ELECTROCARDIOGRAPHIC PATTERN AND CARDIOVASCULAR RISK FACTORS AMONG UNIVERSITY STUDENTS IN DAR ES SALAAM – TANZANIA

A DESCRIPTIVE CROSS SECTIONAL STUDY

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CERTIFICATION

The undersigned certify that he had read and hereby recommend for acceptance of dissertation entitled ***"Electrocardiographic pattern and cardiovascular risk factors among university students in Dar es Salaam – Tanzania a descriptive cross sectional study"*** In fulfillment of the requirements for the degree of Master of Science (Cardiology) of Muhimbili University of Health and Allied Sciences.

_____

Dr Johnson M. Lwakatare

(Supervisor)

Date:…….

DECLARATION AND COPYRIGHT

I, **Delilah Charles Kimambo,** declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature: _____ Date: _____

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DEDICATION

To *Werner, Christian, Cathleen and Pendo*

ABSTRACT

Background: Abnormal resting electrocardiogram (ECG) findings have been strongly associated with subsequent increase in all cause CAD and CVD mortality. The abnormalities are defined as either major or minor based on the different criteria. Minor and major abnormalities have been correlated with increasing risk for CAD events and mortality.

Moderately elevated cholesterol levels found in the majority of young adults in their 20s and 30s were associated with damage to coronary arteries, which could accumulate over time and persisted into middle age. Individuals exposed to higher levels of LDL cholesterol or lower levels of HDL cholesterol during young adulthood were more likely to develop coronary calcium.

Objectives: To describe the ECG pattern and cardiovascular risks factors among students aged 18-40 years at the University of Dar es salaam Mlimani Campus

Methodology: This was a descriptive cross sectional study describe the ECG abnormalities and cardiovascular disease risks factors among UDSM students aged 19-40 years conducted among university of Dar es salaam students. A total number of 411 university students were evaluated from May to October 2011. Standardized questionnaire was used to collect socio-demographic characteristics and clinical presentation of study participants. ECG abnormalities were divided into minor and major abnormalities based on Minnesota code criteria.

Results: 411 participants were included in the study out of which 140 (34.1%) were female and 271(65.9%) were male. The age range was (19-40) & mean age of 23.6±2.6. The participants were free from any form of cardiovascular disease. The mean SBP/DBP was 120.1 ±11.6/73.4 ± 9.6 respectively. One participant was found to be diabetic and one hypertensive. Family history of cardiovascular disease, hypertension, stroke and diabetes mellitus was reported in 26(6.3%), 54(13.1%), 16(3.9%) and 85(20.7%) participants respectively. Fifteen (3.6%) participants were active smoker at the time of recruitment.

Majority of ECG were either normal or within acceptable limits, the automated Minnesota coding reported 152(37%) normal ECG, when the ECG were re-evaluated, 326(76.3%) were

within normal & acceptable limit.

The prevalence of major ECG abnormalities was found in 37(9.0%), minor ECG abnormalities were found in 143(34.8%), other ECG abnormalities were found in 79(19.2%) The most prevalent ECG coded was arrhythmia 168(40.9%), high amplitude R waves were found in 87(21.2%), males 79(29.2%) were found to have statistically significant high amplitude R waves compared to female 8 (5.7%) p=0.0000, LVH was found in 13(3.2%) participants.

The mean HDL level was significantly higher in women (50.0 ± 12.5 mg/dl) as compared to men (42.6 ± 12.2 mg/dl), p <0.001.The proportion of women (18.6%) with low levels of HDL was significantly lower than that observed in men (29.2%), p <0.001 (table 2). BMI > 30kg/m^2 was found in 3(0.7%).

Conclusion

The prevalence of major and minor ECG findings was high 34.8%, the relationship between major and minor ECG abnormalities; low HDL, increased waist circumference and prehypertensive state varied with gender with male predominance but could not be associated with ECG abnormalities found.

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LIST OF ABBREVIATIONS

BMI……..Body Mass Index

BP…….Blood pressure

CAD…….Coronary arterial Disease

CPL……..Central Pathology Laboratory

CVD…….Cardiovascular Disease

DM……Diabetes mellitus

DPB……..Diastolic Blood Pressure

ECG…….Electrocardiogram

ECHO……...Echocardiogram

FBG……..Fasting Blood Glucose

HDL-C…….High Density Lipoprotein Cholesterol

IDF……International Diabetes federation

IFG……Impaired Fasting Glucose

IGT……Impaired Glucose Tolerance

JNC…….Joint National Committee

LDH-C……...Low Density Lipoprotein Cholesterol

LVH……...Left Ventricular Hypertrophy

LAD……..Left Axis Deviation

MS…….Metabolic Syndrome

MI…….Myocardial Infarction

MNH…….Muhimbili National Hospital

MUHAS……Muhimbili University of Allied and Healthy Science

NCEP……National Cholesterol Education Program

NOMA……..Norad's Programme for Master Studies

PWD…….P-Wave dispersión

RAD…….Right Axis deviation

SPSS…….Statistical Parkcage for Social Sciences

SSA…….Sub.-Saharan África

TG……..Triglyceride

UCSF…….The University of California, San Francisco

UDSM……The University of Dar es salaam

WHO…….World health Organization

WPW……Wolf Parkinson White

CHAPTER ONE

1. INTRODUCTION AND LITERATURE REVIEW

1.1. The resting electrocardiogram (ECG)

The resting ECG is the registration on the surface of the body of the heart's electrical activity. It is through perturbation in the normal electrical patterns that many different cardiac disorders, including myocardial infarction, cardiac ischemia, and arrhythmias, are diagnosed. Even though ECG is one of the oldest diagnostic medical tools, it continues to be the most commonly used cardiovascular laboratory procedure. It is noninvasive, cheap, simple to record, highly reproducible and can be applied serially.[1]

The ECG has been widely used in epidemiological studies designed to determine the prevalence of ischemic heart disease and to identify latent heart disease. However, the resting ECG has also been considered unspecific and its prognostic value as independent marker has been much debated [2]. The diagnostic and prognostic implication of a given ECG abnormality has been considered to differ depending on the population studied and the reason for the ECG recording [2, 3].

The ECG has been widely described in medical reports as a useful diagnostic tool for assessing "silent" heart disease. Many epidemiological studies have shown the association between ECG findings and subsequent coronary and CVD mortality[4, 5, 6]. The use of ECGs in epidemiological research has been greatly facilitated by the introduction of the Minnesota code classification system [7,]. There are several reports from different populations on the prevalence of ECG abnormalities determined on the basis of the Minnesota coding criteria.[8, 9]Studies showing the prevalence of ECG abnormalities were previously conducted among older population with age range between, 45–64 years [4,5,6,7.10]. There is a strong age dependency of ECG changes;Thus any study looking at the prevalence of ECG abnormalities should take this into account. An important ethnic difference among individuals free of CVD in the occurrence of abnormalities on the resting ECG has also been reported[4, 11, 12, and 15].

The definitions of major and minor ECG abnormalities in many studies are based on major studies on population using Minnesota coding[11, 12, 18, and 22]. In a community-based survey to assess the prevalence of risk factors for coronary heart disease (CHD) in rural Tanzanians, 8581 subjects (3705 men, 4876 women) aged >15 years were recruited, out of which major ECG changes on ECG were recorded in 7.8% of men and 17.4% of women aged ≤40 years [14]. In South Africa, Sliwa et al reported the prevalence of major and minor ECG abnormalities to be 27% and 50% respectively [13].

De Bacquer et al reported major ECG abnormalities in 6% of men and 4.3% of women aged between 35 to 54 years. From the same study minor ECG abnormalities were reported in 10.4% of men and 9.5% of women[6].In a population study of elderly, Auer et al reported increased incidence of CHD events independent of traditional CVD risks factors in a population of blacks and whites. They reported that major and minor ECG abnormalities picked up at baseline, development of new changes during follow up and persistence of ECG abnormalities during follow up.

QRS complex

Abnormalities of the QRS complex on an ECG include abnormal Q waves which are usually picked on leads aVL, III, and aVF. Other abnormalities include QS Complex in lead V2 and infrequently in lead V3, tall R wave in leads V1 and V2. Abnormal voltages in leads I, aVL, V4 V5, V6 as well as intraventricular conduction delays and altered sequence of ventricular activation are considered QRS abnormalities[16].

The majority of abnormal Q waves are due to atypical position of the heart in the thorax. They are frequently observed in obese persons with high diaphragms and are usually picked up on leads III and aVF. In persons with low diaphragm, Q wave can be observed in leads II, III, and aVF, in relationship with tall R waves[16]. The QS complex in leads V1,V2, and V3 can also be due to a low-lying diaphragm with reasonably higher positioning of the electrodes in relation to the heart, and placement of electrodes one or two interspaces lower will display an R wave.

The prevalence of abnormal Q has been reported from different studies. In Tanzania the first study to report abnormal Q waves was done in 1979 by Vaughan et al in a population aged between 24-64 years [17]. In that study only ECG of individual aged more than 35 years were reported, prevalence in men was 0.4%,0.8% while in women it was 1.0%, 1.9% [17].Sliwa et al in south Africa reported a prevalence of abnormal Q waves to be 7.4% in asymptomatic adults with mean age of 37.4±14.2 years [13].

The pattern of RR' can be recorded in many young individuals from the V1, site and in most from positions to the right of V2. The R' is a normal reflection of late activation of the posterior septum. It can be differentiated from incomplete right bundle-branch block by the R' amplitude being lower than that of the R and especially if the R' is of brief duration [16].

