JIMMA UNIVERSITY

INSTITUTE OF HEALTH

FACULTY OF MEDICAL SCIENCES

DEPARTMENT OF BIOMEDICAL SCIENCES (PHYSIOLOGY)

MAGNITUDE OF METABOLIC SYNDROME AND ASSOCIATED RISK FACTORS AMONG ADULT CARDIAC PATIENTS ATTENDING CHRONIC ILLNESS FOLLOW UP CLINIC IN JIMMA UNIVERSITY MEDICAL CENTER, SOUTHWEST ETHIOPIA, 2024

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A THESIS TO BE SUBMITED TO DEPARTMENT OF BIOMEDICAL SCIENCES (PHYSIOLOGY), FACULTY OF MEDICAL SCIENCES, INSTITUTE OF HEALTH, JIMMA UNIVERSITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS SCIENCE (MSc) IN MEDICAL PHYSIOLOGY.

JUNE, 2024

JIMMA, ETHIOPIA

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Abstract

Background: *Metabolic syndrome is a condition that includes a cluster of risk factors associated with cardiovascular disease. The cluster of metabolic factors include abdominal obesity, high blood pressure, impaired fasting glucose, high triglyceride levels, and low high density lipoprotein cholesterol levels. However, when a person has three or more of these metabolic disorders, it is usually diagnosed as metabolic syndrome, which further increases the risk for additional health problems. Metabolic syndrome is becoming a big public health problem in developing countries like Ethiopia. Developing countries have an almost two-fold higher risk of death due to these non-communicable diseases compared to high-income countries.*

Objective: *The main aim of the present study is to determine the magnitude of metabolic syndrome and associated risk factors among adult cardiac patients attending a chronic illness follow-up clinic at Jimma University Medical Center.*

Methods: *A hospital-based cross-sectional study was carried out among 321 sequentially selected adult cardiac patients from December 21, 2023, to March 21, 2024. Data was collected on socio-demographic, clinical, anthropometric, and lifestyle characteristics using a structured questionnaire adapted from the different literatures. Fasting blood glucose and lipid profiles were tested using a blood sample. A binary logistic regression analysis was used to identify factors associated with metabolic syndrome, and variables will be considered statistically significant at* $p < 0.05$.

Results: *A total of 321 participants were included in the study, of whom 182 (56.69%) were females and 139 (43.30%) were males. A total of 131 (40.81%) and 133 (41.43%) adult cardiac patients were found to have metabolic syndrome according to modified adult treatment panel III and international diabetic federation criteria, respectively. Metabolic syndrome was seen more among females (28.03%) as compared to males (12.77%), according to modified adult treatment panel III. The frequency of metabolic syndrome components was reduced high density lipoprotein cholesterol (55.1%), raised blood pressure (46.72%), elevated triglyceride (46.40%), elevated fasting glucose (22.42%), and abdominal obesity (7.47%).*

Conclusion: *The prevalence of metabolic syndrome among cardiac patients was high, with low high density lipoprotein cholesterol and elevated blood pressure being the most commonly encountered abnormalities. Eating less than 1 plate per week vegetables, being physically inactive, khat chewing and eating red meat greater than or equal to 2kg per week were found to have a significant association with the occurrence of MetS.*

Keywords: *Magnitude, metabolic syndrome, adult, cardiac patients, Jimma University Medical Center, Southwest Ethiopia*

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First of all, I would like to express my gratitude to almighty God, since without his help, nothing could happen. Secondly, my heartfelt gratitude goes to my advisors, Professor Andualem Mossie and Mr. Moyata Bariso, for their continuous and constructive comments throughout the conduct of this research. At last, I need to acknowledge both data collectors and participants for their contributions.

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LIST OF ABREVATIONS AND ACRONYMS

ATP III	Adult treatment panel III
BF	body fats
BH	body height
BMI	Body mass index
BW	body weight
BP	Blood Pressure
CAD	Coronary artery disease
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
FBG	fasting blood glucose
FGL	Fasting glucose level
HbA1C	hemoglobin A1C
2-h BG	2 hours blood glucose after meals
HDL	high density lipoprotein
2-h IC	2 hours insulin concentration after
IR	insulin resistance test
LDL	low density lipoprotein
HTN	Hypertension
IDF	International diabetic federation
JIS	Joint Interim Societies
JUMC	Jimma university medical center

Kg	kilogram
MetS	Metabolic syndrome
mmHg	millimeter mercury
NCEP	National cholesterol education program
Non HDL	Raised non- high density lipoprotein cholesterol
NCD	Non-communicable Diseases
NHANES	National Health and Nutrition Examination Survey
OGTT	oral glucose tolerance test
OR	Odd Ratio
SES	socioeconomic status
SBP	systolic blood pressure
WC	waist circumference
TC	total cholesterol
TG	Triglycerides
WHR	waist: hip ratio

CHAPTER ONE: Introduction

1.1 Background

Metabolic syndrome (MetS), a group of comorbid diseases that includes obesity, hypertension, and disordered carbohydrate and lipid metabolism, is a major health and social problem worldwide(1). There have been numerous definitions of MetS (2,3), but the most commonly used definition at present is the one provided by the American Heart Association/National Heart, Lung, and Blood Institute which defines MetS as the occurrence of at least 3 of the following 5 cardio metabolic components: fasting blood glucose ≥ 100 mg/dl, blood pressure ≥ 130/85 mmHg, triglycerides ≥ 150 mg/dl, high density lipoprotein level cholesterol (HDL-C) < 40 mg/dl in males or < 50 mg/dl in females, waist circumference ≥ 102 cm (40 in) in males or ≥ 88 cm (35 in) in females (2).

Within 5 to 10 years, MetS increases the risk of cardiovascular disease (CVD) and diabetes by twofold and fivefold, respectively (4). Cardiovascular diseases (CVDs) are the leading cause of death worldwide (5). Despite the various and intensive management protocols used, many patients fail to achieve their desired clinical outcomes. Insulin resistance, elevated blood pressure, central obesity, atherogenic dyslipidemia, genetic susceptibility, hypercoagulable state, and chronic stress are among the most important risk factors of CVDs (6).

Pathophysiology

There are numerous intricate processes involved in the pathophysiology of the MetS that have not yet been completely understood. Apart from genetic and epigenetic variables, some lifestyle and environmental factors, such as overeating and inactivity, have been recognized as significant contributors to the development of metabolic syndrome (7). High calorie intake can be attributed to a causal role because it has been demonstrated that visceral adiposity is a significant trigger that triggers the majority of MetS pathways (8,9). From the various pathways that have been suggested, it appears that insulin resistance, chronic inflammation, and neurohormonal activation are crucial for the development of MetS and its eventual progression to cardiovascular diseases and type 2 diabetes (Figure 1).

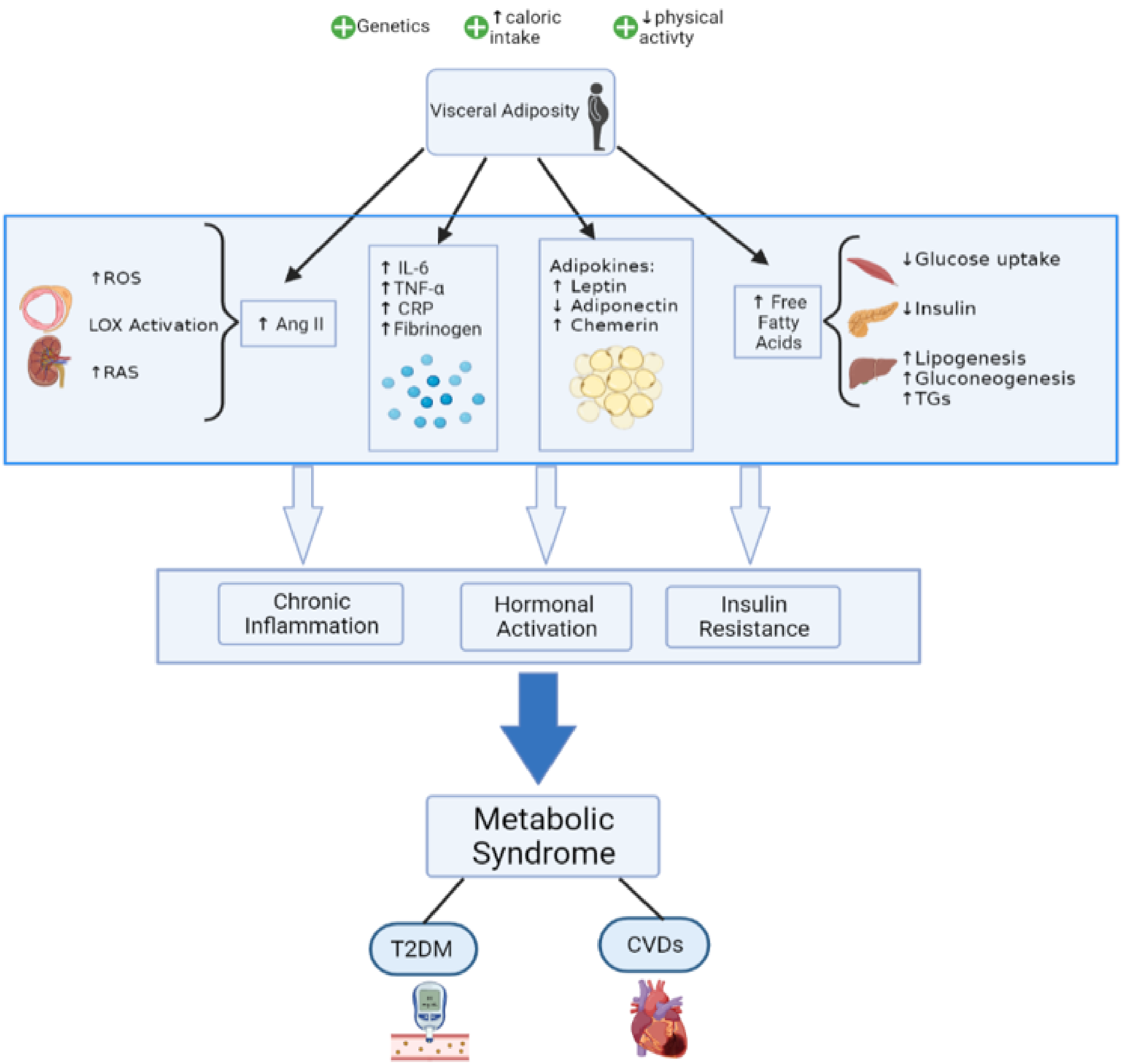

Figure 1: Mechanisms highlighting MetS pathophysiology (10)

Insulin Resistance

Insulin increases the uptake of glucose in the liver, muscles, and adipose tissues while inhibiting lipolysis and hepatic gluconeogenesis to produce anabolic effects. Insulin-mediated inhibition of lipolysis becomes impaired when insulin resistance occurs in adipose tissues. A vicious cycle is created when there is an increase in free fatty acids (FFAs) in circulation, which then develops insulin resistance by altering the insulin signaling cascade in several organs (11,12).

Another contribution of insulin resistance to MetS is the development of hypertension, caused partly by the loss of insulin's vasodilatory effect and by FFA-induced vasoconstriction due to reactive oxygen species production and subsequent scavenging of nitric oxide (13).

