌊_⌊_⌋ Don't know 77	D13

CORE: Physical Activity		
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employmalet. [Insert other examples if needed]. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.		
Question	Response	Code
Work		
Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 4	P1
In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days ⌊_⌋	P2
How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes ⌊_⌊_⌋ : ⌊_⌊_⌋ hrs mins	P3 (a-b)
Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads]for at least 10 minutes continuously? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 7	P4
In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days ⌊_⌋	P5
How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes ⌊_⌊_⌋ : ⌊_⌊_⌋ hrs mins	P6 (a-b)
Travel to and from places		
The next questions exclude the physical activities at work that you have already maletioned.		

Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. [Insert other examples if needed]		
Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 If No, go to P 10	P7
In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days ⌊__⌋	P8
How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P9 (a-b)

Physical Activity, Continued		
Question	Response	Code
Recreational activities		
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure),[Insert relevant terms].		
Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football]for at least 10 minutes continuously? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P 13	P10
In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?	Number of days ⌊__⌋	P11
How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ Hrs.mines	P12 (a-b)
Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking,[cycling, swimming, and volleyball] for at least 10 minutes continuously? [INSERT EXAMPLES] (USE SHOWCARD)	Yes 1 No 2 If No, go to P16	P13
In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?	Number of days ⌊__⌋	P14
How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ Hrs.mines	P15 (a-b)

Physical Activity		
Sedentary behavior		
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, train, reading, playing cards or watching television, but do not include time spent sleeping. [INSERT EXAMPLES] (USE SHOWCARD)		
How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes └─┴─┘ : └─┴─┘ Hrs. mins	P16 (a-b)

History of Raised Blood Pressure				
Question	Response			Code
Have you ever had your blood pressure measured by a doctor or other health worker?	Yes No	1 2	If No, go to H6	H1
Have you ever been told by a doctor or other health worker that you have raised blood pressure or hypertension?	Yes No	1 2	If No, go to H6	H2a
Have you been told in the past 12 months?	Yes No	1 2		H2b
In the past two weeks, have you taken any drugs (medication) for raised blood pressure prescribed by a doctor or other health worker?	Yes No	1 2		H3
Have you ever seen a traditional healer for raised blood pressure or hypertension?	Yes No	1 2		H4
Are you currently taking any herbal or traditional remedy for your raised blood pressure?	Yes No	1 2		H5

History of Diabetes				
Have you ever had your blood sugar measured by a doctor or other health worker?	Yes No	1 2	If No, go to H12	H6
Have you ever been told by a doctor or other health worker that you have raised blood sugar or diabetes?	Yes No	1 2	If No, go to H12	H7a
Have you been told in the past 12 months?	Yes No	1 2		H7b
	Yes	1		

In the past two weeks, have you taken any drugs (medication) for diabetes prescribed by a doctor or other health worker?	No	2	H8
Are you currently taking insulin for diabetes prescribed by a doctor or other health worker?	Yes No	1 2	H9
Have you ever seen a traditional healer for diabetes or raised blood sugar?	Yes No	1 2	H10
Are you currently taking any herbal or traditional remedy for your diabetes?	Yes No	1 2	H11

History of Raised Total Cholesterol

Question	Response		Code
Have you ever had your cholesterol (fat levels in your blood) measured by a doctor or other health worker?	Yes No	1 2If No, go to H17	H12
Have you ever been told by a doctor or other health worker that you have raised cholesterol?	Yes No	1 2 If No, go to H17	H13a
Have you been told in the past 12 months?	Yes No	1 2	H13b
In the past two weeks, have you taken any oral treatment (medication) for raised total cholesterol prescribed by a doctor or other health worker?	Yes No	1 2	H14
Have you ever seen a traditional healer for raised cholesterol?	Yes No	1 2	H15
Are you currently taking any herbal or traditional remedy for your raised cholesterol?	Yes No	1 2	H16

History of Cardiovascular Diseases

Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)?	Yes No	1 2	H17
Are you currently taking aspirin regularly to prevent or treat heart disease?	Yes No	1 2	H18
Are you currently taking statins (Lovastatin/Simvastatin/Atorvastatin or any other statin) regularly to prevent or treat heart disease?	Yes No	1 2	H19

Lifestyle Advice

During the past three years, has a doctor or other health worker advised you to do any of the following?

(RECORD FOR EACH)		
Quit using tobacco or don't start	Yes 1 No 2	H20a
Reduce salt in your diet	Yes 1 No 2	H20b
Eat at least five servings of fruit and/or vegetables each day	Yes 1 No 2	H20c
Reduce fat in your diet	Yes 1 No 2	H20d
Start or do more physical activity	Yes 1 No 2	H20e
Maintain a healthy body weight or lose weight	Yes 1 If C1=1 go to M1 No 2 If C1=1 go to M1	H20f

(for female only): Cervical Cancer Screening

The next question asks about cervical cancer prevention. Screening tests for cervical cancer prevention can be done in different ways, including Visual Inspection with Acetic Acid/vinegar (VIA), pap smear and Human Papillomavirus (HPV) test. VIA is an inspection of the surface of the uterine cervix after acetic acid (or vinegar) has been applied to it. For both pap smear and HPV test, a doctor or nurse uses a swab to wipe from inside your vagina, take a sample and send it to a laboratory. It is even possible that you were given the swab yourself and asked to swab the inside of your vagina. The laboratory checks for abnormal cell changes if a pap smear is done, and for the HP virus if an HPV test is done.

