SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

CARDIOVASCULAR DISEASE RISK ASSESSMENT AMONG AUTOMOBILE TECHNICIANS AT THE INDUSTRIAL AREA IN THE TAMALE METROPOLIS, NORTHERN REGION, GHANA

BY

ERIC MISHIO BAWA

(10805159)

A THESIS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY IN APPLIED EPIDEMIOLOGY AND DISEASE CONTROL

DECEMBER, 2021.

DECLARATION

I, Eric Mishio Bawa, declare that except for duly acknowledged reference work, this thesis is my original work undertaken under the supervision of Dr. Samuel O. Sackey and Dr. Seth Kwaku Afagbedzi. I also declare that no part of this research work has been submitted elsewhere or within the university for the award of another degree.

Signature: Date: 04/07/2022

Eric Mishio Bawa

(Student)

Signature: Date: 07/07/2022

Dr. Samuel O. Sackey

(Supervisor)

Signature: Date: 06/07/2022

Dr. Seth Kwaku Afagbedzi

(Co-supervisor)

DEDICATION

For their unwavering support, I dedicate this project to my family and friends.

ACKNOWLEDGMENT

I thank the almighty God for the miracles that came my way before and during this phase of my life and for the numerous blessings bestowed on me.

My heartfelt gratitude goes to Dr. Samuel O. Sackey and Dr. Seth Kwaku Afagbedzi for the supervisory roles they played and for the numerous supports beyond the scope of this research work. May God richly bless you.

To the Director and staff of the Ghana Field Epidemiology and Laboratory Training Program (GFELTP) and the West African Health Organisation (WAHO), I wish to express my sincerest appreciation for the training, guidance, and sponsorship provided.

To my wife, Lieutenant Grace Awadari, and friend, Mr. Ayambire Felix Apelba for their encouragement and support through thick and thin, and to all and sundry who played either direct or indirect roles in making this study a reality.

ABSTRACT

Background: There is a rapid increase in the burden of CVD in Low and Middle-Income Countries (LMIC). The prevalence of its risk factors and early outcomes are reaching epidemic proportions in Ghana. The global risk function presented by the Framingham investigators estimates the risk of developing CVD and can be used to quantify risk and guide preventive care. Automobile technicians are constantly in contact with harmful chemicals in their work environment that impact their health negatively. Regular exposure to automotive pollutants increases the risk of developing atherosclerosis leading to adverse cardiovascular events among automobile technicians. Though total risk assessment is recommended and the rise in morbidity and mortality associated with CVD is noticeable, individuals and societies, particularly automobile technicians, have no idea of their level of risk. This results in limited and untargeted preventive measures. This study, therefore, aimed at assessing the risk of developing CVD in 10-years among automobile technicians at the industrial area in the Tamale Metropolis, Northern Region

Methods: A cross-sectional study involving automobile technicians aged 20 years or older in the industrial area of the Tamale metropolis was carried out. A multi-stage sampling technique was used to select participants. Data on individual factors, risk factors, knowledge, attitude, and practices were collected with the aid of a semi-structured questionnaire. Anthropometric measurements were taken and blood samples were also collected for biochemical analysis. Using the Framingham Risk Scoring algorithm, the 10-year CVD risk for each participant was estimated. Data collected was analyzed using STATA 15 and results were presented as frequencies, proportions, and odds ratios in tables and graphs.

Results: All the study participants (210) were males, with 36 years being the median age. The most prevalent risk factor for CVD was hypertension with a prevalence of 32.86%. Hypertension

was significantly associated with diabetes (p = 0.016) and other risk factors. The prevalence of low, moderate, and high 10-year CVD risk was 80.0%, 11.43%, and 8.57%, respectively. The 10-year CVD risk varied significantly with age (p <0.001), years of work experience (p < 0.001), and the job category/specialty (p = 0.004). The majority of the participants had adequate knowledge (74.29%) and attitude (57.14%) towards cardiovascular disease risk factors and prevention with a few (<5%) engaging in good practices. Those with an adequate attitude had 87% reduced odds of having a high 10-CVD risk score when compared to those with inadequate attitudes.

Conclusion: There was a high prevalence of CVD risk factors among the automobile technicians, with a fifth of them having a moderate to high 10-year CVD risk score. Whiles the majority of the participants had adequate knowledge and attitude scores, only a few had adequate practices scores on CVD risk factors and prevention. Adequate attitude had a reduced the 10-year CVD risk score among the automobile technicians.

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LIST OF ABBREVIATIONS

BMI	-	Body Mass Index
BP	-	Blood Pressure
CVD	-	Cardiovascular Disease
CVDs	-	Cardiovascular Diseases
DBP	-	Diastolic Blood Pressure
ERC	-	Ethics Review Committee
FRS	-	Framingham Risk Score
GFELTP	-	Ghana Field Epidemiology and Laboratory Training Program
GHS	-	Ghana Health Service
GHS-ERC	-	Ghana Health Service Ethics Review Committee
HDL	-	High-Density Lipoprotein
LDL	-	Low-Density Lipoprotein
LMIC	-	Low and middle-Income Countries
NCD	-	Non-Communicable Disease
NCDs	-	Non-Communicable Diseases
NGO	-	Non-Governmental Organisation
PROCAM	-	Prospective Cardiovascular Munster

SCORE	-	Systematic Coronary Risk Evaluation
TC	-	Total Cholesterol
TG	-	Triglycerides
TMA	-	Tamale Metropolitan Assembly
SBP	-	Systolic Blood Pressure
WAHO	-	West Africa Health Organisation
WHO	-	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 Background

Cardiovascular diseases (CVD) are a group of heart and blood vessels disorders (Wang et al., 2015). They include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism (Wang et al., 2015; World Health Organization, 2017). Tobacco use, together with physical inactivity, inappropriate diet, obesity, elevated blood pressure, and a poor lipid profile, accounts for about 75% of new cases of CVD (Beaglehole et al., 2001). Contributing to the rise of non-communicable diseases particularly CVDs, are non-modifiable and modifiable risk factors. Non-modifiable risk factors include age, sex, and race, whereas modifiable risk factors include diabetes, alcoholism, elevated blood pressure, overweight, smoking, abnormal blood lipids, and unhealthy diet (Mohammadnezhad et al., 2016).

Globally, CVD is one of the leading causes of death. In 2016, an estimated 17.9 million people representing 31% of deaths in the world, died from CVD (World Health Organization, 2017). In 2016, ischemic heart disease (IHD) was the leading cause of the worldwide burden of CVD, followed by stroke, which accounted for 33% of all CVD cases. Hypertensive heart disease, cardiomyopathy, atrial fibrillation, endocarditis, and other cardiovascular diseases account for relatively small proportions of the total CVD burden (Thomas et al., 2018).

There is a great concern that the morbidity and mortality burden associated with CVD is increasing rapidly in Low and Middle-Income Countries (LMICs), within which sub-Saharan Africa countries can be classified (Mensah et al., 2015). The surge in the incidence of Non-Communicable

Diseases (NCDs), particularly CVDs within sub-Saharan Africa can be accounted for by countries currently experiencing an epidemiological transition characterized by increased urbanization and changing lifestyle factors (BeLue et al., 2009). Death associated with CVD in sub-Saharan Africa constitutes 8.8% of all deaths. However, these deaths occur on average at younger ages than it is for the rest of the world (Moran et al., 2013). In 2013, nearly one million deaths were caused by CVD in sub-Saharan Africa. This constituted 38.3% of NCD deaths and 11.3% of deaths from all causes (Mensah et al., 2015).

In Ghana, the burden of CVD is on the rise and this is driven by a significant behavioral change in the country as a result of globalization (Ofori-Asenso & Garcia, 2016). In Ghana, CVD has been identified as one of the leading causes of mortality (World Health Organization, 2010). The country is experiencing epidemic proportions of the prevalence of its risk factors and early outcomes (Li et al., 2020). In 2008, CVD was the leading cause of institutional deaths accounting for 14.5% of total deaths compared to 13.4% from malaria in the country (Bosu, 2013). According to the WHO, the likelihood of dying from cancer, chronic respiratory illness, CVD, or diabetes between age 30 and 70 years in Ghana was 20.8% for both sexes, 18.2% for males, and 23.2% for females in 2016 (WHO, n.d.). Between 2004 and 2014, there was a 78% increase in CVD admissions with heart failure, dysrhythmias, and ischemic heart disease being the top 3 causes of CVD admissions in a tertiary medical center in Ghana (Appiah et al., 2017). In a study on the prevalence and determinants of obesity, Lartey et al. (2019) revealed that there is an increase in the prevalence of overweight and a decrease in the prevalence of underweight among Ghanaian adults.

Cardiovascular Diseases are also on the rise in the Northern part of Ghana. Within the Tamale metropolis, uncontrolled hypertension is at appreciable levels (Isaac, 2015). A study conducted

among type 2 diabetics receiving primary care at the Tamale Teaching Hospital by Brobbey et al., (2020) revealed that 65% of the patients had hypertension, 89% had elevated glycated hemoglobin levels and 49% received statin for primary prevention of CVD. Ayijunu, (2015) also found that the majority of school teachers in the Tamale metropolis were at risk of developing cardiovascular diseases. Even among school children aged 5 to 14 years, the prevalence of overweight/obesity, which is a risk factor for CVD was found to be high (Mogre et al., 2013). Opare-Asamoah et al., (2017) highlighted the surge in the prevalence of hypertension (55.7%), general obesity (19.7%), and abdominal obesity (49.2%) among type 2 diabetics in the Tamale metropolis.

There is an agreement by member states of the United Nations to reduce premature cardiovascular disease deaths by 25% by the year 2025, but this can only be achieved by a reduction in risk factors associated with CVD (Roth et al., 2015). With a continuous increase in CVD risk factors, a corresponding increase in associated mortalities will be experienced in both developing and developed countries (Deaton et al., 2011).

A major advancement in the systematic approach to preventing CVDs in both research and clinical practice is the identification of factors in determining the risk of developing CVD (Teramukai et al., 2016). Because CVD risk factors are multifactorial and interact over time to produce an effect, the Framingham investigators developed the Framingham risk functions or scores to evaluate the likelihood of developing CVD in individuals (D'Agostino et al., 2013). The CVD risk score ranks individuals and groups to target therapy to those at greatest risk and also provides prognostic information on the likely benefit from therapeutic interventions (Chamnan et al., 2009). These functions combine information on CVD risk factors such as age, sex, diabetes status, systolic blood pressure, smoking, total cholesterol, and high-density lipoprotein to produce an estimate that reflects the risk of developing CVD over a fixed time (D'Agostino et al., 2013).

The global risk function presented by the Framingham investigators in 2008 estimates the risk of developing CVD and can be used to quantify risk and guide preventive care (D'agostino et al., 2008). Though for clinical guidelines, the Framingham risk functions are commonly used, other important risk functions are also available. These include but are not limited to the European Systematic Coronary Risk Evaluation (SCORE) function, and the Prospective Cardiovascular Munster (PROCAM) model (Lloyd-Jones, 2010).

The risk of developing CVD in 10 years has been reported to be higher in urban areas. In Indonesia, the proportion of individuals with high CVD risk was found to be 29.2%, with the proportion of individuals with high CVD risk being greater in urban (31.6%) than in semi-urban(28.7%) and rural areas (26.2%) (Maharani et al., 2019). The proportion of men with an increased risk of developing cardiovascular disease was also found to be greater among those in urban Ghana (45.5%) than in rural Ghana (34.7%) (Boateng et al., 2017).

In Nigeria, Oguoma et al., (2016) revealed that the prevalence of high, moderate, and low risk of developing CVD in 10 years was 1.9%, 11.8%, and 86.3% respectively among apparently healthy individuals. The proportion of patients with high, low, and medium risk of developing cardiovascular disease in 10 years have also been found to be 30.4%, 41.5%, and 28.1% respectively among patients attending two cardiac clinics in the Ashanti Region of Ghana, with men being at a higher risk than women (Nyiambam et al., 2020). With notable risk factors being hypertension along with diabetes mellitus, a moderate to high risk of a fatal or non-fatal event of CVD was found in 10.4% of adults in Northern Ghana (Skerratt & Wilson, 2021).

Automobile technicians are constantly in contact with harmful chemicals in both soil and air that impact their health negatively (Obianime et al., 2017). Particulate matter exposure due to air pollution has become a recognizable risk factor for adverse cardiovascular events with smaller-

sized particles produced mainly from combustion sources shown to be very toxic (Fang et al., 2010). The quality of air around the workshops where automobile technicians repair vehicles is very poor and puts them at risk of CVD morbidity and mortality over time (Akintunde et al., 2019). Regular exposure to automotive pollutants increases the risk of developing atherosclerosis leading to adverse cardiovascular events among automobile technicians (Sharman et al., 2002).

Despite the high level of physical activity and exertion, the prevalence of metabolic syndrome was found to be higher among automobile technicians when compared to teachers in Southwest Nigeria (Akintunde & Oloyede, 2017). Metabolic syndrome, characterized by mild hypertension, overweight, dyslipidemia, and impaired glucose and insulin metabolism increases the occurrence of CVDs in men (Lakka et al., 2002). Even in the absence of obesity, metabolic syndrome, closely associated with CVDs is on the rise among manually active populations such as automobile technicians (Amidu et al., 2012)

Though there is a noticeable rise in morbidity and mortalities associated with CVD globally, individuals and societies particularly automobile technicians, have no idea of their risk of developing CVD. This study, therefore, aimed at assessing the risk of developing CVD in 10 years among automobile technicians in the industrial area in the Tamale metropolis.