Additional mechanisms include the kidneys' renin-induced sodium reabsorption and increased sympathetic stimulation (14).

Adipose Tissue, an Endocrine Organ

The release of different adipokines includes the release of hormones such as leptin and adiponectin, peptides such as apelin, resistin, angiotensinogen, and plasminogen activator inhibitor (PAI)-1, and inflammatory cytokines such as interleukin (IL)-6, tumor necrosis factor (TNF), visfatin, omentin, and chemerin. These factors play an essential role in the pathophysiology of insulin resistance and metabolic syndrome (MetS)(15).

Chronic Inflammation

The various pathogenic pathways that lead to the development of MetS end up resulting in a pro-inflammatory state, which explains why people with MetS have elevated levels of inflammatory markers like TNF, C-reactive protein (CRP), and IL-6 (16). Systemic oxidant stress brought on by obesity and insulin resistance triggers downstream inflammatory cascades that result in tissue fibrosis, atherogenesis, and ultimately CVDs (17).

MetS is becoming a worldwide public health concern as the Western lifestyle spreads. Premature morbidity and mortality due to non-communicable diseases (NCDs) provide a significant development problem, and MetS increases the risk of NCDs as well as the cost of treatment (18,19). MetS is spreading at an alarming rate in developing nations as a result of lifestyle changes, urbanization, declines in levels of physical exercise, and increased calorie intake (18,20).

According to a South African study, black urban residents had a high prevalence of MetS, which is mostly caused by dietary change (21). Every year, NCDs kill the lives of 41 million people, or 71% of the total deaths worldwide. More than 85% of these deaths take place in low- and middle-income countries (22).

In Ethiopia, NCDs are responsible for 42% of all fatalities overall and 27% of deaths among people under the age of 70. Ethiopia has experienced a rise in NCD-related mortality over time (23). The age-standardized death rate in Ethiopia was primarily caused by NCDs in 2015 (24).

Additionally, a study conducted in Ethiopia showed a 4.8% prevalence of NCDs (11.7% in urban areas and 3.2% in rural ones) (25).

MetS affects 21.8% of people, with women being somewhat more likely to have it (24.6%) than males (18.5%). The most common symptoms of MetS were hypertension and central obesity, which had prevalence rates of 42.5% and 41.7%, respectively (18). Low HDL-C was a major cause of MetS in Ethiopia, and women are more likely than males to develop it (26,27).

1.2 Statements of the problem

The metabolic syndrome is prevalent and that its prevalence is rising around the world. Its prevalence is thought to be between 20 and 25 percent globally, but there are significant regional variations. This might be a result of differences in gender, age, race, diets, education, job and environment (28).

The average prevalence of MetS in the United States increased to 35% between 1980 and 2012; however, it has been gradually decreasing in recent years (29). East Asia and China are seeing a significant increase in the prevalence of the MetS. The prevalence was 29.0 and 16.8% in men and women in South Korea, respectively, based on modified NCEP and ATP III criteria (30).

In developing nations, the prevalence of the MetS is also rising. Sub-Saharan African and Middle Eastern nations have high prevalence of the MetS; South Africa, Morocco, Oman, Turkey, and Iran revealed prevalences of 33.5, 16.3, 21, 33.4, and 33.7%, respectively (31). The pooled prevalence of MetS in Ethiopia was reported to be 30.0% (32).

In developing countries like Ethiopia, the prevalence of NCDs is significantly increasing. MetS is spreading at an alarming rate in developing nations as a result of lifestyle changes, urbanization, declines in levels of physical exercise, and increased calorie intake. Recently, metabolic syndrome has taken dominance and is becoming Ethiopia's top healthcare concern. This pattern may be partially explained by the country's recent sustained economic growth as well as the growing adoption of western lifestyles due to globalization. In addition, Ethiopia's health system is inadequate to combat this disease.

A few hospital-based studies were carried out in Ethiopia to determine prevalence of MetS (18,25–27,33,34). The majority of the studies were conducted on individuals with diabetes, HIV patients receiving antiretroviral therapy (ART), and hypertensive patients (26,34–36). Even though there are different studies done on the prevalence of metabolic syndrome in different parts of the world, data regarding the situation in Ethiopia is very sparse; and even the few reports on MetS in the area are not specifically done among cardiac patients. In considering this gap in literature and the significance of developing programs for disease prevention and health promotion in low- and middle-income nations, we are going to determine the prevalence of MetS and associated risk factors among adult cardiac patients attending chronic illness clinic for follow up in Jimma University Medical Center.

1.3 Significance of the study

The purpose of this study was to provide information about the magnitude of the metabolic syndrome and associated risk factors that contribute to MetS. It provides crucial details on the body mass index (BMI), waist circumference (WC), blood pressure status, blood glucose level, and lipid profile of cardiac patients. Their level of awareness will increase as a result, which will allow them to get screened early and take protective measures against its effects. Policymakers and planners could benefit from this study for future planning on the prevention and control of metabolic syndrome. Additionally, the outcomes of this study provide important information for future researchers and could be utilized as a useful reference.

CHAPTER TWO: Literature Review

The metabolic syndrome is prevalent and that its prevalence is rising around the world, which is mostly related to increased obesity and sedentary lifestyles. The metabolic syndrome has become a clinical and public health concern as a result (4). MetS prevalence is thought to be between 20 and 25 percent globally, but there are significant regional variations (37). The literature indicates that the prevalence of MetS patients ranges from 6.1% at the lowest to 55.6% at the highest. This might be a result of differences in gender, age, race, diets, education, health care, job requirements, and environment. The average prevalence of MetS in the United States increased to 35% between 1980 and 2012; however, it has been gradually decreasing in recent years (29).

East Asia and China are seeing a significant increase in the prevalence of the metabolic syndrome. The prevalence was 29.0 and 16.8% in men and women in South Korea, respectively, based on modified NCEP and ATP III criteria(30). Additionally, urban Brazil (25.4%) and Venezuela (31.2%) have significant prevalence rates (38,39).

South Asian nations appear to be experiencing a similar issue. The prevalence of insulin resistance among Asian Indians living in India ranged from 20 to 55% as determined by replacement markers; the variation in the prevalence was caused by population heterogeneity (higher in urban areas compared to rural areas) and socioeconomic status (SES) (higher in those with high SES compared to low SES) (38). According to recent data, the metabolic syndrome affects between one-fourth and one-third of India's urban population. In addition, women are 1.5–2 times more likely to have it than men (40).

In developing nations, the prevalence of the metabolic syndrome is also rising. Sub-Saharan African and Middle Eastern nations have reported having a high prevalence of the metabolic syndrome; South Africa, Morocco, Oman, Turkey, and Iran revealed prevalences of 33.5, 16.3, 21, 33.4, and 33.7%, respectively (31). In Ethiopia, the systematic review revealed a pooled prevalence of MetS of 26.0% (32).

Prevalence of the metabolic syndrome components

According to a cross-sectional study by the Joint Interim Societies (JIS) criterion carried out in rural China, the prevalence of MetS components was 57.75% for abdominal obesity, 44.05% for elevated blood pressure, 40.98% for reduced HDL cholesterol, 23.33% for elevated triglycerides, and 18.95% for increased fasting plasma glucose. In terms of specific MetS components, abdominal obesity was the most prevalent in both men (54.77%) and women (60.12%), followed by high blood pressure in men (49.35%) and low HDL-C in women (49.11%). Hypertension was prevalent (total 30.09%, 33.56% in men, and 27.32% in women) (41). Reduced HDL was the most common abnormality in both males (64.1%) and women (67.1%), according to a study done in Palestinian refugee camps (42).

According to a systemic review conducted in Brazil, the overall weighted mean prevalence (range) by component was as follows: abdominal obesity 38.9%; hyperglycemia 16%; hypertension 52.5%; hypertriglyceridemia 24%; low HDL-c 59.3% (43). According to A Systematic Review and Meta-analysis in the Ethiopian Population, our nation had an overall prevalence of each factor of abdominal obesity of 35.85%, hyperglycemia of 26.4%, hypertension of 27.87%, hypertriglyceridemia of 39.7%, and low HDL-C of 51.0% (44).

Association of risk factors with MetS

Differences in metabolic syndrome prevalence could be explained by genetic, behavioral, and environmental variables (32). The prevalence of MetS increases with age, with a 2.9-fold increase in the frequency from age 18–30 to age 51–65 when the NCEP/ATP III criteria were used. The prevalence of IDF-defined metabolic syndrome increased from 11.0% in the 20–29 years age group to 47.2% in the 80–89 years age group in men, and from 9.2% to 64.4% for women in the corresponding age groups (45,46). Adults aged 40 years and above had a 2.6 (AOR: 2.545, 95% CI: 1.201–5.392) times higher risk of developing MetS compared to under 40 years (4). The prevalence of MetS increased with age in both men and women according to all of the criterion and peaked at 55–64 years in men and at ≥65 years in women (41). Being older age was significantly associated with a higher risk of MetS. This may be due to physical inactivity and physiological changes like increased fat mass accompanied by decreased muscle mass among the older age participants(18).

A multiple-factor analysis revealed that consumption of less than one plate of vegetables and two kilograms or more of red meat per week was associated with a higher risk of MetS, while consumption of 1.5 liters or more of fresh milk per week was associated to a lower risk of MetS (OR = 0.64, 95% CI: 0.49, 0.85) (41).

The overall prevalence of metabolic syndrome in users of primary healthcare units in São Paulo, SP, Brazil, study was 4.8%, higher in females than in males (8.6% vs. 1.8%). Prevalence is higher in urban population than rural population (11.7% vs. 3.2) (46).

According to a study done in South Africa, participants who had low levels of education (grades 1–7), were married, and were retired had a greater prevalence of MetS. After adjusting for confounders, marriage (AOR = 2.3, CI = 1.6, 3.3), female sex (AOR = 1.6, CI = 1.1, 2.4), alcohol use (AOR = 2.0, CI = 1.3, 3.1), unemployment (AOR = 1.8, CI = 1.2, 2.6), and earning an income below 1200 (AOR = 1.1, CI = 1.1, 2.4) were significant and independent predictors of MetS. Married non-alcohol users and unemployed participants were two times more likely to have MetS than unmarried alcohol users and employed individuals (47).

In Gondar, Northwest Ethiopia, a community-based cross-sectional study discovered a strong association between urban birthplace and metabolic syndrome. Urban adult populations tend to lead more sedentary lifestyles (bad eating habits and insufficient exercise), which may contribute to the increased metabolic syndrome. The study also discovered an important association between metabolic syndrome and alcohol use 30 days prior to testing (48)**.** Being married, divorced, or widowed affected the prevalence of MetS, according to Tadewos et al. These factors increase the prevalence of MetS (32).

According to a study conducted in Addis Abeba, regardless of the population studied, female gender, older age, obesity, overweight, high educational status, income status, taking medications for chronic diseases like diabetes mellitus, hypertension, and HIV/AIDS, and physical inactivity were the most frequently observed predictors of MetS. Males are less likely than females to develop MetS. Following these occurrences, there was an increase in body fat and insulin resistance, two crucial indicators of MetS (49). High income and educational status were additional predictors of MetS prevalence across all study populations, according to a population-based cross-sectional study. Possible relationships to sedentary lives, increased access to high-calorie meals that change metabolism, and harmful habits like smoking and alcohol use were a few of the most likely reasons for how socioeconomic and educational status affect MetS (50–52).