Left axis deviation

Left anterior divisional block or abnormal left axis or axis in excess of -30° is found in 1.4% of individuals younger than 25 years and significantly higher proportion of individuals older than 70 years[16]. Abnormal left axis is frequently registered in the absence of clinically evident heart disease and is often associated with a good long-term prognosis [3, 6]. The presence of Left Axis Deviation (LAD) is of prognostic significance to individuals with underlying heart diseases. It is not known whether the presence of LAD carries the same significance in young people without heart disease or in the aged it reflect an acquired anatomical disorder

High voltage R waves

Abnormally high R wave voltage recorded over the left ventricle may point toward Left Ventricular Hypertrophy (LVH), the sensitivity and specificity of voltage alone for that diagnosis are reasonably low [7,16]. The criteria for LVH are not applicable to individuals younger than age 25 or to patients in other age groups with thin chest walls [11, 12]. De Bacquer et al have speculated that the inadequate criteria for LVH by the Minnesota Code may in part be responsible for the findings of high prevalence of LVH among men, as thresholds of criteria should be lower in women than men [6]. In De Bacquer et al study the prevalence of left

ventricular hypertrophy was found to be significantly higher in males than females (0.7% *v*s 0.5%) [6]. Sliwa et al also reported a high prevalence of high voltage R waves and LVH among Men 22% vs 5.1% women [13].

ST segment and T wave changes

A commonly encountered deviation of the ST segment in the absence of heart involvement is an elevation, so-called early repolarization [12, 19] .The elevated ST segment is usually concave, most often present in leads II, III, and aVf, less commonly in lateral leads V4, V5,and V6, and least commonly in leads V1, V2, and V3. The diagnosis of "early repolarization" is fairly secure in the young, especially when accompanied by slow heart rates [16]. De Bacquer and colleagues found that women have significantly more ST changes (2.6% *v* 2.3%) and T wave abnormalities (7.6% *v* 6.5%) on their resting ECG compared to men when adjustment is made for age [19], although the absolute differences in percentage terms were small (0.3% and 1.1%, respectively) [19]. This sex difference persisted in virtually all age deciles from 25 to 74 years. In a further analysis adjusted for age and other prognostic factors, only the ST changes remained significantly more common in women.

Rose and colleagues reported the prevalence of ST segment depression of 2.6% to 3.6%, while for T wave abnormalities the rates were between 3.4% and 5.9% [2]. In the Australian Busselton study (40–79 years) [20], prevalence rates of ST and T wave changes were 2.4% and 6.8% in women and 0.5% and 4.6% in men. These differences between sexes concurred with data by Ostrander and colleagues in their paper on ECG findings in about 5000 men and women aged 16 to 80 years, with ST changes occurring in 5.4% of women and in 2.5% of men, while T wave abnormalities were found in 11.6% of men and 13.1% of women [86]. The extent of the sex difference on the other hand was not established by data from the Framingham study in population of 44–74 year old subjects, where prevalence of ST and T wave changes were 7.7% and 11.0% in women, and 6.9% and 12.8% in men respectively [21].

In South Africa the pattern reported recently was, 38 (9.3%) had significant ST elevation and 9 (4.6%) had ST depression. A greater number of subjects (n = 52, 12.7%) had inverted/biphasic T waves [13].

1.2. ECG as a screening tool

In the beginning ECGs were used primarily for the intention of clinical diagnosis, and clinicians were familiar with the implications of findings as they occurred in patients with specific cardiac diseases. In recent years ECGs are increasingly being recorded in apparently healthy people of different ages in order to assess occupational fitness, screening services or epidemiological surveys.[4]

The value of any screening test depends critically on four key principles: its cost, the prevalence of the abnormalities detected in the population assessed the link of the abnormalities to morbidity and mortality; and the possibility of reducing or avoiding future morbidity or mortality given the information provided by the test. In particular, to be worth the additional expense, the ECG must add significantly to the ability of standard risk factors in identifying asymptomatic persons with sub-clinical disease [22].

1.3. Electrocardiogram and CVD risks factors

Resting electrocardiogram (ECG) abnormalities have been strongly associated with subsequent all cause coronary heart disease (CHD) and CVD mortality [2,3,4,10,23]. For example, the severity of abnormal ECG findings, defined as minor and major abnormalities by Nova code criteria, has been correlated with increasing risk for CHD events and mortality[15, 23]. Most prevalence increase exponentially with age, and are greater among people with diabetes, obesity, and a history of coronary heart disease. Smoking behavior seems unrelated to any ECG features except for a negative association with the occurrence of left ventricu n lar hypertrophy.

Studies have related different ECG abnormality with the metabolic syndrome or with cardiovascular risks as defined by number of metabolic syndrome. [23-28]Increased P-wave duration and P-wave dispersion have been reported to relate to increase risk of AF[25]. P-wave

dispersion (PWD) is defined as the difference between maximum and minimum p- wave duration, PWD is related to inhomogeneous and discontinuous propagation of sinus impulse through the atria wall. This has been found to be high prevalent in individual with metabolic syndrome. [25]

The relationship between insulin resistances and QT interval has been found in people with uncomplicated metabolic syndrome [23, 27].Soydink et al reported that uncomplicated metabolic syndrome is associated with prolonged QT-interval and QT dispersion [27]. Prolongation of QT interval has been reported to be associated with sudden cardiac death or bad prognosis by inducing arrhythmias in healthy adults and in diabetic patients.[27] The same findings were also reported in china by Weiju Li et al [27]

Ventricular arrythmogenicity is present in people with metabolic syndrome and is associated with myocardial dysfunction, risk factor for atherosclerosis and low grade inflammation.[28]. Voulgari et al examined differences in ventricular arrythmogenicity assessed by classic (QT interval)and newer (spatial QRS-T angle (spQRS-Ta) ECG markers. They concluded an independent association between spQRS-Ta and metabolic syndrome implies that the clustering of metabolic disturbances has additional prognostic information than individual components.[28]

In their study to evaluate association between variable components of the Metabolic Syndrome and Electrocardiographic abnormalities in Korean adults Kim et al reported that the overall prevalence rates of ECG abnormalities were significantly higher in subjects with metabolic syndrome than in those without metabolic syndrome. Ischemic ECG was strongly associated with metabolic syndrome in all age groups of both sexes, except for younger women.[23]

T-wave axis deviation is influenced by action potential duration alterations, shortening or prolongation, in any myocardial region [35].Studies have reported a relationship between T-wave axis deviation and an increased risk of sudden death due to fatal ventricular arrhythmias[29]

The risk for abnormal frontal T-wave axis increases progressively with a higher number of

metabolic syndrome (MS) components. These relationships are independent of age, race, BMI categories, and other potential risk factors. The abnormal frontal T-wave axis deviation is an indicator for impaired ventricular repolarization [34]. Therefore these data [24-29] indicate that MS is associated with ventricular repolarization impairment, which means that individuals with MS are at a higher risk for ventricular arrhythmias. Whether calculated automatically or manually, measurement of the frontal T-wave axis is likely to be less susceptible to noise and problems of the existing axis and amplitude measurements in the electrocardiogram [24,25]

1.4 Cardiovascular Disease

Atherosclerosis is the frequent pathological background to cardiovascular disease (CVD) [30]. An intact vascular endothelium prevents the resettlement of lipids and inflammatory cells into the intima of arteries, while the risk factors for coronary heart disease (CHD), such as hypercholesterolemia, hypertension, and cigarette smoking lead through different mechanisms to endothelial injury, with thickening of the intima and subsequent formation of a plaque with lipid core and fibrous cap.[30]

Atherosclerosis starts early in life, followed by a long asymptomatic phase before clinical manifestations become noticeable in mid or late life. The terminal events, such as myocardial infarction (MI) or cerebral infarction, are usually derived from secondary changes within the fibrous plaque that lead to the formation of occlusive thrombus [31, 32]. “Vulnerable plaque” is the term that has been used to assign a thrombosis-prone plaque with high likelihood for undergoing progression.

UCSF researchers have found that even moderately elevated cholesterol levels found in young people (20-39yrs) is more liable to develop into coronary artery calcium and atherosclerosis later on in life, [33, 83] .The findings indicate that cholesterol levels found in the majority of young adults in their 20s and 30s are associated with damage to coronary arteries, which can build up over time and persist into middle age. Individuals exposed to higher levels of LDL cholesterol or lower levels of HDL cholesterol during young adulthood were more likely to develop coronary calcium [33, 34, 83]. For example, 44 percent of study participants with an average LDL cholesterol level

greater than 160 mg/dL had calcifications in their coronary arteries two decades later, compared to only eight percent of participants with optimal LDL levels less than 70 mg/dL [33], they also found that even modest rises in LDL as low as 100-129 mg/dL were associated with a significantly higher risk of atherosclerosis. The majority of young adults studied (65 percent) had LDL levels higher than 100 mg/dL.[33, 83]

Cholesterol levels in young adults are more important than what was considered earlier as even the moderate non-optimal levels that are present in most young adults may alter their health decades later, For many people in their 20s and 30s, it possibly matters in the long run what they eat and how much they exercise, even though their risk for having a heart disease in the short term is low.[33, 83]

1.5. Cardiovascular risks Factors

The Framingham Heart Study has played a key role in establishing that cigarette smoking, physical inactivity, cholesterol, and obesity are risk factors for CVD, and it has also opened the link between hypertension and stroke. Hypertension is a strong and common risk factor for CVD and was one of the first risk factors to be identified [35, 36]. It is understood that hypertension, alongside with metabolic derangements (metabolic syndrome or insulin resistance syndrome contributes to cardiovascular target organ damage [34]. The metabolic syndrome includes hypertension, obesity, Type 2 diabetes, impaired glucose tolerance, and central obesity

Moderate increase in body weight has also been linked with an increased risk of coronary death and non-fatal MI [34]. Other risk factors found in the literature include smoking [36], leucocytes counts, lipoprotein (a), plasma fibrinogen, homocysteinemia, sleep disorders [14], C-reactive protein [35], and renal dysfunction [36]

Cardiovascular risk factors have been studied in the younger populations of children, adolescents, and youth in different parts of the world [32].Most studies have been mainly confined to high income countries of North America, Europe and Australasia. Examples from

USA include the Bogalusa Heart Study in Caucasians and Black Americans [37], National Health and Nutrition Examination Surveys(NHANES) [38], Muscatine Study [39], Coronary Artery Risk Development in Young Adults (CARDIA) study [40],Atherosclerosis Risk in Young Adults (ARYA) study [41],Atherosclerosis Risk Factors in Male Youngsters (ARMY) study [42], Pathobiological Determinants of Atherosclerosis in Young (PDAY) study[43], Minneapolis Children's Blood Pressure Study [44], and in Europe the Cardiovascular Risk in Young Finns study [45], North Ireland Young Heart Project [46] and many British studies [36]. All these studies have reported that the atherosclerosis factors start early in childhood and youth and the risk factors tend to track and magnify with age. The mean age at which the risk factors establish varies from 40–50 years

1.6. Impaired FBG

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[30] Impaired glucose tolerance (IGT) is known to increase vascular risk and the risk of developing diabetes. Peoples with IGT can reduce the risk of diabetes mellitus by changing their lifestyle as well as reduce their weight. The normal glucose level by WHO criteria is <100 mg/dl (<5.6 mmol/l) 2hrs post oral glucose of <140 mg/dl (<7.8 mmol/l). Impaired fasting blood glucose is defined as fasting blood glucose of 100–125 mg/dl (5.6–6.9 mmol/l) or 2hrs post oral glucose test of 140–199 mg/dl (7.8–11.0 mmol [47].