1.2 Problem statement

Globally, CVD is one of the leading causes of death. In 2016, it was estimated that 17.9 million individuals died from CVD globally, and this represents 31% of all deaths (World Health Organization, 2017). In low and middle-income countries, CVDs and other NCDs are responsible for the increase in the proportions of preventable deaths (Moran et al., 2014). Out of a total of 17

million premature deaths attributed to NCDs, 37% are caused by CVDs and 82% are in LMIC (World Health Organization, 2017). Because NCDs still pose a global threat, the Sustainable Development Goal (SDG) 3.4 is targeted at reducing by one-third, premature mortality from NCDs through prevention and treatment by the year 2030 (CEPAL, 2019)

Cardiovascular diseases have been implicated to be one of the most common causes of death and morbidity in Ghana. CVD constituted 22.2% of all causes of deaths from autopsy cases at the Korle-Bu Teaching Hospital within 5 years (Sanuade et al., 2014). In Ghana, the proportion of men with a higher likelihood of developing cardiovascular disease was also found to be 45.5% among men in urban areas and 34.7% among men in rural areas (Boateng et al., 2017).

Particulate matter exposure due to air pollution has become a recognizable risk factor for adverse cardiovascular events (Fang et al., 2010). Exposure to particulate matter from multiple combustion sources contributes to CVD (Lee et al., 2019; Pope et al., 2018). Automobile technicians are constantly exposed to harmful chemicals and particulate matter in the work environment that impacts their health negatively (Obianime et al., 2017). Regular exposure to automotive pollutants increases the risk of developing atherosclerosis leading to adverse cardiovascular events among automobile technicians (Akintunde et al., 2019; Sharman et al., 2002).

Though total risk assessment is recommended and the rise in morbidity and mortality associated with CVD is noticeable, individuals and societies, particularly automobile technicians, are unaware of their level of risk. This results in limited and untargeted preventive measures. Also, little is known about the CVD risk among populations whose occupational activity is mainly manual and energy-based resulting in limited literature in the area of CVD risk assessment, particularly among automobile technicians.

This study, therefore, aimed at assessing the risk of developing cardiovascular disease in 10-years among automobile technicians at the industrial area in the Tamale Metropolis. Since CVD and other NCDs are major causes of preventable deaths, it is important that risk assessments are carried out to support decisions and policies that seek to reduce the burden of such conditions. Earlier knowledge of the risk of developing CVD will result in individuals and institutions engaging in practices that will lower the risk. In addition, Studies of this will contribute towards achieving the target of SDG 3.4, which is to reduce premature mortality from NCDs (CEPAL, 2019)

1.3 Justification

Most cardiovascular diseases can be prevented. Cardiovascular disease risk assessment can help identify individuals or groups that may benefit from interventions targeted at reducing risk. Early detection and management are therefore important for individuals at high risk. Premature deaths can be prevented by identifying individuals and groups at the highest risk of CVD and making sure they receive the appropriate treatment.

The development of CVD is gradual. There is a need for a preventive approach to the management of CVDs because once CVD manifests, it is mostly immediately lethal and survivors can seldom be restored to full function (Kannel, 2005). Assessing the risk of developing CVD over time can help with CVD management, especially in people who are not yet symptomatic and may most likely benefit (Francula-Zaninovic & Nola, 2018). Total risk assessment and management have been recommended by cardiovascular prevention guidelines.

Assessment of Cardiovascular Disease Risk among automobile technicians in the industrial area of the Tamale metropolis will contribute to the efficient use of limited resources by targeting individuals and groups that will benefit more. In relation to current health expenditures, the

economic impact of CVD is substantial (Gheorghe et al., 2018). This approach of risk assessment will limit unnecessary treatment and reduce the cost of drugs by about 50% (Mendis et al., 2011).

Estimation of CVD risk can be used to raise the awareness of the population on CVD and to motivate adherence to recommended therapies and lifestyle changes. Knowledge of an individual or a group of their risk of developing CVD over a period will go a long way to support policy formation on the prevention and management of CVDs in the country. This study will also serve as baseline data with which other studies can be compared or the basis on which decisions on CVD management can be taken.

1.4 Conceptual Framework

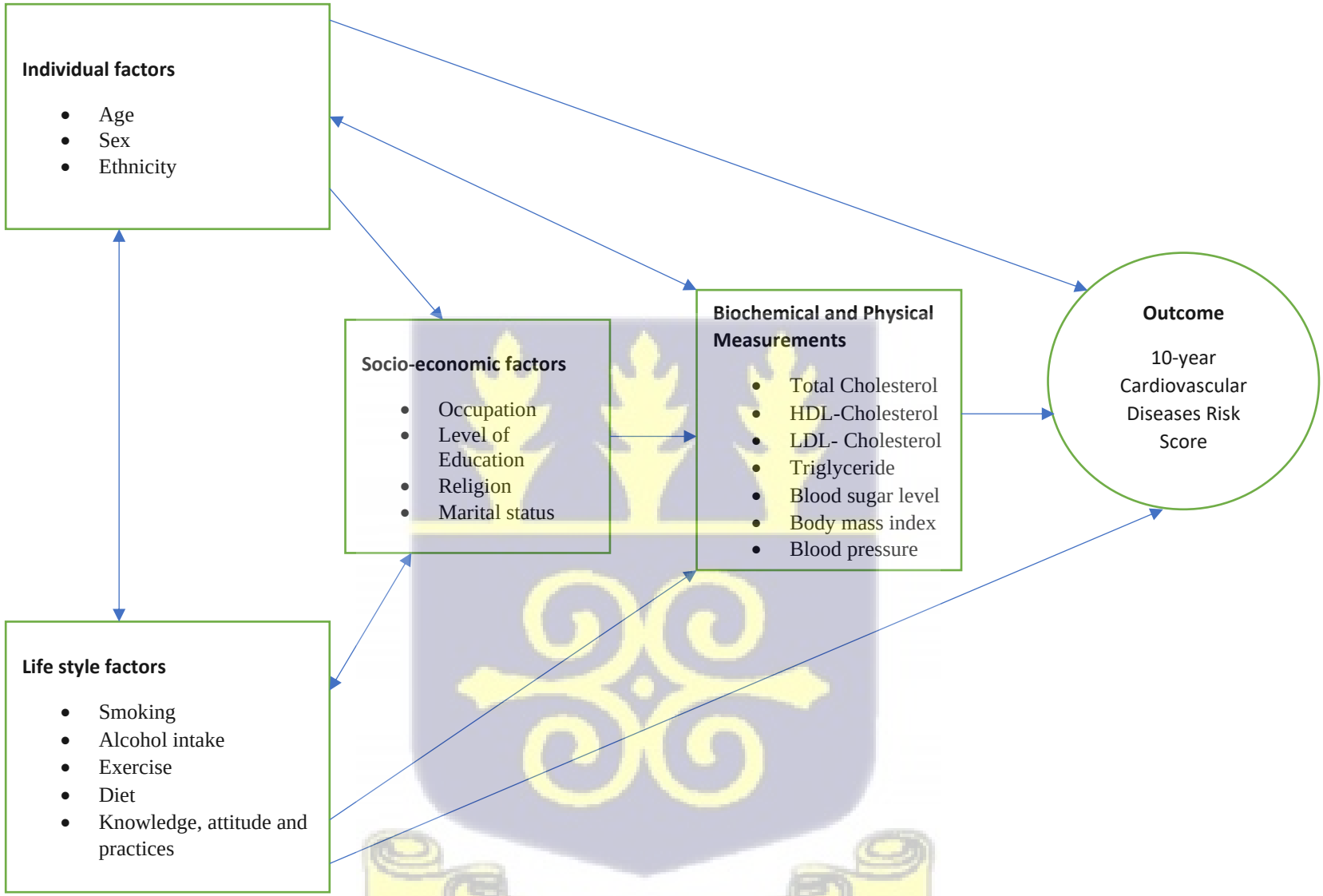

Figure 1 Conceptual Framework

The risk of developing cardiovascular disease is generally influenced by several factors. It is influenced indirectly by non-modifiable risk factors through its effect on the modifiable risk factors and also directly by the non-modifiable risk factors themselves. These modifiable and non-modifiable factors interrelate to cause CVD and can also be regrouped into individual, lifestyle, socioeconomic and biochemical factors.

Individual factors directly influence the outcome, which is the 10-year cardiovascular disease risk score. They are also able to indirectly influence the 10-year CVD risk by influencing or playing a role in the socioeconomic factors and biochemical factors. For instance, the risk of developing CVD increases with age. The older you get, the higher the chances of developing CVD, hence an increasing CVD risk score.

Lifestyle factors such as smoking, alcohol intake, and exercise have a direct effect on the risk of developing CVD in 10 years and an indirect effect on the outcome through its influence on biochemical factors. Tobacco use for instance could result in oxidative stress and endothelial dysfunction leading to CVD. Salt intake, which falls under diet results in or worsens one's hypertensive state which could further result in CVD, and lack of physical exercise will result in dyslipidemia leading to CVD.

Biochemical and physical measurements also do influence the outcome variable. These biochemical factors include the lipid profile and the blood sugar level. Alterations or deviations in the lipid profile result in dyslipidemia. Conditions such as atherosclerosis and ischaemic heart disease could be the consequence of poor lipid and sugar metabolism.

1.5 Research Questions

1. What is the prevalence of cardiovascular disease risk factors among automobile technicians at the industrial area in the Tamale metropolis?
2. What is the distribution of the 10-year cardiovascular disease risk score among automobile technicians at the industrial area in the Tamale metropolis?
3. What are the levels of knowledge, attitude, and practices regarding cardiovascular diseases and cardiovascular disease risk factors among automobile technicians at the industrial area in the Tamale metropolis?
4. What are the factors associated with the 10-year CVD risk among automobile technicians at the industrial area in the Tamale Metropolis?

1.6 Objectives

1.6.1 General Objective

To assess the risk of developing cardiovascular disease in 10 years among automobile technicians at the industrial area of the Tamale metropolis using the Framingham risk score algorithm

1.6.2 Specific Objectives

1. To determine the prevalence of cardiovascular disease risk factors among automobile technicians at the industrial area of Tamale metropolis
2. To determine the distribution of the 10-year cardiovascular disease risk score among automobile technicians at the industrial area of Tamale metropolis
3. To assess the knowledge, attitude, and practices regarding CVD, its risk factors, and prevention among automobile technicians at the industrial area in the Tamale metropolis
4. To determine the factors associated with the 10-year CVD risk score among automobile technicians at the industrial area in the Tamale metropolis

CHAPTER TWO

LITERATURE REVIEW

2.1 Cardiovascular Diseases

Cardiovascular Diseases (CVDs) are diseases of the heart muscle and of the vascular system that supply the brain, heart, and other vital organs (Gaziano et al., 2006). These conditions affect the functions and structures of the heart. They include rheumatic heart disease, coronary heart disease, cerebrovascular disease, peripheral arterial disease, deep vein thrombosis, and congenital heart disease, (WHO, 2017). Symptoms associated with CVDs vary based on the specific conditions. However, pain in the chest, shortness of breath, fatigue, nausea, dizziness, cold sweats, lightheadedness, and pain in the left shoulders are typical of an underlying cardiovascular issue.

2.2 The Global Burden of CVD

Globally, CVD is one of the leading causes of death. In 2016, it was estimated that 17.9 million individuals died from CVD globally, and this represents 31% of all deaths (Tulu et al., 2021; World Health Organization, 2017). In 2016, ischemic heart disease (IHD) was the leading cause of the worldwide burden of CVD, followed by stroke, which accounted for 33% of all CVD cases. Hypertensive heart disease, cardiomyopathy, atrial fibrillation, endocarditis, and other cardiovascular diseases account for relatively small proportions of the total CVD burden (Thomas et al., 2018). Even in some regions where other causes of mortality such as injuries, nutritional deficiencies, respiratory infections, and HIV/AIDS play the main role, CVD is now an important cause of mortality (Gaziano et al., 2006).

2.3 The Burden of CVD in Sub-Saharan Africa

There is a great concern that the morbidity and mortality burden of CVD is increasing rapidly in Low and Middle-Income Countries (LMIC) within which countries in sub-Saharan Africa can be

classified (Mensah et al., 2015). LMICs account for about 80 percent of global CVD mortalities (Gaziano et al., 2006). In sub-Saharan Africa, the rise in the incidence of Non-Communicable Diseases (NCDs), particularly CVDs can be accounted for by countries currently experiencing an epidemiological transition characterized by changing lifestyle factors and increased urbanization (BeLue et al., 2009). Death associated with CVD in sub-Saharan Africa constitutes 8.8% of all deaths. However, these deaths occur on average at younger ages than it is for the rest of the world (Moran et al., 2013). In 2013, nearly one million deaths were caused by CVD in sub-Saharan Africa. This constituted 38.3% of NCD deaths and 11.3% of deaths from all causes (Mensah et al., 2015).

2.4 The Burden of CVD in Ghana

In Ghana, the burden of CVD is on the rise and this is driven by the significant behavioral changes in the country as a result of globalization (Ofori-Asenso & Garcia, 2016). CVD has been identified as one of the common causes of mortality in Ghana (World Health Organization, 2010). In 2008, CVD was the leading cause of institutional deaths. It accounted for 14.5% of total mortalities compared to 13.4% from malaria in the country (Bosu, 2013). According to the WHO, the likelihood of dying from cancer, chronic respiratory illness, CVD, or diabetes between age 30 and 70 years in Ghana was 20.8% for both sexes, 18.2% for males, and 23.2% for females in 2016 (WHO, n.d.). Between 2004 and 2014, there was a 78% increase in CVD admissions with heart failure, ischaemic heart disease and dysrhythmias being the top 3 causes of CVD admissions in a tertiary medical center in Ghana (Appiah et al., 2017).

