ASSESSMENT OF ELECTROCARDIOGRAPHIC ABNORMALITY AND ASSOCIATED FACTORS AMONG ADULT TYPE 2 DIABETIC PATIENTS ON CHRONIC FOLLOW UP AT JIMMA MEDICAL CENTER, JIMMA ETHIOPIA

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A THESIS SUBMITTED TO JIMMA UNIVERSITY, INSTITUTE OF HEALTH, DEPARTMENT OF BIOMEDICAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS IN MASTER OF SCIENCE IN MEDICAL PHYSIOLOGY (MSC.).

November, 2019

Jimma, Ethiopia

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Abstract

***Background**: Diabetes mellitus is a group of a metabolic disorder causing chronic hyperglycemia which leads to long term damage to the cardiovascular system. Cardiovascular complications remain asymptomatic and an important cause of death in diabetic people. An electrocardiograph is a simple and first-line tool in screening of cardiovascular diseases. Electrocardiographic abnormality is associated with cardiovascular diseases.*

***Objective**: To assess electrocardiographic abnormality and associated factors among adult type 2 diabetes patients on chronic follow up at Jimma Medical Center, 2019*

***Materials and methods:** Institutional based cross-sectional study was conducted from April 1-May 30, 2019, at JMC among selected ıype 2 diabetes patients. Systematic random sampling was employed to select the study participants.* The World *Health Organization stepwise approach and interviewer administered semi structured questionnaire was employed for collecting the risks of CVDs among adult type 2 diabetes patients. Electrocardiography was done using a standard 12-lead electrocardiograph machine. The collected data were checked for completeness, coded, entered into the Epi-data Version 4.0.2. and exported to SPSS Version 21. Descriptive statistics like frequencies, percentages, mean and standard deviations were carried out. Binary and multiple logistic regression was done and a* p-value of less 0.05 was used as a level of significance.

***Results**: A total of 344 type 2 diabetes patients were interviewed and underwent electrocardiography making a 100% response rate. Electrocardiographic abnormality was identified among 209 (61%) of the respondents. Not attending formal education [AOR=3.07, 95%, CI=1.37-6.87], solid oil use, [AOR=1.79, 95%, CI=1.07-2.98], body mass index ≥ 25kg/m^2 [*AOR=2.74, 95%, CI=1.67-4.50*] and long duration of diabetes ≥ 10 years [AOR=3.36 , 95%, CI=1.46-7.71]were associated with ECG abnormality.*

***Conclusions and recommendation:** In this study, the majority (3/5th) of the participant had ECG abnormality. Not attending formal education, longer duration of diabetes ≥ 10 years, solid oil use and increased body mass index ≥ 25kg/m2 were independent predictors of electrocardiographic abnormality. Integrating ECG screening in routine diabetic management helps to better evaluate the impact of T2DM on the cardiovascular system.*

***Keywords**: Type 2 diabetes mellitus, ECG abnormality, Minnesota ECG criteria Jimma medical center.*

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ABBREVIATIONS AND ACRONYMS

AOR	Adjusted odd ratio
aVF	Augmented Voltage Foot
aVL	Augmented Voltage Left
aVR	Augmented Voltage Right
BGL	Blood Glucose Lebel
BMI	Body Mass Index
BP	Blood Pressure
CI	Confidence Interval
COR	Crude odd ratio
CVDs	Cardiovascular Diseases
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
ECG	Electrocardiogram
ETB	Ethiopian Birr
FBS	Fasting Blood Sugar
HC	Hip Circumference
JMC	Jimma Medical Center
LA	Left Arm
LL	Left Leg
NSR	Normal Sinus Rhythm
OR	Odds Ratio
RA	Right Arm
RL	Right Leg
SBP	Systolic Blood Pressure
T2DM	Type 2 Diabetes Mellitus
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist to Hip Circumference Ratio

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CHAPTER ONE: INTRODUCTION

1. 1. Background

Diabetes mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycemia due to defects in insulin secretion, action or both which leads to metabolic disturbances (1). Diabetes is diagnosed based on plasma glucose or HbA1C criteria. Diabetes is classified for treatment purposes into the four categories. Type 1 Diabetes Mellitus, Type 2 diabetes mellitus (T2DM), Gestational diabetes mellitus and other Specific types of diabetes due to other causes (2). Type 2 diabetes mellitus (T2DM) is caused by a progressive loss of β-cell insulin secretion on the background of insulin resistance (3). T2DM may present with or without symptoms and might cause long term damage to the cardiovascular system (4).

The complex molecular mechanisms involving genetic and environmental factors link T2DM and cardiovascular diseases (CVDs) (5). These links are hyperglycemia, hypoglycemia, dyslipidemia, and hyperinsulinemia. These factors change metabolic profiles and cellular signaling directly or indirectly affecting the cardiovascular system (6). Another effect of DM on the cardiovascular system is diabetic autonomous neuropathy which brings autonomous nervous system imbalance (7). These all increase the risks of CVDs among diabetic populations. American heart association states CVDs risks increased 2- 4 times of among T2DM (8).

Electrocardiography (ECG) is the recording of cardiac electrical activity which provides the duration and amount of electrical activity of heart muscles (9). A resting 12-lead electrocardiogram is frequently used in evaluating patients with suspected cardiovascular disease (10). The arteriosclerotic process in diabetic patients progresses earlier and accelerated in the diabetic patients than non-diabetic populations. Usually, physicians do not routinely screen DM patients for arteriosclerotic unless the disease is suspected (11).

`1. 2. Statements of problem

Diabetes is growing globally with a rapid rate especially in middle and low-income countries like Sub-Sahara aggravated by a change in socio-economic, nutritional and lifestyles (12). There were about 451 million diabetic adults between 18-99 years in 2017 making the global adult prevalence of 8.8%. The adult prevalence of diabetes was 4.2% in Africa and 5.2% in Ethiopia in 2015 (13). Currently, an epidemic of T2DM is increasing worldwide with 80% of them are living in low to middle- income countries (14). In Africa, T2DM account for about 90–95% of all diabetes (15). Hyperglycemia was 5.9% in Ethiopia (16). About 49.7% of the world and 69.2% of Africa's diabetes are undiagnosed (17).

A link between DM and CVDs is a central cause of morbidity and mortality in diabetic patients. From this, atherosclerotic cardiovascular disease plays the leading role (18). Diabetes and CVDs accounts for more than 80% of deaths in developing countries (19). The leading causes of morbidity and mortality among T2DM are atherosclerotic cardiovascular diseases such as coronary heart disease, cerebrovascular disease or peripheral arterial disease (14). There were about 3.7 million deaths due to hyperglycemia in 2012 worldwide. From these, 1.5 million deaths due to DM while 2.2 million CVDs deaths (20). CVDs were the 2^{nd} while diabetes was the 9^{th} leading cause of premature death and disability in Ethiopia (16). Microvascular complications were 41.5% of diabetic patients in JMC (21).

Diabetes mellitus may be considered as a disease cardiovascular system due to microvascular and macrovascular complications which are directly or indirectly related to the CVDs (22). The presence of major ECG abnormalities are associated with an increased risk of CVDs in diabetic patients (23). There are few studies conducted in Ethiopia to assess the risk of CVDs in an asymptomatic diabetic patient. Implementing an efficient noninvasive screening and identification of cardiac abnormalities can pick unrecognized and asymptomatic diabetic cardiac impairment (24). Thus, this study is aimed to assess electrocardiographic abnormality and associated factors among adult T2DM patients.

1. 3. Significance of the study

The findings from this study will provide input for policymakers to design appropriate policies, programs and strategies to screen and manage cardiovascular risks early in an asymptomatic diabetic patient. It also draws the attention of health care providers in the screening of diabetes patients with asymptomatic diabetic cardiac impairments. It also prevents complications that might happen in screened diabetic patients as the early intervention and risk reduction will be made. This study will also help as baseline data for further study.

CHAPTER TWO: LITERATURE REVIEW

2. 1. Overview of ECG abnormality, CVDs and T2DM

T2DM predisposes to diabetic cardiomyopathy and atherosclerotic cardiovascular disease leading to heart failure through a myocardial infarction and chronic pressure overload (6). Multiple mechanisms link between T2DM and the development of CVDs as a result of diabetic complications (5). Insulin resistance is linked with endothelial and vascular dysfunction which may cause vascular or neurological complications (25). These cardiovascular diseases due to diabetes might be manifested as ECG abnormality when investigated.

2. 2. Magnitude of ECG abnormalities in DM

Electrocardiographic abnormalities are common in patients with diabetes as cardiovascular complications of diabetes are usually hidden. A facility-based cross-sectional study done in the United States in 2014 and in Slovakia in 2019 among diabetic patients revealed 60% (26) and 53.7% (27) of ECG abnormality while a prospective cohort study conducted in Denmark in 2016 among T2DM patients showed 49.8% (28). Hospital-based cross-sectional studies conducted among diabetic patients in Uganda (29) in 2016, Sudan (30) in 2016 and India (31) in 2017 showed 67.8 %, 23% and 26% of abnormal ECG respectively.

2. 3. Factors associated with ECG Abnormalities

2. 3. 1. Socioeconomic and demographic factors.

Socioeconomic and demographic factors are among factors affecting the cardiovascular system among diabetic patients. For instance, the cohort study conducted in France (32) in 2012 and in Sweden (33) in 2015 among diabetic patients showed high CVDs risks in low socioeconomic status like low income and unemployed. Similarly, an institutional-based cross-sectional study done in Pakistan (34) in 2016 and in China (35) in 2016 in among diabetic patients disclosed high ECG abnormality with increased age and high CVDs in a patient with low educational status. A community-based cross-sectional study in Malaysia (36) in 2012 showed high CVDs among urban dwellers while a hospital-based cross-sectional study done in Senegal (37) in 2017 disclosed higher ECG abnormality among female diabetic patients.

2. 3. 2. Behavioral factors

2. 3. 2. 1. Smoking

Both smoking and diabetes are risk factors for cardiovascular morbidity and mortality. These CVDs may be picked by ECG screening. A hospital-based cross-sectional study was done in Pakistan (34) in 2016 and Iran in 2017 (38) showed 19.6% of ECG abnormality and increased CVDs risk among smoker patients respectively. A meta-analysis results on DM and CVDs showed that active cigarette smoking increases the risk of CVDs while quitting of smoking decrease the risk of CVDs among diabetic patients (39).

2. 3. 2. 2. Alcohol consumption

Alcohol consumption is one of the factors that affect the electrophysiology of the heart in diabetic populations by aggravating cardiovascular complications. The systemic review on alcohol consumption among diabetic population showed a derangement in metabolic profile and cell signaling (40). It is also supported by another systemic review as acute alcohol use causes abnormal autonomic nervous system discharges, electrolytes derangement and interfere with ion channel in the cardiac cells causing ECG abnormality (41). The prospective cohort study conducted in Europe (42) in 2014 and a community-based cross-sectional study in American (43) in 2010 demonstrated moderate alcohol consumption reduces the risk of CVDs among T2DM while excessive alcohol consumption amplifies CVDs. Another facility-based cross-sectional study done in China in 2017 showed alcohol consumption increase the risk peripheral arterial diseases among T2DM (44).

2. 3. 2. 3. Khat chewing

Khat chewing is another factor that aggravates cardiovascular complications among diabetic patients. A meta-analysis finding showed that an active ingredient in khat increases blood pressure, heart rate and has positive inotropic and chronotropic actions (45). Additionally, facility-based comparative cross-sectional studies conducted in Yemen in 2002 (46) and 2015 (47) showed chronic khat chewing increases blood glucose level during the chewing session and poor glycemic control among diabetic individuals than non-diabetics chewers. These effects of khat on the cardiovascular system may cause ECG abnormality.

2. 3. 2. 4. Physical activity

Physical activity plays a key role in cardiopulmonary health depending on the intensity and duration. Physical activity intervention is more important in fighting excessive body fat among DM which are the causes of CVDs. A cohort study conducted in Netherland (48) in 2013 and Finland (49) in 2016 showed exercise reduces visceral, abdominal, and

subcutaneous fat volume as well as liver triglyceride reducing the risk of CVDs among diabetic populations. Meta-analysis findings disclosed that exercise had anti-inflammatory effects by reducing tumor necrosis alpha (50) as well as aerobic exercise increases insulin sensitivity and help in glucose homeostasis (51).

2. 3. 3. Diet

Dietary factors may follow socioeconomic status affecting cardiovascular system as diet quality varies with socioeconomic status (52). A prospective cohort study done in Europe (53) in 2016 and Israel (54) in 2010 showed, the substitution of carbohydrates with saturated fatty acid increases while the substitution with unsaturated fatty acid lower the risk of CVDs mortality among T2DM respectively. A randomized control trial conducted in America in 2009 also showed a low-fat diet and vegan improved glycemic and lipid control among T2DM (55).

2. 3. 4. Body compositions

Excessive body weight, body fat, obesity, and DM are having adverse effects on cardiac structure and function by altering the electrophysiology of cardiac cells among diabetic patients (56). The retrospective cohort conducted in 2012 (57) and a community based cross-sectional study (58) in Chinese in 2012 among patients with type 2 diabetes showed the presence of high ECG abnormality among patients with increased waist circumferences (WC), overweight and obesity.

2. 3. 5. DM conditions

2. 3. 5. 1. Dysglycemia

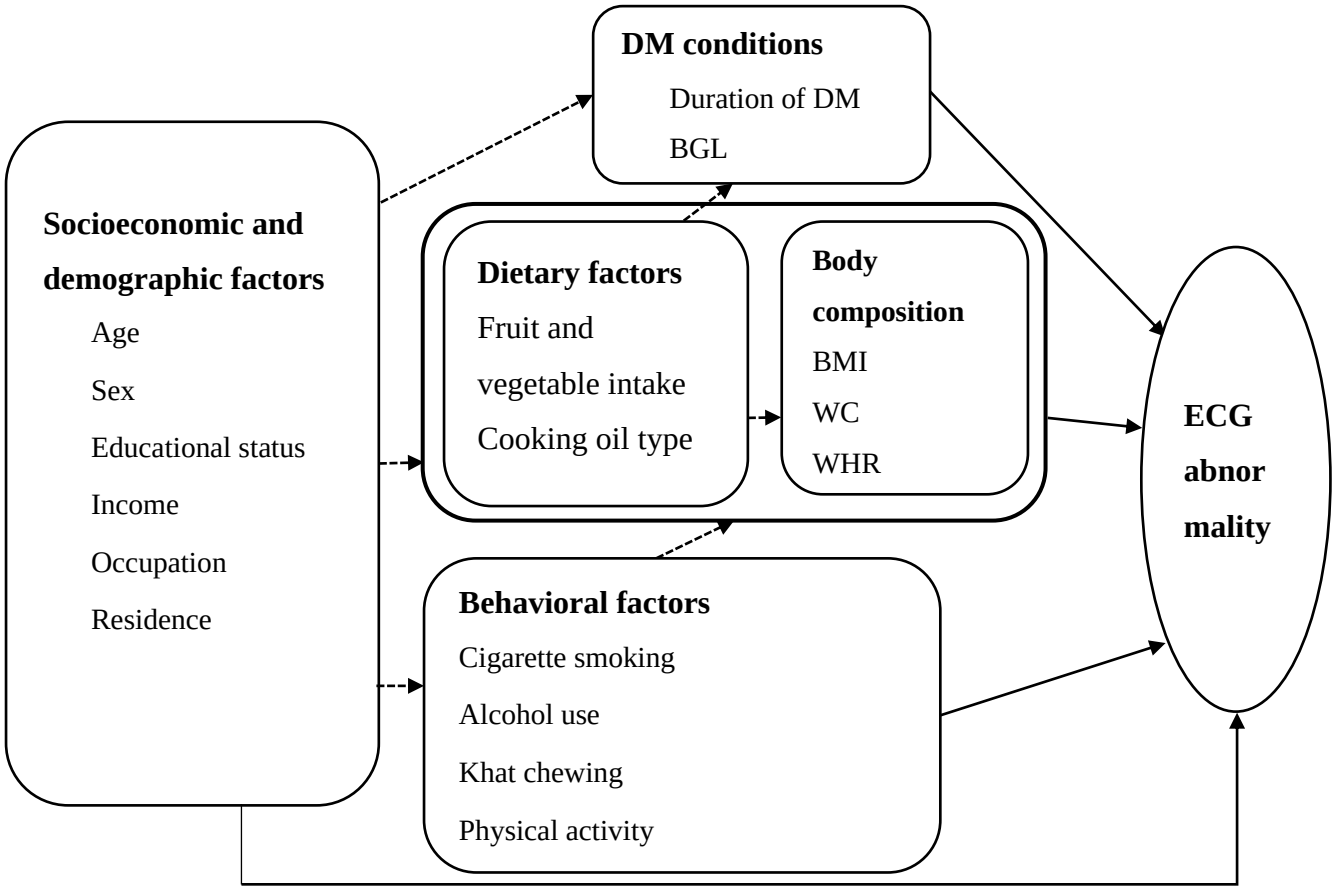
Hyperglycemia and hypoglycemia are the main factors that affect the cardiovascular system and ECG measurements. A facility-based cross-sectional study conducted in the United States (59) in 2012, in Denmark (60) in 2013 and a cohort study conducted in China (57) in 2012 showed a change in ECG measurement among diabetic patients with hyperglycemia and hypoglycemia. Another hospital-based cross-sectional study conducted in India in 2017 showed a 70% ECG abnormality in diabetic patients with uncontrolled blood glucose levels (31).