1.7. Blood cholesterol

Elevated levels of low-density lipoprotein (LDL)- cholesterol and decreased levels of high-density lipoprotein (HDL)-cholesterol are recognized as important predictors of coronary artery disease (CAD) [4,9,48,50], Although controversy existed on whether abnormal levels of serum triglycerides constituted an independent risk factor for CAD, at present there is abundant evidence that fasting triglyceride levels independently predict CAD [50]. Recent NCEP guidelines included considerations of triglyceride lowering in certain high-risk situations

associated with fasting serum triglyceride levels higher than 200 mg/dl [53]. However, this cut point for serum triglycerides is considered to be high in terms of CAD risk assessment [51, 52].

Elevated serum triglyceride levels are indicators of not only atherogenic lipoprotein traits, namely triglyceride- rich lipoproteins, small, dense LDL, and low HDL [53, 54], but other non lipid risk phenotypes such as insulin resistance, hypertension, and a prothrombotic state [50]. Clinical manifestations of CAD do not usually emerge until middle age and overt hypertriglyceridemia generally does not emerge until the third decade of life

It has been reported that even triglyceride levels at or above 100 mg/dl confer increased cardiovascular risk [55].Frontini et al concluded that serum triglycerides at levels considered as normal were adversely related to cardiovascular risk variables in healthy young adults. Since studies conducted in middle-aged and older adults have found a threshold effect for enhanced CAD risk at triglyceride levels as low as 100–150 mg/dl [21, 22], and hence serum triglycerides, may be valuable in the assessment of cardiovascular risk in youth [55]

1.8. Hypertension and pre-hypertension

Hypertension is likely the most common disease in the world, [30] it is associated with an increased risk of morbidity and mortality from cardiovascular disease (CVD) and represents the single most preventable cause of death in humans. The definition of hypertension as blood pressure (BP) >140/90 mm Hg is based on the observation that the risk of CVD increases sharply above this level. However, recent records have shown that an increased risk of CVD is present in persons with BP levels as low as 115/70 mm Hg and that this risk increases steadily with rising BP.[57, 59] The incremental association between BP and CVD risk has been reflected recently in the Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7).[59] In its report, the JNC7 introduced a new BP category, “prehypertension,” defined as a systolic BP (SBP) of 120 to 139 mm Hg and/or a diastolic BP (DBP) of 80 to 89 mm Hg.

Ever since the publication of the JNC7 report, numerous studies have assessed the prevalence

and implication of prehypertension [57,58,59,60]. Still, the importance of this entity in regard to global CVD risk and the preferred approach to its treatment are still a matter of debate, and the term prehypertension has yet to be widely adopted. Evidence supporting ~~a~~ prehypertensive state has been demonstrated in several studies [57-62] among those studies the longitudinal Framingham Heart Study, showed that BP in the prehypertensive range preceded the diagnosis of hypertension in 90% of subjects aged ≥ 55 years.[61]In another longitudinal study, Winegarden et al showed that, relative to normotensive subjects, the risk of hypertension was substantially higher among subjects with "high normal" BP (130 to 139/85 to 89 mm Hg). [62]

Whereas several reports have documented an increased risk of CVD among prehypertensive subjects,[61,62,63] some studies suggest that prehypertension increases the risk of CVD only modestly or that this risk increases only when prehypertension is associated with additional risk factors [61] The significance of the prehypertension category in the JNC7report is a matter of discussion. The term was established after the results of longitudinal studies of subjects >55 years of age, which suggested that subjects with BP 120 to 139/80 to 89 mmHg are at risk for developing hypertension. Moreover, some reports indicated that these subjects are at a greater risk of CVD.

Grotto I et al report in a study conducted among young adults in Israel aged between 25 and 45 reported prehypertension to be common among young adults, with male being affected more than women.[58]From the same study the rate of prehypertension among women increased with age, and prehypertension was strongly associated with obesity. What's more, the global CVD risk profile among prehypertensive subjects, as manifested by the Framingham risk score, shows that prehypertensive subjects carry more than double the risk of a future CVD event than do normotensive subjects [58]

1.9. Waist circumference

Obesity is an important predictor of coronary heart disease. The relations of abdominal height (sagittal diameter) and other obesity measures to coronary heart disease risk factors were examined by Gustat et al in a study conducted in Bogalusa, Louisiana among 409 Blacks and

1,011 Whites aged 20-38 years in (1995-1996). Obesity and the distribution of body fat was reported to be important predictors of coronary heart disease morbidity and mortality [63].

Recently, obesity was identified as an independent risk factor for coronary disease by the American Heart Association [64]. Central obesity, is associated with coronary disease risk factors, including dyslipidemia, hyperinsulinemia/ insulin resistance, and hypertension [65-68]. In epidemiologic studies, various anthropometric measures, including body mass index (weight (kg)/height (m), subcutaneous skin fold thicknesses, and body circumferential measurements, are used to assess adiposity and fat distribution and their relation to coronary disease risk factors. Besides waist/hip ratio, abdominal height and conicity index (abdominal girth (M) ÷ $\sqrt{0.109 \text{weight (kg)} \div \text{height (m)}]}$) are considered indirect measures of visceral fat distribution[63]

1.10. The prevalence of risks factors

The prevalence of CVD risk factors is dramatically increasing in low- and middle-income African countries, particularly in urban areas [68, 69,70,72,73]. Studies conducted in Tanzania have reported high rates of hypertension in both urban and rural areas, predominantly among the obese individuals and the elderly[69, 71]. The estimated prevalence of diabetes in SSA is about 1% in rural areas and 5% to 7% in urban areas [74]. In urban areas of Tanzania, the prevalence of diabetes mellitus has been reported to be 3.9% and 2.8% in men and women respectively [75]

A favorable lipid profile (low total and LDL-cholesterol, and normal to high HDL-cholesterol) and low homocysteine values have been reported among the general population in Africa[75]. On the other hand, hyperlipidemia is becoming common, studies from Tanzania have observed 25% prevalence of elevated serum total cholesterol and 15% prevalence of elevated triglycerides among adults over 35 years of age, with women affected more than men[14]

Njelekela et al reported the overall prevalence for cardiovascular risk factors to be 38% in Tanzanian population with relatively higher prevalence in women. In that study an increasing trend in the prevalence of hypertension was reported.[71]The relatively higher prevalence of hypertension in that study may be attributable to changes in dietary habits, socioeconomic status, sedentary lifestyle, and rates of obesity. Notably, Njelekela et al observed 50% lower

odds of hypertension among women compared to men, despite significantly higher rates of obesity.[71]

The burden of overweight and obesity in developing countries is increasing at a high rate, Puoane et al reported the prevalence of obesity to be approximately 40% in South African population.[70, 76] On the other hand, Sobngwi et al observed that 22% of the urban population and 1.8% of rural population in Cameroon were overweight and obese.[68]

As it is for other developing countries, Tanzania is also experiencing an enormous increase in the burden of overweight and obesity as reported by WHO which has also projected an increase in prevalence by 3% by 2015.Technological advancement and consumption of modern foods are some of the factors which are thought to mitigate change in trend from arithmetic to geometric increase (WHO, 2005).[74]

CHAPTER 2

2.1. PROBLEM STATEMENT

Cardiovascular changes on ECG and ECHO have been studied globally [13, 23]. Despite the extensive knowledge available little is known, about the ECG abnormalities, in African populations where the CVD are gaining momentum in contributing to morbidity and mortality.CVD risks have been widely studied in our population with elderly group being the focus of most of studies. [14, 71] Young adults have been reportedly within the wide range of the study population, and recently not well represented.

Obesity, associated with significant biochemical derangement, is now a health problem in Tanzania[71]. The overall prevalence of obesity (body mass index (BMI)≥30 kg/m^2) was 14.2% and that of adiposity was 16.9%.Hypertension (48.1%), hypercholesterolemia (32.4%), hypertriglyceridemia (20.3%), elevated LDL-C (33.8%), and hyperglycemia (4.6%) were seen among these obese participants[71].In urban areas of Tanzania, the prevalence of diabetes mellitus has been reported to be 3.9% among men and 2.8% among women [75]. The prevalence of obesity in primary school children was reported to be ranging from 4% to 23% in urban and rural respectively and is expected to rise by 3% in 2015.

Different studies recommends screening young adults with CAD, CAD equivalents (other forms of atherosclerotic vascular disease, diabetes, or those with CAD risk of 20% or greater within 10 years), or one or more CAD risk factors (high blood pressure, smoking, family history, and obesity) [39-46.]There are no specific recommendations for persons who do not have CAD risk factors. Thus although screening guidelines vary, there is agreement concerning the need to screen young adults who are at increased risk of CAD. Previous reports based on the Behavioral Risk Factor Surveillance System data indicated a low screening rate among young adults.

2.2. RATIONALE

It is known that some risks elements of CVD are silent's and they can be picked up with ECG, thus bringing in the beneficial use of ECG as a screening tool since we have significant primary and secondary prevention that can reduce the attendant risks.