2.5 Risk Factors of CVD

There are several risk factors associated with the development of CVDs. These risk factors can be classified as either non-modifiable or modifiable. Below are the risk factors of CVD;

2.5.1 Age

Age, a known risk factor of CVD is generally considered non-modifiable for obvious reasons (Dhingra & Vasan, 2012). Aging is inevitable. The process of aging is associated with a gradual deterioration in the heart's structure and function, contributing to the development of CVD (Costa et al., 2015). The most important determinant of cardiovascular health is age (North & Sinclair, 2012). It is included as a predictor in all risk prediction models used in assessing an individual's CVD risk (Dhingra & Vasan, 2012).

Though an independent risk factor, the lifetime risk for people whose lifestyle risk factors remain unchanged is lower at age 70 than 50 (Dhingra & Vasan, 2012). In the same vein, the lifetime risk of CVD does not continue to increase with age for hypertension (Vasan et al., 2002), heart failure (Lloyd-Jones et al., 2002), and stroke (Seshadri et al., 2006). The burden of age-associated CVD risk can be reduced in part by the modification of other coexisting risk factors (Dhingra & Vasan, 2012).

2.5.2 Sex

Diseases are expressed differently in men and women due to sex-related physiological differences (Mikkola et al., 2013). Though seen as men's disease, CVD is less common in men than in women but generally assumed in medicine that the effects of major risk factors on CVD outcomes are the same for both sexes (Appelman et al., 2015). Sex is also a non-modifiable risk factor for CVD. The manifestation of CVD is different in men and women (Maric-Bilkan et al., 2016). This difference in sex manifestation suggests that the biomedical principles in the male may not apply equally to the female (P. et al., 2017). Except for prolonged smoking that was found to be significantly hazardous for women than for men, the effects of risk factors such as obesity, elevated

blood pressure, elevated cholesterol, obesity, and overweight on CVD outcomes was found to be largely similar between men and women (Appelman et al., 2015).

2.5.3 Obesity

Obesity has been on the rise across every age, race, and sex. with most individuals in the highest weight groups (BMI > 40 Kg/m2) than in the lower BMI categories (BMI<35 Kg/m2) (Wright & Aronne, 2012). The global prevalence has doubled since 1980, with close to a third of the population in the world being classified now as either obese or overweight (Chooi et al., 2019). Obesity is associated with an increased likelihood of developing metabolic syndrome, type 2 diabetes, and cardiovascular disease (Phillips, 2013). Localization of excess fat in the muscles, liver, and visceral adipose tissue has been associated with a greater cardiometabolic risk (Chooi et al., 2019).

In epidemiological studies, body mass index (BMI) is typically used to determine obesity, however, it is low in sensitivity due to the variability in body fat partly due to age, ethnicity, and sex (Chooi et al., 2019). In dealing with obesity, most practitioners will need to measure only height, weight, and sometimes waist circumference to enable them to estimate a patient's risk for related co-morbidities such as CVD and diabetes mellitus, and appropriate treatment measures established (Purnell, 2018). The manifestation of obesity in men and women is different. Women have more generalized but less central obesity than men, whereas men have more central but less generalized obesity than women (Purnell, 2018)

2.5.4 Diabetes

Diabetes is a chronic illness characterized by high blood glucose levels and disruption in fat and protein metabolism (Roglic, 2016). It is a common endocrine disorder and affects about 6% of the world's population (Adeghate et al., 2006). Diabetes has become an important public health

condition mainly due to the increase in its prevalence fueled by obesity over the last decade, the mortality, morbidity, reduced life expectancy, and cost of management (Forouhi & Wareham, 2010).

The two main reasons for the increasing prevalence are an aging population and obesity (Kaul et al., 2013). Diabetes can be caused by genetic and environmental factors. For diabetes to become overt, there may have to be an interplay between environmental and genetic factors. Environmental factors that may result in diabetes include viral infection, drugs, and toxic agents, physical inactivity, and obesity (Adeghate et al., 2006).

Diabetes has an economic impact on healthcare systems, national economies, and individuals. It is estimated that a total of 1.7 trillion US dollars losses in gross domestic product with 800 billion US dollars for low and middle-income countries is a result of the direct and indirect costs of diabetes (Roglic, 2016). In 2012 and 2013, 1.5 to 5.1 million people per year died as a result of diabetes, making it the 8th leading cause of death globally with a prediction that about 592 million people will die by the year 2035 (Tao et al., 2015).

2.5.5 Hypertension

Hypertension is the leading cause of CVD. It's a risk factor with a rising prevalence all over the world, particularly in LMIC (Mills et al., 2020). In order to lower the risk of renal disease, cerebrovascular disease, and cardiovascular disease, adherence to prescribed medication is required (Hamilton, 2003).

Even though women have lower blood pressure in the reproductive years when compared to men, women account for half of all CVD-related deaths, resulting in a higher CVD incidence in older women than in men of the same age (Colafella & Denton, 2018). Hypertension is a common

comorbidity with type 2 diabetes, and it is two times more frequent in patients with diabetes compared to those without (Petrie et al., 2018).

Risk factors of hypertension include alcohol consumption, high sodium intake, physical inactivity, low potassium intake, unhealthy diet, and obesity. Reduction in these risk factors are recommended for the control and prevention of hypertension (Mills et al., 2020).

2.5.6 Smoking

Tobacco use, including smoking, are modifiable risk factors for CVD and preventable causes of death (Erhardt, 2009). Smoking is associated with an increased risk of CVD because smokers experience side effects such as insulin resistance and increased catecholamines that contribute to increased blood pressure and heart rate, and hypercholesterolemia (Campbell et al., 2008).

Similar to smoking 20 cigarettes per day, there is a 40 to 50% increased risk of CVD linked with smoking one cigarette per day (Le Bras, 2018). Cigarette smoking increases triglycerides, total cholesterol, and low-density lipoprotein whiles acting to decrease cardioprotective high-density lipoprotein (Campbell et al., 2008).

Though maximum implementation of smoking cessation therapies is lacking, smoking cessation is a cost-effective way to reduce the risk of CVD and improve cardiovascular health among smokers (Erhardt, 2009). The significance of quitting smoking in the prevention of CVD is highlighted in the adverse effects of all forms of smoking (Katsiki et al., 2013).

2.5.7 Dyslipidaemia

Dyslipidemia is an established risk factor for CVD. It is defined as increased serum concentrations of total cholesterol, increased serum concentration of low-density lipoproteins, increased serum concentrations of triglycerides, or a decreased serum concentration of high-density lipoprotein

(Hedayatnia et al., 2020). Globally, hypercholesterolemia has been estimated to cause 18% of strokes and 56% of ischemic heart disease, resulting in 4.4 million deaths every year (Chandra et al., 2014). The progressive decline in dyslipidemia in developed countries is not the same for LMIC (Agongo et al., 2018).

Persons with a favorable lipid profile have a reduced incidence of CVD (Kopin & Lowenstein, 2017). Dyslipidemia causes an increase in blood pressure by causing endothelial damage that results in loss of physiological vasomotor activity (Halperin. et al., 2006). The risk of a stroke or a myocardial infarction can be increased by an imbalance between LDL-C and HDL-C (Gebreegziabiher et al., 2021), and the development of atherosclerosis is aggravated by the presence of dyslipidemia in general (Cziraky, 2004).

2.6 Pathophysiology of CVD

The high incidence of CVD cannot be explained adequately by classic risk factors such as diabetes mellitus, gender, smoking, age, dyslipidemia, obesity, family history, and hypertension (Marinou et al., 2010). There is, therefore, a tendency for CVD risk factors to cluster and interact to promote CVD risk because the pathophysiology of most of the CVD risk factors is similar (Waindim, 2015). Treatment targeted at risk factors such as lowering blood pressure, controlling plasma lipid levels, and controlling diabetes does not eliminate the risk of CVD (Yusuf et al., 2004).

Though the relationship between hypertension and obesity has been well established, the mechanism through which hypertension is caused by obesity is not well established (Kotsis et al., 2010). Excess calories as a result of the imbalance between energy expenditure and intake results in varying disorders which are all major CVD risk factors (Kang, 2013). Studies have revealed that extracellular fluid expansion due to sodium retention, inflammation, high plasma renin

activity, increased aldosterone levels, activation of the renin-angiotensin-aldosterone system, endothelial dysfunction, and insulin resistance are some possible mechanisms of hypertension induced by obesity (Kang, 2013; Kotsis et al., 2010; Yusuf et al., 2004).

The pathophysiology of the link between diabetes and CVD is that of a multifactorial and complex one (Dokken, 2008). Diabetes is linked with increased levels of serum total cholesterol, reduced levels of serum high-density lipoprotein, increased serum levels of low-density lipoprotein, and increased serum levels of triglycerides, (Dokken, 2008; Smith & Lall, 2008). Diabetes and hypertension occur together frequently. With inflammation, insulin resistance, obesity, and oxidative stress thought to be the common pathways, there is a substantial overlap in the aetiology and mechanism of hypertension and diabetes (Cheung & Li, 2012).

Dyslipidemia is one of the main driving forces behind the progression of cardiometabolic disorders and is an important link between obesity and diabetes, hypertension, and CVD (Su et al., 2021). Though it predisposes individuals to CVDs, the mechanism is not well understood (Liu & Li, 2015). Serum lipids can lead to cardiac dysfunction by accumulating in circulation, inducing inflammation and oxidative stress, interfering with the mitochondrial function of cells in the heart, and decreasing microvascular density and autophagy (Yao et al., 2020). Dyslipidemia causes loss of physiological vasomotor activity and endothelial dysfunction, leading to systemic hypertension and increasing the chance of CVD (Dalal et al., 2012).

2.7 Cardiovascular Disease Risk Prediction

Cardiovascular disease risk prediction is essential in the prevention of CVDs. The purpose of CVD risk predictions is to triage decisions on starting, discontinuing, or intensifying preventive medication, and to support informed treatment (Rossello et al., 2019). The use of CVD risk prediction tools is recommended by guidelines on the prevention of CVD (Cooney et al., 2016).

In the past decades, several models for predicting the risk of cardiovascular disease have been developed (Hajifathalian et al., 2015). These models combine predictors mathematically to estimate the CVD risk (Damen et al., 2016). CVD risk prediction models include the Systematic Coronary Risk Evaluation (SCORE), the QRISK mainly used in the United Kingdom, and the Framingham Risk Score (FRS) (Hasabullah et al., 2020).

The Framingham Risk Score algorithm is the first to be conceptualized in respect of CVD assessment and it has been validated in several populations across the world (Bitton & Gaziano, 2010). It makes use of sex, age, smoking status, diabetes, cholesterol profile, treatment of hypertension, and blood pressure to estimate the likelihood of getting a cardiovascular event in 10 years (Bitton & Gaziano, 2010; Devine & Taylor, 2009).

The Systematic Coronary Risk Evaluation (SCORE) is the most preferred by the European Society of Cardiology. It was developed from 12 European cohort studies and (Bitton & Gaziano, 2010; Piepoli et al., 2016). The CVD risk is calculated by a mathematical combination of age, sex, smoking status, systolic blood pressure, and cholesterol level (Piepoli et al., 2016).

The QRISK is used mainly in the UK (Hasabullah et al., 2020). It is recommended updated annually and recommended for use by the National Institute for Health and Care Excellence in the UK and updated annually (Bitton & Gaziano, 2010; Collins & Altman, 2010). The SCORE algorithm incorporates sex, age, ethnicity, smoking status, systolic blood pressure, antihypertensive medication, cholesterol/HDL ratio, weight, height, rheumatoid arthritis, stage of chronic kidney disease, diabetes, atrial fibrillation, and angina (Collins & Altman, 2010).

2.8 Prevention of CVDs

The majority of the global CVD burden can be accounted for by modifiable risk factors. The burden of CVD can therefore be reduced by controlling these risk factors (Feigin et al., 2015, 2016). A population health approach –'prevention is better than cure' is, therefore, the most suitable approach in dealing with CVDs (Buttar et al., 2005). Maintenance of normal blood pressure, being physically active, eating a healthy diet, lowering serum cholesterol and glucose levels, smoking cessation and reduced alcohol consumption are some important interventions that can contribute to reducing the risk of CVD (Hobbs, 2004). Preventive measures in dealing with CVDs include primordial, primary, secondary, and tertiary prevention.

Primordial prevention of CVDs focuses on avoiding the development of risk factors of CVD in the first place and maintaining cardiovascular health (Patel & Daniels, 2020; Siddiqui, 2021). These activities prevent the development of risk factors through the establishment of sociobehavioural, environmental, cultural, and economic patterns that influence lifestyle (Pandian et al., 2018).

Primary prevention refers to the treatment of risk factors once they develop (Patel & Daniels, 2020; Siddiqui, 2021). In primary prevention, steps are taken by individuals to prevent disease onset (Karunathilake & Ganegoda, 2018). These steps may be lifestyle modifications such as exercising, smoking cessation, eating a healthy diet, reducing alcohol consumption, and maintaining a healthy weight. They may also be the use of lipid-lowering therapy to improve the lipid levels (Stewart et al., 2017).