Question	Response	Code
Have you ever had a screening test for cervical cancer, using any of these methods described above?	Yes 1 No 2 Don't know 77	CX1

Khat use (Expanded Khat Chewing)

Have you ever consumed khat?	Yes 1 No 2 if no go to O1	K-1
How old were you when you first started chewing?	Age in years ------- Don't know 77 -----	K-2
Have you consumed khat within the past 12 months?	Yes 1 No 2 if no go to O1	K-3
During the past 12 months, how frequently have you chewed khat?	Daily 1	K-4

	5-6 days per week 2 1-4 days per week 3 1-3 days per month 4 Less than once a month 5	
Have you consumed khat within the past 30 days?	Yes 1 No 2 if no go to O1	K-5
During the past 30 days, how frequently have you chewed khat?	Daily 1 5-6 days per week 2 1-4 days per week 3 1-3 days per month 4 Less than once a month 5	K-6
Do you smoke when you chew?	Yes 1 No 2	K-7
Do one or more of your friends smoke when you chew together?	Yes 1 No 2	K-8
Do you drink alcohol after you chew khat?	Yes 1 No 2 – Go to O1	K-9
How often do you drink alcohol after you chew khat?	Always 1 Sometimes 2 Rarely 3	K-10

Step 2Physical Measurements

Blood Pressure

Question	Response	Code
Interviewer ID	⌊_⌊_⌊_⌋	M1
Device ID for blood pressure	⌊_⌊_⌋	M2
	Small 1	

Cuff size used	Medium Large	2 3	M3
Reading 1	Systolic (mmHg)	└┘└┘└┘	M4a
	Diastolic (mmHg)	└┘└┘└┘	M4b
Reading 2	Systolic (mmHg)	└┘└┘└┘	M5a
	Diastolic (mmHg)	└┘└┘└┘	M5b
Reading 3	Systolic (mmHg)	└┘└┘└┘	M6a
	Diastolic (mmHg)	└┘└┘└┘	M6b
During the past two weeks, have you been treated for raised blood pressure with drugs (medication) prescribed by a doctor or other health worker?	Yes No	1 2	M7
Height and Weight			
For female: Are you pregnant?	Yes No	1 If Yes, go to M 16 2	M8
Interviewer ID		└┘└┘└┘	M9
Device IDs for height and weight	Height Weight	└┘└┘ └┘└┘	M10a M10b
Height	in Centimeters (cm)	└┘└┘└┘ . └┘	M11
Weight If too large for scale 666.6	in Kilograms (kg)	└┘└┘└┘ . └┘	M12
Waist			
Device ID for waist		└┘└┘	M13
Waist circumference	in Centimeters (cm)	└┘└┘└┘ . └┘	M14
Hip Circumference and Heart Rate			
Hip circumference	in Centimeters (cm)	└┘└┘└┘ . └┘	M15
Heart Rate			
Reading 1	Beats per minute	└┘└┘└┘	M16a
Reading 2	Beats per minute	└┘└┘└┘	M16b

Reading 3	Beats per minute ⌊_⌊_⌊_⌋	M16c

Step 3 BiochemicalMeasurements

Blood Glucose

Question	Response	Code
During the past 12 hours have you had anything to eat or drink, other than water?	Yes 1 No 2	B1
Technician ID	⌊_⌊_⌊_⌋	B2
Device ID	⌊_⌊_⌋	B3
Time of day blood specimen taken (24 hour clock)	Hours : minutes ⌊_⌊_⌋ : ⌊_⌊_⌋ Hrs. mins	B4
Fasting blood glucose [CHOOSE ACCORDINGLY: MMOL/L OR MG/DL]	mmol/l ⌊_⌊_⌋ . ⌊_⌊_⌋ mg/dl ⌊_⌊_⌊_⌋ . ⌊_⌋	B5
Today, have you taken insulin or other drugs (medication) that have been prescribed by a doctor or other health worker for raised blood glucose?	Yes 1 No 2	B6

Blood Lipids

Device ID	⌊_⌊_⌋	B7
Total cholesterol [CHOOSE ACCORDINGLY: MMOL/L OR MG/DL]	mmol/l ⌊_⌊_⌋ . ⌊_⌊_⌋ mg/dl ⌊_⌊_⌊_⌋ . ⌊_⌋	B8
During the past two weeks, have you been treated for raised cholesterol with drugs (medication) prescribed by a doctor or other health worker?	Yes 1 No 2	B9

Triglycerides and HDL Cholesterol

Question	Response	Code
Triglycerides [CHOOSE ACCORDINGLY: MMOL/L OR MG/DL]	mmol/l ⌊_⌊_⌋ . ⌊_⌊_⌋ mg/dl ⌊_⌊_⌊_⌋ . ⌊_⌋	B16
HDL Cholesterol [CHOOSE ACCORDINGLY: MMOL/L OR MG/DL]	mmol/l ⌊_⌋ . ⌊_⌊_⌋ mg/dl ⌊_⌊_⌊_⌋ . ⌊_⌋	B17