Many large ECG screening has been done on asymptomatic individuals of non African population, and a good reason to carry out ECG screening to asymptomatic individuals is to acquire a baseline trace which will benefit clinician with availability of past ECG for comparison

There is paucity of data from healthy individuals in our population regarding presence of morphological abnormalities in baseline ECG.

This study was conducted in the light of scarcity of information regarding cardiovascular disease risks factors among young adults in our population

The findings of this study will provide information on cardiovascular risks factors in young adults; it will also provide information on pattern of ECG changes in young in adults therefore provide basis for early intervention before manifestation of overt cardiovascular disease.

2.3: OBJECTIVES

2.3.1. Broad Objective

To describe the ECG patterns and cardiovascular risk factors among students aged 18years to 40 years at the university of Dar-es salaam, Mlimani campus

2.3.2. Specific objectives

1. To assess frequency of ECG findings in young adults aged 18years and above
2. To describe the cardiovascular risks factors associates with the ECG findings

CHAPTER THREE

3. Methodology

3.1. Study design

This was a descriptive cross-sectional study

3.2. Study site

The University of Dar es salaam is the oldest and biggest public university in Tanzania. It is situated on the western side of the city of Dar es salaam, occupying 1,625 acres on the observation hill, and 13 kilometers from the city centre. In 1961 it was founded as University College affiliated to the University of London. I t became an autonomous university by an act of parliament to award own degrees in 1970.

The University of Dare es Salaam (UDSM) is a public institution funded primarily by the government of Tanzania. It has a number of different academic units, 2 constituent colleges, 3 campus colleges, 4 schools, 4 institutes and several centers and bureaus.

The University of Dar es salaam offers various academic programmes leading to the award of certificates, diplomas, and degrees. A total of 4 certificates, 5 diplomas and 63 undergraduate degree programmes are offered at various academic units of the University of Dar es salaam

The number of students admitted at the University of Dar es salaam has been increasing steadily, from 14 in 1961 to 18,266 (11, 472 male and 6,794 female) undergraduate degree and non-degree in the 2010/2011 academic year. Female students constitute 37.2% of all undergraduate students at the University of Dar es salaam.

The university has 2 residential campuses for the students, the Mabibo campus and the Mlimani campus, the Mlimani campus has a total number of seven residential halls, with approximately 500 students in each hall

3.4. Study population

411 students from University of Dar-es-Salaam aged 18 and above who gave the consent to take part in the study were studied. Due to time limitation 11 students were not recruited

3.5. Sample size

The sample size was obtained using the following formula

Sample size was calculated using:

$$N = \frac{Z^2 P(1-P)}{E^2}$$

z at 5% was 1.96

p will be considered 49.5% (prevalence of central obesity in metabolic syndrome urban sub-Saharan Africa)

E maximum likely error of 0.05

Therefore, the minimum sample size was 422 students; a total number of 411 students were included in the study.

3.6. Sampling technique

280 participants were obtained from previous study which was conducted to determine the prevalence of metabolic syndrome Mastidia et al 2011), [88] in which multistage sampling technique was used, 131 participants were randomly selected by multistage random sampling

A multistage sampling technique was employed to select study subjects from the previous study. University of Dar-es salaam, Mlimani campus has a no of 14 faculties 4 faculties was randomly selected by investigator to give an estimated sample size of 422.From 4 faculties, In each faculty approximately 100 student was selected randomly .2 departments was selected randomly from a each of the 4 faculty, and estimated no of 50 students from each of the selected department.

From the lists of name from each selected department (1, 2,3rd year undergraduate) will be

selected, 50/3=17 i.e. 17 from each year of study. The 17 student will be selected by sampling fractionize the total number of students in each year divide by 17.by lottery method the investigator choose where to start (where to play a lottery)

Stages 1.Conveniently, from University of Dar-es-Salaam (UDSM) students were selected, mainly because of easy access within the allocated time

Stage 2.Selection faculties:

The list of all names of faculties was obtained from UDSM administration office. Four faculties were randomly selected from a list of 14 provided

Stage 3.Selection of degree program

Each faculty has at least 6 degree programs which run for a 3year period. The study required to select 2 degree program from each selected faculty. The 2 degree programs were selected by random sampling

In order to get a sample of 422 students, 106 students were further select randomly from each faculty. Since each selected faculty had different programs, the two selected program from each faculty had students in year one, two and three, a further random selection of 18 students from each year was done making a total of 53 students selected from each program and 106 students from the two program of each selected faculty. The list of student's names was obtained from head of departments.

Systematic sampling technique was used to select the students by name from a list given to participate in a study. The sample fraction was calculated by total number of students per class divided with sample size needed per class in order to get the starting point, therefore and by rotary method the first name from a list was picked. The next name was picked by adding up the sample fraction from a serial number of a previous student.

3.7. Selection of participants from the previous study

Phone contacts for 324 participants from Mastidia et al study [88] were available. The participants were contacted and requested to be re-evaluated; 44 participants refused and 280 were willing to participate.

More participants (200) were added to reach the estimated sample number. These were

selected from the university of Dar es salaam Mlimani campus excluding those who were previously involved. The campus has seven residential halls; each hall has a capacity to accommodate 520 students, one hall was randomly selected. From the selected hall, 200 names were randomly picked from the 520 students. Of the 200 randomly selected; 21 were already recruited in the previous data collection and 179 agreed to participate. Of these, 48 did not show up and were not followed up due to time limit.

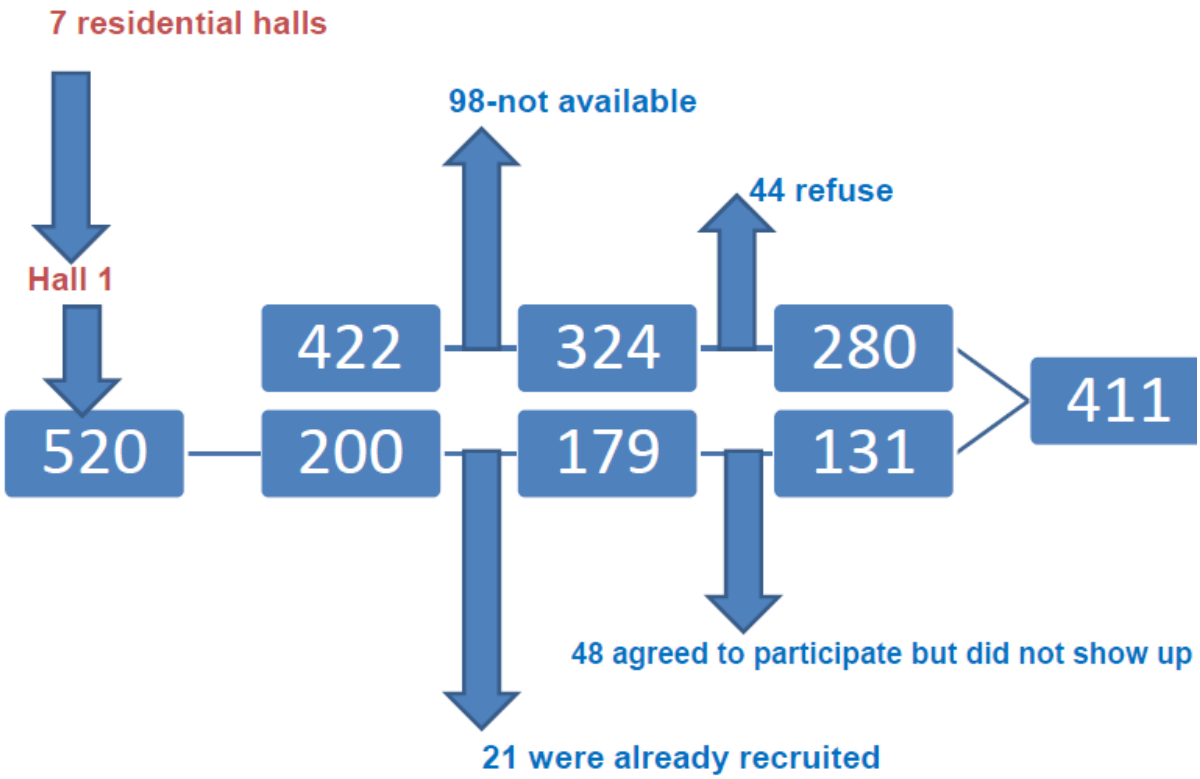


Figure 1; Schematic diagram showing sampling procedure

3.8. Inclusion criteria

i) Aged 18years to 40 years

ii) Consent to participate after information about the study

3.9. Exclusion criteria

i) Pregnancy at time of evaluation

ii) More than 40 years

3.10. Data collection procedures

3.10.1. Definition of Risk Factors

The risk assessed in this study includes, history of hypertension, history of DM, family history of hypertension, stroke, DM, history of smoking, BMI, waist circumference, blood pressure fasting blood glucose, fasting HDL, fasting triglyceride, and ECG

Hypertension was taken as a positive history, use of antihypertensive drugs or persistently elevated BP (>140/90 mmHg) while DM was regarded as a positive history, use of hypoglyceaemic agents or a fasting plasma glucose > 126 mg/dl (7.0 mmol/L). Total cholesterol was considered to be high if it was >200 mg/dl. LDLc was considered to be raised if it was >130 mg/dl, triglycerides was considered to be high if it was > 150 mg/dl and HDLc was considered to be low if it was < 35 mg/dl and <39 mg/dl in men and women respectively. Obesity was defined with the BMI using the WHO classification

Participants were classified as having metabolic syndrome using the modified WHO definition as;

The individual has to diabetic, or have impaired fasting Glucose (IFG) >5.6, and then have at least two of the following

1. BMI ≥30kg/m^2
2. Serum triglycerides ≥ 150mg/dl or HDL cholesterol <35mg/dl in men and < 39mg/dl in women
3. Blood pressure ≥ 140/90mmHg

3.10.2. Clinical Measurements

Height and weight

Weight was measured while subjects were wearing light clothing without shoes by using the SECCA weighing scale (SECCA Vogel and Halke, Haamburg, Germany). Calibration of the weighing scale was done daily. Reading were taken to the nearest 0.5kilograms

Height measurement was taken using portable Harpenden stadiometer Holtain Ltd, London,Uk without shoes and recorded to the nearest 0.5 centimeters.

Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. BMI ≥ 25kg/m^2 was regarded as overweight.

Waist circumference

Waist circumference was measured using a no stretchable tape measure at the level of uppermost edge of the hip bone on a bare abdomen with the tape parallel to the ground and recorded to the nearest 0.5 centimeters. The measurement above 102cm and 88cm in men and women respectively was considered as central obesity.

Blood pressure

Blood pressure was measured with a digital sphygmomanometer, after a 5 minutes rest two reading at one minutes apart were taken from the upper arm (Brachial artery) Average of the two readings was recorded as the respondent's blood pressure.

The blood pressure was then classified as per JNC VII criteria in adults aged ≥18 years as follows:

BP classification	SBP		DBP
Normal	<120	And	<80
Pre Hypertension	120-139	Or	80-89
Stage 1 hypertension	140-159	Or	90-99
Stage 2 hypertension	≥160	Or	≥100

National Heart, Lung, and Blood Institute. JNC 7 Express. The Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation and Treatment of High Blood Pressure. 2003.

Study Procedures

The above students was contacted physically from their class and requested to participate, a phone number was taken to all who agree to participate .The student was contacted by phone and reminded to participate ,they were given an appointment according to their convenience time to come to the university clinic for ECG evaluation and physical examination

A structured pre tested questionnaire designed purposely for the study was used. All students were physically examined in privacy and confidentiality observed. All students had their weight, height and BP taken as explained above. A total number of 10 students were evaluated per day

Laboratory Investigation

Venopuncture was done; 10mls of blood was collected for biochemical and haematological investigations. This included Fasting blood glucose count, Serum triglyceride and HDL-C,

Laboratory investigations were done in the Central Pathology Laboratory (CPL) of the Muhimbili National Hospital (MNH).

3.10.4. Electrocardiogram

Each student had a Standard 12-lead ECGs recorded using FX-3010 vol-04 ECG machine with automated Minnesota code readings .All ECGs were done by the same experienced ECG technician. . Tracings were performed at 25mm/s paper speed and 10 mm/mV gain. Low-pass

filtering was set at 150 MHz. Special attention was paid to locating the limb and chest electrodes at precise positions.

All ECGs will be inspected visually to detect technical errors, missing leads, and inadequate quality. ECGs were coded by using the automated Minnesota code system[9, 77]. Assigned Minnesota Codes will be used to define the type and severity of ECG findings.

For comparison with the automated ECG results; every 10th participant's ECG was manually Minnesota coded and QTc interval determined by the investigator with assistance of a Senior Cardiologist. FX-3010 vol-04 ECG machine with automated Minnesota code has been validated for use in field studies.[8, 9, and 77]

For manually read ECG, LVH was present if the Sokolow-lyon voltage criterion was above 35mm, or if the Cornell voltage-duration product criterion was above 2440mm/ms.

All tracings were then categorized into normal, minor and major abnormal ECG findings.

Major ECG abnormalities consist of major Q wave abnormality (code 1.1, 1.2 except 1.2.8), major ST segment depression (code 4.1, 4.2), major T wave abnormality (code 5.1, 5.2), major ventricular conduction defect (code 7.1, 7.2, 7.4), WPW pattern (code 6.4), artificial pacemaker (code 6.8), atrial fibrillation or flutter (code 8.3), and ST segment elevation (code 9.2).

Minor ECG abnormalities include minor Q wave abnormality (code 1.2.8, 1.3), minor ST segment depression (code 4.3, 4.4), minor T wave abnormality (code 5.3, 5.4), minor ventricular conduction defect (code 7.3, 7.5), high R wave (code 3.1, 3.3), prolonged PR interval (code 6.3), and left anterior fascicular block (code 7.7)

Left ventricular hypertrophy (LVH) was divided into probable LVH (code 3.1 with code 5.1, 5.2, or 5.3) and possible LVH (code 3.1 without code 5.1, 5.2, and 5.3; code 3.3) according to the presence or absence of repolarization change

Probable myocardial infarction was defined as major Q/QS waves (code 1.1.1–1.1.7), or moderate Q/QS waves (code 1.2.1–1.2.7) in conjunction with ST segment depression or T wave inversion (code 4.1, 4.2, 5.1, or 5.2). Possible myocardial infarction was defined as moderate Q/QS waves without ST segment depression or T wave inversion, or minor Q/QS waves (code 1.2.8 or 1.3.1–1.3.6) with ST segment depression or T wave inversion.

3.10.5. The Minnesota Code classification

The Minnesota Code classification system is the electrocardiogram (ECG) classification system most widely used for clinical trials and epidemiologic studies. It was initially designed for visual ECG coding to overcome the lack of standardization and the poor repeatability of clinical ECG interpretation by providing a framework for reporting ECG findings in standardized and clearly defined terms. The Minnesota Code combines three major elements: a set of measurement rules, a classification system for reporting ECG findings, and a set of exclusion rules. The visual methodology has been incorporated into several computer algorithms and validated against expert manual Minnesota coding. [8,9,77.] The Minnesota Code itself does not produce an interpretation of an ECG but, rather, provides a classification of electrocardiographic morphology on the basis of rigid criteria [8, 9]

3.10.6. ECG quality assurance during the screening

- All ECGs were performed by the experienced ECG technician
- Supervised by physician
- Performance of repeated ECG was done to ECG with technical errors from automated interpretation & ECG with pre excitation syndrome findings

Interpretation of ECGs

Investigator, two experienced cardiologist .ECGs with findings considered physiologic for this age group, were designated “within acceptable limits.” isolated premature atrial contractions, incomplete right bundle branch block, early repolarization, mild bradycardia (40, 60 beats per minutes), low atria rhythms, Infrequent premature ventricular contractions (3 per ECG rhythm strip) were considered “within normal limits” for this study

3.10.7. Data entry, cleaning and analysis

All questionnaires were daily checked for completeness and accuracy by the investigator**.** Pre-coded data were entered into computer SPSS version 16, data was cleaned before analysis. Data was then summarized into frequency distribution tables and cross tabulations. Data are expressed as means ± SD. A chi-square ($\chi 2$) test is used to compare categorical variables of ECG and cardiovascular risks abnormalities between groups. Statistical analyses were done by SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). A p value of less than 0.05 will considered statistically significant.

3.10.8. Ethical consideration

The study received ethical clearance from the Research and Publication committee of MUHAS and permission from authorities of the university of dare s salaam, participant were included after informed verbal and written consent. Confidentiality was adhered to when filling the data collection sheets. Physical examinations were conducted in privacy.

Disposal of Study participant

All participants with significant finding from their ECG and laboratory investigations were l referred to the appropriate centers for further investigation, counseling and management follow up.

CHAPTER FOUR

RESULTS

Characteristics of study participants

Four hundred and eleven participants were included in this study out of which 140(34.1%) were female and 271(65.9%) were male. The age of participants ranged from 19-40 years with mean age of 23.6±2.6. Table 1 describes the characteristics of study participant. Study population had a mean BMI of 21.7 ± 2.8 which was significantly higher in women (22.27± 0.27) as compared to men (21.34±0.15) p <0.001. Mean systolic blood pressure was 120.1 ± 11.6 mmHg, men were noted to have significantly higher mean systolic blood pressure (122.1 ± 11.8 mmHg) as compared to female (116.4 ± 10.5 mmHg), p <0.001. The mean HDL level was significantly higher in women (50.0 ± 12.5 mg/dl) as compared to men (42.6 ± 12.2 mg/dl), p <0.001. Mean R+S component duration was significantly longer in male (1.64 ± 0.48) as compared to female (1.96 ± 0.20) p<0.001. Male participants had higher overall prevalence (71.4%) of ECG abnormalities as compared to female (28.6%) p=0.020.

Table 1. Demographic and clinical characteristics of the study population by sex (n=411)

Variable	Total population N=411	Male N=271	Female N=140	p-value
Age (years)	23.6±2.6	24.2 ± 2.6	22.5 ± 2.3	0.000
Waist circumference (cm)	75.9 ± 8.6	76.4 ± 8.4	74.8 ± 8.9	0.078
BMI Kg/m^2	21.7 ± 2.8	21.3 ± 2.6	22.3 ± 3.2	0.002
Heart rate (b/min)	68.3 ± 11.3	65.3 ± 10.1	74.2 ± 11.2	0.000
Systolic BP (mmHg)	120.1 ± 11.6	122.1 ± 11.8	116.4 ± 10.5	0.000
Diastolic BP (mmHg)	73.4 ± 9.6	73.8 ± 9.9	72.7 ± 8.9	0.273
FBG (mmol/dl)	4.8 ± 0.9	4.7 ± 0.9	4.9 ± 0.9	0.234
Triglycerides (mg/dl)	76.0 ± 34.4	78.1 ± 32.1	72.0 ± 38.0	0.091
HDL (mg/dl)	45.1 ± 12.7	42.6 ± 12.2	50.0 ± 12.5	0.000
PR interval (msec)	0.145 ± 0.021	0.146 ± 0.220	0.141 ± 0.228	0.026
QTc (msec)	0.388 ± 0.266	0.383 ± 0.021	0.396 ± 0.033	0.000
QRS duration (msec)	0.111 ± 0.143	0.109 ± 0.133	0.113 ± 0.161	0.802
QRS Axis	67.1 ± 26.6	67.0 ± 30.1	67.2 ± 18.4	0.954
R+S duration	2.90 ± 1.00	1.64 ± 0.48	1.96 ± 0.20	0.000
+ Components of metabolic syndrome	176(42.8%)	123(69.9%)	53(30.1%)	0.171
ECG Abnormality	259(63%)	185(71.4%)	74(28.6%)	0.020

Electrocardiographic findings

Majority of ECG were either normal or within acceptable limit, the automated Minnesota coding reported 152(37%) normal ECG, when the ECG were re-evaluated, 326(76.3%) were within normal and acceptable limit, the prevalence of major ECG abnormalities were found in 37(9.0%) and minor ECG abnormalities were found in 143(34.8%), Other ECG abnormality was found in 79(19.2%).