Prevalence of metabolic components among sex and age specificity

Insulin resistance and obesity are the main variables contributing to the development of MetS (53). The majority of adult Palestinian refugees in Nablus, according to IDF criteria (81.3%) and NCEP definition (56.5%) findings had high central obesity. Additionally, the overall prevalence of overweight and obesity in this group was alarming (63%) (27.3% overweight and 35.7% obese), and it was much greater in women (67.8%) than in men (58.1%) (1). In addition to having more central obesity than men (71.2%) and significantly more metabolic abnormalities (53.6%) grouped together than men (41.7%), the majority of women (88.9%) also had these disorders. There was a high prevalence of diabetes, obesity, and other cardiovascular risk factors. Women were more likely than men to have central obesity and elevated fast blood sugar levels, which enhanced their risk of premature death(42,54).

A meta-analysis conducted in Ethiopia found that women were more likely than men to have MetS. Abdominal obesity, which is mostly caused by a lack of physical activity, a greater birth rate, the presence of estrogen receptors, and menopause, is the reason for the higher prevalence of MetS in women. In addition to genetic diversity, lifestyle may also play a role. The most frequent individual MetS component in the Ethiopian meta-analysis was low HDL-C. The second-most noticeable MetS component was revealed to be hypertriglyceridemia. Due to its inability to remove low-density lipoprotein from the body, the low concentration of HDL-C strongly supports the buildup of low-density lipoprotein in the blood vessels (44).

In subgroup analysis, MetS was shown to be more prevalent in type 2 diabetes mellitus patients (56%) than in other subgroups. One probable explanation is that type 2 diabetic individuals are insulin-resistant and typically fat. Obesity and insulin resistance are two risk variables that are intimately interrelated and are thought to be the main abnormalities driving MetS pathogenesis. Blood lipids are also important in the development of MetS in diabetic patients. Because of insulin resistance, there is an increase in triglyceride hydrolysis and the release of non-esterified fatty acids, which are related to changes in blood lipid concentration and metabolism, leading to dyslipidemia (55).

Hypertension patients (44% had MetS) were another subgroup with a higher prevalence. Antihypertensive drugs may be responsible for the increased occurrence. Antihypertensive drugs such as thiazide diuretics and beta-blockers, as evidenced by various types of literature, increase total cholesterol, low-density lipoprotein cholesterol, and triglyceride levels, particularly at high doses, and contribute to insulin resistance and worsening glycemic control in hypertension patients with diabetes (56).

Researchers found that regular physical activity that was roughly comparable to 30 minutes of brisk walking per day was associated with a decreased prevalence of MetS in a study of rural Cameroonians (57). Additional research from low-, middle-, and high-income nations has revealed an antagonistic relationship between MetS and increasing levels of physical activity or markers of cardiorespiratory fitness. For instance, Carroll and colleagues found that among participants in the British Regional Heart Study, higher levels of physical activity were linked to decreases in a wide range of cardiometabolic risk factors (58). According to Halverstad and colleagues, body fat baseline or variations were unaffected by diet or the effects of 24 weeks of endurance exercise training on plasma lipoprotein and lipid profiles. For instance, mean serum triglycerides can decrease with exercise training (49).

According to a cross-sectional study conducted in Gondar Town, northern Ethiopia, when utilizing ATP III, the overall prevalence of MetS was 11.2% (95% CI: 10.1, 12.3), and when using IDF, it was 11.9% (95% CI: 10.8, 13.2). Regardless of the diagnostic criteria for the metabolic syndrome, females had a higher prevalence of the condition than males did. Being a woman, being born in a city, and often using alcohol are significantly associated with MetS (48).

Risk factors of MetS and how to control it

Lifestyle: People with metabolic syndrome tend to be overweight and engage in sedentary lifestyles (59). Inadequate physical activity or muscle contraction appears to affect both glucose metabolism and lipid clearance (7). Rhythmic dancing, aerobics, yoga, and running are further exercise interventions (60).

Age: As people age increases, their skeletal volume as a whole diminishes and their percentage of fat tissue increases. It has been demonstrated that the age-related declines in basal metabolic rate may be entirely attributable to the decrease in muscle mass compared to total body weight. Body fat tends to accumulate in the abdomen in the elderly (61).

Gender: Male adults and old female had the highest risk of getting MetS (62). The prevalence of metabolic syndrome was significantly higher in young male than female subjects (63). MetS is more prevalent among females than males due to unhealthy lifestyle factors such as unhealthy dietary habits, a lack of physical activity, hormonal differences, and abdominal obesity. Unhealthy dietary patterns, such as high consumption of refined sugars, saturated fats, and processed foods, contribute to MetS. Females may be more prone to these unhealthy habits, while males may have higher androgen levels, which may provide some protection against MetS. Estrogen plays a protective role against cardiovascular diseases. However, after menopause, estrogen levels decline, which may contribute to MetS development in females. Additionally, females with conditions like polycystic ovary syndrome (PCOS) may have hormonal imbalances that increase MetS risk. Females tend to accumulate fat around the waist more than males, which elevates their MetS risk (64).

Diet: The prevalence of MetS was found to be common among subjects who favor omnivores than vegetarian meals (47.55%) in a cross-sectional analysis of 773 subjects. This finding was attributed to the lower levels of glucose and triglycerides in vegetarian diet (65). Moreover, prolonged consumption of high saturated fat diet concentrations induces deposition of fat and fat-derived lipotoxins in liver, skeletal muscle, and pancreas which develops insulin resistance (66).

Cardiovascular disease (CVD): Several studies reveled that atherosclerosis increased the prevalence of MetS by 2-2.9-fold, while CVD enhanced the MetS frequency by 14.6-fold after 30 years (67). Recently, a representative sample of adolescent cohort (n = 1516) was evaluated to define the correlation between CVD and MetS prevalence, The data showed that raised systolic blood pressure (SBP) was related with a high MetS prevalence risk significantly, whereas diminished levels of SBP and glucose were linked with MetS diminution (68). Hence, early detection and management of these disorders may resist the developing epidemic of MetS.

Obesity: People who have more length in WC (≥80 cm for women and ≥90 cm for men) have the chance of occurring MetS 28 times higher than those with lesser WC. Obesity and overweight people could occur MetS 17 times and seven times higher than their normal counterparts (69).

Smoking: Smokers people have a superior risk of developing MetS than nonsmokers by 1.07–1.66-fold (70). Smoking was found to reduce insulin sensitivity, increase cardiovascular risk factor, and upgrade the levels of triglycerides (71) . Prolonged smoking of tobacco and nicotine was reported to upgrade the expression levels of leptin hormone that resulted in decreasing the hormone sensitivity and ended by overweight (72).

Alcohol: Heavy alcohol consumption (more than 20 times / months) correlated with the low serum HDL cholesterol level, raised serum triglycerides, higher waist circumference, hyperinsulinemia, as well as prevalence of MetS. Contrariwise, mild and moderate consumption of alcohol (1-19 times / month) lowered the levels of insulin, serum lipids, as well as the MetS incidence (n = 8,125) (73).

Khat chewing: Chewing khat releases catehinone, which has a significant impact on the metabolism of carbohydrates. It does this by raising cortisol levels, which limit insulin secretion and promote insulin resistance by upregulating the expression of resistin (74). Research revealed that the serum levels of cortisol and resistin were higher in khat chewers with diabetes and in healthy individuals than in non-khat chewers (75). Due to its adrenergic action, cathinone elevates plasma catecholamine levels and inhibits the effects of insulin, which leads to the release of glucagon, the activation of glycogenolysis in the liver, the secretion of adrenocorticotropic hormone (ACTH), and the suppression of insulin release from pancreatic beta cells (α 2 adrenoreceptor-mediated response). All of these processes typically result in elevated blood sugar levels (76).

Nonalcoholic fatty liver disease: NAFLD and metabolic syndrome are linked to insulin resistance. Ninety percent of NAFLD patients had at least one MetS risk factor, and thirty-three percent had every characteristic associated with MetS (77)**.**

Polycystic ovary syndrome: PCOS, or polycystic ovarian syndrome, affects 10–18% of women who are fertile. It appears that IR plays a significant role in the pathophysiology of PCOS and its associated metabolic syndrome. Up to 33% of women with PCOS have metabolic syndrome, which is linked to long-term issues like type II diabetes and cardiovascular disease (CVD) (78).

Inadequate sleep: Prolonged periods of inadequate sleep have also been identified as a risk factor for metabolic syndrome. In addition to increasing the risk of obesity and diabetes, getting too little sleep can cause stress on the mental and physical (79). Likeness, It has been discovered that obstructive sleep apnea raises blood sugar, body weight, insulin resistance, and cardiovascular risk, in addition to lowering HDL (80).

Income : Surprisingly, people in higher socioeconomic groups have MetS at a higher rate than those in lower socioeconomic groups (81). MetS prevalence has been observed to be 10% higher in urban residents than in rural areas (82). Furthermore, a different study in Mexico revealed that the prevalence of MetS was higher in urban than rural populations (45.4% vs. 27.6%, n = 605)(83).

Positive family history: The families with a positive history have a higher susceptibility to MetS than the negative families with no history of MetS (7).

Diagnosis of MetS

The ATP criteria define metabolic syndrome based on having three or more of the following factors:

Large waist: A waistline measuring at least 35 inches (88 centimeters) for women and 40 inches (102 centimeters) for men.

High triglyceride level: 150 mg/dL (or 1.7 mmol/L) or higher.

Reduced "good" HDL cholesterol: Less than 40 mg/dL (1.04 mmol/L) in men or less than 50 mg/dL (1.3 mmol/L) in women.

Increased blood pressure: 130/85 mm Hg or higher.

Elevated fasting blood sugar: 100 mg/dL (5.6 mmol/L) or higher (84).

General laboratory tests used in the diagnosis of MetS include determination of lipid profile (concentrations of total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides) and glucose metabolism (total glucose concentration, oGTT, and glycated hemoglobin HbA1c).

There are other laboratory tests that are not recommended for diagnosing MetS but may be ordered by some doctors to provide additional information. Tests that can also be useful include measuring of lipoprotein particle size (measurement of small dense low-density lipoprotein particles in particular) and determination of high sensitive C-reactive protein (CRP) concentration.

General laboratory tests

1. Glucose

Insulin is a hormone that facilitates the uptake of glucose by tissue. From glucose, the liver makes fatty acids, glycogen, or both. Insulin resistance causes the pancreas to release more insulin. Elevations in blood glucose and insulin concentrations may result from this.

Blood glucose may be measured on a fasting basis (8- to 10-hour fasting), randomly, or as part of an oral glucose tolerance test (oGTT), a series of blood glucose tests.

2. Triglycerides

In MetS, high triglycerides are the consequence of increased glucose and insulin concentrations. Diminishing glucose entering the cells increases the production of fatty acids (supported by a high insulin concentration) and triglycerides.