2. 2. 5. 2. Duration of DM

Complications of DM increase as the duration of the disease increases. This chronic effect of DM also involves the cardiovascular system. A hospital-based cross-sectional study conducted in India in 2017 showed increased ECG abnormality among 5-10 years of the duration of DM than shorter duration of time (31). A cohort study done in Denmark in 2017

revealed an increment of heart failure with a longer duration of DM among T2DM (61). An additionally, a cohort study conducted in Sweden in 2016 among diabetic patients revealed a longer duration of diabetes increases the risk of CVDs (62).

2. 4. Conceptual framework



The broken arrow - - → shows association that might exist among independent variables and not addressed in this study wile solid arrow → shows factors associated with ECG abnormality

Figure 1: Conceptual framework showing risk factors of ECG abnormalities developed after reviewing different related literatures.

CHAPTER THREE: OBJECTIVES OF THE STUDY

3. 1. General Objective

- To assess electrocardiographic abnormality and associated factors among adult type 2 diabetic patients on chronic follow up at JMC, 2019

3. 2. Specific objectives

- To determine magnitude of electrocardiographic abnormality among adult type 2 diabetic patients on chronic follow up at JMC, 2019

- To identify factors associated with ECG abnormality among adult type 2 diabetic mellitus diabetic patients on chronic follow up at JMC, 2019

CHAPTER FOUR: MATERIALS AND METHODS

4. 1. List of materials

The following lists of materials were used during data collection. Seca 213 stadiometer produced by Seca Deutschland Germany, digital weighting scale model SFBMI made in Thailand, mercury sphygmomanometer model CNME-X002 made in China, 3M litman statoscope classic III made in USA, non-stretchable tape meter, BG5 model digital glucometer made in India, a 12 leads ECG machine produced by York company, ECG electrodes with their leads, ECG paper, cardiac gel, surgical blades, alcohol swabs, and gauze pads.

4. 2. Study area and period

The study was conducted at JMC located in Jimma town which is located in Oromia Regional State 350km southwest of Addis Ababa. JMC is the referral teaching hospital giving health service for about 15 million people in the South West of Ethiopia. It was established in 1983 as a health science college and transferred to Jimma University. JMC has about 1600 staff members, 32 intensive care units and 800 beds. DM patients getting follow up service in the diabetic clinic are usually appointed in one to two months regularly. Fasting or random blood sugar is always routinely done for all DM patients while electrocardiography is not unless CVDs are suspected.

The study was conducted from April, 1-May 30, 2019

4. 3. Study design

Institutional based cross-sectional study was conducted to assess ECG abnormality and associated factors among adult T2DM patients on chronic follow up at JMC.

4. 4. Population

4. 4. 1. Source population

All adult type 2 diabetic patients who are on chronic follow up at JMC.

4. 4. 2. Study population

All randomly selected adult type 2 diabetic patients on chronic follow up at JMC during study period and who fulfill the inclusion criteria.

3. 4. 3. Study unit

Individual T2DM patient

4. 4. 3. 1 Inclusion criteria

- Type 2 diabetic patients who had no **diagnosed** cardiovascular diseases.

4. 4. 2. 2 Exclusion Criteria

- Type 2 diabetic patients with **diagnosed** concomitant diseases like chronic liver disease, kidney disease, thyroid diseases etc.
- Type 2 diabetic with acute complications diabetes ketoacidosis or hyperosmolar hyperglycemic state.

4. 5. Sample size Determination and Sampling Technique

4. 5. 1. Sample size determination

Sample size was determined using single population proportion formula by considering the following assumptions: P=50% since no similar study done in Ethiopia, margin of error=5% and 95% confidence interval.

$$n = \frac{(z\alpha/2)^2\, p(1-p)}{d^2} = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384$$

From chronic follow up record data, the total number of type 2 diabetic patients on follow up at JMC in 2018 were 1685. Since the source population is less than 10,000 applying the formula for finite population correction the final sample size was calculated as follows.

$$nf = \frac{n}{\{1+(n/N\}} = \frac{384}{\{1+(384/1685)\}} = 313$$

Adding 10% non-response rate = 313 + 31 = 344

4. 5. 2. Sampling Procedure

Systematic random sampling was employed and the sampling interval value was calculated by dividing total numbers of T2DM on active chronic follow up at JMC for calculated sample size and the calculated sampling interval was 5. The data collection was started by randomly selecting from the first five visitors using the lottery method to get the first patient. The third visitor patient was randomly selected and then continued to the next patient by adding the sampling interval on the first patient. The patient who does not fulfill the inclusion criteria was replaced by the next patient.

4. 6. Data Collection Procedures

World health organization (WHO) stepwise approach was employed for collecting the risks of CVDs among T2DM patients (63). Data collection format containing individual patient was prepared before the data collection time. The data collectors stayed at DM clinics. The patients fulfilling inclusion criteria based on the calculated sampling interval were asked to participate in the study. The interview was conducted using interviewer-administered semi structured questionnaires to fill the data collection format. Information about patient's

socioeconomic and demographic factors, behavioral factors such as smoking of cigarettes, alcohol consumption, khat chewing, and physical activity were collected.

The measurements of height, weight, waist circumference (WC), hip circumferences (HC), blood pressure (BP), Fasting blood sugar (FBS), and electrocardiography were made according to their respective standards **(Annex II)**.

The height was measured with stadiometer as participant stand vertical with no shoes with their back against the wall, heels together and eyes focused forward. The weight was measured with a digital weighting scale and checked on daily basis with known weight. WC was measured using a non-stretchable measuring tape at the midpoint between the costal margin and iliac crests at the end of expiration. HC was measured as the maximum circumference at the level of the greater trochanter (the widest portion of the hip) on both sides. FBS was done with a simple finger prick using digital glucometer. BP was measured three times in sitting position from the right arm using a mercury sphygmomanometer after the participant rested for 5 minutes before taking the measurement and 3 minutes before repeating the subsequent measurements. A resting electrocardiography was recorded by two trained B. Sc. nurses using YORK" 12 lead Electrocardiography manufactured by York Scientific Company. The suggested procedure for electrocardiography was followed in the reference to standard manual for the Minnesota ECG criteria (64) and interpreted by two internists. The questionnaires were checked for completeness by supervisors and principal investigator every day.

4. 7. Study Variables

4. 7. 1. Dependent variable

ECG abnormality

4. 7. 2. Independent variables

Socioeconomic and demographic characteristics

Age	Educational status
Sex	Occupation
Income	Place residence

Dietary factors

Cooking oil type

Fruit and vegetable intake

Body composition

Weight	WC

Height	HR
BMI	WHR

Behavioral factors

Physical activity	Alcohol consumption
Khat chewing	Cigarette smoking

DM conditions

Diabetes duration

Blood glucose level

4. 8. Operational definition

Alcohol users: A respondent who drinks more than 3 standard units of alcohol per day or all most daily.

Current alcohol user: A respondent who drinks more than 3 standard units of alcohol per day or all most daily for the last one month or more.

Non-alcohol user: A respondent who drinks less than 3 standard units of alcohol.

Smoker: A respondent who smokes at least one tobacco product either daily or occasionally.

Non-smokers: A participants who never smoke any tobacco product.

Physical activity: Any body movement produced by skeletal muscles causing energy expenditure and classified as a vigorous and moderate activity as well as a sedentary life.

Physically inactive: Consumption of less than 600 metabolic equivalents of energy per week.

Physically active: Consumption of greater than 600 metabolic equivalents of energy per week**.**

Unhealthy diet: Low in fruit & vegetable intake and saturated type of oil used for cooking.

Low fruit and vegetable intake: Less than five servings of fruits or vegetables per day which is about 400 grams per day.

Electrocardiography: Recording the heart's electrical echoes using ECG machine by placing electrodes on the surface of the body.

Normal sinus rhythm: A regular heart rate between 60 and 100 beats per minutes with normal p waves, PR interval, QRS complex, T waves, and p waves preceding each QRS complex.

ECG abnormality: Any ECG change beyond normal sinus rhythm (NSR).

Abnormal blood glucose level: Fasting plasma glucose ≤70 mg/dl or ≥130 mg/dl.

4. 9. Data analysis procedures

The data were entered into Epi-data version 4.0.2. and exported to SPSS version 21 for analysis after checking for completeness. The exported data were explored to check outliers and missing values. Descriptive statistics like frequencies, percentages, mean, and standard deviations were carried out. Cross-tabulations and binary variable analyses were performed to select variables for multivariable analysis. The variables with a p-value < 0.25 in the bivariable analysis were taken as candidates for multivariable analysis. Finally, multivariable logistic regression analysis using backward selection. The variables with a p-value of less than 0.05 were taken as statistically significant determinants for abnormality of ECG. Odds ratio with its 95% CI was used to show the degree of association and estimation between the independent and the outcome variables.

4. 10. Data Quality control

The questionnaires were adapted from WHO stepwise surveillance of non-communicable disease and the tools that were applied in different studies related to factors associated with ECG abnormalities. The questionnaire was translated from English to Afan Oromo and Amharic and back to English to assure its consistency in a blinded manner. Two days of training was given for four data collectors (B. Sc. Nurses) and two supervisors (B. Sc. Nurses) on the purpose of study and data collection procedures. A pre-test was done on 5% of the total sample size at Shanan Gibe Hospital prior to the actual data collection to ensure clarity, understandability and completeness. Correction and modification on grammar, sequences, and timing were made based on the result of the pre-test before the start of actual data collection. Data collection was conducted by trained data collectors using semi structured questionnaires under the supervision of the PI. All the measurements blood pressure, fasting blood glucose levels, weight, height, waist, and hip circumferences were made according to the respective standards. The collected data were checked for completeness, accuracy, clarity, and consistency by the principal investigator. The recorded ECG papers were interpreted by two internists. The data were explored to check outliers, missing data and assumptions.

4. 11. Ethical Considerations

Ethical clearance was obtained from the ethical review board of Jimma University, Institute of Health. A support letter was obtained from the department of biomedical sciences and internal medicine. All the study participants were informed about the purpose of the study,

their right to refuse, assured confidentiality and informed written consent was obtained prior to the interview. At the end of each interview and procedures, participants with abnormal ECG finding were linked to cardiac clinic for further evaluation and management whereas the participants with normal ECG finding were informed their results and advised for future timely screening.

4. 12. Dissemination plan

This thesis will be presented to Jimma University advisors, examiners, submitted to the to department of biomedical science and school of post graduate study. An attempt will be made to present on different conferences and symposiums. Copies of the document will be given to the JMC and other stakeholders so that it will be used as a source of information for possible planning and implementation of health intervention. An effort will be made for possible publication on a reputable journal.

CHAPTER FIVE: RESULTS

5.1. Socio demographic characteristics

A total of 344 T2DM patients were interviewed and underwent electrocardiography giving a response rate of 100%. The majority of 210 (61%) the respondents were males. The mean age of the respondents was 53.34±11.07 years with a minimum age of 18 and a maximum of 80 years. More than half 202 (58.7%) of the respondents were in the age group of 51-70 years. Farmer respondents were 109 (31.7 %) while merchants and government employee accounted 83 and 84 (24%) each. More than half 199 (57.8%) of the respondents were urban dwellers while half 175 (50.9%) of the participants were below the poverty line.

Table 1: Socioeconomic and demographic characteristics of adult type 2 diabetes patients on chronic follow up at JMC May, 2019

Variable	**category**	**Frequency**	**Percent**
Age group	<40	46	13.4
	41-50	70	20.3
	51-60	111	32.3
	61-70	91	26.4
	>70	26	7.6
sex	male	210	61.0
	female	134	39.0
Occupational status	Farmer	109	31.7
	Daily laborer	12	3.5
	Merchant	83	24.1
	Government employee	84	24.4
	NGO/private	31	9.0
	Others*	25	7.3
Educational status	No formal education	63	18.3
	Primary education	136	39.5
	Secondary education	74	21.5
	Tertiary education	71	20.6
Reported Income status	Below extreme poverty	175	50.9
	Above extreme poverty	169	49.1
Place of residency	Urban	199	57.8
	Rural	145	42.2

* Housewife, students, pensions, carpenter.

5. 2. Behavioral measurements of the respondents

The majority of the respondents, 333 (96.8%) and 319 (92.7%) were nonsmokers and non-alcohol users respectively. Most of the respondents 331 (96.2%) were involved in physical activity less than 150 minutes of moderate or 75 minutes of vigorous physical activity per week. This is the same as consumption of less than 600 metabolic equivalent of energy. Non khat chewers accounted 304 (88.4%) of the respondents.

5. 3. Dietary factors of the respondents

Most of the respondents 339 (98.5%) were using fruits and vegetables below five servings per day. Five serving of fruit and vegetables per day which is equivalent to 400 grams of fruits and vegetables intake was recommended daily. Solid oil users were 235 (68.3%).

5. 4. Body composition and blood pressure measurements of the respondents

An average systolic blood pressure (SBP) was 121.20±7.34 mmHg while average diastolic blood pressure (DBP) was 77.85±4.15 mmHg.

Table 2: Distribution of anthropometric and blood pressure measurement of adult type 2 diabetes patients on chronic follow up at JMC May, 2019.