Table number 2 shows general characteristics of the ECG finding from this study. Fifty three participants (12.9%) had Q/QS pattern in their ECG out of which 5 (1.2%) had major Q/QS of ≥ 0.04 seconds and 48 (11.7%) had minor Q/QS of ≤ 0.03 seconds. QRS axis deviation were noted in 22 (5.4%) participants, which were defined as LAD 1 (0.2%) participant, RAD 11 (2.7%) participants and 10 (2.4%) had indeterminate axis.

High amplitude R wave were noted in 87 (21.2%), on further analysis only 13 (3.2%) ECGs were found to have LVH features. Arrhythmias were the most common finding on ECG and was detected in 168 (40.9%) participants, with predominance of sinus bradycardia85 (20.7%) followed by sinus arrhythmia 64 (15.6%) and ventricular premature conduction 7 (1.7%).

Table 2: Electrocardiographic classification of the study population as by Minnesota code (n=411)

Minnesota code	ECG abnormality	Present	Absent
1-1-1 1-3-6	Q waves	53(12.9%)	358(87.1%)
2-1 2-5	QRS axis deviation	22(5.4%)	389(94.6%)
3-1 3-3	High amplitude R waves	87(21.2%)	324(78.8%)
4-1-1 4-4	ST junction (J) and segment depression	11(2.7%)	400(97.3%)
5-1 5-4	T wave items	43(10.5%)	368(89.5%)
6-1 6-8	A-V conduction defect	9(2.2%)	402(97.8%)
7-1-1 7-8	Ventricular conduction defect	51(12.4%)	361(87.8%)
8-1-1 8-9	Arrhythmias	168(40.9%)	243(59.1%)
9-1 9-8-2	Miscellaneous including ST segment elevation	74(18.0%)	337(82.0%)

The most prevalent ECG coded was arrhythmia 168(40.9%) in which Sinus bradycardia (under 50/min) was found in 85(20.7%),Sinus arrhythmia in 64(16.6%) and both bradycardia & arrhythmia in 12(29%),ventricular premature contraction 7(1.7%)(not shown in the figure).High amplitude R waves were found in 87(21.2%),Male 79(29.2%)were found to have statistically significant high amplitude R waves compared to female8(5.7%) p=0.0000.LVH was reported in 13(3.2%) participants and all of them were male

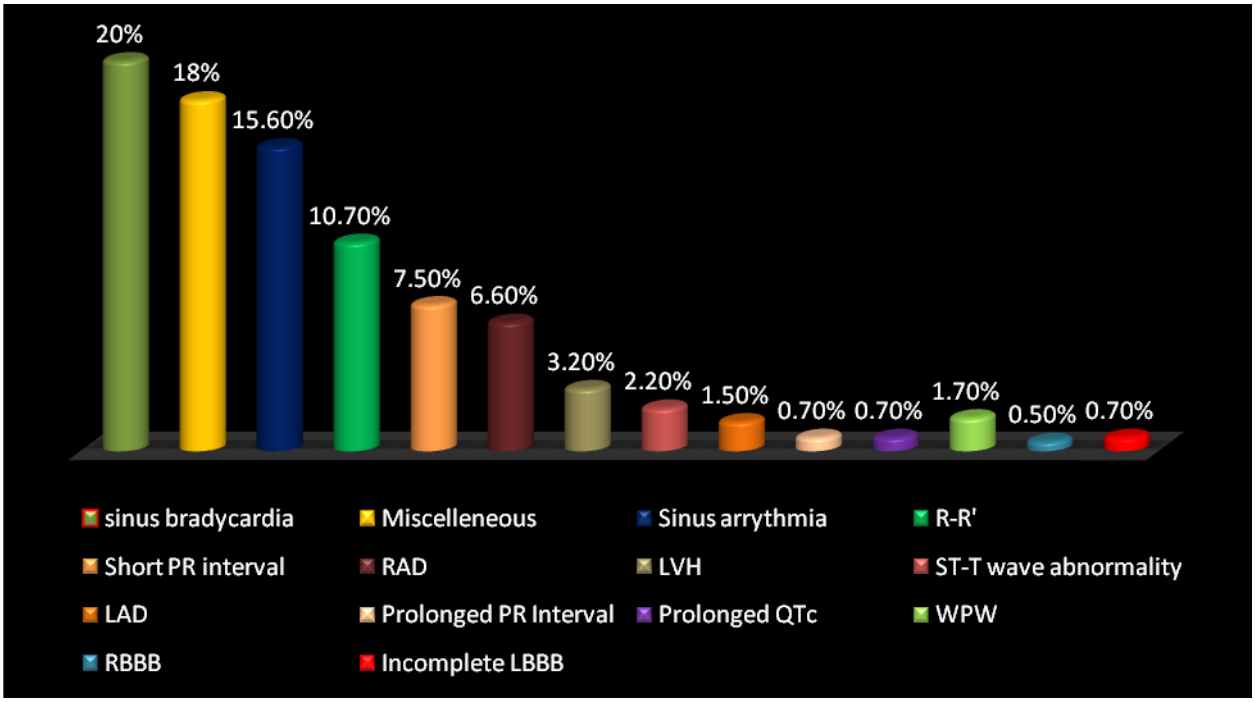


Figure 2; Overall distribution of common major and minor ECG findings

The above figure shows the distribution of the commonest major and minor ECG findings as classified by the Minnesota code, of note 7(1.7%) of the participants were classified as having WPW, and 74(18%) had miscellaneous ECG findings in which the common reported one was QRS transition zone at V4 or to the left of V4 or transition zone at V3 or to the right of V3 on the chest (code 9-4-2,9-4-1),R-R' pattern was reported in 10.7% 0f the population

Table 3 describes distribution of ECG abnormalities according to sex. Major and minor ECG abnormalities were significantly more prevalent among male participants as compared to females, p values 0.002 and 0.007 respectively. High amplitude R wave (male 29.2%; female

5.7%, p<0.001) ventricular conduction defects (male 15.1%; female 6.5%, p=0.011) arrhythmias (male 48.3%; female 26.4%, p<0.001) and miscellaneous including ST segment elevation (male 21.8%;female 10.7%, p=0.006) were significantly more prevalent in male participants.

Table 3 Electrocardiographic patterns of the study populations by sex (n=411)

Variable	Total	Male	Female	P-value
Major ECG changes	136(33.1)	104(38.4%)	32(22.9%)	0.002
Minor ECG changes	142(34.4%)	106(39.1%)	36(25.7%)	0.007
Q waves	53(12.9%)	35(12.9%)	18(12.9%)	1.000
High amplitude R waves	87(21.2%)	79(29.2%)	8(5.7%)	0.000
LHV	13(14.9%)	13(16.5%)	0(0.00%)	0.600
ST junction (J) and segment depression	11(2.7%)	5(1.8%)	6(4.3%)	0.196
T wave items	43(10.7%)	27(10.0%)	16(11.4%)	0.734
A-V conduction defect	9(2.2%)	5(1.8%)	2(2.9%)	0.492
Ventricular conduction defect	51(12.4%)	41(15.1%)	10(6.5%)	0.011
Arrhythmias	168(40.9%)	131(48.3%)	37(26.4%)	0.000
Miscellaneous including ST segment elevation	74(18.0%)	59(21.8%)	15(10.7%)	0.006
AXIS ≥+90 RAD	27(6.6%)	24(8.9%)	3(2.1%)	
-30 LAD	6(1.5%)	6(2.2%)	0(0.0%)	
Indeterminate	4(1.0%)	3(1.1%)	1(0.7%)	0.007

The percentage of participants with ventricular conduction defect was 51(12.4%), of which 41(15.1%) were male and 10(6.6%) were female p=0.011,the ECG with R'S'R pattern (code 7.5)that did not meet the criteria for bundle branch block was 44(10.7%),RBBB was found on 2(0.5%) and these were male, incomplete RBBB was also found in 2(0.5%) and they were also male, incomplete LBBB was found in 3(0.7%) of participant and these were female.

Cardiovascular risks factors

Majority of the participants were free from any form of cardiovascular disease by history and physical examination. One participant(0.2%) was found to be diabetic and one hypertensive(0.2%), Family history of unspecified cardiovascular disease, hypertension, stroke and diabetes mellitus was reported by 26(6.3%), 54(13.4%), 16(3.9%) and 86(20.7%) participants respectively, Fifteen (3.6%) participants were active smoker at the time of recruitment in which 13(4.8%) were male and 2(1.4%) were female.