3. Total cholesterol

The lipid profile is measured, and the risk of cardiovascular disease is evaluated through the measurement of total cholesterol concentration in the diagnosis of MetS. Because elevated blood cholesterol levels are linked to heart disease, arteriosclerosis, and an increased risk of dying from a heart attack, cholesterol screening is regarded as an essential component of preventive healthcare and a means of evaluating the consequences of specific conditions, like metabolic syndrome.

4. High-density lipoprotein cholesterol

The concentration of HDL-cholesterol is decreased in MetS, probably due to the increased triglyceride concentration. HDL particles become enriched with triglycerides and are more rapidly removed from the circulation. Triglyceride-enriched HDL particles are smaller and become better substrates for hepatic lipase. The test for HDL-cholesterol is used along with other lipid tests to determine the risk of MetS.

5. Low-density lipoprotein cholesterol

Insulin resistance has an unfavorable effect on lipid production. It decreases HDL-cholesterol, increases triglycerides, and also VLDL and LDL. So, determination of LDL-cholesterol is also important in the diagnosis of MetS as well as a prognostic factor for some complications such as cardiovascular diseases.

Alternative laboratory tests

1. High-sensitivity C-reactive protein (hs-CRP)

Although determination of CRP is not useful in the diagnosis of MetS, it may be tested as part of the cardiac risk assessment. People who have hs-CRP results at the upper normal limit have a 1.5- to 4-fold risk of sustaining heart attack found in those with CRP values at the lower normal limit. It may come from cells in the fatty deposits in arterial walls that reflect the process of atherosclerosis; however, it may also come from other tissues. So, CRP determination is not used for large-scale screening of the general adult population but is useful as an independent marker of the risk of cardiovascular disease to help determine the course of treatment (85).

Elevated CRP levels are also seen in smokers, patients with hypertriglyceridemia and hypertension. CRP is not only a risk marker but also a prognostic marker in cardiovascular incidents. Elevated CRP levels help to identify the highest CV risk group patients, which makes this simple and readily available marker a useful diagnostic tool(86).

Microalbumin

This test detects a specific protein called albumin in urine. Increased levels may indicate kidney damage. Increased urinary albumin excretion precedes and is highly predictive of diabetic nephropathy. Microalbuminuria is between normal and overt proteinuria. Microalbumin is an early indicator of kidney disease. This test is used to help monitor diabetics and is recommended under the WHO criteria. Detection of microalbuminuria can be accomplished by using semiquantitative rapid tests or by performing quantitative immunochemical determination of albumin(85).

Hyperuricaemia

Experimental and clinical studies have indicated the role of uric acid in the development of different components of the metabolic syndrome: hypertension, diabetes, fatty liver disease, and chronic kidney disease. Uric acid has been postulated to irreversibly react with nitric oxide, causing endothelial dysfunction and development of hypertension. Nitric oxide deficiency leads to reduced blood flow to insulin-sensitive tissues, which exacerbates insulin resistance. Patients with higher serum uric acid levels have higher cardiovascular morbidity and mortality than those with lower serum uric acid levels. Hyperuricaemia is defined as an elevated serum uric acid level > 7 mg/dl(1).

Liver function test: When diagnosing Metabolic Dysfunction-Associated Steatohepatitis (MASH), liver function tests play a crucial role. These blood tests measure levels of substances produced or metabolized by the liver. Specifically, two liver enzymes are commonly evaluated:
Aspartate Aminotransferase (AST): Elevated AST levels are often observed in most people with MASH.
Alanine Aminotransferase (ALT): Similarly, elevated ALT levels are also indicative of liver inflammation or damage associated with MASH. ALT and AST are sensitive indicators of hepatocellular injury but they lack specificity as they are also present in muscle (cardiac and skeletal), kidney, and RBCs. In hepatocyte cytoplasm AST is more abundant than ALT (84).

A variety of biochemical measurements and biomarkers (Figure 2) may be employed in the diagnosis of MetS; in most situations, these indicators offer a viable and predictable way to diagnose MetS.

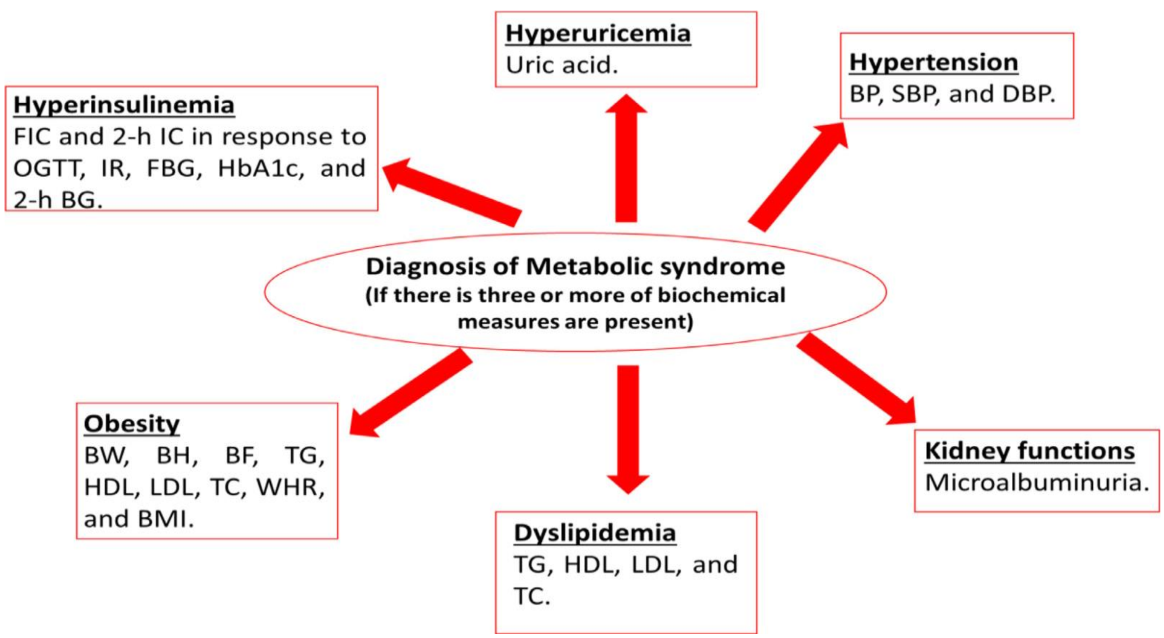

Figure 2: Diagnosis of metabolic syndrome (87)

BW; body weight, BH; body height, BF; body fats, HbA1C; hemoglobin A1C, HDL; high density lipoprotein, LDL; low density lipoprotein, TC; total cholesterol, WHR; waist: hip ratio, BMI: body mass index, BP; blood pressure, DBP; diastolic blood pressure, FIC; Fasting insulin concentration, 2-h IC; 2 hours insulin concentration after OGTT; oral glucose tolerance test, FBG; fasting blood glucose, IR; insulin resistance test, 2-h BG; 2 hours blood glucose after meals, SBP; systolic blood pressure, TG; triglycerides

Management of metabolic syndrome

Dietary patterns

Energy-restricted diets

Dietary treatments for preventing obesity and its associated comorbidities that most frequently used are energy restriction diets. They consist of individualized diet plans that provide lesser calories than the total amount of energy consumed by a particular person. A hypo caloric diet causes a negative energy balance, which leads to a loss of body weight (88). As a result of the lipolysis procedure required to deliver energy substrate, fat is mobilized from various bodily compartments to reduce body weight.

Omega-3 fatty acids enriched diets

Human physiology depends on the omega-3 polyunsaturated fatty acids (n-3 PUFAs) eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Fish, algae, and fatty fish are their main nutritional sources, but humans can also make them from α-linolenic acid (89). These positive effects are believed to be primarily caused by these essential fatty acids' capacity to lower levels of plasma TG (90). The pro-inflammatory cytokines IL-6 and tumor necrosis factor-alpha (TNF), as well as plasma C-reactive protein (CRP), have also been associated to decreased plasma levels in people who consume more n-3 PUFA (91).

High meal frequency pattern: Professionals are currently using the pattern of progressively more frequent meals in weight loss and weight control therapies (92). The goal is to break up the overall number of daily calories into smaller, more frequent meals.

Single nutrients and bioactive compounds

Ascorbate: Since humans cannot generate vitamin C, also known as ascorbic acid or ascorbate, it is a necessary nutrient. It is a water-soluble antioxidant that is mostly present in plants (pepper, kale), citrus fruits (lemon, orange), and fruits (88). This vitamin has been linked to several positive effects, including anti-inflammatory and antioxidant characteristics, as well as the prevention or treatment of CVD and type 2 diabetes (93).

Hydroxytyrosol

It is regarded as one among nature's most important antioxidants and the olive oil's strongest antioxidant (94). Hydroxytyrosol has the capacity to prevent macrophage oxidation of low-density lipoprotein-cholesterol (LDL-C). This phenolic molecule is also thought to have cardiovascular protective properties. By decreasing the expression of intercellular adhesion molecule 1 (ICAM-1) and vascular cell adhesion protein 1 (VCAM-1), it has anti-atherogenic effects (95).

Resveratrol

Red grapes and their derivatives, such as red wine and grape juice, are the main source of the phenolic chemical resveratrol. It has demonstrated anti-inflammatory, antioxidant, and cardio protective properties, plus anti-obesity, anti-diabetic, and anti-obesity capacities (96). According to reports, resveratrol's antioxidant benefits work via scavenging radicals caused by metals, superoxide, and hydroxyl ions as well as by antioxidant actions in cells that produce reactive oxygen species (ROS) (88).

Natural approaches in metabolic syndrome treatment

A multi-drug treatment or polypharmacy is a major difficulty for the treatment of patients with MetS because of poor patient compliance, drug-drug interactions, and side effects including anti-hypertensive, anti-diabetic, and lipid lowering agents, as well as heart failure, and anti-obesity drugs. Reduction of LDL-C and inhibition of intestinal cholesterol absorption are common treatments for patients with MetS (97). For example, blueberry anthocyanins, and polyphenols that reduce plasma ghrelin concentrations and enhance blood glucose tolerance could be used in the management of MetS (98). Also, ginseng that aid in lowering the cholesterol and LDL-C by inhibition of β-hydroxy- β-methylglutaryl-CoA reductase (72). Mulberry leaf extract has impact on MetS by decreasing postprandial glucose, triglycerides, LDL-C and increasing HDL-C (99).

Medications

Renin-Angiotensin System (RAS) Inhibitors

The systemic vasoconstriction induced by the activation of the SNS, leading to a subsequent decrease of the blood flow and affecting the delivery of glucose and insulin to the skeletal muscle cells, the induction of oxidative stress by the production of reactive oxygen species and finally, the direct inhibition of insulin signaling at cellular level. Therefore, blockage of the renin-angiotensin system is expected to have a positive effect not only on the management of hypertension but also on glucose metabolism. As a result, RAS inhibitors have been proposed as the preferred antihypertensive treatment in patients with MetS in the past (100).

Weight-loss surgery

Studies have shown that gastric bypass surgery helped lower blood pressure, cholesterol, and body weight at one year after the procedure. Weight-loss surgery can be done in several ways, but all are either malabsorptive, restrictive, or a combination of the two. Malabsorptive procedures change the way the digestive system works. Restrictive procedures are those that greatly reduce the size of the stomach. The stomach then holds less food, but the digestive functions remain intact and raise HDL cholesterol, increase weight loss, or some combination of these (101).