Variable	**category**	**Frequency**	**Percent**
BP measurements	Normal BP	63	18.3
	Pre hypertension	246	71.5
	Stage I hypertension	35	10.2
BMI category	Under weight	27	7.8
	Normal weight	183	53.2
	Over weight	85	24.7
	Obese	49	14.2
WC category	Normal	126	36.6
	Increased risk	218	63.4
WHR	Normal	48	14.0
	Increased risk	296	86.0

5. 5. DM conditions of the respondents

The mean fasting blood glucose was 123.65±17.34 mg/dl. From the total respondents, 210 (61%) had a fasting blood sugar within a normal range whereas hyperglycemia and hypoglycemia were 123 (35.8%) and 11 (3.2%) respectively. The mean duration of diabetes was 7.31±4.54 years with a minimum duration of 1 year and a maximum of 19 years. Most of the respondents 109 (31.7%) and 102 (29.7%) had a diabetes duration of 2-5 and 5-10 years respectively.

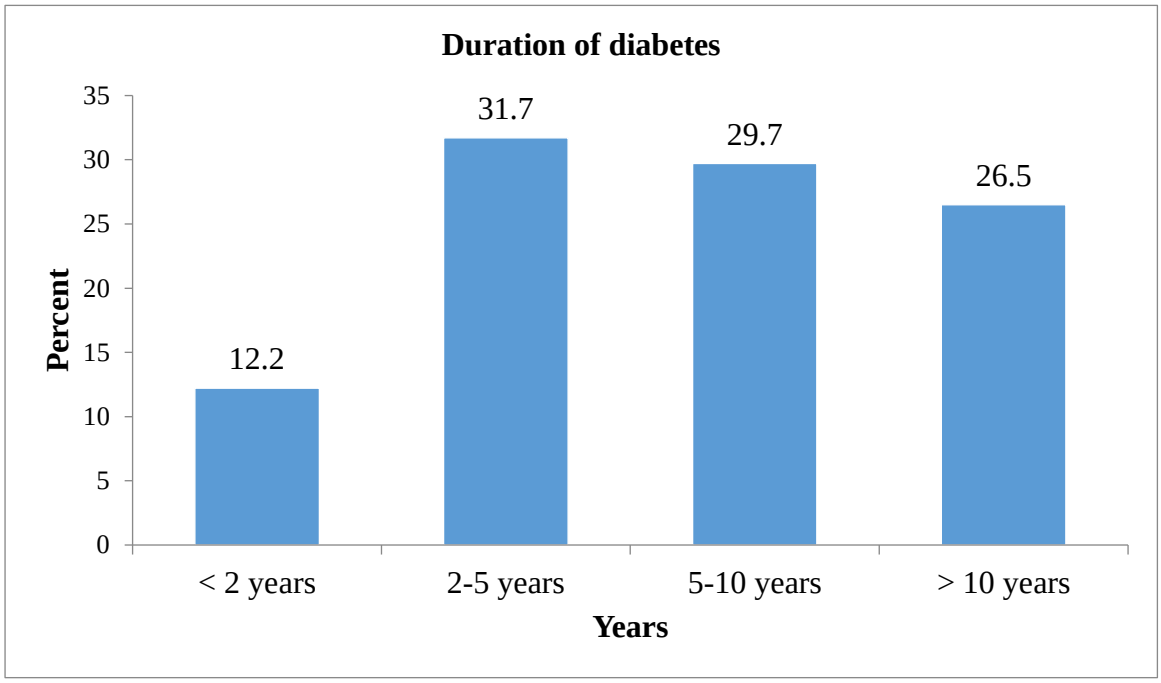


Figure 2: Duration of diabetes of adult type 2 diabetes on chronic follow up at JMC May, 2019.

5. 6. ECG status of the respondents

Majority 209 (61%) of the respondents had at least one electrocardiographic abnormality. ECG abnormality was 115 (33.4%) among participants with abnormal body weight, 136 (39.5%) in high risk WC, 69 (20.1%) in %), DM duration > 10 years, 158 (45.9%) in solid oil users and 109 (31.7 and Urban dwellers.

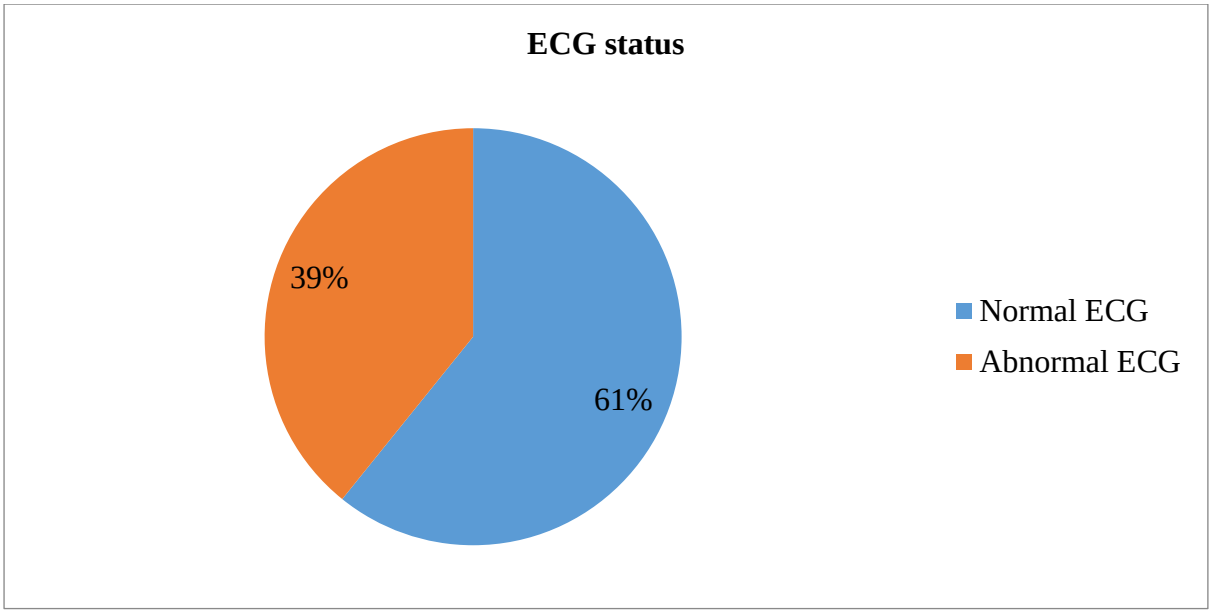


Figure 3: Normal and abnormal ECG status of adult type 2 diabetes on chronic follow up at JMC May, 2019.

5. 6.1 Components of ECG abnormality

The most common form of ECG abnormality was arrhythmia which accounted of 129 (37.5%) while myocardial infarction was 112 (32.6%) in this study (Table 4).

Table 3: ECG abnormality classification status according to standard Minnesota code of electrocardiogram classification among adult type 2 diabetes on chronic follow up at JMC May, 2019

Variable	category	Frequency	Percent
Myocardial infarction	Lateral leads I, aVL V6.	5	1.5
	Inferior leads II or aVF	58	16.9
	Anterior leads V1-V5	49	14.2
	Total	**112**	**32.6**
Axis deviation	Left axis deviation	56	16.3
	Right axis deviation	4	1.2
	Extreme right axis deviation	5	1.4
	Total	**65**	**18.9**
Enlargement & hypertrophy	Left atrial enlargement	2	0.6
	Right ventricular hypertrophy	16	4.7
	Left ventricular hypertrophy	40	11.6
	Total	**58**	**16.9**
Conduction abnormalities	P-R interval $\geq$ 0.22 s	7	2.0
	Short P-R interval	3	0.9
	Wolff-Parkinson-White Pattern	9	2.6
	Complete right bundle branch block	16	4.7
	Incomplete right bundle branch block.	6	1.7
	Complete left bundle branch block	1	0.3
	Total	**42**	**12.2**
Arrhythmia	Sinus arrhythmia	11	3.2
	Sinus tachycardia	40	11.6
	Sinus bradycardia	12	3.5
	Atrial/junctional premature beats	32	9.3
	Ventricular premature beats	17	4.9
	Both atrial/junctional and ventricular premature beats.	7	2.0
	Atrial fibrillation.	7	2.0
	Atrial flutter.	3	0.9
	Total	**129**	**37.5**

5. 4. Factors Associated with ECG abnormalities

Binary and multivariable analysis

For bivariate analysis variables like socioeconomic and demographic factors, behavioral factors, dietary factors, DM conditions, and body composition measurements were included. From these variables age category, educational status, occupation, place of residence, duration of DM, solid oil use, BMI category, WC category, SBP, and fasting blood sugar were associated with ECG abnormalities at a P-value of less than 0.25.

The finding of multivariable logistic regression indicated that educational status, duration of DM, solid oil use and BMI category were independently associated with ECG abnormality.

Diabetic patients who had no formal education were 3 times higher odds of more likely to have abnormal ECG compared to those who had attended above secondary education (AOR=3.07, 95%, CI=1.37-6.87). The odds of having ECG abnormality were 1.8 times higher among solid oil users compared to their counterparties (AOR=1.79, 95%, CI=1.07-2.98). ECG abnormality also showed association with participants with a BMI $\geq$ 25kg/m^2. Patients with BMI $\geq$ 25kg/m^2 were 2.7 times odds more likely to develop ECG abnormality compared to normal weighted diabetic patients (AOR=2.74, 95%, CI=1.67-4.50). The duration of DM had also an association with ECG abnormalities. Those who had a duration of DM greater than 10 years were 3 times odds more likely to develop ECG abnormalities compared with patients with duration of less than two years (AOR=3.36, 95%, CI=1.46-7.71).

Table 4: Bivariable and multivariable analysis of factors associated with ECG abnormalities among adult type 2 diabetes on chronic follow up at JMC May, 2019

Variable	Category	ECG abnormality		COR (95% CI)	AOR (95% CI)
		No (%)	Yes (%)		
Age group(yrs.)	<40	23(6.7)	23(6.7)	1	1
	40-50	31(9.0)	39(11.3)	1.26[.60-2.65]	1.03[.45-2.38]
	51-60	40(11.6)	71(20.6)	1.78[.89-3.56]	1.42[.64-3.15]
	61-70	35(10.2)	56(16.3)	1.60[.78-3.27]	1.14[.50-2.61]
	>70	6(1.7)	20(5.8)	**3.33[1.13-9.82] ***	1.90[.58-6.21]
Educational status	No formal education	14(4.1)	49(14.2)	**3.81[1.79-8.10] ***	**3.07[1.37-6.87] ***
	Primary education	51(14.5)	85(24.7)	**1.81[1.02-3.24] ***	1.79[.96-3.31]
	Secondary education	33(9.6)	41(11.9)	1.35[.70-2.60]	1.65[.82-3.35]
	Tertiary education	37(10.8)	34(9.9)	1	1
Occupation	Farmer	34(9.9)	75(21.8)	1	1
	Daily labor	5(1.5)	7(2.0)	.64[.19-2.14]	.77[.18-3.23]
	Merchant	36(10.5)	47(13.7)	.59[.33-1.07]	1.14[.46-2.81]
	Government employ	39(11.3)	45(13.1)	**.52[.29-.94] ***	. 1.54[.57-4.19]
	NGO/private	14(4.1)	17(4.9)	.55[.24-1.24]	1.72[.61-4.85]
	Other	7(2.0)	18(5.2)	1.17[.45-3.05]	1.42[.42-4.74]
Place of residency	Urban	90(26.2)	109(31.7)	**.55[.35-.85] ***	.83[.49-1.44]
	Rural	45(13.1)	100(29.1)	1	1
Solid oil use	Yes	77(22.4)	158(45.9)	**2.33[1.47-3.71] ****	**1.79[1.07-2.98] ***
	No	58(16.9)	51(14.8)	1	1
Duration of DM	< 2 years	20(5.8)	22(6.4)	1	1
	2-5 years	41(11.9)	68(19.8)	1.51[.74-3.09]	1.79[.83-3.88]
	5-10 years	52(15.1)	50(14.5)	.87[.43-1.80]	1.02[.47-2.21]
	>10 years	22(6.4)	69(20.1)	**2.85[1.32-6.17] ***	**3.36[1.46-7.71] ***
Fasting BGL	Normal fasting BGL	91(26.5)	120(34.9)	1	1
	Abnormal fasting BGL	44(12.8)	89(25.9)	1.53[.98-2.41]	1.43[.86-2.37]
Average SBP	Normal BP	36(10.5)	70(20.3)	1	1
	Abnormal BP	99(28.8)	139(40.4)	.72[.45-1.16]	.59[.35-1.01]
WC category	Normal	53(15.4)	73(21.2)	**1**	**1**
	Risk	82(23.8)	136(39.5)	1.20[.77-1.88]	1.19[.70-2.03]
BMI category	Normal weight	90(26.2)	94(27.3)	1	1
	Abnormal weight	45(13.1)	115(33.4)	**2.43[1.55-3.82] ****	**2.74[1.67-4.50] ****

* $p<0.05$, ** $p<0.001$

CHAPTER SIX: DISCUSSION

Two hundred nine (61%) of the respondents had at least one type of ECG abnormality. This finding is comparable with a study conducted in the United States (60%) (26). But, it is lower than the study done in Uganda (67.8 %) (29). On the other hand, the present finding was higher than the studies conducted in Slovakia (53.7%) (27), India (26%) (31) and Sudan (23%) (30). These differences may be due to the difference in the socio-economic, health care system, other co-morbidities, study design, selection criteria, the presence or absence of other risk factors, environmental and genetic variations. Dysglycemia, insulin resistance, environmental factors, and genetic factors, other co-morbidities, and drug side effects may link diabetes and the cardiovascular system. These cardiovascular diseases might be directly or indirectly related to ECG abnormality.

Lack of formal education was one of the predictors with ECG abnormality among T2DM patients. This finding was supported by the study conducted in Sweden (65), Iran (66), Malaysia (36) and Japan (67) that revealed higher risks of CVDs among diabetic patients with low educational status. A study conducted in 20 developing countries showed that CVDs were more common among those with low levels of education (68). This might probably lack of education affects individuals' healthcare-seeking behavior. Lack of education also might be related to insufficient knowledge that affects an individual's drug adherence. Poor drug adherence might cause poor glycemic control further complicating diabetes and affecting other systems including the cardiovascular system.

The use of solid oil was one of the predictors of electrocardiographic abnormalities among T2DM patients in this study. High saturated fatty acid causes cardiometabolic dysfunction and poor glycemic control (69). The cell membrane fatty acid change has a direct and indirect effect on the electrophysiological property. Increased cell membrane cholesterol causes a change in the duration of action potential (70). This finding was in harmony with studies conducted in Europe (53) and Israel (54) that showed the substitution of carbohydrates with saturated fatty acid increases risk of CVDs and as dietary modification reduces CVDs the risks among T2DM respectively. Saturated fatty acid use reduce endothelial function and insulin sensitivity being a risk of CVDs (71). These all might cause CVDs that may be explained as ECG abnormality.

This study revealed that increased body weight was also associated with ECG abnormality. Increment in body mass index greater than 25kg/m^2 was strongly associated with ECG abnormality. This finding was supported by the study conducted in Turkey ECG parameter

changes in overweight individuals compared with the normoweight (72). Obesity alters morphology and electrophysiology of myocardial cells and increases CVDs risks shifts cardiac axis leftward (73) and may increase the risk of atherogenesis (74). The meta-analysis findings revealed that excess weight is associated with CVDs mortality (75). The Obesity may also cause abnormal myocardial perfusion in among T2DM patients (76). These cardiovascular risks might be displayed as electrocardiographic abnormalities.

The duration of diabetes greater than ten years was also among factors that affect ECG patterns. A study conducted in India showed the duration of diabetes mellitus 5-10 years had ECG changes (31). A survey conducted in Denmark showed heart failure was diagnosed 37.4% after 10 years or more in type 2 diabetes (61). The study conducted in Sweden among diabetic patients revealed a longer duration of diabetes increases the risk of CVDs (62). As duration of DM increases the risks on CVS and other system increases. The long duration of oral hypoglycemic agents use might also impose its long-term impact on the cardiovascular system.