Through early diagnosis, secondary prevention focuses on minimizing the impact of the disease thereby limiting life-threatening situations and permanent damage. Secondary prevention involves the identification of risk factors and determining how the variation in these risk factors affects

CVD (Karunathilake & Ganegoda, 2018). Tertiary prevention comes to play when a long-term event set in. It focuses on managing pain, increasing the quality of life, and increasing the life expectancy of patients (Karunathilake & Ganegoda, 2018).

2.9 Conclusion of Literature Review

The literature review section summarized literature on CVD, its burden, risk factors, prevention and the 10-year CVD risk score. There was a a noticeable gap in respect of the prevalence and distribution of CVD risk factors among special subgroup populations, particularly automobile technicians. As deaths from CVDs are preventable, studies aimed at answering questions in relation to CVD among subgroup populations such as automobile technicians will be useful is developing targeted interventions.

CHAPTER THREE

METHODS

3.1 Study Design

The study was a cross-sectional study carried out from June to July 2021 among automobile technicians in the industrial area of the Tamale metropolis. Data on modifiable and non-modifiable risk factors of CVD were collected for each participant with the aid of a semi-structured questionnaire, knowledge, attitude, and practices assessed, blood samples collected for laboratory analysis, and the risk of developing CVD in 10 years was estimated.

3.2 Study Area

The study was carried out at the industrial area in the Tamale metropolis. It is the hub of automobile technicians in the metropolis. In addition to these technicians, several other business entities that deal in the sale of vehicle spare parts, food, and general merchandise can be found there. Tamale is the regional capital of Ghana's Northern Region and is home to the Mole-Dagomba ethnic group, with other ethnic groups such as Akans, Gas, and Ewes making up the minority. According to the 2010 census, it has a population of 371,351, making it Ghana's third-largest settlement and West Africa's fastest-growing city. The majority of residents (90.5%) are Muslims, with a small minority belonging to other religious sects. Most of the indigenous people are traders, with many others practicing other informal jobs.

3.3 Study Population

The population for the study was made up of automobile technicians at the industrial area of the Tamale metropolis who aged 20 years or older and willing to partake in the study.

3.4 Sample Size Determination

Using Cochran's (1977) sample size formula, below is the calculation of the minimum sample size that was required for this study:

$$n = \frac{z^2 \text{ x } p(1-p)}{d^2}$$

where n represents the minimum sample size, z represents confidence level 95% (standard value of 1.96), d represents acceptable error margin (5%), and p the estimated prevalence of CVD among automobile technicians. A prevalence of 13.8% as estimated by Pyakurel et al., (2016) among industrial workers in Nepal was used for the sample size calculation. The minimum sample size for this study was then calculated as follows

$$n = \frac{1.96^2 \text{ x } 0.138(1-0.138)}{0.05^2}$$

$$n = \frac{3.8416 \text{ x } 0.138(0.862)}{0.0025}$$

$$n = 182.79 \approx 183$$

Therefore, the minimum sample size for this study was 183 automobile technicians. A total of 210 was however collected because of the availability of extra resources

3.5 Sampling technique

A multi-stage sampling approach was employed in this study. The sampling frame of automobile technician shops in the industrial area was retrieved from the Business Advisory Center (BAC) of the Tamale metropolis.

Each shop was treated as a cluster. With a cluster size of 3, the minimum number of shops that were selected based on the estimated sample size for this study was 61. The shops were selected

using a simple random selection approach by assigning numbers to the shops in the sampling frame and drawing at random the shops to be included.

Three automobile technicians in each of the selected shops were then recruited for the study. Where the technicians who qualified for selection in a shop were more than 3, the 3 participants required were selected by balloting. However, if the qualified technicians in a shop were less than or equal to 3, they were all recruited.

3.6 Inclusion Criteria

All automobile technicians at the industrial area in the Tamale metropolis who were at least 20 years old were included in the study. This is because the Framingham risk assessment tool used was meant for individuals who were greater than or equal to 20 years.

3.7 Exclusion Criteria

The study excluded automobile technicians who were absent from work, or ill at the time of the study.

3.8 Study Variables

3.8.1 Dependent Variable

In this study, was the 10-year cardiovascular disease risk score was the dependent variable. It was estimated by using the Framingham risk assessment tool and guidelines. Based on categorical values of systolic blood pressure, age, treatment of hypertension, smoking, high-density lipoprotein, and total cholesterol, participants received a point score. These point scores were then added to get the total risk points and the total risk points used to obtain the corresponding 10-year CVD risk score with the aid of the Framingham chart. The risk scores were then categorized as low risk for less than 10%, moderate risk for 10% to 20%, and high risk for greater than 20%.

Table 1 Operational definition of the dependent variable

Variable	Operational definition	Scale of measurement	Source of data
10-year CVD risk score	The risk of developing cardiovascular disease in 10 years	Ordinal - Low risk (a 10-year CVD risk score of < 10%) - Moderate risk (a 10-year CVD risk of 10% - 20%) - High risk (a 10-year CVD risk of > 20%)	Interview Laboratory analysis Anthropometric measurements

3.8.2 Independent Variables

The independent variables were classified into individual factors, socioeconomic factors, lifestyle factors, and biochemical factors. Individual factors that were measured included age, sex, blood pressure, and body mass index, knowledge, attitude, and practices of participants. Socioeconomic factors that were measured included occupation, level of education, marital status, and religion. Lifestyle factors that were assessed included exercise, smoking, and alcohol intake. Biochemical factors that were measured included the blood glucose level, total cholesterol, low-density lipoprotein, triglycerides, and high-density lipoprotein. Table 2 below shows the operational definitions of the independent variables

Table 2 Operation definition of independent variables

Variable	Operational Definition	Scale of measurement	Source of data
Sex	Being a female or a male	Nominal - Male - Female	Observation
Age	Age (in years) of the participant at the last birthday	Ratio	Interview
Marital status	Relationship status with a partner as per law	Nominal - Never married - Currently married - Divorced - Widowed	Interview
Highest level of education	Highest level of formal education attained	Ordinal - No formal education - Primary school - Junior High School - Senior High School - Tertiary	Interview
Religion	Religious denomination	Nominal - African Traditional Religion - Christian - Islam	Interview

Variable	Operational Definition	Scale of measurement	Source of data
Body Mass Index (BMI)	The body mass index, calculated by dividing the weight by the square of the height	Ratio	Measurement of weight and height
BMI category	Grouping BMI into categorical variables	Ordinal - Underweight (a BMI of less than 18.5 Kg/m^2) - Healthy weight/ normal weight (a BMI 18.5 to 24.9 Kg/m^2) - Overweight (a BMI 25.0 to 29.9 Kg/m^2) - Obese (a BMI of 30.0 Kg/m^2 and above)	Measurement of weight and height
Work experience	Number of completed years of work as an automobile technician	Ordinal - Less than 10 years - 10 to 19 years - 20 to 29 years - 30 to 39 years - Greater than 40 years	Interview

Variable	Operational Definition	Scale of measurement	Source of data
Job category	Specialty of work as an automobile technician	Nominal - Auto electrician - Auto mechanic - Pump technician - Welding and fabrication technician	Interview
Ownership of workshop	Whether the workshop is the property of the participant	Nominal - Yes - No	Interview
Stage of work	Whether the participant is under training or not	Nominal - Master - Apprentice	Interview
Use of personal protective equipment	Using safety equipment such as gloves, goggles, and booths during work	Nominal - Yes - No	Interview Observation
Hypertension	Having ever been diagnosed of hypertension, or use of antihypertensives, or an elevated BP measurement (≥140/90 mmHg)	Nominal - Yes - No	Interview Measurement of blood pressure with a sphygmomanometer

Variable	Operational Definition	Scale of measurement	Source of data
Diabetes	Random blood glucose level greater than or equal to 11.1 mmol/L or use of any hypoglycemic agent	Nominal - Yes - No	Interview Measurement of blood glucose
Smoking	Currently smoking or having ever smoked	Nominal - Yes - No	Interview
Alcohol consumption	Having ever taken alcohol or currently taking alcohol	Nominal - Yes - No	Interview
Knowledge score	The aggregate of scores from knowledge assessment questions.	Ordinal - Poor (a total score of less than 50%) - Moderate (a total score of 50% to 79%) - Adequate (a total score of 80% to 100%)	Interview

Variable	Operational Definition	Scale of measurement	Source of data
Attitude score	The aggregate of scores from attitude assessment questions.	Ordinal - Poor (a total score of less than 50%) - Moderate (a total score of 50% to 79%) - Adequate (a total score of 80% to 100%)	Interview
Practices score	The aggregate of scores from practices assessment questions.	Ordinal - Poor (a total score of less than 50%) - Moderate (a total score of 50% to 79%) - Adequate (a total score of 80% to 100%)	Interview

3.9 Measurement of Weight and Height

Weight was measured in light clothing to the nearest 0.1kg with the aid of a weighing scale manufactured by SECA (Hamburg, Germany). Using a portable microtoise tape measure manufactured by SECA (Hamburg, Germany), height was also measured to the nearest 1cm then converted to meters.

3.10 Measurement of Blood Pressure

Blood pressure was measured with the aid of an automated blood pressure apparatus (Omron M3, HEM-7155-e, Omron Corporation, Japan) in a sitting position after subjects were made to sit for at least five (5) minutes per the recommendation of the American Heart Association (Muntner et al., 2019). Triplicate measurements were taken with a five (5) minute rest interval between measurements and the mean value recorded to the nearest 2.0 mmHg.

3.11 Blood Sample Collection and Processing

With the aid of a vacutainer set, 5 mL of blood was collected into a serum separator gel tube and Fluoride oxalate-containing tube under aseptic conditions. The samples were well labeled and transported immediately on ice to the laboratory where they were centrifuged for 5 minutes at a speed of 3000 rpm. Serum from the gel tubes and plasma from the fluoride samples were then aliquoted into cryotubes, labeled, and stored at -70^{o}C until the time for biochemical assay. COVID 19 safety protocols were strictly adhered to. Appropriate precautionary measures to fight COVD 19 were ensured. These measures included the wearing of a face mask, social distancing, hand washing, and the use of hand sanitizers. Participants were provided with a face mask and given education on COVID 19 safety protocols. Study participants were not put together in a group, but they were attended to on a one-on-one basis.

3.12 Biochemical Analysis

Lipid profile (total cholesterol, high-density lipoprotein, low-density lipoprotein, and triglycerides) and blood glucose were measured using an automated Mindray BS-240 (Mindray, China) and Medsource Diagnostic reagents according to the manufacturer's instruction.

In brief, serum from the samples was brought out of the freezer and allowed to thaw at room temperature. These samples were then aliquoted and fed to the machine which operates using the

principle of spectrophotometry. The reagents were added to the serum in predetermined proportions by the machine, incubated and change in absorbance read at a wavelength of 454nm. The concentration of the analyte is directly proportional to the change in absorbance.

3.13 Measurement of Knowledge, Attitude and Practices Score

Knowledge, attitude and practices was measured through an interview with the aid of a questionnaire. Knowlegde, attitude, and practices were treated as separate arms and a set of 10 questions were used to determine the score of each arm. A correct answer to each question was worth 1 point and the score was determnined by adding the number of points made under each arm. Final scores were converted into percentages by diving the number of points made by 10 and multiplying by 100. The maximum point for each arm was 100% and the minimum was 0%. The cutoff point for poor was total scores less than 50%, moderate was a total of 50% to 79% and adequate was a total of 80% to 100%

3.14 Ten-year (10-year) CVD Risk Scoring

For each participant, the 10-year CVD risk score was estimated with the aid of the Framingham risk scoring algorithm as described by Schisterman & Whitcomb, (2004). For each category, participants were assigned a score based on conditions such as sex and age. The various risk scores were then added to get the total risk points and the total risk points used to obtain the corresponding 10-year CVD risk score with the aid of the Framingham chart.

3.15 Data Collection techniques

Data was collected through a face-to-face administration of a questionnaire to respondents. A semi-structured questionnaire was used to extract information on age, sex, weight, blood pressure, diabetes status, smoking, alcohol consumption, hypertension, height, knowledge, attitude, and practices of each participant. Data on laboratory measures of blood glucose and lipid profile were

also recorded after testing and matched to the appropriate semi-structured questionnaire for each participant.

3.16 Data collection tools

The data collection tool for this study was a semi-structured questionnaire. This was designed to collect data on personal information, modifiable, and non-modifiable risk factors of CVD for each participant. It was also used to collect data on the knowledge, attitude, and practices of the participants.

3.17 Quality control

Healthcare workers with skills in blood sample collection and transport were recruited and trained as research assistants. Training on data collection methods and research ethics was carried out for the research assistants to harmonize understanding and ensure similar ways of data collection to minimize errors during data collection. Data collectors were closely supervised during data collection and collected data checked for completeness and accuracy.

The questionnaire for data collection was pretested among randomly selected automobile technicians within the Tamale metropolis to enable the identification of errors, correction of errors, and streamlining the questionnaire before the study.

3.18 Data Storage and Processing

Data collected password protected on a computer. Codes were used to identify participants. The data collected on the sheets were checked for errors and missing values. After that, the data was entered into Microsoft Excel, double-checked for errors again, and then exported to STATA I/C 15 (Stata Corp LLC, Texas, USA) for analysis.