As reported in table 1, participant mean BMI was within the normal range, with 319(77.7) having normal range BMI, 39(9.5%) of the participant were underweight, 50(12.9%) were overweight and obesity was found in 3(0.7%)

Impaired fasting blood glucose was found in 81(19.7%) of the participant,47(17.3%) were male,

Normal BP was observed in 243(59.1%) of the participant.146 (35.5%) were in pre hypertensive state, 22 (5.4%) had stage I hypertension. Male 105(38.7%) were significantly prehypertensive than female 41(29.3%) p=0.006

Metabolic syndrome was found in 10(2.4%) of the participants

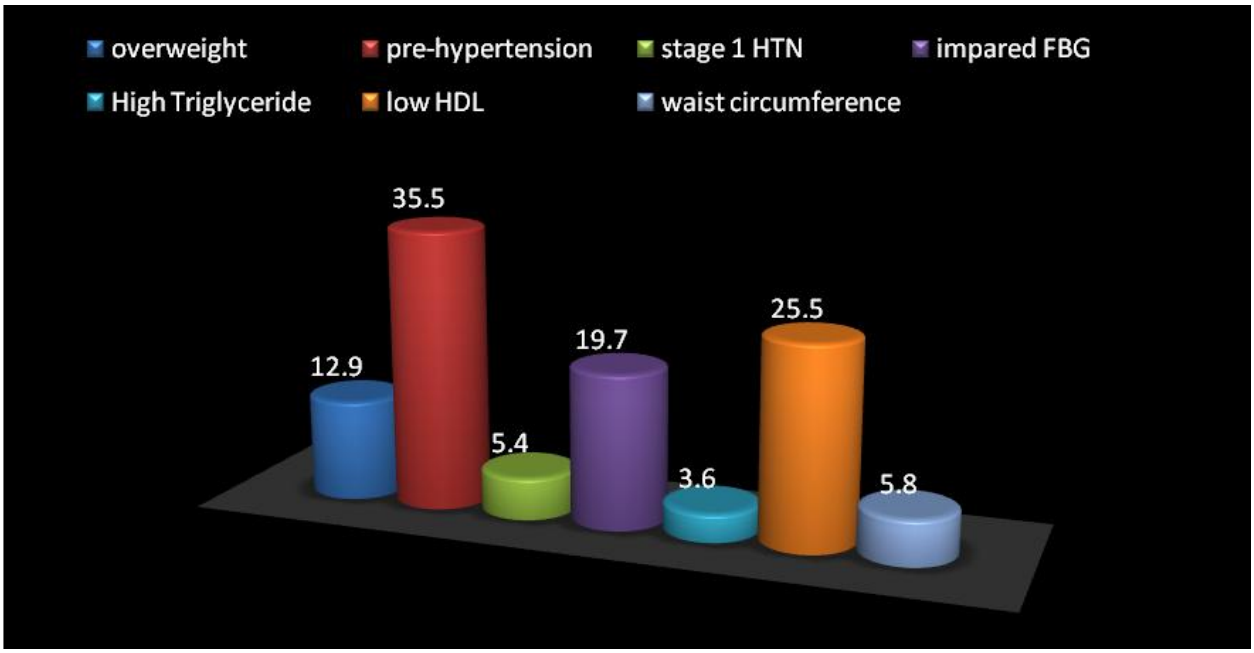


Figure 3; Distribution of common CVD risks factors

The proportion of women who had abnormal waist circumference (12.1%) was significantly higher than that observed for men (2.6%), p <0.001. The proportion of male (29.2%) participants with low HDL level was higher than that observed for female participants (18.6%), p=0.0198. Male participants had significantly higher proportion of participants (7.0%) with elevated blood pressure as compared to their female counterparts (2.1%), p=0.039 (Table 4)

Table 4: Cardiovascular risks factor by sex (n=411)

Variable	Yes n (%)	No n (%)	p-value
FBG (≥5.6 mmol/L)			
Male	47 (17.3%)	224 (82.7%)	
Female	34 (24.3%)	106 (75.7)%	0.094
HDL			
Male (≤35 mg/dl)	79 (29.2%)	192 (70.8%)	
Female (≤ 39 mg/dl)	26 (18.6%)	114 (81.4%)	0.0198
Triglyceride (> 150 mg/dl)			
Male	9 (3.3%)	262 (96.7%)	
Female	6 (4.3%)	134 (95.7%)	0.621
Waist circumference			
Male (≥ 108 cm)	7 (2.6%)	262 (97.4%)	
Female (≥ 88 cm)	17 (12.1%)	123 (87.9%)	0.000
Blood pressure (≥ 140/90 mmHg)			
Male	19 (7.0%)	225 (93.0%)	
Female	3 (2.1%)	137 (97.9%)	0.039*

FBG fasting blood glucose; HDL high density lipoprotein
*Fischer's exact test

CHAPTER FIVE

DISCUSSION

The ECG has been widely described in medical reports as a useful diagnostic tool for assessing "silent" heart disease. Many epidemiological studies have shown the association between ECG findings and subsequent coronary and cardiovascular disease and mortality [4, 5, 6]. The use of ECGs in epidemiological research has been greatly facilitated by the introduction of the Minnesota code classification system.[8, 9]

In other studies showing the prevalence of ECG changes, the age range is often more limited than our range of 19-40 years, and is usually restricted to 45–64 years [4, 5, 6,7,10]. Because of the strong age dependency of ECG changes, any study comparing prevalence of ECG abnormalities should take this into account. As reported by several other investigators, there are also important ethnic differences among individuals free of coronary heart disease in the occurrence of abnormalities on the resting ECG[4, 11, 12, 15].

The definitions of major and minor ECG abnormalities in this study are based on those in the pooling different major studies on community using Minnesota coding[11, 12, 18, and 22]. A community-based survey was used to assess the prevalence of risk factors for coronary heart disease (CAD) in rural Tanzanians. In all, 8581 subjects (3705 men, 4876 women) aged >15 years in eight villages in three regions in rural Tanzania. ST, T changes on ECG were recorded in 7.8% of men and 17.4% of women aged ≥40 years.[14]

In south Africa 409 subjects of African descent with aged <40 years ECG was done to evaluate pattern in this age group, these participant were determined to be free of any form of cardiovascular disease and type 2 diabetes with intact cardiac structure and function Overall, "major" ECG abnormalities were detected in 106 subjects (26%) and "minor" abnormalities in 204 subjects (50%) of subjects.[13]

In the results obtained from the records of 47 358 men and women aged 24-74 years

participating in four large Belgian epidemiological studies during the past 30 years [6].Major ECG findings were observed in 6.0% of all men and 4.3% of women, resulting in a significant adjusted sex ratio of 1.66 (95% confidence interval 1.46 to 1.88). The prevalence of minor ECG changes was slightly higher among men (10.4% *v* 9.5% in women).[6] They also observed age and sex effects on the prevalence's of major and minor ECG changes finding similar to what have been found in this study, more so they found significant associations with obesity, diabetes, prevalent coronary heart disease, and to a lesser extent region and employment status

The Q wave abnormality found in this study was 53(12.9%), with 48(11.6%) participant having minor Q wave, and these were female. Five (1.21%) participants had major Q waves. Findings from this study are higher than those reported by Swai et al, Sliwa et al and Sriratanaviriyakul et al. in studies conducted in Tanzania, South Africa and Thailand respectively. The prevalence of Q wave abnormality on ECG reported in the study from Tanzania was 2.7% in men and 3.7% in women, In south Africa 30 (7.3%) , and in Thailand 2.2% respectively [13,14,81]. The difference could be due to the difference in age group of the participants where by majority of their participant were above 40 years and the use of Minnesota coding by this study, the previous Tanzania study use manual assessment of ECG and the South African study use the DeBacquer et al.'s classification of ECG.

The observed abnormal Q waves in this asymptomatic young population of 19-40 years could be attributed an unusual position of the heart in the thorax. An "abnormal" Q wave in leads III and aVL, is frequently observed in obese individuals with high diaphragms. Similarly, a Q wave can be observed in leads II, III, and aVL, in association with tall R waves, both the result of a vertical position seen in individuals with a low diaphragm. The QS complex in leads V1, V2, and V3 can be due to a low-lying diaphragm with a relatively high position of the electrodes in relation to the heart, and placement of electrodes one or two interspaces lower will display an R wave. Failure to register an R wave suggests an organic cause for its absence.

Macfarlane et al suggest that the prevalence of the relevant Minnesota Code abnormalities (1-1, 1-2) is in the order of 50% of the prevalence of acute myocardial infarction by history, however in the Belgian job stress project, which was looking at the independent relation of perceived job stress with the incidence of fatal or non-fatal myocardial infarction, showed that there were 0.5% of ECGs with Q wave evidence suggestive of myocardial infarction in the absence of any relevant history both in men and women [7]

We have found ST segment depression (code 4.1,4.2) in 11(2.7%),findings which are lower that what previously reported, In south Africa, Karen Sliwa et al have found, 38 (9.3%) significant ST elevation and 9 (4.6%),in the Thailand ECG study, ST segment depression (Code 4) was found in 0.5%.81.These findings could differ with Sliwa et al due to the age group of the study population whereby in Sliwa et al study they were older than this study and in Thailand it was lower than us may be due to ethnicity.

LAD represents a shift in the electrical axis of the heart, it is is usually considered to be an indication of left anterior hemiblock.[16]We have found the prevalence of LAD of 1.5%, and these were in male participants. Other studies have found that in men, the prevalence varies from 3.1% in both the Whitehall study5 (40–64 years) and the Framingham study (30–62 years) to 6.4% in the Australian Busselton study (40–79 years [20]. In all those studies, a strong age dependency was shown, and prevalence in men were about twofold higher than in women same as what we have found though our age group is younger than the fore mentioned studies

High amplitude R wave was found to be significantly more in men 79(29.2%) than women 8(5.7%),findings that are the same as to what have been found in south Africa where males had significantly higher amplitude in the R waves compared to females[13] .LVH was found in 13(14.9%) and all of these were male. The male prevalence is also the same as what has been observed in the South Africa study where by ECG pattern indicative of left ventricular hypertrophy was more evident in males 22% (n = 29, 22%) than females (n=14, 5.1%)[13] and other study reported a low prevalence of significantly higher in males than females (0.7% *v*s

0.5%) [7]. It had been suggested that inadequate criteria may in part be responsible for the low LVH finding, because criteria thresholds should be lower in women than men, but this is not the case in the Minnesota Code 7, 83.The findings of LVH common in male than female could be explained by the thin chest wall in male than in female of the same age group and the automated Minnesota code could have interpret high amplitude R wave as LVH in some of the ECG

In this study 7(1.7%) of the participants met the criteria for diagnosis of WPW, Estimates of WPW prevalence in the general population are contingent on the likelihood of asymptomatic patients having an electrocardiogram (ECG) performed, and range from 0.1–0.2%. A long term follow-up of military personnel with WPW reported a mortality rate of 0.02% per year.[84]

The prevalence of RR' was 10.7%, though not reported by other studies, this pattern is a normal manifestation of late activation of posterior septum, and can be diffentiated from incomplete RBBB by R' amplitude being lower than that of R. This result can be recorded in many young individual mostly from V1 position and to the right of V1.[16]

Cardiovascular risks Factors

Developing countries face the double danger of prevalent infectious diseases and increasing CVD with projected epidemic proportions in the near future. Earlier studies in Tanzania sought to describe prevalence of risk factors for CVD in specific populations like those with hypertension, diabetes and the elderly.[14, 71]

The study of CV risk factors in Tanzania conducted 19 years earlier reported the regional difference in prevalence of hypertension in rural area, qualifying BP level of 140/90 mmHg Hypertension was found in 6.6% of men and 7.5% of women in Kilimanjaro region, 3.3% and 4.7% in Morogoro, and 2.6% and 3.4% in Mara region in adults of >15 years.[14]

In 2009 Njelekela et al in Tanzania reported gender-related differences in the prevalence of cardiovascular disease risk factors and their correlates in urban Tanzania.That study includes

participant aged 44 to 66 years, hypertension was defined as per WHO Classification of Hypertension, and they found hypertension in 57% and severe hypertension 30%.[71]

The prevalence of hypertension found in this study is lower 5.4% compared to that found by these other works above,[14,71] this could be explained by the selective young age group of the participants involved 19-40 years. Of importance is the higher rate of prehypertension 146(35.5%) found in this study, with male predominance with men having significantly mean systolic blood pressure of (122.1 ± 11.8 mmHg) as compared to female (116.4 ± 10.5 mmHg).