Limitation of the study

- Biochemical measurements like lipid profile, serum electrolytes were not done because of financial constraints.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATION

7.1. Conclusion

In this study, majority (3/5th) of the participant had ECG abnormality. Not attending formal education, longer duration of DM ≥ 10 years, solid oil use and increased BMI ≥ 25kg/m2 were independent predictors of ECG abnormality.

7.2. Recommendation

Integrating ECG screening in routine diabetic management helps to better evaluate the impact of T2DM on the cardiovascular system. Monitoring and harmonizing modifiable cardiovascular risk factors may prevent or delay the complication that might occur among diabetic populations. Prevention of CVDs in diabetic patients decreases the prevalence of ECG abnormality. Therefore, the following recommendations are made to the respective stakeholders.

- Policy makers are suggested to think of designing a program that integrates ECG screening in diabetic patients during routine follow up.
- Ministry of health may think of integrating of ECG screening for diabetic patients' management during routine follow up.
- Health workers are recommended to provide ECG screening for the asymptomatic diabetic patient during routine activities of chronic follow up.
- Local media are recommended to advocate ECG screening for diabetic patients. Issue health information related to the relation of diabetes mellitus and cardiovascular disease, nutritional and physical activity by inviting experts.
- Researchers are suggested to conduct further study using strong study design on this subject area.

REFERENCES

1. American Diabetic Association: Diabetes Care in the Hospital: Standards of Medical Care in Diabetes. Diabetes Care. 2018;41:13–5.
2. World Health Organization: Global Report on Diabetes. Geneva; 2016.
3. Golden SH, Anderson C, Bray GA, Burke LE, Boer IH De, Pignone M, et al. Update on Prevention of Cardiovascular Disease in Adults With Type 2 Diabetes Mellitus in Light of Recent Evidence : A Scienti fi c Statement From the American Heart Association and the American Diabetes Association. Diabetes Care. 2015;38:1777–803.
4. Khandoker AH, Al-angari HM, Khalaf K, Lee S, Almahmeed W, Safar HS Al, et al. Association of Diabetes Related Complications with Heart Rate Variability among a Diabetic Population in the UAE. Plosone. 2017;12:4–10.
5. Wang CCL, Hess CN, William R. Hiatt A, Goldfine AB. Atherosclerotic Cardiovascular Disease and Heart Failure in Type 2 Diabetes – Mechanisms, Management, and Clinical Considerations. Circulation. 2017;133:2459–502.
6. Brunetti A, Indolfi C. Type 2 Diabetes Mellitus and Cardiovascular Disease : Genetic and epigenetic Links. Endocrinology. 2018;9:1–13.
7. Vinik AI, Casellini C, Parson HK, Colberg SR, Nevoret M. Cardiac Autonomic Neuropathy in Diabetes : A Predictor of Cardiometabolic Events. 2018;12:1–11.
8. Fox CS, Golden SH, Anderson C, Bray GA, Burke LE, Boer IH De, et al. Prevention of Cardiovascular Disease in Adults With Type 2 Diabetes Mellitus in Light of Recent Evidence:A Scientific Statement From the American Heart Association and the American Diabetes Association. Circulation. 2015;132:691–18.
9. Rajni R, Bhagat S, State S, Campus T. Electrocardiogram Signal Analysis - An Overview Electrocardiogram Signal Analysis - An Overview. Int J Comput Appl. 2013;84:22–4.
10. Perez M V, Dewey FE, Tan SY, Myers J, Ph D, Froelicher VF. Added Value of a Resting ECG Neural Network That Predicts Cardiovascular Mortality. Ann Noninvasive Electrocardiol. 2009;14:26–34.
11. Tavares CAF, Wajchjenberg BL, Rochitte C, Lerario AC. with type 2 diabetes mellitus. Endocrinol Metab. 2016;60:143–51.
12. Glezeva N, Chisale M, Mcdonald K, Ledwidge M, Gallagher J, Watson CJ. Diabetes and complications of the heart in Sub-Saharan Africa : An urgent need for improved

awareness , diagnostics and management. Diabetes Res Clin Pract. 2018;137:10–9.

13. Cho, Shaw JE, Karuranga S, Huang Y, Fernandes JD da R, Ohlrogge AW, et al. IDF Diabetes Atlas : Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2018;138:271–81.
14. Mohan V, Cooper ME, Matthews DR. The Standard of Care in Type 2 Diabetes : Re-evaluating the Treatment Paradigm. Diabetes Ther. 2019;13:1–13.
15. Peer N, Kengne A, Motala AA, Claude J. Diabetes in the Africa region : An update. Diabetes Res Clin Pract. 2013;103:197–205.
16. Shiferaw F, Letebo M, Misganaw A, Feleke Y, Gelibo T. Non-communicable Diseases in Ethiopia : Disease burden , gaps in health care delivery and strategic directions . Ethiop J Heal Dev. 2018;32:1–12.
17. Adebamowo SN, Tekola-ayele F, Adeyemo AA, Rotimi CN. Genomics of Cardiometabolic Disorders in Sub-Saharan Africa. PHG. 2017;20:9–26.
18. Leon BM, Maddox TM. Diabetes and cardiovascular disease : Epidemiology , biological mechanisms , treatment recommendations and future research. World J Diabetes. 2015;6:1246–58.
19. International Diabetes Federation. Diabetes and cardiovascular disease. Brussels; 2016.
20. World health Organization: Global report on diabetes. 2016.
21. An T, Waktola C, Gm T, Gt S, Dw A, Yohannis M, et al. Endocrinology & Metabolic Syndrome Major Micro vascular Complications and Associated Risk Factors among Diabetic Outpatients in Southwest Ethiopia. Endocrinol Metab Syndr. 2017;6:1–9.
22. Kittnar O. Electrocardiographic Changes in Diabetes Mellitus. Physiol Res. 2015;64:559–66.
23. Bebu I, Orchard TJ, Zinman B, Lachin JM. Electrocardiographic Abnormalities and Cardiovascular Disease Risk in Type 1 Diabetes : The Epidemiology of Diabetes Interventions and Complications (EDIC) Study. Diabetes Care. 2017;40:793–9.
24. Schernthaner G, Lotan C, Trendafilova EB, Ceponis J, Clodi M, Ducena K, et al. Unrecognised cardiovascular disease in type 2 diabetes : is it time to act earlier ? Cardiovasc Diabetol. 2018;17:4–9.
25. Ormazabal V, Nair S, Elfeky O, Aguayo C, Salomon C, Zuñiga FA. Association between insulin resistance and the development of cardiovascular disease. Cardiovasc Diabetol. 2018;17:1–14.
26. Sellers MB, Divers J, Lu L, Xu J, Smith SC, Bowden DW, et al. Prevalence and

determinants of electrocardiographic abnormalities in African Americans with type 2 diabetes. J Epidemiol Glob Health. 2014;4:289–96.

27. Gaspar L, Murin J, Oravec S, Bulas J, Caprnda M. Holter ECG fi ndings in diabetics with medial arterial calci fi cation. Bratisl Med J. 2019;120:676–9.
28. Jørgensen PG, Jensen MT, Mogelvang R, Scholten BJ Von, Bech J, Fritz-hansen T, et al. Abnormal echocardiography in patients with type 2 diabetes and relation to symptoms and clinical characteristics. Diabetes Vasc Dis Res. 2016;13:321 –30.
29. Muddu M, Mutebi E, Mondo C. Prevalence , types and factors associated with echocardiographic abnormalities among newly diagnosed diabetic patients at Mulago Hospital . Afr Health Sci. 2016;16:183–93.
30. Ishag M. Pattern of ECG abnormality in Type 2 diabetic patients in Shendi locality-Sudan. IJRDO-Journal Heal Sci Nurs. 2016;1:7–14.
31. Gupta S, Gupta RK, Kulshrestha M, Chaudhary AR. Evaluation of ECG Abnormalities in Patients with Asymptomatic Type 2 Diabetes Mellitus. J Clin Diagnostic Res. 2017;11:39–41.
32. Jaffiol C, Thomas F, Bean K, Jégo B, Danchin N. Impact of socioeconomic status on diabetes and cardiovascular risk factors : Results of a large French survey. Diabetes Metab. 2013;39:56–62.
33. Rosengren A. Impact of Socioeconomic Status on Cardiovascular Disease and Mortality in 24 , 947 Individuals With Type 1 Diabetes. Diabetes Care. 2015;38:1518–27.
34. Zaman H, Zeb J, Saeed MI, Rauf A. Silent ECG changes in patients of diabetes mellitus. Pak Hear J. 2017;50:26–32.
35. Tao X, Li J, Zhu X, Zhao B, Sun J, Ji L, et al. Association between socioeconomic status and metabolic control and diabetes complications : a cross - sectional nationwide study in Chinese adults with type 2 diabetes mellitus. Cardiovasc Diabetol. 2016;15:1–10.
36. Su TT, Amiri M, Hairi FM, Thangiah N, Bulgiba A, Majid HA. Prediction of Cardiovascular Disease Risk among Low-Income Urban Dwellers in Metropolitan Kuala Lumpur , Malaysia. Biomed Res Int. 2015;2015:1–8.
37. Ndour MA, Abdoulaye L, Codou FB, Mohamed LY, Nafy N, Diaba DN, et al. Electrocardiographic Changes in Patients with Type 2 Diabetes Multicenttic Cross Sectional and Descriptive Study in Dakar. Open J Intern Med. 2017;7:64–73.
38. Rezaei-adl S, Tali AG, Saffar H, Rajabiani A, Abdollahi A. Comparing the Levels of

Acute-Phase Reactants Between Smoker and Nonsmoker Diabetic Patients : More Predicted Risk for Cardiovascular Diseases in Smoker Compared to Nonsmoker Diabetics. Acta Med Iran. 2017;55:563–7.

39. Pan A, Wang Y, Talaei M, Hu FB. Relation of Smoking With Total Mortality and Cardiovascular Events Among Patients With Diabetes Mellitus A Meta-Analysis and Systematic Review. Circulation. 2015;132:1795–804.
40. Munukutla S, Pan G, Deshpande M, Thandavarayan RA. Alcohol Toxicity in Diabetes and Its Complications : A Double Trouble ? Alcohol Clin Exp Res. 2016;40:686–97.
41. Raheja H, Namana V, Chopra K, Sinha A, Gupta SS. Electrocardiogram Changes with Acute Alcohol Intoxication : Open Cardiovasc Med J. 2018;12:1–6.
42. Blomster JI, Zoungas S, Chalmers J, Li Q, Chow CK, Woodward M, et al. The Relationship Between Alcohol Consumption and Vascular Complications and Mortality in Individuals With Type 2 Diabetes. Diabetes Care. 2014;37:1353–9.
43. Adjemian MK, Volpe RJ, Adjemian J. Relationships between Diet , Alcohol Preference , and Heart Disease and Type 2 Diabetes among Americans. PLoS One. 2015;10:1–12.
44. Yang S, Wang S, Yang B, Zheng J, Cai Y, Yang Z. Alcohol Consumption Is a Risk Factor for Lower Extremity Arterial Disease in Chinese Patients with T2DM. J Diabetes Res. 2017;2017:1–6.
45. Al J, Ali WM, Aleryani SL. Clinica Chimica Acta Cardiovascular complications of Khat. Clin Chim Acta. 2013;419:11–4.
46. Saif-Ali R, Al-Qirbi A, Al-Geiry A, AL-Habori M. Effect of Catha edulis on plasma glucose and C-peptide in both type 2 diabetics and non-diabetics. J Ethnopharmacol. 2003;86:45–9.
47. Al-sharafi BA, Gunaid AA. Effect of Habitual Khat Chewing on Glycemic Control , Body Mass Index , and Age at Diagnosis of Diabetes in Patients with Type 2 Diabetes Mellitus in Yemen. Clin Med Insights Endocrinol Diabetes. 2015;8:47–53.
48. Vries ST De, Widya RL, Webb AG, Kan HE. Exercise and Type 2 Diabetes Mellitus : Changes in Tissue-specific Fat Distribution and Cardiac Function 1. radiology.rsna.org. 2013;269:1–9.
49. Tikkanen-dolenc H, Wadén J, Forsblom C. Frequent and intensive physical activity reduces risk of cardiovascular events in type 1 diabetes. Diabetologia. 2017;60:574–80.
50. Pedersen BK. Anti-inflammatory effects of exercise : role in diabetes and

cardiovascular disease. Sticht Eur Soc Clin Investig J Found. 2017;47:600–11.

51. Yaribeygi H, Atkin SL, Mendía LES. Molecular mechanisms by which aerobic exercise induces insulin sensitivity. J Cell Physiol. 2019;10:1–8.
52. Psaltopoulou T, Hatzis G, Papageorgiou N, Androulakis E, Briasoulis A, Dimitris Tousoulis. Socioeconomic status and risk factors for cardiovascular disease : Impact of dietary mediators. Hell J Cardiol. 2017;58:32–42.
53. Freisling H, Overvad K, Boeing H, Masala G, Panico S, Tumino R, et al. The association of substituting carbohydrates with total fat and different types of fatty acids with mortality and weight change among diabetes patients. Clin Nutr. 2016;35:1096–102.
54. Elhayany A, Lustman A, Abel R, Vinker S. A low carbohydrate Mediterranean diet improves cardiovascular risk factors and diabetes control among prospective randomized intervention study. Diabetes, Obes Metab. 2010;12:204–9.
55. Arnard N, Ohen JOC. A Low-Fat Vegan Diet Improves Glycemic Control and Cardiovascular Risk Factors in a Randomized Clinical Trial in Individuals With Type 2 Diabetes. Diabetes Care. 2006;29:1777–83.
56. A. E, V. H, Michael, T. R, Morrow K, P. H and J. Clinical Overview of Obesity and Diabetes Mellitus as Risk Factors for Atrial Fibrillation and Sudden Cardiac Death. fphys. 2019;9:1–13.
57. Li X, Ren H, Xu Z, Liu Y, Yang X, Liu J. Prevalence and Risk Factors of Prolonged QTc Interval among Chinese Patients with Type 2 Diabetes. Exp Diabetes Res. 2012;2012:1–6.
58. Lin L, Chen G, Zou X, Zhao J, Zhu F, Tu M, et al. Diabetes , pre-diabetes and associated risks on Minnesota code-indicated major electrocardiogram abnormality among Chinese : a cross-sectional diabetic study in Fujian province , southeast China. Int Assoc Study Obes. 2009;10:420–30.
59. Nguyen LL, Su S, Nguyen HT, Member S. Identification of Hypoglycemia and Hyperglycemia in Type 1 Diabetic Patients Using ECG Parameters. In: IEEE EMBS. San Diego, California USA; 2012. p. 2716–9.
60. Larsen A, Højlund K, Poulsen MK, Juhl REM and CB, Larsen Da, Højlund K, et al. Hypoglycemia-Associated Electroencephalogram and Electrocardiogram Changes Appear Simultaneously. J Diabetes Sci Technol. 2013;7:93–9.
61. Rungby J, Schou M, Warrer P, Ytte L, Andersen GS. Prevalence of cardiovascular disease and evaluation of standard of care in type 2 diabetes: A nationwide study in

primary care. Cardiovasc Endocrinol. 2017;6:145–51.