3.19 Data Analysis

Data was analyzed using STATA I/C 15 (Stata Corp LLC, Texas, USA). Categorical variables were described using percentages and proportions whiles mean ± SD was used for continuous variables. Chi-square test was used to compare categorical variables. Univariate and multivariate ordinal logistic regression was conducted to determine factors associated with the 10-year CVD risk score among participants. Independent variables with a p-value of 0.1 at the univariate level were used in a multivariate analysis. The model with the best Bayesian's Information Criterion (BIC) and Akaike's Information Criterion (AIC) was selected. The significance level was set at 5% for all associations. Regression diagnostic was performed to assess to assess for collinearity. Variables with a Variance inflation factor (VIF) of greater than 5 was taken out of the model. Below is a table of how data were analyzed per objective.

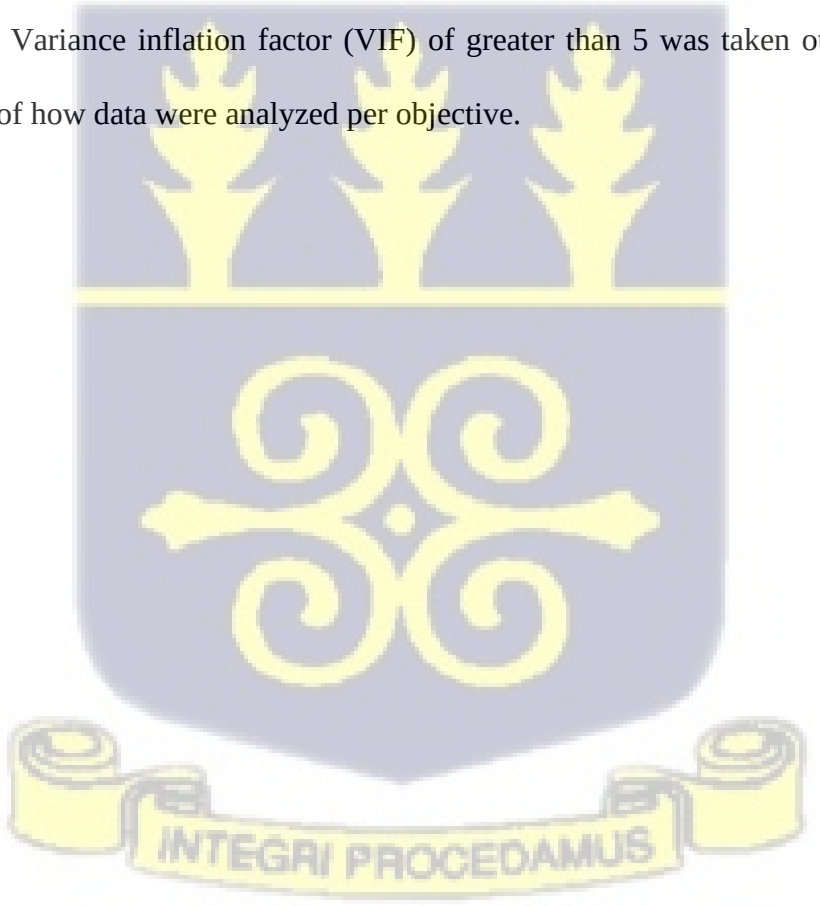

Table 3 Data analysis per specific objective

Specific objective	Statistical analysis
To determine the prevalence of CVD risk factors among the automobile technicians at the industrial area in the Tamale Metropolis	- Frequencies and proportions
To determine the distribution of the 10-year CVD risk among the automobile technicians at the industrial area in the Tamale Metropolis	- Frequencies and Proportions - Chi-square/ Fisher exact test
To assess the knowledge, attitude, and practices regarding CVD and its risk factors among the automobile technicians at the industrial area in the Tamale Metropolis	- Frequencies and Proportions - Chi-square/ Fisher exact test
To determine the factors associated with the 10-year CVD risk among the automobile technicians at the industrial area in the Tamale Metropolis	- Univariate ordinal logistic regression - Multivariate ordinal logistic regression

3.20 Ethical Considerations

Ethical approval was sought from the Ghana Health Service Ethical Review Committee (GHS-ERC). Approval was granted on the 3rd June 2021 with GHS-ERC 051/04/21 as the GHS-ERC number. Approval was also sought and granted by the Tamale Metropolitan Assembly before the commencement of the study.

Informed consent was obtained from each participant to ensure voluntary participation in the study. They were informed of their right to withdraw from the study at any time during the study.

Participants who agreed to partake in the research were made to endorse the informed consent form. The endorsement of the form was either with a signature or a thumbprint. Participants' names were not taken in order to maintain anonymity. The completed questionnaires were kept under lock and key, and no third parties were allowed to handle them.

The completed questionnaires will be stored for no more than one year before being destroyed by burning.

3.21 Sponsorship

The Ghana Field Epidemiology Laboratory Training Program (GFELTP) in collaboration with the West African Health Organization (WAHO) supported this study.

CHAPTER FOUR

RESULTS

4.1 Characteristics of the Study Population

Table 4 shows the characteristics of the study participants. They were all (210) males with the majority (32.38%) being within the 20 to 29 years age group. The median age was 36years (IQR: 27,49) and 134/210 (63.81%) were under training (apprentice). Most of the participants were Muslims (91.60%), currently married (76.67%), and had no formal education (37.60%). Of the total, the majority (71.90%) were auto mechanics and 61 (29.05) were the owners of the workshops visited.

Table 4 Characteristics of Study Participants

Variable	Frequency (N=210)	Percentage
Age group (years)		
20 – 29	68	32.38
30 – 39	48	22.86
40 – 49	43	20.48
50 – 59	30	14.29
>60	21	10.00
Highest Level of education		
No formal education	79	37.60
Primary School	21	10.00
Junior High School	49	23.33
Senior High School	45	21.43
Tertiary	16	7.62
Marital Status		
Never married	46	21.90
Currently married	161	76.67
Widowed	1	0.48
Divorced	2	0.95
Religion		
African Traditional Religion	4	1.90
Christianity	13	6.19
Islam	193	91.90
Work experience (years)		
Less than 10	81	38.57
10 – 19	60	28.57
20 – 29	32	15.24
30 – 39	16	7.62
Greater than 40	21	10.00
BMI classification		
Underweight	9	4.29
Normal weight	115	54.76
Overweight	60	28.57
Obese	26	12.38
Job category		
Auto electrician	8	3.81
Auto mechanic	151	71.90
Pump technician	4	1.90
Welding and fabrication	47	22.38
Own the workshop		
No	149	70.95
Yes	61	29.05
Stage of work		
Apprentice	134	63.81
Master	76	36.19
Use of personal protective equipment		
No	98	46.67
Yes	112	53.33

4.1.1 Anthropometric, Hemodynamic, and Biomechanical parameters of study participants

The mean weight and height of study participants were 72 ± 17.5 Kg (95% CI: 70.30, 74.94) and 17.6 ± 0.73 m (95% CI: 16.96, 17.12) respectively. The mean BMI of the participants was 24.98 ± 5.92 Kg/m^2 and within the healthy weight range but very close to being overweight. The mean total cholesterol, triglycerides, and LDL cholesterol were 156.33 ± 45.80 mg/dL, 127 ± 75.56 mg/dL, and 74.79 ± 26.40 mg/dL respectively and within the desirable range whiles the mean HDL cholesterol (56.11 ±18.63 mg/dL) was below the desirable levels (Table 5).

Table 5 Anthropometric, Hemodynamic, and Biomechanical parameters of study participants

Variable	Mean ± SD	95% Confidence Interval
Weight (Kg)	72 ± 17.05	70.30 - 74.94
Height (m)	17.06 ± 0.73	16.96 – 17.12
Body mass (Kg/m2)	24.98 ± 5.92	24.18 – 25.79
Systolic Blood Pressure (mmHg)	131.71 ± 20.38	128.94 – 134.49
Diastolic Blood Pressure (mmHg)	83.38 ± 14.38	81.42 – 85.33
Total Cholesterol (mg/dL)	156.33 ± 45.80	150.10 – 162.56
Triglycerides (mg/dL)	127.11 ± 75.56	116.83 – 137.39
HDL Cholesterol (mg/dL)	56.11 ±18.63	53.58 – 58.65
LDL Cholesterol (mg/dL)	74.79 ± 26.40	71.20 – 78.38
Random Blood Glucose (mmol/L)	6.49 ± 2.12	6.20 – 6.78

4.2 Prevalence of CVD risk factors

The most prevalent CVD risk factor was hypertension and the least prevalent risk factor was alcohol intake. The prevalence of alcohol intake and hypertension among the study participants was 2.38% (95% CI: 0.78, 5.47) and 32.86% (95% CI: 26.55, 39.66), respectively. The prevalence of obesity was 12.38% (95% CI: 8.25, 17.61) among the study participants (Table 6).

Table 6 Prevalence of CVD risk factors among Automobile Technicians

Risk factor	Frequency (N=210)	Percentage	95% confidence interval
Hypertension	69	32.86	(26.55 - 39.66)
Diabetes	10	4.76	(2.31 - 8.58)
Obesity	26	12.38	(8.25 - 17.61)
Smoking	24	11.43	(7.46 - 16.53)
Alcohol	5	2.38	(0.78 - 5.47)
High Cholesterol	39	18.57	(13.55 - 24.50)
High Triglycerides	65	30.95	(24.77 - 37.68)
High LDL	39	18.57	(13.55 - 24.50)
Low HDL	49	23.33	(17.79 - 29.65)

4.2.1 Distribution of CVD Risk Factors

Prevalence of hypertension was significantly low (p=0.029) among auto mechanics (27.2%) compared to the prevalence of hypertension among auto electricians (50.0%), pump mechanics (46.8%), and welding and fabrication technicians (46.8%). The proportion of pump mechanics with high total cholesterol (75.0%) was higher (p=0.001) than the proportions of participants with high total cholesterol among auto electricians (12.50%), auto mechanics (13.91%), and welding and fabrication technicians (29.79%). Similarly, high LDL was significantly higher (p= 0.022) among pump technicians when compared to auto electricians, auto mechanics, and welding and fabrication technicians. However, high triglycerides were significantly lower (p=0.013) among pump mechanics as compared to the other groups (Table 7).

Table 7 Distribution of CVD risk Factors by Job Category

Variable	Auto electrician (N=8) n (%)	Auto mechanic (N=151) n (%)	Pump mechanic (N=4) n (%)	Welding and Fabrication (N=47) n (%)	Fisher's exact
Hypertension	4 (50.00)	41 (27.15)	2 (46.81)	22 (46.81)	**0.029**
Diabetes	1 (12.50)	5 (3.31)	0 (0.00)	4 (8.51)	0.188
Obesity	0 (0.00)	16 (10.60)	0 (0.00)	10 (21.28)	0.226
Smoking	3 (37.50)	16 (10.60)	1 (25.00)	4 (8.51)	0.073
Alcohol	0 (0.00)	2 (1.32)	0 (0.00)	3 (6.38)	0.257
High Cholesterol	1 (12.50)	21 (13.91)	3 (75.00)	14 (29.79)	**0.001**
High Triglycerides	4 (50.00)	39 (25.83)	0 (0.00)	22 (46.81)	**0.013**
High LDL	3 (37.50)	25 (16.56)	3 (75.00)	8 (17.02)	**0.022**
Low HDL	0 (0.00)	4 (26.49)	0 (0.00)	9 (19.15)	0.235

4.2.3 Prevalence of Hypertension Co-morbidities

Table 8 shows the prevalence of hypertension co-morbidities among the study participants. Some study participants had hypertension in addition to other risk factors. Hypertension was significantly associated with alcohol intake ($p = 0.003$), obesity ($p < 0.001$), diabetes ($p = 0.016$), high cholesterol ($p < 0.001$), high triglycerides ($p = 0.006$) and low HDL ($p = 0.034$).

Table 8 Hypertension co-morbidities among participants

Factor	Hypertension status		Chi-square value	P-value
	No (N=141)	Yes (N=69)		
N	n (%)	n (%)		
Diabetes	3 (2.13)	7 (10.14)	Ω	**0.016**
Obesity	10 (7.09)	16 (23.19)	11.06	**<0.001**
Smoking	16 (11.35)	8 (11.59)	0.00	0.96
Alcohol	0 (0.00)	5 (7.25)	Ω	**0.003**
High Cholesterol	17 (12.06)	22 (31.88)	12.04	**<0.001**
High Triglycerides	35 (24.82)	30 (43.48)	7.54	**0.006**
High LDL	21 (14.89)	18 (26.09)	3.84	0.05
Low HDL	39 (27.66)	10 (14.49)	4.49	**0.034**

Ω: Fischer's exact chi-square test

4.3 Ten-year (10-year) CVD risk

The majority (80.0%) of the study participants had a low 10-year CVD risk score. Less than 10% of the participants had a high-risk score with 20% of participants in the moderate to high-risk score category (Table 9)

Table 9 Ten-year CVD risk score of participants

10-year CVD risk	Frequency	Percentage	95% CI
Low risk (<10%)	168	80.00	(73.99 – 84.91)
Moderate risk (10 – 20%)	24	11.43	(7.75 – 16.53)
High risk (>20%)	18	8.57	(5.45 – 13.24)

4.3.1 Distribution of 10-year CVD Risk Score

Table 10 shows the distribution of the 10-year CVD risk score of the participants. The risk scores varied significantly ($p < 0.001$) with age. Participants who were 20 to 29 years old were the majority (40.48%) among those with low CVD risk scores whiles participants who were greater than 60 years old were the majority among those with high CVD risk scores. None (0.0%) of the participants who reported to have never married had a high CVD risk score. The risk score also increased with an increasing number of years of work experience ($p <0.001$). The majority (38.89) of the participants with a high CVD risk score worked for greater than 40 years while the majority of participants who had low CVD risk scores worked for less than 10 years. Compared to the other job categories welding and fabrication technicians were the majority (44.44%) among participants with a high 10-year CVD risk score whereas, among those with a low CVD risk score, the majority (77.98%) were auto mechanics ($p = 0.004$).