Conceptual framework

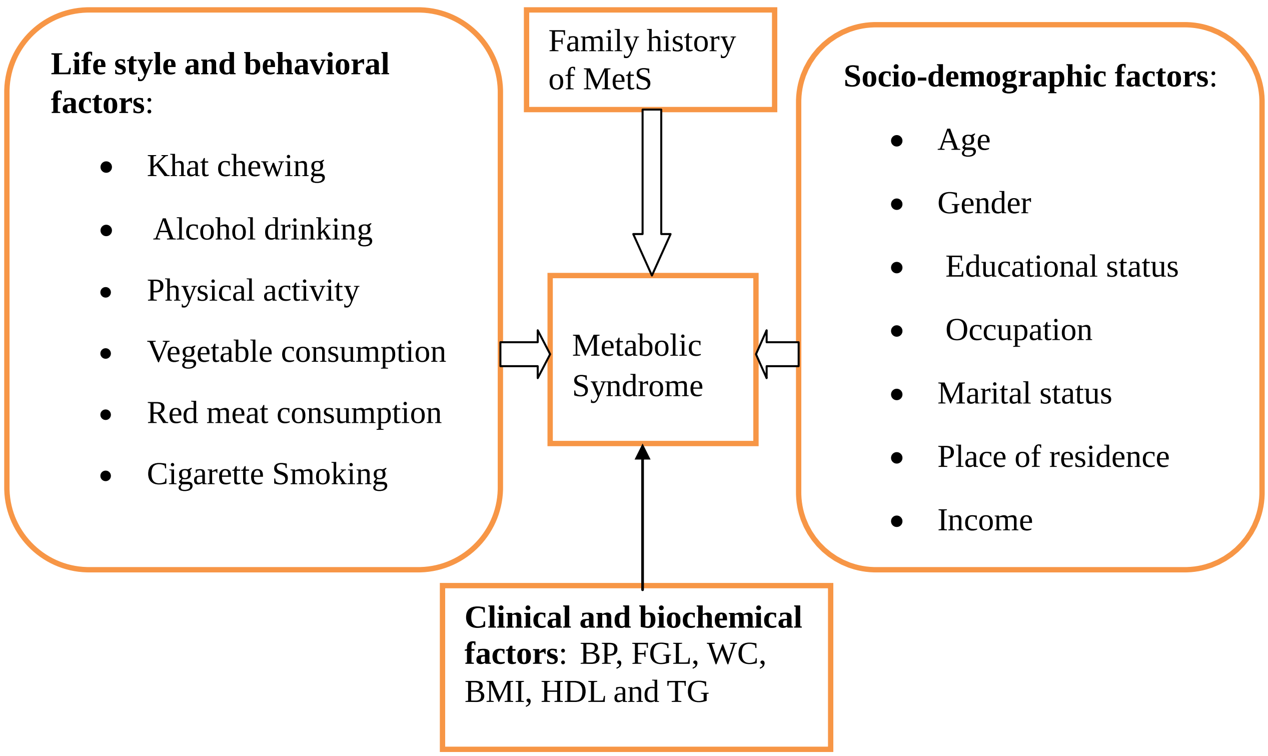

Figure 3: Conceptual framework of metabolic syndrome and associated risk factors adopted from different literature. Double arrow indicates the association of life style factors and Socio-demographic factors with MetS while single arrow shows clinical and biochemical factors in diagnosis of Met.

CHAPTER THREE: OBJECTIVE

3.1 General Objective

The main aim of the present study is to determine the magnitude of metabolic syndrome and associated risk factors among the adult cardiac patients attending a chronic illness follow-up clinic at Jimma University Medical Center, southwest Ethiopia, in 2024.

3.2 Specific Objectives

1. To determine the magnitude of metabolic syndrome among the adult cardiac patients at Jimma University Medical Center, Southwest Ethiopia, in 2024
2. To determine the association between lifestyle, behavioral factors, and MetS among the adult cardiac patients at Jimma University Medical Center, southwest Ethiopia, in 2024
3. To determine the association between sociodemographic factors and MetS among the adult cardiac patients at Jimma University Medical Center, southwest Ethiopia, in 2024

CHAPTER FOUR: MATERIALS AND METHODS

4.1 Study Area and Period

This study was conducted at Jimma University Medical Center, Southwest Ethiopia, from December 21, 2023, to March 21, 2024. Jimma University Medical Center is located southwest of Ethiopia in the Oromia region, Jimma zone, 352 km away from the capital city, Addis Ababa.

4.2 Study design

This study was implemented using a hospital-based cross-sectional study design.

4.3 Population

Source populations: all cardiac patients who were 18 years of age or older attending the chronic illness clinic at JUMC.

4.3.1 Study populations: volunteer cardiac patients who were 18 years of age or older, attended the chronic illness clinic, were available at JUMC during the data collection period, and fulfilled inclusion criteria.

4.3.2 Eligibility Criteria

4.3.3 Inclusion criteria

Adult cardiac patients 18years or older attending chronic illness follow up clinic present during data collection

4.3.4 Exclusion criteria

Pregnant women were excluded from the study because of unreliable waist circumference measurements and BMI.

Critically ill patient was also excluded from the study.

4.4 Sample size and sampling technique

The volunteer adult cardiac patients who were attended JUMC during data collection period were recruited for the purpose of this study. The sample size was determined using the single population proportion formula, considering 50% proportion since no report on prevalence of MetS on cardiac patients with a 5% margin of error.

N (source population) = $(Z\alpha 2)2\ P\ (1-P)/d2 = (1.96x1.96)\ (0.5x\ (1-0.5))\ /\ (0.05)\ (0.05) = 384$

N = 1500(source population); p= proportion;

d= margin of error =5%;

$Z\alpha 2$=standard score

Adjusted sample Size: $n/\ (1+n/N) = \quad 384/\ (1+ 384/1500) = 306$

Non-respondent (5%) = 15

Final sample size =306+15 =321

Volunteers who fitted the requirements for inclusion were chosen one at a time until 321 people were chosen during the data collection period.

4.5 Data collection

Data were collected by trained health workers, which include two nurses. To ensure the quality of the interview, data collectors were trained by the principal investigator, and later on, random checks were carried out by supervisors and the principal investigator. Data were collected by interviewing eligible subjects using a structured questionnaire. The questionnaire were pretested before the initiation of the study to check the flow of the questionnaires, measure the length of time required for interviews, determine feasibility, and check the clarity of the language used.

4.6 Measurements

Anthropometric measurements were taken using WHO-standardized stepwise techniques and calibrated equipment. Subjects were weighed to the nearest 0.1 kg in light indoor clothing and bare feet or with stockings. The participant's height was measured using a stadiometer. This was done when the subject stands in an erect posture without shoes and was recorded to the nearest 0.5cm. Measures were taken twice, and the average was considered in the analysis. Waist girth was measured by placing a plastic tape to the nearest 0.5 cm, horizontally midway between the 12th rib and the iliac crest on the mid-axillary line. Waist circumference (WC) was categorized as low risk if it is less than 102 cm for men and less than 88cm for women and high risk if it is 102cm or more for men and 88 cm or more for women.

The body mass index (BMI) was calculated as the ratio of body weight in kilograms to the square of body height in meters. BMI was used to define underweight (BMI < 18.5), normal (18.5 to BMI < 25.0), overweight (25.0 to BMI < 30.0), and obese (BMI greater or equal to 30) adults.

Blood pressure (BP) was measured using a digital measuring device after resting for at least five minutes prior. High blood pressure was classified as hypertension with a systolic blood pressure (SBP) greater or equal to 130 mmHg and/or a diastolic blood pressure (DBP) greater or equal to 90 mmHg.

Socio-demographic and behavioral characteristics

Socio-demographic and behavioral characteristics were collected through face-to-face interviewing of study participants about chat chewing and cigarrete smoking behaviors were defined as self-reported current chewing of khat and practicing smoked tobacco or smokeless tobacco products, respectively. Current alcohol consumption was assessed by asking participants to respond by ticking yes or no to the question, "Have you consumed any alcoholic drink, such as beer, wine, Tela, Tej, or local Areki, in the last 30 days?" Data about dietary habit and current smoking were found out by asking participants to respond in the same manner to the question. Example: "Do you currently smoke any tobacco products, such as cigarettes? Gender, age, educational status and income status were asked.

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 standardizes serum separator tube from each participant by trained laboratory technologist. The process of blood sample collection was 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 Laboratory for Clinical Chemistry, for analysis or stored at 2-8 0c until analysis was done.

Biochemical analysis: Laboratory tests were performed for blood glucose, triglyceride,   and HDL- cholesterol using COBAS 6000 (Roche Diagnostics GmbH, Mannheim, Germany) clinical chemistry analyzer. All these tests were done with minimum 8 hours fasting. Laboratory test results were assessed and categorized according to the definition.

4.7 Study Variables

4.7.1 Dependent variable

The dependent variable was metabolic syndrome

4.7.2 Independent variables: age, sex, educational status, employment status, income per month, marital status, Cigarette smoking, khat chewing, alcohol consumption, physical activity, dietary status, place of residence.

4.8 Operational Definition

Definition of metabolic syndrome

MetS as defined by ATP III and IDF criteria as follows (102).

ATP III Definition (2005)		**IDF Definition (2005)**	
Criteria: any three or more of the following five factors:		Criteria: if participants had abdominal obesity (defined as waist circumference of ≥94 cm for men and ≥80 cm women) plus two of any of the following risk factors:	
Central obesity, defined as waist circumference > 102 cm in men or > 88 cm in women		plus, any two of the following four factors:	
Raised triglycerides	≥150 mg/dL	Raised triglycerides	≥150 mg/dL
	or specific treatment for this lipid abnormality		or specific treatment for this lipid abnormality
Reduced HDL cholesterol	<40 mg/dL in males <50 mg/dL in females	Reduced HDL cholesterol	<40 mg/dL in males <50 mg/dL in females
	or specific treatment for this lipid abnormality		or specific treatment for this lipid abnormality
Raised blood pressure	≥130/85 mm Hg	Raised blood pressure	≥130/85 mm Hg
	or treatment of previously identified hypertension		or treatment of previously identified hypertension
Raised fasting plasma glucose	≥100 mg/dL	Raised fasting plasma glucose	≥100 mg/dL
	or previously diagnosed T2DM		or previously diagnosed T2DM

ATP III = Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults; IDF = International Diabetes Federation; MetS = metabolic syndrome; HDL = high-density lipoproteins; T2DM = type 2 diabetes mellitus.

4.9 Data Processing and Analysis

The data were checked for completeness, coded and entered into EPI Data Version 4.21, and exported to SPSS 26 for analysis. Descriptive analysis was explored using frequency and percentage for categorical variables. Binary logistic regression was applied to identify factors associated with the metabolic syndrome. P-value < 0.25 was used as a cut-off and included variables in the multivariate binary logistic regression model. The results were considered statistically significant at a P-value of less than 0.05. The results of the OR were used for the interpretation of the strength of prediction of the independent variables for the dependent outcome. For all statistical significance tests, the cut-off value set were P < 0.05 with a CI of 95%.