62. Eryd SA, Svensson A, Franz S, Eliasson B, Nilsson PM. Epidemiology Risk of future microvascular and macrovascular disease in people with Type 1 diabetes of very long duration : a national study with 10-year follow-up. DIABETICMedicine. 2016;34:411–8.
63. World Health Organization: The WHO STEPwise approach to Surveillance of noncommunicable diseases (STEPS). World Health Organization. 2003;1–42.
64. Richards. S, Crow, J. R, MB P, Zhang Z-M. The Minnesota Code Manual of ECG Findings: Standards and Procedures for Electrocardiographic Measurement. second. New York: springer; 2010. 1-338 p.
65. Rawshani A, Svensson A-M, Zethelius B, Eliasson B, Rosengren A, Gudbjörnsdottir S. Association Between Socioeconomic Status and Mortality, Cardiovascular Disease, and Cancer in Patients With Type 2 Diabetes. JAMA Intern Med. 2016;176:1146–54.
66. Madmoli1 M, Eilami O, Rezaie K, Aliabad3 MA, Moslemirad O. Diabetes and the risk of suffering cardiovascular diseases: Int J Ecosyst Ecol Sci. 2018;8:649–56.
67. Okuda N, Nishi N, Kadota A, Okamura T, Ueshima H. Socioeconomic Status and Knowledge of Cardiovascular Risk Factors. J Epidemiol. 2018;28:46–52.
68. Rosengren A, Smyth A, Rangarajan S, Ramasundarahettige C, Bangdiwala SI, Alhabib KF, et al. Socioeconomic status and risk of cardiovascular disease in the Prospective Urban Rural Epidemiologic (PURE) study. Lancet Glob Heal. 2019;7:748–60.
69. Apaijai N, Arinno A, Palee S, Pratchayasakul W. High-Saturated Fat High-Sugar Diet Accelerates Left-Ventricular Dysfunction Faster than High-Saturated Fat Diet Alone via Increasing Oxidative Stress and Apoptosis in Obese-Insulin Resistant Rats. Mol Nutr food Res jornoul. 2019;63:1–12.
70. Coronel R. Pharmacology & Therapeutics The pro- or antiarrhythmic actions of polyunsaturated fatty acids and of cholesterol. Pharmacol Ther. 2017;176:40–7.
71. Lane-cordova AD, Witmer JR, Dubishar K, Dubose LE, Chenard CA, Siefers KJ, et al. High trans but not saturated fat beverage causes an acute reduction in postprandial vascular endothelial function but not arterial stiffness in humans. Vasc Med. 2016;21:429–36.
72. Kuzu F. Relation of homeostasis model of insulin resistance and body mass index with cardiac repolarization inhomogeneity in overweight and obese patients. Med Sci Int Med J. 2019;1–5.
73. Hussain G, Farooque I. Effect of obesity on electrocardiographic parameters of

ventricular. Jebmh.com. 2017;4:5915–20.

74. Varun S, Jain HR, Singh GS, Parekh S, Shetty S. Cardiovascular and Electrocardiography Changes in Obese Individuals at Rest and During Stress Test. 2017;5.

75. Chen H, Deng Y and, Shunhui L. Relation of Body Mass Index Categories with Risk of Sudden Cardiac Death. 2019;1–7.

76. Jr TD, Leinig C, Cerci RJ, Lafitte A, Jr S, Vítola JV. Study of Myocardial Perfusion in Obese Individuals without Known Ischemic Heart Disease. 2018;121–8.

77. World Health Organization. Waist Circumference and Waist-Hip Ratio Report of a WHO Expert Consultation. 2008.

ANNEXES

Annex I. Patients' information sheets

English version

Title of Research: Assessment of electrocardiographic abnormalities and associated factors among adult type 2 diabetes on chronic follow up at Jimma medical center, 2019.

Institution: Jimma University institute of health, department of biomedical sciences (Post Graduate Program)

Name of sponsor: Jimma University

Purpose of the study: The purpose of this study is to determine magnitude of electrocardiographic abnormalities and associated factors among adult type 2 diabetes on chronic follow up at JMC, 2019

Electrocardiographic abnormalities are common in patients with diabetes. Early screening of asymptomatic diabetes patients for cardiovascular help diabetic patients to be screened early for cardiovascular risks to prevent complications that might happen. By considering this implication I want to take study on this area. Please read the following description about the study and ask any unclear points before you agree to participate.

Duration: It will take about 20 minutes to understand the objective of the study, respond to the questions and undergo ECG recording procedure.

Procedure: Before Procedure to be carried out first, you will be asked few questions about your socioeconomic and demographic factors, behavioral factors, measurement of blood pressure, height, weight, waist circumference, hip circumferences, fasting blood sugar and ECG recording will be done. Principal investigator will cover the cost fasting blood sugar and for ECG recordings.

Risk: It may cause minimal discomfort but, will not cause you any physiological, financial and psychological harm. This study will pick cardiovascular disease in early stage so that early intervention will be taken.

Benefits: Even if there is no direct payment for your participation in this study, the information you give will help you and your physician to know your cardiovascular system. This also helps other diabetic patients by recommendation of cardiovascular system screening management in diabetic patients. If your results indicate the presence of ECG abnormality, you will be referred to cardiac clinic for further managements by care givers.

Confidentiality: The unique code will be given for the information you will give us and your ECG result so that your result will not be identified. Only the principal investigator and

selected health professionals have access to your result and the result will be used for this study only with confidentiality.

Voluntary Participation and Withdrawal from the Study: Your participation will be completely based on your willingness and you have the right not to participate and withdraw from participating in the study at any time after giving your consent and start your participation. You can also jump any question if you do not wish to respond for that question. This decision will not affect your current or future medical care in the health facility.

Contact information: If you have any questions about this study, you can contact the principal investigator.

Principal Investigator: Deriba Abera (B.Sc.)

Mobile: +251917634318

E-mail: deribaabera@gmail.com

Patients' information sheets

Afan Oromo version

Mata duree qorannichaa: Assessment of electrocardiographic abnormalities and associated factors among adult type 2 diabetes on chronic follow up at Jimma medical center, 2019.

Inistituushinii: Inistitiyuutii fayyaa Yunvarsiitii Jimmaatti Muummee baayoomeedikaalaa, (Post Graduate Program)

Maqaa dhaabbata ispoonsera godhee: Yunvarsiitii Jimmaa

Kaayyoo qorannichaa: Kaayyoon qorannichaa hanga ECG jijjiirame (electrocardiographic abnormalities) fi wantoota isaan wal qabatan dhukkubsattoota dhibee sukkaaraa gosa lammaffaa ga'eessota ta'ainiifi hordoffii isaanii Giddugaleessa wal'aansa Jimmaatti bara 2019 ALA taasisaan calaludha.

Jijjiramni ECG irratti ta'u dhukkubsattoota dhibee sukkaaraa irratti ni baay'ata. Calalliin yeroodhan dhukkubsattota dhibee sukkaaraaf godhamu rakkoo onnee yeroon mu'isuufi osoo miidhaa cimaa hin geessisin adda baasuuf oola. Kanafuu qorannoon kun dhukkubsattota dhibee sukkaaraatif bu'aa guddaa kan buusu yoo ta'u qorannicha irratti hirmaachuun dura waan isiniif hin galle adda baafachuu dandeechu.

Turtii: Qorannichi walumaa galatti gara daqiiqaa 20 kan fudhatuudha.

Tartiiba gochaaa: Qorannichi kan jalqabamu gaafiwwan muraasa waa'ee hawaasdiinagdee, amaloota faayyaa keetin wal qabatan gaafatamuu, dhiibbaa dhiigaa, ulfaatina, dheerina marsaa mudhii safaramu, hanga sukkaaraa dhiiga keessa jiruu safaramuufi maashina ECG jedhamuun qorannoon onnee taasifamuudha. Gatii baasii kanneenif barbaachisu nama qorannoo kana geggeessutu haguuga.

Rakkoo fayyaa: Dhukkubbii xiqqaa irraa kan hafe qoranannon kun rakkoo qaamaas ta'ee kan xiinsammuu kan hin geechifne akkasumas baasii kan isin hin baasisne ta'uu isin hubachiisna.

Bu'aa: Qorannoo kanarratti waan hirmaattaniif kaffaltiin kallattiin isiif kaffalamu hin jiraatu. Garuu, qorannichi rakkoo onneen wal qabatu yeroon adda baasuu kan danda'u yoo ta'u wal'aansi barbaaaachisaan akka dafee kennamu gargaara. Bu'aan ECG keessanii rakkoo fayyaa onnee keessanii kan agarsiisu yoo ta'e gara ogeessa kutaa ogeessonni onnee jiranitti kan isin dabarsinu ta'a.

Iccitii ragaaa: odeeffannoon isin nuuf kennitan kamuu koodii dhoksaan kan kennamuuf yoo ta'u nama qorannoo kana geggeessuufi ogeessota fayyaa dhimmi kun ilaalun alatti qaama biraatti hin dabrfamu.

Hirmaannaa fedhii irratti hundaa'eefi mirga qorannicha adda kutuu: Mirgi qorannicha irratti hirmaachuufi dhiisuu keessanii kan eeggame yoo ta'u, erga eegaltaniis adda kutuuf mirga guutuu kan qabdan akkasumas waan isinii hin galle gaafachuufillee mirga qabdu. Kunis tajaajila fayyaa isin argattan iarrtti dhiibbaa tokkollee kan hin qabne ta'uu isin hubachiisna.

Teessoo odeeffannoo: Yoo gaaffii qabaattan nama qorannicha abbumaan gegeessu argagachuuf

Teessoo qoratichaa: Dirribaa Abarraa (B.Sc.)

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Patient information sheet

Amharic version

የጥናቱ ርዕስ፡ Assessment of electrocardiographic abnormalities and associated factors among adult type 2 diabetes on chronic follow up at Jimma medical center, 2019.

ጥናቱን የፈቀደዉ ተቋም፡ ጂማ ዩኒቨርሲቲ

የጥናቱ አላማ፡ በጅማ ሜድካል ሴንተር በተመላላሽ ቀጠሮ ህክምና እያገኙ ባሉ ምድብ ሁለት የስኳር ታካሚወች ላይ ያለዉን የelectrocardiographic ልዉጥና ተያያዥ ጉዳዮች ላይ ጥናት ማካሄድ እና በጥናቱ መሰረት አስፈላጊዉ ምርመራ እና ክትትል ለ ስስኳር ታካሚወች እንዲደረግ ማድረግ ነው፡፡በስኳር ታካሚወች የሚከሰት የelectrocardiographic ልዉጥ ባፋጣኝ ተለይቶ ተገቢዉ ህክምና ካልተደረገለት ከስኳር ህመም ጋር ተያይዘዉ ሊከሰቱ የሚችሉ የልብ ባሽታ እንዲከሰቱ እና እንዲባባሱ እድል ይፈጥራል፡፡ በመሆኑም የዚህ ጥናት ዉጤት ለታካሚዎችም ሆነ ለህሙማኖች ክትትል ለሚያደረጉ የጤና ባለሙያዎች እንደ ተጨማሪ ግብአት በመሆን; የelectrocardiographic ልዉጥና እነዲሁም ለመከሰቱ ምክንያት የሚሆኑ ነገሮችን በመጠቆም; በክትትል ወቅት በወቅቱ የመለየት እና አስፈላጊዉ ክትትል እና ህክምና የማድረግ ስራ እንዲሰራ አስተዋፅኦ ያደረጋለ፡፡ እነዚህን አስተዋፆወች በማስብ በዚህ ቦታ ላይ ጥናት ማካሄድ ፈልጌያለሁ፡፡ በመሆኑም ጥናቱ ከታሰበለት ደረጃ እንዲደረስ እና ከጥናቱ የሚገኘዉን ጥቅም ተግባር ላይ እንዲዉል ከእርሶዎ የሚገኘዉ ትክክለኛ መረጃ ወሳኝነት አለዉ፡፡ በመሆኑም እነዚህን ጉዳዮች ከግምት በማስገባት አስፈላጊዉን ትብብር እንዲያደርጉልኝ በአክብሮት እጠይቃለሁ፡፡ ጥናቱን በተመለከተ ያልገባዎት እና ግልፅ ያልሆነ ነገር ካለ በማንኛዉም ጊዜ መጠየቅ ይችላሉ፡፡

ጥናቱ የሚወስደዉ ጊዜ፡ በጥናቱ አላማ ዙሪያ ለመነጋገር፤ በጥናቱ ከተስማሙ ስምምነትዎን የሚገልፁበት እና እንዲሁም የECG የልብ መርመራ ለመረግ በአጠቃላይ እስከ 20 ደቂቃ ሊወስድ ይችላል፡፡

በጥናቱ የሚካተቱ ተግባራት፡ በመጀመሪያ ማህበረሰባዊ አካባቢያዊ እና ኢኮኖሚያዊ ጉዳዮችን የሚዳስሱ ጥያቄዎችን ይጠየቃሉ፡፡ በመቀጠልም የደም ግፊት፡ ቁመት፡ ክብደት እና የወገብ ስፋት ይለካል ይህም ከክብት እና ከደም ግፊት ጋር ተያይዘዉ በስኳር ታካሚዎች ላይ የሚከሰቱ ተያያዥ የጤና ችግሮችን ለመለየት ያመቻል፡፡ በመጨረሻም ኢሲጂ (Electerocardiogram) ሪከርድ ይደረጋል። ከጥናቱ ጋር በተያያዘ ለሚጠየቅ እና በጥናቱ ምክንያት ከመደበኛ ዉጪ ለሚካሄድ የላብራቶሪ ምርመራ ወጪ ጥናቱን በሚያካሂደዉ ግለሰብ ስለሚሸፈን ተጨማሪ ወጪ አይጠበቅብዎትም፡፡

ከጥናቱ ሊያጋጥሙ የሚችሉ ጉዳቶች፡ በዚህ ጥናት ሳቢያ ከትንሽ ህመም በስተቀር ልደርስብዎት የሚችል ምንም አይነት ጉዳትም ሆነ ያሳስብዎ የሚችል ነገር የለም።

ከጥናቱ የሚገኘዉ ጥቅም፡ ምንም እንኳን ጥናቱን ላይ በመሳተፍዎ ቀጥታ የሚከፈልዎት ክፍያ ባይኖርም የጥናቱ ዉጤት በእርሶ ላይ የኤሲጂ ለውጥ መኖር አለመኖሩን እና እነዲሁም ከዚሁ ጋር ሊያያዝ የሚችል የልብት መጎዳት መኖር አለመኖሩን ስለሚያመለክት በጥናቱ ተጠቃሚ ይሆናሉ፡፡ የምርመራ ዉጤቱ የልብ መጎዳት መኖሩን ወይም ከስኳር ህመሙ ጋረ የተያያዘ የልብ ችግር መኖሩን ወይም ሁለቱንም የሚያመለክት ከሆነ ወደ የልብ ህክምና ክፍል እንዲሄዱ እና ተጨማሪ የህክምና አገልግሎት እንዲያገኙ ይደረጋል፡፡

የጥናቱ ሚስጥራዊነት፡ እርሶ የሚሰጡትን መረጃም ሆነ ከእርሶ የደም ምርመራ የሚገኘዉ ዉጤት ሚሥጢራዊ በሆነ ኮድ ስለሚመዘገብ ሚስጥራዊ ነዉ፡፡

በፈቃደኛነት ላይ የተመሰረተ ተሳትፎ እና ተሳተፎዉን የማቋረጥ መብት፡ ተሳትፎዉ ሙሉ በሙሉ በፈቃደኛነት ላይ የተመሰረተ ሚሆን ተሳታፊዉ በጥናቱ ያለመሳተፍ ሙሉ መብት አለዉ፡፡ ለመሳተፍ ፈቃደኛነትዎን ካረጋገጡና መሳተፍ ከጀመሩ በኋላም ቢሆን የማቋረጥ መብት አለዎት፡፡ ለተጠየቁት ጥያቄ መልስ ለመስጠት ፈቃደኛ ካለሆኑም ጥያቄዉን

ሣይመልሱ የመዝለል መብት አለዎት፡፡ ባለመሳተፍዎ ወይም የተጠየቁትን ለመመለስ ፈቃደኛ ባለመሆንዎ ከተቋሙ በሚያገኙት አገልግሎት ላይ ዛሬም ወደፊትም የሚፈጥረዉ ምንም ተፅእኖ የለም፡፡

የጥናቱ ተዋናይ አድራሻ፡ ከጥናቱ ጋር በተያያዘ ማንኛዉም አይነት ጥያቄ ካላችሁ ጥናቱን የሚያካሂደዉን ግለሰብ በሚከተለዉ አድራሻ ማግኘት ትችላላችሁ፡፡

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Annex II. Data collection procedures

i. Blood pressure measurements

Blood pressure was measured three times in sitting position from the right arm using a mercury sphygmomanometer and recorded to the nearest mm Hg. The patient sat quietly for 5 minutes before taking the measurement and 3 minutes before repeating the measurement. The patient's arm was rested comfortably with palm up and supported at heart level with legs uncrossed. The patients sat relaxed and comfortably. The mean of the three measurements were used for analysis.

ii. Anthropometric measurements

Weight, height, waist circumference and hip circumferences were measured according to world health organization standard (77).