Table 10 Distribution of the 10-year CVD risk score

Factor N	Total N	Low risk n (%)	Moderate risk n (%)	High risk n (%)	P-value
	210	168 (80.00)	24 (11.43)	18 (8.57)	
Age group (years)					**<0.001**
20 – 29	68	68 (40.48)	0 (0.00)	0 (0.00)	
30 – 39	48	47 (27.98)	1 (4.17)	0 (0.00)	
40 – 49	43	36 (21.43)	6 (25.00)	1 (5.56)	
50 – 59	30	15 (8.93)	13 (54.17)	2 (11.11)	
>60	21	2 (1.19)	4 (16.67)	15 (83.33)	
Highest Level of education					0.39
No formal education	79	63 (37.50)	7 (29.17)	9 (50.00)	
Primary School	21	15 (8.93)	4 (16.67)	2 (11.11)	
Junior High School	49	40 (23.81)	7 (29.17)	2 (11.11)	
Senior High School	45	34 (20.24)	6 (25.00)	5 (27.78)	
Tertiary	16	16 (9.52)	0 (0.00)	0 (0.00)	
Marital Status					**0.012**
Never married	46	44 (26.19)	2 (8.33)	0 (0.00)	
Currently married	161	122 (72.62)	22 (91.67)	17 (94.44)	
Widowed	1	1 (0.60)	0 (0.00)	0 (0.00)	
Divorced	2	1 (0.60)	0 (0.00)	1 (5.56)	
Religion					0.18
African Traditional Religion	4	3 (1.79)	1 (4.17)	0 (0.00)	
Christianity	13	10 (5.95)	0 (0.00)	3 (16.67)	
Islam	193	155 (92.26)	23 (95.83)	15 (83.33)	
Work experience (years)					**<0.001**
Less than 10	81	74 (44.05)	4 (16.67)	3 (16.67)	
10 – 19	60	54 (32.14)	3 (12.50)	3 (16.67)	
20 – 29	32	24 (14.29)	8 (33.33)	0 (0.00)	
30 – 39	16	8 (4.76)	3 (12.50)	5 (27.78)	
Greater than 40	21	8 (4.76)	6 (25.00)	7 (38.89)	
BMI classification					**0.028**
Underweight	9	9 (5.36)	0 (0.00)	0 (0.00)	
Normal weight	115	100 (59.52)	8 (33.33)	7 (38.89)	
Overweight	60	43 (25.60)	10 (41.67)	7 (38.89)	
Obese	26	16 (9.52)	6 (25.00)	4 (22.22)	
Job category					**0.004**
Auto electrician	8	5 (2.98)	2 (8.33)	1 (5.56)	
Auto mechanic	151	131 (77.98)	11 (45.83)	9 (50.00)	
Pump technician	4	3 (1.79)	1 (4.17)	0 (0.00)	
Welding and fabrication	47	29 (17.26)	10 (41.67)	8 (44.44)	
Owner of the workshop					**<0.001**
No	149	131 (77.98)	11 (45.83)	7 (38.89)	
Yes	61	37 (22.02)	13 (54.17)	11 (61.11)	
Stage of work					**<0.001**
Apprentice	134	122 (72.62)	9 (37.50)	3 (16.67)	
Master	76	46 (27.38)	15 (62.50)	15 (83.33)	
Use of personal protective equipment					**0.017**
No	98	75 (44.64)	9 (37.50)	14 (77.78)	
Yes	112	93 (55.36)	15 (62.50)	4 (22.22)	

4.3.2 Knowledge, Attitude, and Practices Score of Study Participants

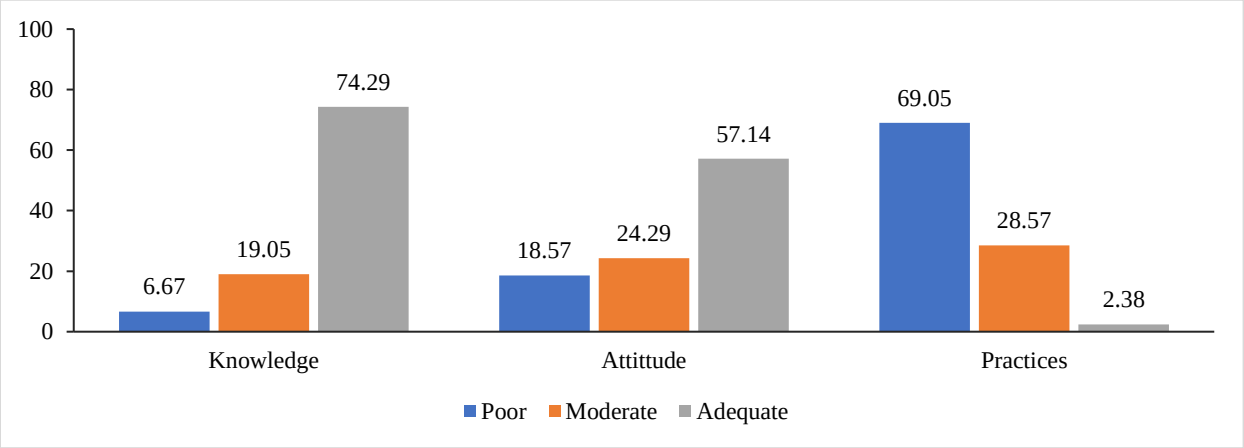

Figure 2 Knowledge, attitude, and practices of automobile technicians on CVD, risk factors, and prevention

The trend of knowledge and attitude scores were similar. The majority of the participants had adequate knowledge (74.29%) and attitude (57.14%). About 3 times the proportion who had poor knowledge (6.67%) also had a poor attitude (18.57%). Less than 5% of the study participants had adequate practices towards the prevention of CVD with the majority (69.05) having poor practices towards the prevention of CVD (Figure 2).

4.3.3 Knowledge of CVD and its risk factors

The mean knowledge score obtained was 82.86 ± 19.62 with 0.0% and 100.0% being the minimum and maximum scores respectively. Table 11 summarizes the responses participants gave to questions that were meant to assess their knowledge on, CVD, risk factors, and prevention. More than 60% of the participants answered correctly for each question. Almost 30% of the participants answered that prayer prevents the occurrence of CVD and a little over 10% of the participants did not know whether tobacco smoking can result in CVD or not.

Table 11 Knowledge regarding CVD and its risk factors

Item	Answer choices		
	True	False	I don't know
CVD is heart related	178 (84.76) *	13 (6.19)	19 (9.05)
Most CVD cases are hereditary	19 (9.05)	172 (81.90) *	19 (9.05)
CVD is a disease for only women	9 (4.29)	189 (90.00) *	15 (5.71)
CVD can occur in young people	162 (77.14) *	30 (14.29)	18 (8.57)
CVD is a disease for only the rich	15 (7.14)	190 (90.48) *	5 (2.38)
Controlling high-fat food is essential	189 (90.00) *	5 (2.38)	16 (7.62)
Prayer prevents the occurrence of CVD	60 (29.05)	139 (66.19) *	10 (4.76)
Slender people do not need to exercise	21 (10.00)	181 (86.19) *	8 (3.81)
Tobacco smoking can result in CVD	171 (81.43) *	71 (8.10)	22 (10.48)
Adequate exercise prevents CVD	169 (80.48) *	25 (11.90)	16 (7.62)

* Correct answers

4.3.4 Distribution of the Knowledge Scores

Table 12 shows the distribution of the knowledge scores of participants. Apart from age group and the use of personal protective equipment, there was no significant difference in the distribution of the knowledge scores of the study participants. Among participants with adequate knowledge, the majority (35.90%) were within the 20 to 29 years age bracket whiles the majority of participants with poor knowledge (42.86%) were within the 40 to 49 year age group. The majority of the participants with poor knowledge (71.43%) did not use personal protective equipment whereas most of those with adequate knowledge (58.97%) used personal protective equipment.

Table 12 Distribution of the knowledge scores of study participants

Factor N	Knowledge Score Total N	Poor n (%)	Moderate n (%)	Adequate n (%)	P-value
	210	14 (6.67)	40 (19.05)	156 (74.29)	
Age group (years)					**0.028**
20 – 29	68	2 (14.29)	10 (25.00)	56 (35.90)	
30 – 39	48	2 (14.29)	9 (22.50)	37 (23.72)	
40 – 49	43	6 (42.86)	4 (10.00)	33 (21.15)	
50 – 59	30	2 (14.29)	9 (22.50)	19 (12.18)	
>60	21	2 (14.29)	8 (20.00)	11 (7.05)	
Highest Level of education					0.091
No formal education	79	8 (57.14)	21 (52.50)	50 (32.05)	
Primary School	21	1 (7.14)	3 (7.50)	17 (10.90)	
Junior High School	49	1 (7.14)	8 (20.00)	40 (25.64)	
Senior High School	45	4 (28.57)	8 (20.00)	33 (21.15)	
Tertiary	16	0 (0.00)	0 (0.00)	16 (10.26)	
Marital Status					0.520
Never married	46	2 (14.29)	8 (20.00)	36 (23.08)	
Currently married	161	12 (85.71)	31 (77.50)	118 (75.64)	
Widowed	1	0 (0.00)	1 (2.50)	0 (0.00)	
Divorced	2	0 (0.00)	0 (0.00)	2 (1.28)	
Religion					0.350
African Traditional Religion	4	0 (0.00)	2 (5.00)	2 (1.28)	
Christianity	13	0 (0.00)	1 (2.50)	12 (7.69)	
Islam	193	14 (100.0)	37 (92.50)	142 (91.03)	
Work experience (years)					0.130
Less than 10	81	5 (35.71)	14 (35.00)	62 (39.74)	
10 – 19	60	1 (7.14)	9 (22.50)	50 (32.05)	
20 – 29	32	4 (28.57)	6 (15.00)	22 (14.10)	
30 – 39	16	1 (7.14)	6 (15.00)	9 (5.77)	
Greater than 40	21	3 (21.43)	5 (12.50)	13 (8.33)	
BMI classification					0.300
Underweight	9	1 (7.14)	0 (0.00)	8 (5.13)	
Normal weight	115	6 (42.86)	19 (47.50)	90 (57.69)	
Overweight	60	6 (42.86)	15 (37.50)	39 (25.00)	
Obese	26	1 (7.14)	6 (15.00)	19 (12.18)	
Job category					0.340
Auto electrician	8	1 (7.14)	2 (5.00)	5 (3.21)	
Auto mechanic	151	7 (50.00)	30 (75.00)	114 (73.08)	
Pump technician	4	0 (0.00)	1 (2.50)	3 (1.92)	
Welding and fabrication	47	6 (42.86)	7 (17.50)	34 (21.79)	
Owner of the workshop					0.270
No	149	8 (57.14)	26 (65.00)	115 (73.72)	
Yes	61	6 (42.86)	14 (35.00)	41 (26.28)	
Stage of work					0.310
Apprentice	134	7 (50.00)	23 (57.50)	104 (66.67)	
Master	76	7 (50.00)	17 (42.50)	52 (33.33)	
Use of personal protective equipment					**0.015**
No	98	10 (71.43)	24 (60.00)	64 (41.03)	
Yes	112	4 (28.57)	16 (40.00)	92 (58.97)	

4.3.5 Attitude towards the Prevention of CVD

The mean score obtained for attitude was 67.62 ± 29.99 with, 0.0% and 100.0% being the minimum and maximum scores respectively. Table 13 summarizes the responses of participants to questions that were used to assess their attitude towards the prevention of CVD. The majority of the participants answered 'agree' to stop smoking (70.0%), reduce salt intake (78.57%), take less oily food (76.19%), and prefer walking to somewhere near (77.62%). Only 17.62% of the participants answered 'disagree' to snacking and 10.0% of the participants answered 'disagree' to stop smoking.

Table 13 Attitude towards the prevention of CVD among participants

Item	Answer choices		
	Agree	Neutral	Disagree
Stop smoking	147 (70.00) *	42 (20.00)	21 (10.00)
Regular medical check up	172 (81.90) *	31 (14.76)	7 (3.33)
Fruits and/or vegetables intake	168 (80.00) *	37 (17.62)	5 (2.38)
Prefer fast food	14 (6.67)	57 (27.14)	139 (66.19) *
Prefer not to exercise	15 (7.14)	47 (22.38)	148 (70.48) *
Prefer walking to go somewhere near	163 (77.62) *	34 (16.19)	13 (6.19)
Avoid carbonated drinks	121 (57.62) *	47 (22.38)	42 (20.00)
Take less oily food	160 (76.19) *	36 (17.14)	14 (6.67)
Reduce salt intake	165 (78.57) *	41 (19.52)	4 (1.90)
Snacking	88 (41.90)	85 (40.48)	37 (17.62) *

* Expected answers

4.3.6 Distribution of Attitude Scores

There was a significant difference in the distribution of the attitude score among the age groups ($p < 0.001$), work experience ($p < 0.001$), BMI classification ($p = 0.036$), job category ($p < 0.001$), owning the workshop ($p = 0.046$) stage of work ($p = 0.009$), and the use of personal protective equipment ($p = 0.001$). Subjects in the 20 to 29 years age group constituted the highest proportion (40.00%) and the least proportion (12.82%) among those with adequate attitude and poor attitude respectively. The majority of the participants with adequate attitude (60.00%) had normal weight whereas the majority of participants with poor attitude (30.77) were overweight. (Table 14).