The prehypertensive state is the similar to what had been reported by Grotto I et al, they observed Israeli adults between the ages 25 and 45, assessed the prevalence of prehypertension in this population. Their results show that prehypertension is very common among young adults, that men are affected more often than women at this age.[58]
Similar finding were reported by the Bogalusa Heart Study which involve young adult participants (age range 20-44 years) The prevalence of prehypertension was significantly higher among men than women (35 vs. 22%) and among blacks than whites (29 vs. 27%). Compared with normotensives, prehypertensive had a greater adverse cardiovascular risk factor profile [63]

This is among the few observation study to report prehypertension status in Tanzania. The true question regarding prehypertension is not the mere method of its progression to overt hypertension but rather the global CVD risk associated with this condition and the potential risk reduction to be gained by early initiation of treatment. A simulation model has shown that elimination of prehypertension results in a substantial public health benefit, thus providing the rationale for an interventional approach to this condition. It is important to note that prehypertension, per se, is not associated with an increased risk of CVD, unless accompanied by additional risk factors in which it was not possible to identify then in this study set up

The prevalence of low HDL was found to be 25.5%, and triglycerides level of above 150mg/dl

in 11(2.7%) findings higher than what have been reported earlier in the other part of Tanzania. The study in Mwanza report a prevalence of HDL of 10.3% and hypertriglyceridemia of 1.0% in adults aged 20 to 50 years [87] .Assessing cholesterol levels in adults' ≥20 years of age is necessary to provide an accurate assessment of CAD risk to an individual. This would identify young individuals who should lower their cholesterol levels, using diet and lifestyle changes as the primary treatment. Atherosclerosis begins early in life, and cholesterol levels in young adults predict CVD risk 30-40 years later. Waiting until mid-life to find elevated cholesterol loses a significant portion of the benefit.[83]

Metabolic syndrome was present in 2.4% of our participants, the findings are slightly lower than what has been observed in other part of our country.One such study evaluate the prevalence of cardiovascular disease risks factors among young and middle aged men aged 20-50 years reported a prevalence of metabolic syndrome of 3.1% .Findings in another countries reported a prevalence of MS in similar age group, ranges 0.2% in India by Gupta et al [85] and 8% in Korea Hong-kyu kin et al. [23]

CONCLUSION

There was an observational trend toward increased prevalence of minor and major ECG changes in this young population of 19-40 years, Male were more likely to have major and minor ECG changes, axis abnormality, ventricular conduction defects, high amplitude R waves, arrhythmia and ST,T changes compared to women

The relationship between most prevalent found CVD risks factors (Low HDL, increased waist circumference and Blood pressure varies with gender

The high prevalence of prehypertension 35.5%, with also male predominance and low level of HDL in 25.5% of the participants which was common in male than female calls for more preventive strategies in this young age group before the development of overt CVD

LIMITATION

- ECGs with findings considered physiologic for this age group, were designated “within acceptable limits.”I acknowledge this limitation as that may be an important finding in symptomatic individuals
- ECG were not repeated for participant with baseline prolonged PR interval, abnormal T wave inversion, major Q wave abnormality
- All the participants were believed to be fasting at the time of blood sample collection
- The population selected could not be generalized to the same age group who are not in institution

RECCOMENDATION

- Population study with ECG and ECHO evaluation including all the young at different community group and addressing the limitation above may give better results (in showing the relationship between ECG findings and cardiovascular risks factors)
- High prevalence of HDL and pre hypertension call for preventive strategies in this young age group.

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APPENDICES

Appendix: I: Questionnaire

Electrocardiographic patterns and cardiovascular risk factors among university students in Dar es Salaam – Tanzania a descriptive cross sectional study

A. Participant information's

1. Name…….
2. Contact address/phone no……
3. Registered course and year of study……
4. Age……
5. Sex M/F

B. Family history

1. Is there a family history (parents or siblings) of the following conditions/disease onset prior to age 60?

a) Cardiac disease 1.Yes 2.No

If yes specify 1.hypertension 2.Others explain……

b) Diabetes 1.Yes 2.No

c) Stroke 1.Yes 2.No

d) Cardiac disease 1.Yes 2.No

2. Please provide details for any "YES" response below

Familial Relationship	Specific condition(s)	age when diagnosed	current age (if living)	deceased (list age @ time of death)
Father				
Mother				
Sibling 1				
Sibling2				

C. Medications - List ALL current medications, prescription and non-prescription (including vitamins, nutritional supplements, herbal preparations, etc) in the space provided below

Medication	Dose	Medication	Dose
1.		5.	
2.		6.	
3.		7.	
4.		8.	

4. Do you have any other significant health issues or medical conditions not outlined or mentioned?

a. Condition(s)…….
   List treatment……
   Current status…….

b. None - NO other medical conditions or health issues

D. Cardiovascular Risks factors

1. Are you current cigarette smoking……..
2. Diagnosed with diabetes…….
3. Medication used for Diabetes……..
4. Ever been diagnosed with Hypertension……
5. Medication used for hypertension…….
6. Fasting Blood glucose (mmol/l)…….
7. Serum Triglycerides (mg/dl)……..
8. HDL (mg/dl)…….

E. Physical examination

1. Height (cm)……
2. Weight (kg)……

3. Waist circumference (cm)…….
4. waist circumference more than 90 percentile
5. BMI (Kg/m^2)……
6. Pulse rate……..
7. Pulse character a) Normal b) Abnormal c) Explanation……..
8. BP 1st average……..
9. Current BP 1st ……2nd (after 5 minutes rest)…….
10. Average BP (1st and current)…….
11. Heart sounds a) Normal b) abnormal c) Added 1.3rd 2. 4th 3.Murmur
e) Explain……

F. ECG Findings

Minnesota Code	**ECG abnormality**	**Participant Minnesota code**	**Interpretation**
1-1-1 1-3-6	Q waves		
2-1 2-5	QRS axis deviation		
3-1 3-3	High amplitude R waves		
4-1-1 4-4	ST junction (J) and segment depression		
5-1 5-4	T wave items		
6-1 6-8	A-V conduction defect		
7-1-1 7-8	Ventricular conduction defect		
8-1-1 8-9	Arrhythmias		
9-1 9-8-2	Miscellaneous including ST segment elevation		

Appendix II: Consent form to participate in the study – English version

Title; Electrocardiographic patterns and cardiovascular risk factors among university students in Dar es Salaam – Tanzania a descriptive cross sectional study

Greetings! My name is **Dr. Delilah Kimambo,** a cardiology fellow in the department of Internal Medicine. I would like to conduct a study mentioned above for my dissertation.

Purpose of this study

The aim of the study is to do an ECG and cardiovascular risks assessment in adults

How to participate

There will be an interview using a questionnaire, which will include your social demographic characteristics, medical history, and clinical examination.

What is an ECG?

The ECG is the most commonly performed cardiac test. This is because the ECG is a useful screening tool for a variety of cardiac abnormalities; ECG machines are readily available in most medical facilities; and the test is simple to perform and risk-free.

How is the ECG performed?

You will lie on an examination table, and 10 electrodes (or leads) are attached to your arms, legs, and chest. The electrodes detect the electrical impulses generated by your heart, and transmit them to the ECG machine. The ECG machine produces a graph (the ECG tracing) of those cardiac electrical impulses. The electrodes are then removed. The test takes less than 5 minutes to perform.

What information can be gained from the ECG?

From the ECG tracing, the following information can be determined, the heart rate, the heart rhythm, whether there are “conduction abnormalities” (abnormalities in how the electrical impulse spreads across the heart) ,whether there has been a prior heart attack, whether there may be coronary artery disease ,whether the heart muscle has become abnormally thickened

All of these features are potentially important. If the ECG indicates a certain abnormality, further testing will be done to completely define the nature of the problem and decide on the optimal therapy

What are the limitations of the ECG?

The ECG reveals the heart rate and rhythm only during the time that the ECG is taken. If intermittent cardiac rhythm abnormalities are present, the ECG is likely to miss them. Ambulatory monitoring is needed to record transient arrhythmias.

Risks

There are no risks associated with taking these measurements.

Benefits

Patients found to have significant ECG abnormality will be managed according to the national guidelines.

Blood for laboratory evaluation

A needle prick will be done at the antecubital fossa and a 5mls of blood will be collected for evaluation of your blood sugar and blood cholesterol, there is minimal pain associated with venopuncture

Confidentiality:

Results will not be revealed to anybody except attending doctors and the participant

Cost.

No payment is requested from you as a fee to participate in the study.

Person to contact in questions or problems:

Prof.E.Lyamuya (Tel; 255 22 2152489, Mobile; 0754 49 59 33) Director of Research and Publications, MUHAS.

Dr. J.Lwakatare (Tel: 0754 26 26 48) Department of Internal Medicine, MUHAS.

I…… have read/been told of the contents of this form and understood its meaning. I agree to participate in this study.

Signature…….. (Participant) Date……

Signature…….. (Researcher) Date……