Height: Height was measured with a stadiometer to the nearest centimeter without shoes. All the participants were stand vertical with no shoes with their back against the wall, heels together and eyes focused forward.

Weight: Weight was measured with a digital weighting scale that is kept on a flat surface. The scale was checked every day with known weights. Participants wore light clothing and weight was recorded to the nearest kg.

Body mass index: BMI was calculated using the formula: observed weight in kg divided by height in meter squared (kg/m^2).

Waist circumference was measured using a non-stretchable measuring tape. All the participants were stood upright in a comfortable position with both feet together on a horizontal surface. Waist circumference was measured at the midpoint between the costal margin and iliac crests at least respiration.

Hip circumference: HC was measured as the maximum circumference at the level of the greater trochanter (the widest portion of the hip) on both sides. Measurements were noted to the nearest centimeter.

Waist and hip ratio (WHR): WHR was obtained by dividing the waist circumference in cm by the hip circumference in centimeter.

iii. Blood glucose level (BGL) measurements

Fasting blood sugar (FBS) was done with a simple finger prick using digital glucometer. The patient's finger was cleaned off with an alcohol pad, then dried with a clean gauze pad and prepared for finger pick. The finger test site was pricked with quick motion and gently pressed and obtained a drop of blood at least one microliter. The drop of blood was held to a

narrow channel in the test strip and a blood was drawn into the strip. The blood glucose level was displayed along with unit of measure and the result was recorded.

iv. Electrocardiography

The suggested procedure for obtaining a resting ECG and the technical requirements for a suitable ECG was followed in the reference to standard manual for the Minnesota code (64).

Equipment: "YORK" 12 lead Electrocardiography manufactured by York Scientific company.

Calibration: The paper speed is 25 mm/s and voltage are 10 mm/mV.

Patient preparation: Patient preparation as well as lead attachment was made according to standard manual for Minnesota code protocol.

1. Hands were washed and the following equipment and supplies were gathered.
    - 12-lead ECG Machine
    - ECG Electrodes
    - Alcohol swabs
    - Adhesive remover swabs
    - Gauze pads
    - Surgical blade
    - Cardiac jell
2. An ECG recorder was introduced him/herself and verified the patient's name and chart.
3. The patient removed metallic ornaments and clothing from the waist up an ensuring privacy.
4. The ECG procedures was explained for the patients and answered their questions appropriately.
5. Then, stood on the right side of the patient and the skin was prepared for the electrodes placement by shaving hair, rubbing the lower legs, lower forearms, and chest area with alcohol swabs and dried the areas with gauze pads.
6. The electrodes were applied starting with the lower legs, lower forearms and chest area.

    Electrode placement:

7. Bipolar limb leads (frontal plane)
    a. Lead I: RA (-) to LA (+) (Anterolateral)

    b. Lead II: RA (-) to LL (+) (Inferior)
    c. Lead III: LA (-) to LL (+) (Inferior)
8. Augmented unipolar limb leads (frontal plane)
    a. Lead aVR: RA (+) to [LA & LL] (-) (Rightward)
    b. Lead aVL: LA (+) to [RA & LL] (-) (Anterolateral)
    c. Lead aVF: LL (+) to [RA & LA] (-) (Inferior)
9. Unipolar (+) chest leads (horizontal plane)
    a. Leads V1, V2, V3, V4 & V5: (Anterior)
    b. Lead V6: (Anterolateral)
10. V1: In the fourth intercostal space (between ribs 4 & 5) just to the right of the sternum.
11. V2: In the fourth intercostal space (between ribs 4 & 5) just to the left of the sternum.
12. V3: Between leads V2 and V4.
13. V4: In the fifth intercostal space (between ribs 5 & 6) in the mid-clavicular line.
14. V5: Horizontally even with V4, in the anterior axillary line.
15. V6: Horizontally even with V4 and V5 in the midaxillary line.
16. The lead wires were connected to the corresponding electrodes first beginning with the right leg.
17. Electrical equipment was turned off during recording.
18. The machine was turned on and entered the participant's information ID number and date.
19. The patient was asked to breathe normally, relaxed, remained comfortable and calm.
20. ECG recording was acquired in the quiet room.
21. Then the ECG record was printed when the satisfactory waves were acquired.
22. Lead wires, electrodes and adhesive gel were removed from the participant
23. The traced ECG papers were kept for authorized reading.
24. The recorded ECG papers were read and interpreted by two internists.

Annex III. Data Collection Tools

1. English Version Questionnaires

Introduction and Consent

Greetings! My name is ----------I am data collector of the study being conducted by Deriba Abera, master's student at Jimma University, Institute of Health Science, Faculty of Medical Sciences department of Biomedical Sciences. We are conducting a scientific research on assessment of electrocardiographic abnormality among adult type 2 diabetes mellitus. As you are one of the potential candidates in this study, you are kindly requested to participate in this study. Your participation is entirely based on your willingness and your refusal doesn't affect the service you get from us. It will not cause you any physiological, financial and psychological harm. This study will pick cardiovascular disease in early stage so that early intervention will be taken. If you are willing to participate, we will interview you and review your chart for some health-related questions and ECG recording will be conducted. You have the right to refuse participation and you can interrupt at any point and you have full right to ask questions. Any information obtained from you and your medical records will remain confidential indefinitely. Do you wish to participate in the study? If the participant agrees to participate in the study, the patient will be interviewed, chart will be reviewed and ECG will be recorded.

I_____ have been told of the contents of this research form and I have adequate information about the research and understood it and I do agree to participate in this Research study.

Name of the participant ---------- sign ---------- Date----------

Name of Data collector---------- sign ---------- Date----------

Name of the supervisor ---------- Sign ---------- Date----------

THANK YOU!!

Questionnaires

PART I: Questions on Socio- demographic characteristics of the Respondents.

Sr. No	Question	Response	Remark
Part I- Socioeconomic and demographic Characteristics			
101	Identification Number	1. ID NO _____	
102	Age	_____years	
103	Sex	1. Male 2. Female	
104	Educational status	1. Don't read and write 3. Secondary 2. Primary (1-8) 4. Tertiary	
105	Occupation	1. Farmer 4. Governmental employee 2. Daily laborer 5. Private/NGO 3. Merchant 6. Other specify (_____)	
106	Average monthly income	_____ETB	
107	Place of residency	1. Urban 2. Rural	
108	Duration of diabetes	_____years	

PART II: Questions behavioral measurements of the Respondents.

Tobacco use practice			
Sr. No	Question	Response	Remark
201	Do you have history of cigarettes smoking?	1. Yes 2. No	If no skip to 206.
202	How long ago did you start smoking?	_____in years	
203	How often were you smoking?	1. Daily 2. Less than daily 3. Don't know	
204	How many cigarettes do you smoke each day/week on average?	_____ numbers of cigarettes	
205	Do you currently smoke tobacco products daily?	1. Daily 2. Less than daily 3. Don't know	
206	Is there family member who smokes cigarette?	1. Yes 2. No	If no skip to 208
207	How often was His/her smoking?	1. Daily 2. Less than daily 3. Don't know.	

Alcohol use practice				
208	Do you have a history of alcohol drinking?	1. Yes 2. No		If no skip to 212
209	If yes to 208, Are you currently drinking alcohol?	1. Yes 2. No		If no skip to 212
	If yes to 209, which one?		Quantity	Fill the quantity at single episode in space given
		1. Beer/Draft		
		2. Wine		
		3. Tejj/tella		
		4. Local areke		
		5. Other (____)		
210	How often do you have a drink containing alcohol?		Scores	
		1. Never	0	
		2. Monthly or less	1	
		3. 2-4 times a month	2	
		4. 2-3 times a Week	3	
		5. 4 or more times a week	4	
211	How many standard drinks containing alcohol do you have on a typical day when you are drinking?	1. 1 – 2	0	
		2. 3 – 4	1	
		3. 5 - 6	2	
		4. 7 – 9	3	
		5. 10 or more	4	

212	How often do you have 5 or more drinks in one occasion?	Never	0	
		Less than Monthly	1	
		Monthly	2	
		Weekly	3	
		Daily/almost daily	4	
Khat chewing				
213	Do you chew Khat?	1. Yes 2. No		
Physical Inactivity				
214	During the last 7 days, did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling that cause large increases in breathing or heart rate for at least 10 minutes continuously?	1. Yes 2. No		If no skip to 217
215	If yes, in a typical week, on how many days' do you do vigorous-physical activities?	_____days.		
216	If yes, how much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	_____hrs. _____minutes.		
217	During the last 7 days, did you do moderate physical activities like carrying light loads, bicycling at a regular pace, tennis or activities that cause a small increase in breathing or heart rate such as active walking, for at least 10 minutes continuously?	1. Yes 2. No		If no skip to 222.

218	If yes, in a typical week, on how many days' do you do you do any moderate-intensity sports, fitness or recreational (leisure) activities	_____days.	
219	If yes, how much time do you spend doing any moderate-intensity sports, fitness or recreational (leisure) activities?	_____hrs. _____minutes.	
220	How much time do you usually spend sitting or reclining on a typical day?	_____hrs.	

PART III: Dietary practice

Dietary practice			
Sr. No	Questions	Responses	Remark
301	In a typical week, on how many days do you eat fruit?	_____days	If zero-day skip to 303
302	How many servings of fruit do you eat on one of those days?	_____servings.	
303	In a typical week, on how many days do you eat vegetables?	_____days.	If zero-day skip to 306
304	How many servings of vegetables do you eat on one of those days?	_____servings.	
305	In a typical week, on how many days do you eat fats (fats and oils)?	_____days.	
306	What type of oil or fat is most often used for meal preparation in your household?	1. Liquid Vegetable oil(type) 2. Solidified oil (type) 3. Butter 4. Shenolega 5. Other	
307	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.	_____meals.	

PART IV: physical measurements

401	**Blood Pressure (BP)(mmHg)**			
		Systolic(mmHg)	Diastolic(mmHg)	
	Reading one			
	Reading two			
	Reading three			
Anthropometry and body fat Measurements				
402	Height	Height in (m)_____		
403	Weight	Weight in (kg)_____		
405	Waist Circumference (WC)	WC in (cm)_____		
406	Hip Circumference (HC)	HC in (cm)_____		
407	**Fasting Blood Sugar (FBS)**			
	Reading	_____ in (mg/dl)		

2. Afan Oromo Version Questionnaires

Yooyyaa!

Harka fuune! Maqaan koo ----------jedhama. Qorannoo saayinsawaa barataa digirii lammataa Dirribaa Abarraatin Yuunvarsiitii Jimmaatti Inistituutii saayinsii fayyaatti muummee baayoomedikaalaatti geggeeffamuuf daataa (odeeffannoo) funaana. Qorannoon saayinsawaa kunis jijjiirama elektrookaardi'oogiraafii dhukkubsattoota dhibee sukkaaraa gosa lamaffaa irratti kan geggeeffamuudha. kanaafuu, namoota qoarannoo kana irratti hirmaachuu danda'an keessaa isa tokko waan taatanif akka irratti hirmaattan kabajaan isin gaafanna. Hirmaannan keessan fedhii keessan irratti kan hundaa'e yoo ta'u, hirmaachuu dhabuun keessan tajaajila nu biraa argattan irratti rakkoo tokkoyyuu hin qabu. Qoranannon kun rakkoo qaamaas ta'ee kan xiinsammuu kan hin geechifne akkasumas baasiif kan isin hin saaxille ta'uu isin hubachiisna. Qorannichi rakkoo onneen wal qabatu yeroon adda baasuu kan danda'u yoo ta'u wal'aansi barbaaaachisaan akka dafee kennamu gargaara. Qorannicha irratti hirmaachuuf yoo fedhii qabaattan gaafiifi deebii kan isiniif goonu akkasumas, hanga sukkaara dhiiga keessan keessa jiru kan safarruufi maashinii ECG tiin onneen keessan kan ilaalamu ta'a. Migi qorannicha irratti hirmaachuu dhiisuu keessanii kan eeggame yoo ta'u, erga eegaltaniis adda kutuuf mirga guutuu kan qabdan akkasumas waan isinii hin galle gaafachuufillee mirga guutuuu qabdu. Odeeffannoon isinirraa fudhatame iccitiin kan turuudha. Qorannicha irrati hirmaachuuf fedhii qabduu? Yoo maamilli itti walii gale gaafiifi deebiin akkasumas maashinii ECG 'n onnee ilaaluun itti fufa.

Ani_____ qabiyyeen qorannoo kanaa kan natti himame, waa'ee qorannichaa odeeffannoo ga'aa kanan argadhe yoo ta'u qorannicha irratti hirmaachuuf walii galee jira.

Maqaa nama odeeffannoo kennuu----------mallattoo -------- guyyaa---------

Maqaa nama odeeffannoo funaanuu---------- mallattoo --------- guyyaa-------

Maqaa to'ataa ---------- mallattoo ---------- guyyaa ----------

GALATOOMAA!

KUTAA I: Gaaffilee waa'ee hawaasummaafi dinagdee.

Lakk.	Gaafii	Deebii	Yaada
KUTAA I: Gaaffilee waa'ee hawaasummaafi dinagdee.			
101	Lakk. Eenyummaa	1. Lakk eenyummaa_____	
102	Umrii	_____waggaadhan	
103	Saala	1. Dhiira 2. dhalaa	
104	Sadarkaa barnootaa	1. dubbisuufi barreessuu kan hin dandeenye 2. sadarkaa 1ffaa (1-8) 3. sadrakaa olaanaafi qophaa'ina 4. sadarkaa barnoota olaanaa	
105	Gosa hojii	1. Qotee bulaa 2. Hojii guyyaa 3. Daldalaa 4. Hojjetaa mootummaa 5. Hojii dhuunfaa/miti mootummaa 6. Kan biraa ibsi (_____)	
106	Galii jia'aa giddu galeessan	_____Qarshii	
107	Bakka jireenyaaa	1. Magaalaa 2. Baadiyyaa	
108	Dheerina yeroo dhibee sukkaaraa	_____waggaadhan	

KUTAA II: Gaafilee waa'ee amaloota hirmaattotaa.