Table 14 Distribution of the attitude scores of study participants

Factor	Attitude score				
	Total	Poor	Moderate	Adequate	P-value
N	N	n (%)	n (%)	n (%)	
	210	39 (18.57)	51 (24.29)	120 (57.14)	
Age group (years)					**<0.001**
20 – 29	68	5 (12.82)	15 (29.41)	48 (40.00)	
30 – 39	48	6 (15.38)	9 (17.65)	33 (27.50)	
40 – 49	43	13 (33.33)	8 (15.69)	22 (18.33)	
50 – 59	30	6 (15.38)	13 (25.49)	11 (9.17)	
>60	21	9 (23.08)	6 (11.76)	6 (5.00)	
Highest Level of education					0.23
No formal education	79	17 (43.59)	17 (33.33)	45 (37.50)	
Primary School	21	4 (10.26)	8 (15.69)	9 (7.50)	
Junior High School	49	9 (23.08)	11 (21.57)	29 (24.17)	
Senior High School	45	9 (23.08)	13 (25.49)	23 (19.17)	
Tertiary	16	0 (0.00)	2 (3.92)	14 (11.67)	
Marital Status					0.61
Never married	46	8 (20.51)	12 (23.53)	26 (21.67)	
Currently married	161	30 (76.92)	38 (74.51)	93 (77.50)	
Widowed	1	0 (0.00)	0 (0.00)	1 (0.83)	
Divorced	2	1 (2.56)	1 (1.96)	0 (0.00)	
Religion					0.43
African Traditional Religion	4	1 (2.56)	2 (3.92)	1 (0.83)	
Christianity	13	1 (2.56)	4 (7.84)	8 (6.67)	
Islam	193	37 (94.87)	45 (88.24)	111 (92.50)	
Work experience (years)					**<0.001**
Less than 10	81	10 (25.64)	21 (41.18)	50 (41.67)	
10 – 19	60	8 (20.51)	7 (13.73)	45 (37.50)	
20 – 29	32	10 (25.64)	6 (11.76)	16 (13.33)	
30 – 39	16	3 (7.69)	9 (17.65)	4 (3.33)	
Greater than 40	21	8 (20.51)	8 (15.69)	5 (4.17)	
BMI classification					**0.036**
Underweight	9	0 (0.00)	1 (1.96)	8 (6.67)	
Normal weight	115	18 (46.15)	25 (49.02)	72 (60.00)	
Overweight	60	12 (30.77)	16 (31.37)	32 (26.67)	
Obese	26	9 (23.08)	9 (17.65)	8 (6.67)	
Job category					**<0.001**
Auto electrician	8	2 (5.13)	3 (5.88)	3 (2.50)	
Auto mechanic	151	19 (48.72)	37 (72.55)	95 (79.17)	
Pump technician	4	4 (10.26)	0 (0.00)	0 (0.00)	
Welding and fabrication	47	14 (35.90)	11 (21.57)	22 (18.33)	
Owner of the workshop					**0.046**
No	149	23 (58.97)	33 (64.71)	93 (77.50)	
Yes	61	16 (41.03)	18 (35.29)	27 (22.50)	
Stage of work					**0.009**
Apprentice	134	19 (48.72)	28 (54.90)	87 (72.50)	
Master	76	20 (51.28)	23 (45.10)	33 (27.50)	
Use of personal protective equipment					**0.001**
No	98	24 (61.54)	31 (60.78)	43 (35.83)	
Yes	112	15 (38.46)	20 (39.22)	77 (64.17)	

4.3.7 Practices towards the prevention of CVD

The mean practice score obtained was 42.76 ± 12.26 with the minimum score being 10.0% and the maximum score being 80.0%. Table 15 summarizes the practices of participants towards the prevention of CVD. The majority of the participants were engaged in work that involves vigorous activity for more than 10 minutes (97.14%), never smoked (90.95%), and usually walk for more than 10 minutes to places (96.67%). Of the total (210), 167/210 (79.52%) seldom took fruits and only 69/210 (32.86%) ate vegetables always.

Table 15 Practices towards the prevention of CVD among participants

Item	Answer choices		
	Always	Seldom	Never
Work involves vigorous activity > 10 min	204 (97.14) *	3 (1.43)	3 (1.43)
Walking >10 min to places	203 (96.67) *	1 (0.48)	6 (2.86)
Exercise for > 20 min per session	117 (55.71) *	52 (24.76)	41 (19.52)
Fruit intake	36 (17.14) *	167 (79.52)	7 (3.33)
Fast-food intake	10 (4.76)	170 (80.95)	30 (14.29) *
Snacking	26 (12.38)	26 (12.38)	158 (75.24) *
Stressful life	191 (90.95)	17 (8.10)	2 (0.95) *
Vegetable intake	69 (32.86) *	139 (66.19)	2 (0.95)
Smoking	11 (5.24)	8 (3.81)	191 (90.95) *
Carbonated drinks intake	18 (8.57)	167 (79.52)	25 (11.90) *

*Expected positive practices

4.3.8 Distribution of Practices Score

There was a significant difference in the distribution of the practice score among the highest level of education($p = 0.018$), religion ($p = 0.004$), job category ($p = 0.027$), and the use of personal protective equipment ($p < 0.021$). Among participants that engaged in adequate practices, the majority (80.00%) had secondary school education whereas, among those who engaged in inadequate practices, the majority (41.38%) had no formal education. Welding and fabrication technicians were the majority (80.00%) among participants who engaged in adequated practices whereas the majority of participants who engaged in inadequate practices were auto mechanics (75.86%). All the participants who engaged in adequate practices did not use personal protective equipment (Table 16).

Table 16 Distribution of practices score of the participants

Factor N	Practices Score Total N	Poor n (%)	Moderate n (%)	Adequate n (%)	P-value
	210	145 (69.05)	60 (28.57)	5 (2.38)	
Age group (years)					0.10
20 – 29	68	55 (37.93)	12 (20.00)	1 (20.00)	
30 – 39	48	32 (22.07)	15 (25.00)	1 (20.00)	
40 – 49	43	30 (20.69)	12 (20.00)	1 (20.00)	
50 – 59	30	18 (12.41)	11 (18.33)	1 (20.00)	
>60	21	10 (6.90)	10 (16.67)	1 (20.00)	
Highest Level of education					**0.018**
No formal education	79	60 (41.38)	19 (31.67)	0 (0.00)	
Primary School	21	12 (8.28)	8 (13.33)	1 (20.00)	
Junior High School	49	38 (26.21)	11 (18.33)	0 (0.00)	
Senior High School	45	27 (18.62)	14 (23.33)	4 (80.00)	
Tertiary	16	8 (5.52)	8 (13.33)	0 (0.00)	
Marital Status					0.28
Never married	46	36 (24.83)	10 (16.67)	0 (0.00)	
Currently married	161	107 (73.79)	49 (81.67)	5 (100.00)	
Widowed	1	0 (0.00)	1 (1.67)	0 (0.00)	
Divorced	2	2 (1.38)	0 (0.00)	0 (0.00)	
Religion					**0.004**
African Traditional Religion	4	1 (0.69)	3 (5.00)	0 (0.00)	
Christianity	13	5 (3.45)	6 (10.00)	2 (40.00)	
Islam	193	139 (95.86)	51 (85.00)	3 (60.00)	
Work experience (years)					0.50
Less than 10	81	56 (38.62)	24 (40.00)	1 (20.00)	
10 – 19	60	44 (30.34)	14 (23.33)	2 (40.00)	
20 – 29	32	24 (16.55)	8 (13.33)	0 (0.00)	
30 – 39	16	9 (6.21)	6 (10.00)	1 (20.00)	
Greater than 40	21	12 (8.28)	8 (13.33)	1 (20.00)	
BMI classification					0.075
Underweight	9	6 (4.14)	3 (5.0)	0 (0.00)	
Normal weight	115	89 (61.38)	24 (40.00)	2 (40.00)	
Overweight	60	34 (23.45)	23 (38.33)	3 (60.00)	
Obese	26	16 (11.03)	10 (16.67)	0 (0.00)	
Job category					**0.027**
Auto electrician	8	6 (4.14)	2 (3.33)	0 (0.00)	
Auto mechanic	151	110 (75.86)	40 (66.67)	1 (20.00)	
Pump technician	4	1 (0.69)	3 (5.00)	0 (0.00)	
Welding and fabrication	47	28 (19.31)	15 (25.00)	4 (80.00)	
Owner of the workshop					0.59
No	149	101 (69.66)	45 (75.00)	3 (60.00)	
Yes	61	44 (30.34)	15 (25.00)	2 (40.00)	
Stage of work					0.87
Apprentice	134	91 (62.76)	40 (66.67)	3 (60.00)	
Master	76	54 (37.24)	20 (33.33)	2 (40.00)	
Use of personal protective equipment					**0.021**
No	98	62 (42.76)	31 (51.67)	5 (100.00)	
Yes	112	83 (57.24)	29 (48.33)	0 (0.00)	

4.4 Factors Associated the 10-year CVD Risk Score

Table 17 shows the multivariable ordinal logistic regression model of factors associated with higher 10-year cardiovascular disease risk scores. Before adjusting for other variables, marital status, working experience, stage of work, ownership of the shop, attitude, and practices were significantly associated with the 10-year CVD risk score. However, after adjusting for other variables, only the attitude score was significantly associated with the 10-year CVD risk score (p = 0.001). Having an adequate attitude reduced the proportionate odds of having a high CVD risk score by 87% (aOR: 0.13, 95% CI: 0.04, 0.43).

Table 17 Multivariable ordinal logistic regression model of factors associated with higher 10-year cardiovascular disease risk scores

	Unadjusted ordinal logistic model		Adjusted ordinal logistic model	
Characteristics	**COR [95% CI]**	**P-value**	**AOR [95% CI]**	**P-value**
Highest level of education				
No formal education	1.00 [reference]		1.00 [reference]	
Formal education	0.92 [0.46, 1.85]	0.823	0.86 [0.34, 2.19]	0.746
Marital status				
Not currently married	1.00 [reference]		1.00 [reference]	
Currently married	4.92 [1.45, 16.69]	**0.011**	2.91 [0.70, 11.98]	0.140
Religion				
Non-muslim	1.00 [reference]		1.00 [reference]	
Muslim	0.72 [0.22, 2.32]	0.578	0.38 [0.07, 2.08]	0.267
Work experience (years)				
Less than 10	1.00 [reference]		1.00 [reference]	
10 to 19	1.19 [0.38, 3.73]	0.771	0.96 [0.25, 3.71]	0.948
20 to 29	3.11 [1.03, 9.37]	**0.043**	1.70 [0.38, 7.61]	0.487
30 to 39	12.15 [3.54, 41.69]	**<0.001**	4.36 [0.78, 24.43]	0.094
Greater than 40	17.08 [5.56, 52.51]	**<0.001**	4.45 [0.81, 24.57]	0.087
Job category				
Auto electrician	1.00 [reference]		1.00 [reference]	
Auto mechanic	0.28 [0.06, 1.19]	0.084	0.57 [0.09, 3.44]	0.540
Pump mechanic	0.53 [0.04, 7.11]	0.628	0.10 [0.00, 2.87]	0.179
Welding and fabrication	1.10 [0.25, 4.87]	0.903	1.45 [0.23, 9.22]	0.695
Owner of the shop				
No	1.00 [reference]		1.00 [reference]	
Yes	4.69 [2.32, 9.47]	**<0.001**	0.94 [0.24, 3.60]	0.923
Stage of work				
Apprentice	1.00 [reference]		1.00 [reference]	
Master	6.89 [3.26, 14.55]	**<0.001**	2.37 [0.51, 10.99]	0.269
Use of personal protective equipment				
No	1.00 [reference]		1.00 [reference]	
Yes	0.61 [0.31, 1.19]	0.147	0.80 [0.32, 2.01]	0.638
Knowledge score				
Poor	1.00 [reference]		1.00 [reference]	
Moderate	1.11 [0.29, 4.19]	0.878	2.95 [0.58, 14.84]	0.190
Adequate	0.48 [0.14, 1.64]	0.244	2.62 [0.55, 12.47]	0.226
Attitude score				
Poor	1.00 [reference]		1.00 [reference]	
Moderate	0.65 [0.28, 1.49]	0.307	0.39 [0.13, 1.17]	0.095
Adequate	0.12 [0.05, 0.29]	**<0.001**	0.13 [0.04, 0.43]	**0.001**
Practices score				
Poor	1.00 [reference]		1.00 [reference]	
Moderate	2.27 [1.11, 4.65]	**0.025**	2.28 [0.90, 5.79]	0.084
Adequate	16.36 [2.42, 110.73]	**0.004**	7.11 [0.59, 85.18]	0.122

CHAPTER FIVE

DISCUSSION

5.1 Prevalence of CVD Risk Factors

This study found hypertension, diabetes, alcohol intake, dyslipidemia, smoking, and obesity to be the prevalent risk factors of CVD among automobile technicians with hypertension being the most prevalent and alcohol intake being the least prevalent. The prevalence of hypertension as found in this study (32.86%) was higher than a pooled national prevalence of 27.0% as found in a meta-analysis conducted by Bosu & Bosu, (2021). The slight increase in the prevalence of hypertension in the study population over the national prevalence could be because of the health-seeking behavior of the participants. Almost 20% of the participants did not agree that regular medical check-up was necessary. The World Health Organization has set a target of reducing hypertension prevalence by 33% globally (WHO, 2021a). Achieving this set objective may be hindered in any population by an increasing prevalence of hypertension and may have negative economic impacts.