4.10 Ethical Considerations

The Jimma University Health Institute's institutional review board (IRB) was granted ethical clearance. The official letter was written to the relevant bodies after it was approved. The participants in the study were informed of the nature, goals, and advantages of the study. The right of any participant to decline or discontinue participation at any time was strictly enforced. The recorded data were kept private and were only accessibled by the principal investigator in order to maintain confidentiality.

4.11 Dissemination plan

The findings of this study will be reported to the biomedical sciences department, and copies will be given to other interested parties and postgraduate programs at Jimma University. It will be submitted for publication in a national or international peer-reviewed journal.

CHAPTER FIVE: Results

Sociodemographic and behavioral characteristics of the study participants

Three hundred twenty-one (321) adult cardiac patients were enrolled in this study, giving a response rate of 100%. About 182 (56.69%) were female and 139 (43.30%) were male.

The majority of the study participants were rural residents (80.3%), completed primary education (65.42%), and married (90.96%) as presented in table 1.

Table 1: Sociodemographic characteristics of adult cardiac patients in Jimma university medical center chronic follow up clinic, March, 2024

Variable		Men	Women	Total (N=321)n (%)
Age	< 30	3	13	16 (4.98)
	30-50	48	44	92(28.66)
	≥51	88	125	213(66.35)
Residence	Rural	109	149	158(49.22)
	Urban	30	33	63(19.62)
Educational Status	Illiterate	30	42	72(22.42)
	Primary school	90	120	210(65.42)
	Secondary school	12	11	23(7.16)
	Higher	7	9	16(4.98)
Marital Status	Single	9	20	28(8.72)
	Married	130	162	293(90.96)
Occupation	Farmer	131	2	133(41.43)
	Government employee	8	9	17(5.29)
	Housewife	0	171	171(53.27)
Monthly income(ETB)	<1500	77	84	161(50.15)
	1500- 3173	17	18	35(10.90)
	3174-6677	29	48	77(23.98)
	>6677	16	32	48(14.95)

Clinical and lifestyle participant characteristics

A total of 155 (48.2%) participants were khat chewers, of whom about 90 (51.61%) were female. A history of alcohol consumption from patients self-reports was found among 13 (4.04%). About 10.9% of the participants had a history of cigarette smoking; 18.38% of the study participants used palm oil to prepare food; 42(13.08%) of the study participants had a day-to-day working habit full of vigorous intensity of activities, which included farming, long-distance walking, and laborious activities.

About 262 (81.61%) of the respondents were taking lipid-lowering medications, of which 49.53% were female. It was found that 97 (30.21%) of the participants had known hypertension and 12 (3.7%) had known type 2 diabetes mellitus, and both conditions were more common among females than males (hypertension in males 8.72%, in females 21.49%); DM (in males =0.62%, in females =3.11%). The mean (± standard deviation) BMI was 24.77 ± 2.89 kg/m². The frequency of metabolic syndrome components was raised blood pressure of 150 (46.7%), high BMI of 24 (7.5%), low HDL of 177 (55.1%), raised FGL of 136 (42.36%), and TG of 149 (46.4%) as presented in table 2.

Table 2: Clinical and biochemical characteristics of adult cardiac patients in the Jimma University Medical Center chronic follow-up clinic, March 2024

Variable		Males N%	Females N%	Total (N=321) n (%)
Oil used in food preparation	Palm oil	19(5.91)	40(12.46)	59(18.38)
	Cereal oil	120(37.38)	142(44.23)	262(81.61)
Physical activity	Vigorous	17(5.29)	25(7.78)	42(13.08)
	Moderate	92(28.66)	96(29.90)	188(58.56)
	low	30(9.34)	61(19.00)	103(32.08)
Red Meat	<2kg/week	96(29.90)	103(32.08)	199(61.99)
	≥2kg/week	43(13.39)	79(24.61)	122(38)
Lipid-lowering treatment	Yes	103(32.08)	159(49.53)	262(81.61)
	No	36(11.21)	23(7.16)	59(18.38)
Alcohol	NO	132(41.12)	172(53.58)	304(94.7)
	YES	7(2.18)	10(3.11)	17(5.29)
Known HTN or on treatment	Yes	28(8.72)	69(21.49)	97(30.21)
	No	111(34.57)	113(35.20)	224(69.78)
Known T_2DM	Yes	2(0.62)	10(3.11)	12(3.73)
	No	137(42.67)	172(53.58)	309(96.26)

Prevalence of metabolic syndrome and frequency of metabolic syndrome components

The prevalence of metabolic syndrome was calculated based on two criteria. According to the modified NCEP-ATP III criteria, the overall prevalence of metabolic syndrome was 40.81%, with females having a higher rate of metabolic syndrome (28.03%) as compared to males (12.77%). A relatively similar result was also obtained using the IDF criteria (41.43%). Based on the IDF criteria, 46 (14.33%) patients had abdominal obesity, of whom 26 (8.09%) were males as shown in table 3.

Table 3: Frequency of metabolic syndrome components among cardiac patients at Jimma medical center, 2024

MetS component	Overall frequency n (%)	Men N = 139 n (%)	Women N = 182 n (%)
Abdominal obesity by NCEP-ATP	24(7.47)	11 (3.42)	13(4.04)
Abdominal obesity by IDF	46(14.33)	26 (8.09)	20(6.23)
Elevated fasting Glucose	136 (22.42)	51 (15.88)	85(26.47)
Elevated triglyceride	149(46.40)	59 (18.38)	90(28.03)
Reduced HDL-c	177 (55.1)	82 (25.54)	95 (29.59)
Raised BP	150 (46.72)	46 (14.33)	104 (32.39)

Association of predictors with metabolic syndrome

Among 321 study participants, a total of 131 (40.81%) adult cardiac patients had metabolic syndrome. MetS was more than two times more likely occur in females than males (COR=2.338 with 95% CI: 1.47, 3.73). The risk of its development increased in those 51 year and older are 1.267 times more at risk of developing metabolic syndrome compared to those under the age of 30 years.

According to the modified NCEP-ATP III criteria, khat chewing and Tobacco smoking increased risk of metabolic syndrome by more than four times than their counterparts, which was statistically significant. Lack of Alcohol drinking reduces odd of having MetS by 64.4% compared to alcohol drunker significantly.

In addition using Palm oil for food preparation and eating vegetable less than one plate per week increased risk of metabolic syndrome by more than two and three times than their counterparts respectively. Those who eat red meat less than two kilogram per week experiences a reduction of 94.2% in the odds of having a MetS compared to those eating red meat two kilogram or more per week. Those who were doing vigorous and moderate physical exercise experienced 92.5% and 95.5% a reduction in the odds of having a MetS compared to those who were physically inactive respectively. However, having a monthly income of more than 3174-6677 Ethiopian birr increased risk of metabolic syndrome by more than four times than those getting less than 1500 Ethiopian birr.

Multivariate analysis of predictors of metabolic syndrome

Eating vegetable less than 1 plate per week increased the risk of metabolic syndrome by about more than five times after adjustment. Similarly, the multivariate analysis showed that those who were doing vigorous and moderate physical exercise experienced 93.2% and 90.4% reduction in odds of having MetS compared to those who were physically inactive. Those who were eating red meat less than two kilogram per week experienced 92.6% a reduction in odds of having MetS compared to those who were eating red meat 2kg or more per week. Khat chewing increased the odds of having metabolic syndrome by more than ten times after adjustment.

Applying the IDF criteria for MetS, the univariate and multivariate analysis showed slightly different in COR and AOR from that of NCEP ATPIII criteria.

Applying the IDF criteria for MetS, the univariate analysis showed that being primary educational level completed (COR=2.478; 95% CI: 1.362, 4.510), secondary level completed (COR=2.750; 95% CI: 1.036, 7.303), and higher level completed (COR=3.857; 95% CI: 1.255, 11.852) were found to be significantly associated with the development of MetS.

Additionally, doing vigorous physical activity (COR=0.075;95% CI:0.031, 0.180), doing moderate physical activity (COR=0.048;95% CI:0.024, 0.095), being a tobacco smoker (COR=4.120; 95% CI:1.905, 8.911), being a khat chewer (COR=4.725; 95% CI:2.926, 7.631), being a vegetable consumer less than 1 plate per week (COR=2.934; 95% CI:1.820, 4.731), being a red meat consumer (COR=0.052; 95% CI: .0.029, 0.093), having an income of >6677 Ethiopian birr per month (COR=16.757;95% CI:7.211, 38.940), and being a palm oil user in food preparation (COR=2.662; 95% CI: 1.490, 4.756) were found to be significantly associated with the development of MetS.

However, the multivariate analysis showed that being a vegetable consumer less than 1 plate per week (AOR = 4.989 , 95% CI: 1.967, 12.650), doing vigorous physical activity (AOR =0.058; 95% CI: 0.017,0.198), doing moderate physical activity (AOR = 0.106; 95% CI: 0.041, 0.276), and being a red meat consumer less than 2kg /week (AOR =0.062; 95% CI: 0.025, 0.155) have maintained the significant association with MetS.

Table 4: Factors associated with metabolic syndrome (MetS) according to the modified NCEP-ATP III criteria among cardiac patients at Jimma Medical Center, 2024

Variables		MetS	No MetS	COR	95% CI	AOR	95% CI	p-value
Gender	Male	41	98	1		1		
	Female	90	92	2.338	1.47, 3.73	3.042	1.396 , 6.628	**0.005**
Age	<30yr	6	10	1				
	30-50yr	33	59	0.932	0.311, 2.795			
	>50yr	92	121	1.267	.444, 3.613			
Educational status	Illiterate	18	54	1		1		
	Primary level	93	117	2.385	1.31, 4.34	2.489	0.893, 6.938	0.081
	Secondary level	11	12	2.750	1.04, 7.30	2.554	0.551 , 11.83	0.231
	Higher level	9	7	3.857	1.26, 11.85	0.424	0.068 , 2.640	0.358
Place of Residence	Rural	104	154	1		1		
	Urban	27	36	1.111	0.64, 1.94			
Monthly income in ETB	<1500	35	126	1		1		
	1501-3173	14	21	2.400	1.11, 5.20	0.565	0.139 , 2.308	0.427
	3174-6677	42	35	4.320	2.41, 7.75	3.624	1.11, 11.827	**0.033**
	>6677	40	8	18.000	7.72, 41.96	1.199	0.315, 4.560	0.790
Oil used in food	Cereal oil	96	24	1		1		
	Palm oil	35	166	2.522	1.42, 4.49	1.224	0.430 , 3.485	0.705
Physical activity	Vigorous	13	29	0.075	0.031,0.180	0.068	0.02, 0.229	**0.000**
	Moderate	40	148	0.045	0.023, 0.089	0.096	0.037, 0.251	**0.000**
	low	78	13	1		1		
Vegetable consumptio n	≥1 Plate/wk	34	100	1		1		
	<1 Plate/wk	97	90	3.170	1.96, 5.14	5.787	2.26 , 14.81	**0.000**
Red meat	<2kg/wk	35	164	0.058	0.033, 0.102	.074	0.03,0.185	**0.000**
	≥2kg/wk	96	26	1		1		
Tobacco smoking	No	106	180	1		1		
	Yes	25	10	4.245	1.96, 9.18	1.975	0.571, 6.833	0.282
Khat Chewing	No	39	127	1		1		
	Yes	92	63	4.755	2.939, 7.69	10.136	3.49 , 29.41	**0.000**
Alcohol drinking	No	120	184	0.356	0.128, 0.987	0.974	0.226, 4.206	0.972
	Yes	11	6	1		1		

MetS = number of participants with metabolic syndrome, No MetS = number of participants without metabolic syndrome, COR = crude odd ratio, CI = confidence interval, AOR = adjusted odd ratio.