Tamboo xuuxuu			
Lakk.	Gaafii	Deebii	yaaada
201	Tamboo xuuxxee beektaa?	1. Eeyyee 2. lakkii	Yoo lakii ta'e gaaffii 206 tti darbi
202	Turtii waggaa meeqaf xuuxaa turte?	_____ waggaadhan	
203	Yoo gaafii 201 eeyyee ta'e yeroo meeqatti xuuxxa?	1. Guyyaa guyyaan 2. Guyyaa guyyaan gaditti 3. Hin beeku	
204	Guyyaatti/torbeetti giddugaleessan sigaaraa meeqa xuuxxa?	sigaaraa_____	
205	Yeroo ammaa kana ni xuuxxaa?	1. Guyyaa guyyaan 2. Guyyaa guyyaan gaditti 3. Hin beeku	
206	Miseensota maatii keessaa namni tamboo xuuxu jiraa?	1. Eeeyee 2. Lakkii	Yoo lakkii ta'e gara 208 darbi
207	Yoo gaafii 206 eeyyee ta'e yeroo akkamii xuuxxa?	1. Guyyaa guyyaan 2. Guyyaa guyyaan gaditti 3. Hin beeku	

Fayyadama dhugaatii alkoolii				
208	Alkoolii dhugdee beektaa?	1. Eeyyee 2. Lakkii		Yoo lakkii ta'e gara 212 darbi
209	Yoo 208 eeyyeee ta'e, amma alkoolii ni dhugdaa?	1. Eeyyee 2. Lakkii		Yoo lakkii ta'e gara 212 darbi
210	Yoo 209 eeyyee ta'e alkoolii gosa kam?	Gosa	Baay'ina	Hamma isaa bakka duuaa irratti guuuti
		1. Biiraa/Diraaftii		
		2. Waayinii		
		3. Farsoo/daadhii		
		4. Araqee		
		5. Kan biraa ibsi (____)		
211	Dhugaatii alkoolii of keessaa qabu, yeroo meeqatti dhudga?		Qabxii	
		1. Gonkuma	0	
		2. Ji'aa gaditti	1	
		3. Ji'atti yeroo 2 - 4	2	
		4. Torbeetti yeroo 2 – 3	3	
		5. Torbeetti yeroo 4 fi isaa ol	4	
212	Guyyaa dhugaatii alkoolii dhugdu, dhugaatii alkoolii istaandaardii meeqa dhugda?	1. 1-2	0	
		2. 3 – 4	1	
		3. 5 - 6	2	
		4. 7 – 9	3	
		5. 10 fi isaa ol	4	

213	Yeroo tokkotti dhugaatii alkoolii istaandaardii shanifi isaa ol yeroo meeqa dhudga?	1. Gonkuma	0	
		2. Ji'aa gadi	1	
		3. Ji'aan	2	
		4. Torbeedhan	3	
		5. Guyyaa guyyaan	4	

Caatii qaamuu			
214	Caatii ni qamaataa?	3. Eeyyee 4. Lakkii	Yoo lakkii ta'e gara 216 tti darbi
Sochii qaamaa			
215	Guyyota torban darban keessatti sochii qaamaa ykn hojii cimaa dhahannaa onnee ykn hargansuu akkan dabalu kan akka ulfaatina kaasuu, lafa qotuu, eeroobiksii ykn biskileettii saffisaan oofuu walitti fufiinsan daqiiqaaa 10f hojjettee?	3. Eeyyee 4. Lakkii	Yoo lakkii ta'e gara 217 tti darbi
216	Torbeetti guyyoota meeqaf sochii qaamaa cimaa hojjetta?	Guyyoota_____	
217	Guyyaatti turtii hagamiif sochii qaamaa cimaa hojjetta?	Sa'aatii_____Daqiiqaa _____	
218	Guyyota torban darban keessatti sochii qaamaa giddu galeessaa dhahannaa onnee ykn hargansuu hanga tokko dabalu kan akka ulfaatina salphaa kaasuu, teenisii	1. Eeyyee 2. Lakkii	Yoo lakkii ta'e gara 220 tti darbi

	taphachuu qotuu, eeroobiksii ykn biskileettii suuta oofuu walitti fufiinsan daqiiqaaa 10f hojjettee?		
219	Torbeetti guyyoota meeqaf sochii qaamaa cimaa hojjetta?	Guyyoota_____	
220	Guyyaatti turtii hagamiif sochii qaamaa giddu galeessaa hojjetta?	Sa'aatii_____Daqiiqaa _____	
221	Guyyatti yeroo (sa'aatii) hagamii taa'uudhaan dabarsita?	Sa'aatii_____	

KUTAA III: Haala sooratаa

Haala sooratаa			
Lakk.	Gaafii	Deebii	Yaada
301	Torbeetti kuduraa guyyoota meeqa sooratta?	Guyyota_____	Yoo zeeroo ta'e gara 303 tti darbi
302	Guyyoota kanneen keessatti kuduraan yeroo meeqa dhiyaata?	Yeroo_____.	
303	Torbeetti muduraa guyyoota meeqa sooratta?	Guyyoota_____	Yoo zeeroo ta'e gara 306 tti darbi
304	Guyyoota kanneen keessatti muduraan yeroo meeqa dhiyaata?	Yeroo_____	
305	Torbeetti guyyota meeqa faatii (coomaa fi zayta nyaataa) sooratttaa?	Guyyoota_____	
306	Nyaata qopheessuuf zayta nyaataa ykn cooma gosa kam fayyadamta?	1. Isa dhangala'aa (Vegetable oil) 2. Isa ititaa 3. Dhadhaa 4. Shanoo lagaaa 5. Kan biraa ibsi (_____)	
307	Torbeetti giddu galeessan nyaata manatti hin qophoofne si'a meeqa nyaatta?	Yeroo_____	

3. Amharic Version Questionnaires

መግቢያና ስምምነት

ጤና ይስጥልኝ እንደምን አረፈዱ/ ዋሉ _____ እባላለሁ

እኔ ከጅማ ዩኒቨርስቲ ስሆን በዲሪባ አበራ የማካሄደው ሰይንሳዊ ጥናት የElecterocardiogram ለውጥ በምድብ ሁልለት የሱኳር ህመምተኛ መረጃ ሰብሳቢ ስሆን እርስዎ በዚህ ጥናት የተመረጡት ያለምንም ቅድመ ሁኔታ ሲሆን በእርስዎ ፈቃደኝነት ላይ ብቻ የተመሰረተ ነው። በዚህ ጥናት ላይ የመሳተፍ መብትዎ የተጠበቀ ነው። ነገር ግን የእርስዎ ተሳትፎ ለዚ ህጥናት ያለው አስተዋፅኦ የላቀ ስለሆነ በሚኖረን የአፍታ ቆይታ የተወሰኑ ጥያቄዎች እናቀርብሎታለን። የሚቀርብሎት ጥያቄዎች አጠቃላይ መረጃዎች የጤናዎትን ሁኔታ የተመለከቱ ናቸው። በዚህጥናት ሳቢያ ልደርስብዎት የሚችል ምንም አይነት ጉዳትም ሆነ ያሳስብዎ የሚችል ነገር የለም። በዚህ መጠይቅ ለይ የእርስዎን ማንነት ልገልፅ የሚችል መረጃ አይፃፍም። የሚሰጡት መረጃ ሚስጥራዊነቱ በጥብቅ የተጠበቀ ነው። የዚህ ጥናት ውጤት እንዲስፈሊጊነቱ በሚቀርብበት ሁኔታ ሁሉ የእርስዎን የግል ማንነት ሊገልፅ የምችል መረጃ አይቀርብም። በዚህ መጠይቅ የሚረብሽዎ ወይም ያላመኑበት ነገር ቢኖር በማንኛውም ሰዓት ማቋረጥ ይችላሉ። በዚህ ጥናት የመሳተፍ መልካም ፈቃዴዎን ሊሰጡኝ ይችላሉ? አዎ …….. (ቃለ መጠይቁን መጀመር ይችላሉ)

የመረጃ ሰጪ ስም፡ _____ፊርማ፡ _____ቀን_____

የመረጃ ሰብሳቢ ስም፡ _____ፊርማ፡ _____ቀን_____

የተቆጣጣሪው ስም፡ _____ፊርማ_____ቀን_____

አመሰግናለሁ!!!

መጠይቅ

ክፍል I: ማህበራዊ፥ ኢኮኖሚያዊና ዲሞግራፊያዊ ሁኔታን የሚመለከቱ ጥያቄዎች.

ተ.ቁ	ጥያቄዎች	ምላሾች	ሀሳብ
አጠቃላይ የማህበራዊ መረጃ.			
101	መለያ ቁጥር	፩. የመ. ቁጥር_____	
102	ዕድሜ	----------ዓመት	
103	ፆታ	፩. ወንድ 2. ሴት	
104	የትምህርት ሁኔታ	1. መፃፍ እና ማንበብ የማይችል 2. 1ኛ ደረጃ (1-8) 3. 2ኛ ደረጃ 4. ኮሌጅ ወይም ዩኒቨርሲቲ	
105	የስራሁኔታ	1. የአርሶአደር 2. የቀንሠራተኛ 3. ነጋዴ 4. የመንግስትሠራተኛ 5. የግል/መንግስታዊ ያልሆነ ድርጂት ሠራተኛ 6. ሌላካለ_____	
106	ወርሃዊ ገቢዎ ምንያህል ነው?	_____ብር	
107	የመኖሪያ ቦታ	፩. ከተማ 2. ገጠር	
109	የሱካር በሽታ ከተመሙ ስንት ዓመት ነዉ	_____ዓመት	

ክፍል II: የግል ጸባይ ሁኔታ ጥያቄዎች

ሲገራማጨስ			
ተ.ቁ	ጥያቄዎች	ምላሾች	ሀሳብ
201	ከዚህ በፊት ሲጋራ አጭስ ታቃለህ/ሽ?	1. አዎ 2. አይደለም	አደለም ከሆኔ ወደ 206 ዕለፍ
202	ሲጋራ ማጨስ ከጀመርክ ስንት ግዜ ሆነህ/ሽ?	_____ ዓመታት	
203	በስንት ግዜ ነዉ የሚታጭሰዉ?	1. በያቀኑ 2. ከበያቀን በታች 3. አላቅም	
204	በንድ ግዜ ስንት ስጋራዎች ነዉ የምታጭሰዉ/ሽዉ?	_____ የስጋራ ብዛት	
205	አሁን በየቀኑ ታጭሻለህ/ሽ?	1. በያቀኑ 2. ከበያቀን በታች 3. አላቅም	
206	በቤተሰበዎ ዉስጥ ሲጋራ የሚጭስ ሰዉ አለ?	1. አዎ 2. አይደለም	አደለምከሆኔ ወደ 208ዕለፍ
207	በስንት ግዜ ነዉ የሚታጭሰዉ?	1. በያቀኑ 2. ከበያቀን በታች 3. አላቅም	

አልኮሆልመጠጥ				
208	አልኮሆል ጠጥተህ/ሽ ታቃለህ/ሽ?	1. አዎ 2. አይደለም		አደለም ከሆኔ ወደ 212 ዕለፍ
209	208አዎ ከሆነ አሁንም ትጠጣለህ/ሽ?	1. አዎ 2. አይደለም		አደለምከሆኔ ወደ 212 ዕለፍ
	208 አዎ ከሆነ, የትኛዉ?		ብዛት	የተሰጠዉቦታ ለይመጠኑን ይሙሉ
		1. ቢራ/ድራፍት		
		2. ወይን		
		3. ጠጅ /ጠላ		
		4. አረቄ		
		5. ሌላካሌ ግለጽ (_____)		
210	የአልኮሆል መጠጥ በስንት ግዜ ትጣጠለህ/ሽ?		ነጥብ	
		1. በጭራሽ	0	
		2. ከወር/ከወር ብታች	1	
		3. በወር 2-4 ግዜ	2	
		4. በሳምንት 2-3 ግዜ	3	
		5. በሳምንት 4 ግዜና ከዛበላይ	4	
209	በአንድ ግዜ ስንት እስታንዳርድ የአልኮሆል መጠጥ ትጣጠለህ/ሽ?	1. 1 – 2	0	
		2. 3 – 4	1	
		3. 5 - 6	2	
		4. 7 – 9= 3	3	
		5. 10 ወይም ከዛ በላይ	4	
211	በአንድ ግዜ አምስትና ከአምስት በላይ	1. በጭራሽ	0	

	እስታንዳርድ የአልኮሆል መጠጥ ትጣጠለህ/ሽ?	2. ካወር በታች	1	
		3. በወር አንዴ	2	
		4. በሳምንት አንዴ	3	
		5. በያቀኑ	4	

ጫት መቃም			
212	በሂዎትዎ ጫት ቅመው ያውቀሉ?	5. አዎ 6. አለውቅም	አለውቅም ከሆኔ ወደ 214 ዕለፍ
የአካል ዕንቂስቃሴ			
213	በሳምንት ካባድ የአካል እንቅስቃሴ ተንፋሽና የልብ ትሪታን በደንብ የሚጨምር ክብደት ማንሳት፣ መቆፈር ኤሮቢክስ፣ በፍጥነት ቢስኪሌት ምንዳት በተከታታይ ለ 10 ደቂቃ ትሰራለህ/ሽ?	5. አዎ 6. አይደለም	አደለም ከሆኔ ወደ 217 ዕለፍ
214	አዎ ከሆነ፣ በሳምንት ስንት ቀናት ተስራለህ/ሽ?	_____ቀናት	
215	በቀን ስንት ሰዓት ተስራለህ/ሽ?	_____ሰዓታት. _____ደቂቃ	
216	ነሳምንት መከከለኛ የኣካል እንቅስቃሴ ተንፋ ልብ ትሪታን በመጠኑ የሚጨምር ቀላል ሽካም፣በ ቃላል ፍጥነት ቢስኪሌት ምንዳት፣ ቴኒስ መጨወት በተከታታይ ለ 10 ደቂቃ ትሰራለህ/ሽ?	1. አዎ 2. አይደለም	አደለም ከሆኔ ወደ 220 ዕለፍ.
217	በሳምንት ስንት ሰዓት ተስራለህ/ሽ?	_____ቀን	

218	በቀን ስንት ሸ ተስራለህ/ሽ?	_____ሰዓታት. _____ደቂቃ	
219	በቀን ስንት ሰዓት በመቀመጥ ታሳልፋለህ/ሽ?	_____ሰዓታት.	