CHAPTER SIX: Discussion

This study showed a higher prevalence of metabolic syndrome among cardiac patients attending follow-up at Jimma University Medical Center when compared with study conducted among outpatients of Jimma University Teaching Hospital in 2016, A systematic review and meta-analysis in Ethiopia and hypertensive patients at University of Gondar Hospital(26,32,103). This could be due to difference in study participants, sample size or sampling techniques used. Using the modified NCE PATP III criteria, the prevalence of metabolic syndrome was found to be 40.81%, which is relatively similar to the prevalence obtained according to the IDF criteria (41.4%).

There could be several reasons for the high prevalence of MetS among cardiac patients. Risk factors for cardiovascular disease and metabolic syndrome, such as obesity, hypertension, and dyslipidemia, are frequently present in cardiac patients. Furthermore, chronic inflammation, frequently observed in heart-related disorders, may also contribute to the development of metabolic syndrome. A major component of the metabolic syndrome, insulin resistance, may be present in cardiac patients (104).

Certain drugs, like beta-blockers, which are used to treat cardiac disorders, can affect metabolic parameters. Long-term use of beta blockers in patients with cardiac disease could increase triglyceride levels and decrease high-density lipoprotein (HDL) levels, which are features of metabolic syndrome. Mechanism: One proposed theory for the lipoprotein effects of beta blockers involves suppression of beta-adrenergic activity, leading to unopposed alpha-adrenergic stimulation. This alpha-adrenergic stimulation results in a decrease in peripheral lipoprotein lipase activity and subsequently reduces the catabolism of very low-density lipoprotein (VLDL) and triglycerides (105).

Cardiac patients often have sedentary lifestyles, poor diets, and high levels of stress, all of which can exacerbate metabolic syndrome. Lack of physical activity leads to weight gain and reduces insulin sensitivity. It affects lipid metabolism by raising triglycerides and lowering HDL (good cholesterol). Triglycerides are fats stored in fat cells and serve as energy sources. Excess calories, particularly from sugars and unhealthy fats, are converted into triglycerides by the body. Lack of physical activity prevents the burning of these calories, leading to higher triglyceride levels. Regular exercise helps burn calories and reduces triglycerides by increasing lipoprotein lipase activity (106).

According to a study conducted at Jimma University Teaching Hospital, 26% of adult outpatients were found to have metabolic syndrome, which is a lower prevalence and not consistent with this current study. This may be due to the different population (outpatient vs. cardiac patient) and sample size (225 vs. 321) (107).

A study from Spain has reported a metabolic syndrome prevalence of 43.78% and 40.82% among ischemic heart disease patients according to the EGIR and NCEP-ATP III criteria, respectively (108). These reports are consistent with the findings in our study, according to NCEP-ATPIII. However, there could be sociodemographic, lifestyle, and genetic differences in sample size (169 vs. 321) between our population and the population of Spain.

The frequency of metabolic syndrome components in this study was abdominal obesity according to NCEP-ATP (7.47%), abdominal obesity according to IDF (14.33%), elevated fasting glucose (42.36%), elevated triglyceride (46.40%), reduced HDL-c (55.1%), and raised BP (46.72%). All these values were lower than those of a study conducted in Spain (108**).** This could be explained by the two populations' different lifestyles and socioeconomic backgrounds, which are reflected in the high percentage of obese people (36.7%) in the Spain study.

According to study in Addis Abeba among adult bank workers the prevalence of metabolic syndrome was 14.5%, whereas current study MetS prevalence was higher by nearly threefold (109). It is clear that the study populations in Addis Ababa and ours were different. The study populations in Addis Ababa were healthy bank workers whose job style is mainly sedentary. People with sedentary lifestyles might be at risk of developing metabolic syndrome. However, these current study populations are cardiac patients visiting follow-up clinics for their illnesses. The rate of occurrence varies depending on components of the metabolic syndrome; elevated blood pressure and reduced HDL-c are predominant in the present study, which is also similar to the study in Addis Ababa. Low HDL-c (55.1%) and raised BP (46.72) were the most frequently occurring risk factors for metabolic syndrome. In the same way, At the University of Gondar Hospital, the most predominant MetS component among hypertensive patients was low HDL-c (81.3%) (26). Nonetheless, the study populations—cardiac patients and hypertensive patients—

were different. The variation in sample size (300 vs. 321) or study population may be the cause of this discrepancy in HDL-c percentage.

Low high-density lipoprotein cholesterol (HDL-C) levels in cardiac patients can be influenced by various factors. Obesity, particularly abdominal obesity, is associated with low HDL-C levels and elevated LDL cholesterol. High blood pressure, also linked to hypertriglyceridemia, can also contribute to low HDL-C levels. Female gender is also associated with low HDL-C levels, making female cardiac patients more susceptible to this lipid abnormality.

Men between 20 and 39 have higher HDL cholesterol levels than women, but their risk increases after menopause due to hormonal changes. Women's levels of total and "bad" LDL cholesterol usually go up, while their levels of "good" HDL cholesterol go down. Physical inactivity is associated with the buildup of fatty deposits in the arteries, leading to atherosclerosis.

Other factors that can impact HDL-C levels include smoking, which can reduce HDL-C levels, and certain medications, such as beta-blockers, which can affect HDL-C levels (110).

Studies have consistently shown gender differences in the prevalence of MetS. For instance, in Japan, where the prevalence of MetS is increasing due to an aging population, women tend to have a higher prevalence of MetS than men, especially after the age of 55 (111).

Similarly, in the United States, Europe, and Taiwan, evidence suggests that MetS is more prevalent in men than in women (64). In this study, MetS was significantly associated with being female. Regardless of the criteria, the sex-specific proportion was higher in females than in males. It is consistent with a study conducted in Gondar Town, northern Ethiopia (70).

MetS is more prevalent among females than males due to unhealthy lifestyle factors such as unhealthy dietary habits, a lack of physical activity, hormonal differences, and abdominal obesity. Unhealthy dietary patterns, such as high consumption of refined sugars, saturated fats, and processed foods, contribute to MetS. Females may be more prone to these unhealthy habits, while males may have higher androgen levels, which may provide some protection against MetS. Estrogen plays a protective role against cardiovascular diseases. However, after menopause, estrogen levels decline, which may contribute to MetS development in females. Additionally, females with conditions like polycystic ovary syndrome (PCOS) may have hormonal imbalances that increase MetS risk. Females tend to accumulate fat around the waist more than males, which elevates their MetS risk (64)

Consumption of less than one plate of vegetables and two kilograms or more of red meat per week was significantly associated with a higher risk of MetS in this study, which is consistent with a study in China (41). Lack of vegetation is significantly associated with the metabolic syndrome in the present study. This may be due to the fact that the fact that vegetables are rich in antioxidants, vitamins, and minerals. Consuming them promotes general health and aids in the prevention of MetS components like dyslipidemia and hypertension. Dietary fiber, which is found in vegetables, lowers blood sugar, increases insulin sensitivity, and helps with weight management. MetS and low fiber intake are related. Many vegetables have anti-inflammatory properties that help reduce the inflammation linked to MetS. Phytochemicals found in vegetables protect against oxidative stress and promote cardiovascular health (112).

Oxidative stress occurs when there’s an imbalance between oxidants (reactive oxygen species, or ROS) and antioxidants in our bodies. These ROS can damage cells, proteins, and DNA, contributing to the development of various common diseases. Phytochemicals, found in vegetables and fruits, are essential for preventing and treating chronic diseases caused by oxidative stress. They act as antioxidants, scavenging reactive oxygen species (ROS) and reducing oxidative damage. Some phytochemicals also modulate inflammatory pathways, contributing to cardiovascular health and potentially managing diabetes and obesity by improving insulin sensitivity and reducing oxidative stress-related complications (113).

Saturated fat and haem-iron in red meat may contribute to metabolic syndrome risk by affecting obesity, hyperinsulinemia, and hyperglycemia (114). Saturated fats found in red meat and other sources can increase LDL (bad) cholesterol levels and raise the risk of MetS. Consuming saturated fats can increase the levels of low-density lipoprotein (LDL) cholesterol, also known as "bad" cholesterol, in the bloodstream. This contributes to plaque buildup in artery walls. When you consume saturated fats, they increase the amount of cholesterol circulating in the bloodstream within LDL particles. These LDL particles can then deposit cholesterol inside the artery walls, leading to atherosclerosis (narrowing of the arteries) and an increased risk of heart disease. Red meat and processed meat have varying saturated fat contents, with processed meat increasing the risk of coronary heart disease by 18% and unprocessed red meat by 9%. The high saturated fat content in red meat and the high sodium content in processed meat contribute to these risks (115).

This current study revealed khat chewing and physical inactivity were significantly associated with MetS. This could be due to chewing khat releases catehinone, which has a significant impact on the metabolism of carbohydrates. It does this by raising cortisol levels, which limit insulin secretion and promote insulin resistance by upregulating the expression of resistin. Resistin is a cysteine-rich hormone secreted by white adipocytes. It is involved in insulin resistance and linked to obesity (74).

Research revealed that the serum levels of cortisol and resistin were higher in khat chewers with diabetes and in healthy individuals than in non-khat chewers (76). Due to its adrenergic action, cathinone elevates plasma catecholamine levels and inhibits the effects of insulin, which leads to the release of glucagon, the activation of glycogenolysis in the liver, the secretion of adrenocorticotropic hormone (ACTH), and the suppression of insulin release from pancreatic beta cells (α2-adrenoreceptor-mediated response). All of these processes typically result in elevated blood sugar levels (116).

Vigorous and moderate physical activity had a significant negative association with MetS. The role of vigorous and moderate physical activity: Increased Adiponectin: Regular and structured physical activity leads to an increase in adiponectin production. Adiponectin is an adipokine (a hormone produced by fat cells) that has several beneficial effects on metabolism. It improves energy and glucose metabolism, modulates energy expenditure, and enhances thermogenesis. Adiponectin, in turn, improves energy and glucose metabolism (117).

ADP reduces fat accumulation in muscles and the liver by increasing lipoprotein lipase activity, improving triglyceride uptake, and improving white adipose tissue storage. Adiponectin promotes insulin responsiveness by regulating glucose uptake and utilization and allowing efficient switching between glucose and fatty acid metabolism. It interacts with receptors on cell surfaces, activating the AMPK pathway and inhibiting acetyl-CoA carboxylase, promoting fatty acid oxidation and efficient energy utilization. Adiponectin downregulates enzymes like G6Pase and PEPCK, preventing glucose production in the liver and thereby maintaining healthy blood glucose levels. Physical activity enhances fitness, glycemic control, lipid profile, weight loss, and improved insulin sensitivity (118).