ክፍል III: ስለአመጋገብ ሁኔታ

ስለ አመጋገብ ሁኔታ			
ተ.ቁ	ጥያቄዎች	ምላሾች	ሀሳብ
301	በሳምንት ስንት ቀናት ፍራፍሬ ትበላለህ/ሽ?	_____ቀናት	ዜሮ ቀን ከሆነወ ወደ 303 ዕለፍ
302	በቀን ፍራፍሬ ስንቴ ትበላለህ/ሽ?	_____ግዜ	
303	በሳምንት ስንት ቀናት አታክልት ትበላለህ/ሽ?	_____ቀናት	ዜሮ ቀን ከሆኔ ወደ 306 ዕለፍ
304	በቀን አታክልት ስንቴ ትበላለህ/ሽ?	_____ግዜ	
305	በሳምንት ጮማና ዘይት ስንት ቀን ትበላለህ/ሽ?	_____ቀናት	
306	ቤት ዉስጥ ለምግብ አገልግሎት ምን አይነት ቅባት ነክ ነጋሮችና ዘይት ትጠቀማለህ/ሽ?	6. ፈሳሽዘይት(Vegetable oil) 7. የሚረጋዘይት 8. ቅቤ 9. ሽኖለጋ 10. ለላካሌግለጽ_____	
307	በሳምንት በቤት ዉጭ የተዘጋጀዉ ምግብ ስንቴ ትበላለህ/ሽ?	_____ግዜ	

ANNEX IV: Minnesota code for ECG classifications

Sr. No	ECG status description	Code _____	
		Yes	No
1	Rhythm (Normal)		
2	Rate (Normal)		
3	P wave (Normal)		
4	PR interval (Normal)		
5	QRS Complex (Normal)		
6	Sinus arrhythmia		
7	Normal Sinus Rhythm		
8	Heart rate		
9	**Q and QS patterns**		
	Anterolateral Site (leads I, aVL, V6)		
	Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 s in lead I or V6. (1.1.1)		
	Q duration ≥ 0.04 second in lead I or V6. (1.1.2)		
	Q duration ≥ 0.04 s plus R amplitude ≥ 3 mm in lead aVL. (1.1.3)		
	Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 s and < 0.03 s in lead I or V6. (1.2.1)		
	Q duration ≥ 0.03 s and < 0.04 s in lead I or V6. (1.2.2)		
	Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 s and < 0.03 s in lead I or V. (1.3.1)		
	Q duration ≥ 0.03 s and < 0.04 s, plus R amplitude ≥ 3 mm in lead aVL. (1.3.2)		
	Inferior site (leads II, III, aVF		
	Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 s in lead II. (1.1.1)		

	Q duration ≥ 0.04 s in lead II. (1.1.2)		
	Q duration ≥ 0.05 s in lead III, plus a Q-wave amplitude ≥ 1.0 mm in the majority of beats in lead aVF. (1.1.4)		
	Q duration ≥ 0.05 s in lead aVF. (1.1.5)		
	Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 s and < 0.03 s in lead II. 1.2.1)		
	Q duration ≥ 0.03 s and < 0.04 s in lead II. (1.2.2)		
	Q duration ≥ 0.04 s and < 0.05 s in lead III, plus a Q-wave ≥ 1.0 mm amplitude in the majority of beats in aVF. (1.2.4)		
	Q duration ≥ 0.04 s and < 0.05 s in lead aVF. (1.2.5)		
	Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 s and < 0.03 s in lead II. (1.3.1)		
	Q duration ≥ 0.03 s and < 0.04 s in lead III, plus a Q-wave ≥ 1.0 mm amplitude in the majority of beats in lead aVF. (1.3.4)		
	Q duration ≥ 0.03 s and < 0.04 s in lead aVF. (1.3.5)		
	QS pattern in each of leads III and aVF. (1.3.6)		
	Anterior Site (leads V1, V2, V3, V4, V5)		
	Q/R amplitude ratio ≥ 1/3 plus Q duration ≥ 0.03 s in any of leads V2, V3, V4, V5. (1.1.1)		
	Q duration ≥ 0.04 s in any of leads V1, V2, V3, V4, V5. (1.1.2)		
	QS pattern when initial R-wave is present in adjacent lead to the right on the chest, in any of leads V2, V3, V4, V5, V6. (1.1.6)		
	QS pattern in all of leads V1-V4 or V1-V5. (1.1.7)		
	Q/R amplitude ratio ≥ 1/3 plus Q duration ≥ 0.02 s and < 0.03 s, in any of leads V2, V3, V4, V5. (1.2.1)		
	Q duration ≥ 0.03 s and < 0.04 s in any of leads V2, V3, V4, V5. (1.2.2)		
	QS pattern in all of leads V1, V2, and V3. (1.2.7)		
	Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 s and < 0.03 s in any of leads V2, V3, V4, V5. (1.3.1)		

	QS pattern in lead V1 and V2. (1.3.2)		
10	**Axis deviations**		
	QRS axis from –30° through –90° in leads I, II and III. (2.1)		
	QRS axis from +120° through –150° in leads I, II, and III. (2.2)		
	Extreme axis deviation QRS axis from –90° through –149° in leads I, II and III. (2.4)		
11	**High Amplitude R Waves**		
	Left: R amplitude > 26 mm in either V5 or V6, or R amplitude > 20.0 mm in any of leads I, II, III, aVF, or R amplitude > 12.0 mm in lead aVL. (3.1)		
	Right: R amplitude ≥ 5.0 mm and R amplitude ≥ S amplitude in the majority of beats in lead V1, when S amplitude is > R amplitude somewhere to the left on the chest of V1. (3.2)		
	Left: R amplitude > 15.0 mm but ≤ 20.0 mm in lead I, or R amplitude in V5 or V6, plus S amplitude in V1 > 35.0 mm. (3.3)		
	Both left and right: Criteria for 3-1 and 3-2 both present. (3.4)		
12	**ST Junction (J) and Segment Depression**		
	Anterolateral Site (leads I, aVL, V6)		
	STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V6. (4.1.1)		
	STJ depression ≥ 1.0 mm but < 2.0 mm, and ST segment horizontal or downward sloping in any of leads I, aVL, or V6. (4.1.2)		
	STJ depression ≥ 0.5 mm but < 1.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V6. (4.2)		
	No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline, in any of leads I, aVL, or V6. (4.3)		
	STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped, in any of leads I, aVL, or V6. (4.4)		
	Inferior Site (leads II, III, avF)		
	STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF. (4.1.1)		

	STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF. (4.1.2)		
	STJ depression ≥ 0.5 mm but < 1.0 mm and ST segment horizontal or downward sloping in lead II or aVF. (4.2)		
	No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline in lead II. (4.3)		
	STJ depression ≥ 1.0 mm and ST segment upward sloping, or U-shaped, in lead II. (4.4)		
	Anterior Site (leads V1, V2, V3, V4, V5)		
	STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in any of leads V1, V2, V3, V4, V5. (4.1.1)		
	STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in any of leads V1, V2, V3, V4, V5. (4.1.2)		
	STJ depression ≥ 0.5 mm but < 1.0 mm and ST segment horizontal or downward sloping in any of leads V1, V2, V3, V4, V5. (4.2)		
	No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline in any of leads V2, V3, V4, V5. (4.3)		
	STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped in any of leads V1, V2, V3, V4, V5. (4.4)		
13	**T wave abnormalities**		
	Anterolateral Site (leads I, aVL, V6)		
	T amplitude negative 5.0 mm or more in either of leads I, V6, or in lead aVL when R amplitude is ≥ 5.0 mm. (5.1)		
	T amplitude negative or diphasic (positive–negative or negative–positive type) with negative phase at least 1.0 mm but not as deep as 5.0 mm in lead I or V6, or in lead aVL when R amplitude is ≥ 5.0 mm. (5.2)		
	T amplitude zero (flat), or negative, or diphasic (negative–positive type only) with less than 1.0 mm negative phase in lead I or V6, or in lead aVL when R amplitude is ≥ 5.0 mm. (5.3)		
	T amplitude positive and T/R amplitude ratio < 1/20 in any of leads I, aVL, V6; R wave amplitude must be ≥ 10.0 mm. (5.4)		

	Inferior) Site (leads II, III, aVF		
	T amplitude negative 5.0 mm or more in lead II, or in lead aVF when QRS is mainly upright. (5.1)		
	T amplitude negative or diphasic with negative phase (negative–positive or positive– negative type) at least 1.0 mm but not as deep as 5.0 mm in lead II, or in lead aVF when QRS is mainly upright. (5.2)		
	T amplitude zero (flat), or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase in lead II. (5.3)		
	T amplitude positive and T/R amplitude ratio < 1/20 in lead II; R wave amplitude must be ≥ 10.0 mm. (5.4)		
	Anterior Site (leads V2, V3, V4, V5)		
	T amplitude negative 5.0 mm or more in any of leads V2, V3, V4, V5. (5.1)		
	T amplitude negative, or diphasic (negative–positive or positive–negative type) with negative phase at least 1.0 mm but not as deep as 5.0 mm, in any of leads V2, V3, V4, V5. (5.2)		
	T amplitude zero (flat), or negative, or diphasic (negative–positive type only) with less than 1.0 mm negative phase, in any of leads V3, V4, V5. (5.3)		
	T amplitude positive and T/R amplitude ratio < 1/20 in any of leads V3, V4, V5; R wave amplitude must be ≥ 10.0 mm. (5.4)		
14	**AV nodal blocks**		
	Complete (3rd degree) A-V block (permanent or intermittent) in any lead. Atrial and ventricular complexes independent, and atrial rate faster than ventricular rate, with ventricular rate < 60. (6.1)		
	Mobitz Type II (occurrence of P-wave on time with dropped QRS and T). (6.2.1)		
	Partial (second degree) A-V block in any lead (2:1 or 3:1 block). (6.2.2)		
	Wenckebach's Phenomenon (P-R interval increasing from beat to beat until QRS and T dropped). (6.2.3)		
	P-R interval ≥ 0.22 s in the majority of beats in any of leads I, II, III,		

	aVL, aVF. (6.3)		
	Wolff-Parkinson-White Pattern (WPW), persistent. Sinus P-wave. P-R interval < 0.12 s, ***plus*** QRS duration ≥ 0.12 s, ***plus*** R peak duration ≥ 0.06 s, coexisting in the same beat and present in the majority of beats in any of leads I, II, aVL, V4, V5, V6. (6.4.1)		
	WPW Pattern, intermittent. WPW pattern in ≤ 50% of beats in appropriate leads. (6.4.2)		
	Short P-R interval. P-R interval < 0.12 s in all beats of any two of leads I, II, III, aVL, aVF. (6.5)		
	Intermittent abnormal atrioventricular conduction. P-R > 0.12 s and wide QRS complex > 0.12 s, and normal P-wave when most beats are sinus rhythm. (6.6)		
15	**Ventricular Conduction Defects**		
	Complete left bundle branch block (LBBB) QRS duration ≥ 0.12 s in a majority of beats in any of leads I, II, III, aVL, aVF, ***plus*** R peak duration ≥ 0.06 s in a majority of beats (of the same QRS pattern) in any of leads I, II, aVL, V5, V6. (7.1.1)		
	Complete right bundle branch block (RBBB). QRS duration ≥ 0.12 s in a majority of beats in any of leads I, II, III, aVL, aVF, ***plus***: R´ > R in V1; or QRS mainly upright, ***plus*** R peak duration ≥ 0.06 s in V1 or V2; or S duration > R duration in all beats in lead I or II. (7.2.1)		
	Incomplete right bundle branch block. QRS duration < 0.12 s in each of leads I, II, III, aVL, aVF, and R´ > R in either of leads V1, V2. (7.3)		
	Intraventricular block. QRS duration ≥ 0.12 s in a majority of beats in any of leads I, II, III, aVL, aVF. (7.4)		
	R-R´ pattern in either of leads V1, V2 with R´ amplitude ≤ R. (7.5)		
	Incomplete left bundle branch block. QRS duration ≥ 0.10 s and < 0.12 s in the majority of beats of each of leads I, aVL, and V5 or V6. (7.6)		
16	**Hemi blocks**		
	Left anterior hemiblock (LAH). QRS duration < 0.12 s in the majority of beats in leads I, II, III, aVL, aVF, ***plus*** Q-wave amplitude ≥ 0.25 mm and < 0.03 s duration in lead I or aVL, ***plus*** left axis deviation of –45° or more negative. (7.7)		
	Fragmented QRS. (7.10)		

17	**Arrhythmias**		
	Presence of any atrial or junctional premature beats. (8.1.1)		
	Presence of any ventricular premature beats. (8.1.2)		
	Presence of both atrial and/or junctional premature beats and ventricular premature beats. (8.1.3)		
	Ventricular fibrillation or ventricular asystole. (8.2.1)		
	Persistent ventricular (idioventricular) rhythm. (8.2.2)		
	Intermittent ventricular tachycardia. Three or more consecutive ventricular premature beats occurring at a rate ≥ 100. (8.2.3)		
	Atrial fibrillation (persistent). (8.3.1)		
	Atrial flutter (persistent). (8.3.2)		
	Supraventricular rhythm persistent. QRS duration < 0.12 s; and absent P-waves or presence of abnormal P-waves. (8.4.1)		
	Supraventricular tachycardia intermittent. Three consecutive atrial or junctional premature beats occurring at a rate ≥ 100. (8.4.2)		
	Sinoatrial arrest. Unexpected absence of P, QRS and T. (8.5.1)		
	Sinoatrial block. Unexpected absence of P, QRS and T, preceded by progressive shortening of P-P intervals. (8.5.2)		
	A-V dissociation with ventricular pacemaker (without capture). Requires: P-P and R-R occur at variable rates with ventricular rate as fast as or faster than the atrial rate, plus variable P-R intervals, plus no capture beats. (8.6.1)		
	A-V dissociation with atrial pacemaker (without capture). (8.6.3)		
	Sinus tachycardia (≥100/min). (8.7)		
	Sinus bradycardia (≤50/min). (8.8)		
18	**ST segment elevation**		
	Anterolateral Site (leads I, aVL, V6)		
	ST segment elevation ≥ 1.0 mm in any of leads I, aVL, V6. (9.2)		

	Anterior site (Leads V1, V2, V3, V4, V5)		
	ST segment elevation ≥ 1.0 mm in any of leads II, III, aVF. (9.2)		
	Anterior site (Leads V1, V2, V3, V4, V5)		
	ST segment elevation ≥ 1.0 mm in lead V5 or ST segment elevation ≥ 2.0 mm in any of leads V1, V2, V3, V4. (9.2)		
19	**Miscellaneous Items**		
	Low QRS complexes		
	QRS amplitude < 5 mm in all beats in each of leads I, II, III, or < 10 mm in all beats in each of leads V1, V2, V3, V4, V5, V6. (9.1)		
	P wave abnormalities		
	P-wave amplitude ≥ 2.5 mm in any of leads II, III, aVF, in a majority of beats. (9.3)		
	Notched and widened P wave ≥ 0.12 s. in frontal plane (usually lead II), or deep negative component to the P wave in lead V1 duration ≥ 0.04 s. and depth ≥ 1 mm. (9.6)		
	R wave progression		
	QRS transition zone at V3 or to the right of V3 on the chest. (9.4.1)		
	QRS transition zone at V4 or to the left of V4 on the chest. (9.4.2)		
	Definite Early Repolarization. STJ elevation ≥ 1mm in the majority of beats, T wave amplitude≥ 5 mm, prominent J point, upward concavity of the ST segment, and a distinct notch or slur on the down-stroke of the R wave in any of V3 –V6, OR STJ elevation ≥ 2 mm in the majority of beats and T wave amplitude ≥ 5 mm, prominent J point and upward concavity of the ST segment in any of V3 –V6. (9.7.1)		
	Probable Early Repolarization. STJ elevation ≥ 1 mm in the majority of beats, prominent J point, and upward concavity of the ST segment in any of V3 –V6 and T wave amplitude ≥ 8 mm in any of the leads V3 –V6. (9.7.2)		

DECLARATION

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

Name: _____

Signature: _____

Name of the institution: _____

Date of submission: _____

This thesis has been submitted for examination with my approval as University advisor

Name and Signature of the first advisor _____ sign_____

Name and Signature of the second advisor _____sign_____

Name and Signature of the examiner _____sign_____