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However, a sedentary lifestyle contributes significantly to the development of metabolic syndrome. When you’re physically inactive, your body burns fewer calories, which can lead to weight gain. Additionally, physical inactivity is associated with insulin resistance. Normally, insulin helps sugar enter cells for energy. However, in people with insulin resistance, cells don’t respond effectively to insulin, leading to elevated blood sugar levels (104).

6.1 Strengths and Limitations of the Study

6.1.1 Strengths of the study

This study was conducted using a larger sample size, whereas previous related studies were conducted on a smaller sample size.

It also addressed certain variables, such as khat chewing, vegetable and red meat consumption, which were not used in the previous studies.

6.1.2 Limitations of the study

Due to the cross-sectional nature of the study, cause and effect relations could not be established between metabolic syndrome and the associated factors. Moreover, only two definitions were used to assess the prevalence of MetS; a different prevalence rate could have been observed if other metabolic syndrome definitions, like the WHO definition, were used. Despite these limitations, this study ultimately adds to the limited data on metabolic syndrome in Ethiopia, particularly in the study area.

7. **Conclusion and Recommendations**

7.1 Conclusion

The magnitude of metabolic syndrome among cardiac patients was high, with low- high density lipoprotein cholesterol and elevated blood pressure being the most commonly encountered abnormalities. Being female, eating less than 1 plate per week of vegetables, doing vigorous and moderate physical activity, khat chewing and eating red meat less than 2 kg per week were found to have a significant association with the occurrence of MetS.

The majority of the cardiac individuals were at a high risk of developing MetS as they had two more very common additional risk factors (elevated blood pressure and reduced HDL-c). Therefore, all cardiac patients should be screened for the presence of additional cardiovascular risk factors that constitute the metabolic syndrome.

7.2 Recommendations

For cardiac patients:

They should have to check their BP status, FGL, WC, TG, and HDL levels regularly.

For health professionals:

They should have to pay attention to the routine measurement of BP, FGL, WC, TG, and HDL levels of their clients. They should advice patients on vegetable consumption and doing physical exercise

For future researchers:

Further in-depth studies should be conducted to assess predictors of MetS and the performance of the health care system in order to design and implement a cost-effective and comprehensive patient care approach for cardiac patients.

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ANNEXE

Annex I: English version of Participants' Information Sheet

Dear participant, Good Morning/Afternoon

Introduction

My name is ______________________I am a member of the study that is conducted in …….

Study Title: Magnitude of Metabolic syndrome and associated risk factors among adult cardiac patients attending chronic illness follow up clinic in Jimma University Medical center, Jimma, Southwest Ethiopia.

Name of principal investigator: Abishu Gemechu

Name of study area: Jimma University Medical center

Research budget: Will be covered by Jimma University

Research objective: The main aim of the this study is to determine the magnitude of metabolic syndrome and associated risk factors among the adult cardiac patients attending chronic illness follow up clinic in Jimma University Medical Center, Jimma, southwest Ethiopia, 2023

Significance of the study: The purpose of this study is aimed provide relevant information about the severity of the metabolic syndrome and associated risk factors that contribute to MetS. It will provides crucial details on the body mass index (BMI), waist circumference (WC), blood pressure status, glucose level, and lipid profile of study participants. Their level of awareness will be increased as a result, it will allow them to get screened early and take protective measures against its effects. Additionally, the outcomes of this study will provide information for future research and will be utilized as a useful reference.

Risks: The risk will be the lowest to the patient except only 15-20 minutes will be spent for the Interview so you are kindly asked to provide important information **Participant right:** Your participation is voluntary and you are not obligated to participate in the study. You have the right to withdraw at any time from the interview or not to participate and to escape questions which are not comfortable for you will be reserved.

Beneficial: The study will be beneficial for patient's quality service delivery system to come across and to promote an intervention for the future perspective.

Confidentialities: The study will not include your name and/or address and data will be accessed only authorized personnel and interview will be made only by ethically conducted, well trained and experienced health care professionals and analyzed by the principal investigator.

Agreement: participants are expected to be fully voluntary to participate in the study.

Whom to contact: If you have any kind of questions or doubt regarding this study, feel-free to contact the principal investigator: **Abishu Gemechu** via the following address

Phone No: 0933647082

E-mail: abishu0317@gmail.com.

Thank you for your participation!!

Informed consent

Name of the investigator: Abishu Gemechu

Research title: Magnitude of Metabolic syndrome and associated risk factors among adult cardiac patients attending chronic illness follow up clinic in Jimma University Medical center, Jimma, Southwest Ethiopia

Card number: Code number__________

1. I, confirm that, I understand the information sheet for this study and have had the opportunity to ask questions.

2. I, understand that my participation is completely voluntary, and that I am free to withdraw at any time, without giving any reason, without legal rights being affected. 3. I understand that my response will be looked, and secured and necessary information will be extracted. I give you a permission to have an access to all my response.

4. I, agree to take part in the above study. I would like to confirm my agreement by signing.

Participants code________________________ Signature:___________date_______

Data collector's name:_____________________Signature:___________date_______

I thank you very much for your willingness to participate honestly and cooperatively

Card number:__________

Participant's code_______________________ Signature: ___________date_______

Data collector's name:______________________ Signature: ___________date_______

Section A: *Socio-Demographic Characteristics of the participant*

01	Participant sex: 1.Male 2. Female
02	Age____
03	Place of residence 1.Rural 2.Urban
04	Participant Ethnicity 1.Oromo 2.Amhara 3.Tigre 4.Gurage 5.Wolayita 6.Other_____

05	Marital status 1.single 2. Married 3. divorced 4.widowed
06	Educational background 1.illiterate 2.primary 3.secondary 4.higher
07	Occupation 1.housewife 2.farmer 3.merchant 4.gov't employer

08	Income--------- Ethiopian birr per month
Section B	***Lifestyle Characteristics***
09	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? 1.Yes 2.No
10	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? 1.Yes 2.No
11	Have you consumed any alcohol within the past 12 months? 1.Yes 2.No
12	Do you currently smoke any tobacco products, such as cigarettes in last 30 days? 1.Yes 2.No
13	Do you currently chewing khat in last 30 days? 1.Yes 2.No
14	Read meat consumption 1.Read meat eating 2kg or more / week 2. Read meat eating less than 2kg / week
15	Oil used in food preparation 1. Palm oil 2. Cereal oil
16	Consumption of vegetable 1.Less than 1 plate per wk. 2. Greater than or equal to 1 plate per wk.
Section C	***Anthropometric Measurements:***
17	Waist Circumstance 1.less than 102 cm for male or 88 cm or female 2. >_ 102cm for male or >_88 cm for female
18	BMI ______ 1.<18kg/m^2 2.18kg/m^2-24.9kg/m^2 3.25kg/m^2 -30kg/m2 4.>30 kg/m2
19	On Treatment of previously diagnosed hypertension IF yes Jump to Q31 1.Yes 2.No
20	BP 1. SBP <130 mmHg 2. SBP ≥130 mmHg 3. DBP <85 mmHg 4. DBP ≥85 mmHg
Section D	***Clinical Measurements:***
21	On Glucose lowering drug treatment if yes skip to Q 34. 1.Yes 2.No
22	Fasting blood glucose level 1.<100 mg/dl 2.≥100mg/dl
23	On Lipid-lowering drug treatment if yes skip to Q 36 1.Yes 2.No
24	Lipid profile 1. HDL: --------mg/dl 2.TG ------mg/dl
25	Do you have family history of Metabolic syndrome? 1. Yes 2.No
26	Metabolic syndrome 1. Yes 2. No

AFAN OROMO VERSION OF QUESTIONAIRE

Kuta A: Amaloota Hawasumma HIrmaata

01	Saala hirmaata: 1.dhiira 2.dubra
02	umrii____waggadhan
03	Iddoo dhaloota 1.Baadiyaa 2.Magaala
04	Saba hirmaata 1.Oromo 2.Amaara 3.Tigree 4.Guragee 5.Wolayita 6.Others ___________

05	Haala bultii 1.kan fudhaan yookin heeruman 2.kan hin fudhiin/ hin heerumin 3.kan adda bahan 4.kan irraa du'amee
06	Sadarka barnoota 1.kan hin baratin 2.Sadarka jalqabaa 3.Sadarkaa lammaffa 4.Sad Olaanaa
07	Gosa Hojii 1.Haadha mana 2.Qote bulaa 3.Daldalaa 4,Hojataa motummaa

08	Hamma galii Ji’aan--------- BIRR
Kuta B	**Amaalota haala Jireenya**
09	Dalagaan tee sochii cimaa hargansuu /dhahana onnee sirriti dabaltuu kan akka waan ulfata olfudhuu/baachuu, qonforuu, hojii ijaarsa yoo xiqqate daqiqaa 10 fudhatu itti fuffinsaan ni hojjatta? 1.Eeyyee 2.Miti
10	Dalagaan tee sochii jiddugalessa hargansuu /dhahana onnee xiqqa dabaltuu kan akka deemsa saffisa yookiin ba’aa salphaa baachuu yoo xiqqate daqiqaa 10 fudhatu itti fuffinsaan ni hojjatta? 1.Eeyyee 2.Miti
11	Alkoolii Gosa kamuu haa ta’uuti ji’aa 12 darbeef fayyadamtee jirtaa? 1.Eeyyee 2.Miti
12	Yeroo dhihoo guyyota 30 darbaan keessa Tamboo akka sijaara xuuxertaa? 1.Eeyye 2.Miti
13	Guyyota dhihoo 30 darbaan keessa Jimaa qamatee jirtaa? 1.Eeyyee 2.Miti
14	Foon diimaa sorachuu 1. Foon diimaa torbaniti kg 2 fi sana ol sorachuu 2.Foon diimaa torbaniti kg 2 gadi sorachuu
15	Gosa Zayitaa nyaata qopheessuuf fayyadaman Zaayita palm Zaayita Cereal
16	Kuduraa soorachuu 1.Torbaaniti saani tokko gadii 2.Torbaniti saani tokko fi sana ol
Kuta.C	Safaraa Antropometirii **:**
17	Safaraa naannawa Mudhii ________cm
18	BMI ______
19	Dhiibbaa dhiigaa_______________mmHg
20	Qorichaa Dhiibba dhigaa fayyadama jirtaa? 1.eyyee 2.miti
KutaD	**safara yaalii:**
21	Hamma sukkara dhiigaa soomarraa 1.<100 mg/dl 2.≥100mg/dl
22	Yaala qorichaa sukkara hir’isuu fudhata jirtaa? 1. Eeyyee 2. miti
23	Safara Lipidii a. HDL: ________mg/dl b. triglyceride___________mg/dl
24	Qoricha lipidi hir’isuu fayyadama jirtaa? 1. Eeyyee 2. miti
25	Maatii kee kan dhukkuba Metabolic syndrome qabuu jiraa? 1. Eeyyee 2. miti
26	Dhukkuba Metabolic syndrome ______________________

XUMURAMERAA

ASSURANCE OF PRINCIPAL INVESTIGATOR

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the Faculty of Medical Sciences in effect at the time of grant is forwarded as the result of this application.

Name of the student: ____

Date.____________________ Signature _________________

APPROVAL OF THE FIRST ADVISOR

Name of the first advisor:_________________________________

Date.____________________ Signature _________________

APPROVAL OF THE SECOND ADVISOR

Name of the second advisor: _________________________________

Date.____________________ Signature ___________