The prevalence of hypertension in this study was also higher than the prevalence of hypertension reported by Akintunde et al. (2019) among automobile technicians. Though the populations are similar (automobile technicians), the difference in the prevalence of hypertension could be due to the difference in the inclusion criteria. This study included participants that were 20 years or older whiles their study included participants that were 15 years or older.

Among the automobile technicians, the prevalence of hypertension was found to be low among auto mechanics (27.15%) compared to the auto electricians, pump mechanics, and welding and fabrication technicians. Though the prevalence among auto mechanics can be said to be low when compared to the other job categories in the study population, it is consistent with the pooled

national prevalence of 27.0% as found by (William Kofi Bosu & Bosu, 2021). About half (50.0%) of participants in the other job categories were found to have hypertension. This may be a worrying situation because of the consequences associated with hypertension. Hypertension is strongly linked with cardiovascular mortality and all-cause mortality (Zanchetti, 2017).

The prevalence of obesity has been on the rise for most countries and it directly contributes to the incidence of other cardiovascular risk factors such as diabetes, dyslipidemia, and hypertension (Powell-Wiley et al., 2021). In this study, 12.38% of the subjects were found to be obese. This is similar to the findings of WHO on obesity. According to the WHO, about 13% of the world's population and 11% of men were obese in 2016 globally (WHO, 2021b). The findings of this study on obesity are also similar to the findings of the Ghana STEPS survey conducted in 2006 in the Greater Accra Region. According to that survey, 11.6% of males were found to be obese in Greater Accra in 2006 (GHS, 2006).

There is a continuous rise in the incidence of diabetes with CVD being the cause of most morbidities and mortalities among diabetics (Leon & Maddox, 2015). In this study, 4.7% of the participants were found to be diabetic. This is lower than the 6.46% reported by Asamoah-Boaheng et al. (2019) in a systematic review and a meta-analysis they carried out. Though the reported prevalence values by both studies are different, the prevalence reported by Asamoah-Boaheng et al. (2019) was within the 95% confidence interval of this study. The difference in the prevalence value of both studies could be attributed to the type of study conducted. This study was a cross-sectional study while that of Asamoah-Boaheng et al. (2019) was a systematic review and a meta-analysis.

This study found the prevalence of smoking among participants to be 11.43% and alcohol intake to be 2.38%. These two risk factors are direct lifestyle factors that could impact the occurrence of

CVD in the population. Owusu-Dabo et al. (2009) found the prevalence of smoking to be 3.8% among Ghanaians in a study they conducted on smoking uptake and prevalence in 2008. The higher prevalence reported in this study could be because of the low educational status of the majority of the participants. Studies have shown that men who have low educational status and are poor (lower socioeconomic category) are more likely to smoke (Nketiah-Amponsah et al., 2018). Alcohol intake was the risk factor with the least prevalence among the other risk factors. The low alcohol intake among the participants could be a result of the influence of religion. Some religions such as Islam prohibit alcohol (Michalak et al., 2007). The majority (91.90%) of the participants being Muslims could therefore be the reason for a low alcohol intake prevalence among the participants.

Dyslipidemia, defined as increased total cholesterol levels, or increased triglycerides levels, or increased low-density lipoprotein levels, or low concentrations of high-density lipoprotein is an established and important risk factor of CVD (Fodor, 2011; Hedayatnia et al., 2020). Individuals with favorable lipid profiles have reduced chances of CVD (Kopin & Lowenstein, 2017). In this study, 18.57%, 30.95%, 18.57%, and 23.33% of the participants had elevated levels of total cholesterol, triglycerides, low-density lipoprotein, and decreased levels of high-density lipoprotein. This may contribute to a rise in the occurrence of CVD among automobile technicians. Management of dyslipidemia and prevention can reduce morbidity and mortality as a result of CVD (Kopin & Lowenstein, 2017)

5.2 The 10- year CVD Risk Score and its Distribution

In this study, it was found that 8.57% of the automobile technicians had a high 10-year CVD risk score. This differs from the proportions of Ghanaians with high-risk scores (12.3%) reported by Boateng et al. (2018). Though both risk scores were arrived at using the Framingham laboratory algorithm, the difference could be because of the difference in the ages of participants recruited for both studies. In the study conducted by Boateng et al. (2018), the minimum age of participants recruited was 40 years while in this study, the minimum age of participants recruited was 20 years. Age is an independent risk factor for developing CVD and the risk of CVD increases with age (Dhingra & Vasan, 2012).

The prevalence of low, moderate, and high CVD risk in this study was found to be 80.00%, 11.43%, and 8.57%. This contradicts what was found by Nyiambam et al., (2020). They reported a prevalence of 41.5%, 28.1%, and 30.4% for low, medium, and high 10-year CVD risk. The variation in as reported in both studies could be because the study conducted by Nyiambam et al., (2020) was among patients attending cardiac clinics. These individuals may have been in such clinics because of cardiovascular-related events.

It was also found that the 10-year CVD risk scores varied with age among the automobile technicians. Most of the participants with high 10-year CVD risk scores were above 60 years old and most of those with a low 10-year CVD risk score were below 30 years old. This variation may be due to the role of age in CVD. Age is a known non-modifiable risk factor of CVD for obvious reasons. As people get older, they are more likely to develop CVD risk factors. Older individuals tend to have more CVD risk factors compared to younger ones (Dhingra & Vasan, 2012).

This role of aging was also reflected in the number of years of work experience in this study. As the number of years of work experience increased, the proportion of participants with a high CVD risk score also increased. An individual's number of years of work may be a subset of the person's age, therefore, those with a higher number of years of work experience may have been those with higher ages.

Among participants who reported that they were never married, none had a high CVD risk score. This contradicts findings of a systematic review carried out by Wong et al. (2018) where they reported that being unmarried was associated with increased odds of CVD. This difference may be accounted for by the quality of marriage. Though marriage has a protective role for men, cardiovascular risk is significantly affected by the quality of a marriage and dissatisfaction in the marriage (Dhindsa et al., 2020).

The 10-year CVD risk score varied significantly with the BMI classification among the automobile technicians. Among those with high 10-year CVD risk scores, the majority were either obese or overweight. This may be because central obesity independently and significantly contributes to cardiovascular outcomes (Dhaliwal & Welborn, 2009). Similar findings were made by Santos et al. (2020) where 40% of obese individuals were classified as high risk by the Framingham Risk Scoring algorithm. Obesity and overweight have a strong relationship with CVD mortality (Dudina et al., 2011).

Being a master and the owner of a workshop may increase the socioeconomic status of the individual. Socioeconomic status refers to the social position of an individual in relation to others in society and has been found to have an inverse relationship with CVD risk (Clark et al., 2009; Podolecka et al., 2018). This was reflected in this study because, among participants with a high CVD risk score, the majority were owners of the workshop and masters at the workshop. This

variation in findings could be due to the effect of age, physical inactivity, and diet. Owners of workshops and masters at the workshops were generally older than apprentices and those who did not own shops. Again, owners of the workshop may be more inactive compared to the apprentice as they may be found playing managerial and decision-making roles and less involved in repair and maintenance which involves more physical activity.

Compared to participants who used personal protective equipment such as utility gloves, goggles, face shields, and safety booths, a higher proportion of participants who did not use personal protective equipment during work had a high CVD risk score. This may be attributed to the exposures and risks associated with their work. Chronic occupational exposure among automobile technicians has been found to be associated with cardiovascular complications (Kumar et al., 2013).

5.3 Knowledge, Attitude and Practices regarding CVD Risk Factors and Prevention

The majority of the participants had adequate knowledge regarding CVD and its risk factors. For each question used to assess knowledge, the majority of the study participants answered correctly. This demonstrates that there may be a general awareness of cardiovascular-related issues among the study participants. Similar findings were reported by Mohammad et al. (2018). It is worthy of note that, though more than half answered correctly to all questions, close to 30% answered that prayer can prevent the occurrence of CVD. This may be because of the influence of religious beliefs among the study participants as more than 90% of the study participants were Muslims.

Close to 50% of the participants above 60 years did not have adequate knowledge. This may be because they were the majority among those with no formal education. Findings on knowledge regarding tobacco smoking were consistent with studies conducted by Mohammad et al. (2018)

and Muhamad et al. (2012) where the majority of the participants were able to identify smoking as a risk factor for CVD.

A greater proportion of participants with adequate knowledge used PPEs compared to the proportion of participants who did not use PPEs but had adequate knowledge. The increase in the proportion of participants who used PPEs among those with adequate knowledge may be due to the influence of their knowledge on the awareness of the hazards associated with their jobs.

For this study, the attitude score obtained was generally good. Most of the participants agreed that to prevent CVD, there was the need to stop smoking, maintain an active lifestyle, reduce salt intake, and do regular medical checkups. This was consistent with findings made by Mohammad et al. (2018) where the majority of the study participants had a positive attitude in a similar study. This may be a good sign towards the reduction of the burden of CVD. Similar to the knowledge score in this study, there was a variation in the distribution of attitude scores in respect of the use of PPEs. The knowledge level of the participants who used PPEs during work may have influenced their attitude resulting in the majority of those who use PPEs having a high attitude score.

Unlike knowledge and attitude, the majority of the participants had poor scores for practices on the prevention of CVD. The mean practice score for the participants (42.76%) was less than half of the total. This is again consistent with the findings made by Mohammad et al. (2018) where the mean practice score was less than half of the total score in a similar study. Though the majority of participants in this study engaged in an active lifestyle, only a few engaged in taking healthy diets always. A few took fruits (17.14%) and vegetables (32.86%) always. The risk of CVD is influenced by diet and lifestyle (Forman & Bulwer, 2006). For instance, dietary salt elevates blood pressure, saturated fats increase the risk of coronary heart disease and polyunsaturated fats have protective effects (Reddy & Katan, 2004). The majority of those engaged in poor practices had no

formal education whiles the majority of those who engaged in adequate practices had secondary education. This suggests that formal education may have an effect on the practices the participants engage in. Improving educational status may lead to preventing approximately 9% of premature deaths (Pednekar et al., 2011).

5.4 Factors Associated with the 10-year CVD Risk Score

Adequare attitude of the study participants was the only factor found to be associated with the 10-year CVD risk in this study. Having an adequate attitude was found to reduce the odds of having a high CVD risk score by 87%. This, therefore, suggests that attitude is an avenue that can be explored to improve cardiovascular risk scores and cardiovascular health. It has been realized that most of the leading causes of death can be linked to behavioral choices made by people every day (Visser et al., 2016). The rise of CVD in Ghana is driven by a significant behavioral change in the country as a result of urbanization (Ofori-Asenso & Garcia, 2016). Timely modifications in lifestyle to achieve a positive attitude are, therefore, necessary to prevent CVD (Zulfiqar et al., 2019).

5.5 Strengths of the Study

This is study is the first of its kind among automobile technicians in the Tamale Metropolis to the best of my knowledge. It will serve as baseline data with which other studies can be compared. By targeting individuals and groups that will benefit more, data from this study will contribute to the efficient use of limited resources by the Public Health Division of the Ghana Health Service in the prevention and control of CVDs.

This study will also provide the basis to raise awareness of CVD and to motivate adherence to recommended therapies and lifestyle changes among automobile technicians by the Tamale

Metropolitan Assembly (TMA), Non-Governmental Organisations (NGO's), and other organisations focused on cardiovascular health

5.6 Limitation of the Study

The findings of this study cannot be generalized to the entire automobile technician population because automobile technicians below the age of 20 years were excluded. It cannot also be generalized to all automobile technicians in the country. Again, because this was a cross-sectional study, inferences on causation cannot be made.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

In this study, one in every five automobile technicians in the industrial area in the Tamale Metropolis had a moderate to high risk of getting CVD in the next 10 years.

Generally, there was a high prevalence of cardiovascular disease risk factors with the prevalence of hypertension exceeding the pooled national prevalence among the automobile technicians at the industrial area in the Tamale Metropolis

The proportion of low, moderate, and high 10-year CVD risk was 80%, 11.43%, and 8.57% respectively among the automobile technicians. The 10-year CVD risk score varied with age, marital status, years of work experience, body mass index, job category/ specialty, workshop ownership, stage of work, and the use of personal protective equipment.

Study participants generally had adequate knowledge and attitude but engaged in bad practices in respect of CVD, its risk factors, and prevention.

Having an adequate attitude in respect of CVD, its risk factors, and prevention reduced the proportionate odds of having a high 10-year CVD risk score among the study participants

6.2 Recommendations

- The Tamale Metropolitan Assembly in partnership with the Health Promotion Division of the Regional Health Directorate should carry out education and sensitisation programs aimed at improving the practices engaged in by the automobile technicians at the industrial area in the Tamale metropolis in respect of CVD, its risk factors, and prevention. Beyond education the Assembly should set up and organise keep-fit clubs, and social support groups for the automobile technicians and
- The Tamale Metropolitan Assembly and the Regional Health Directorate of the Ghana Health Service should implement strategies aimed at reducing the burden of cardiovascular disease risk factors among automobile technicians at the industrial area of the Tamale Metropolis. For instance, the GHS could sanction the establishment of a clinic near the industrial area solely respond for monitoring parameters in relation to the heart health of the automobile technicians and also gathering data to support future research
- Researchers with a research focus on CVDs should replicate this study across the country and expand the scope of the study by employing other cardiovascular risk assessment tools aside from the Framingham Risk assessment tool

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APPENDIX 1: PARTICIPANT INFORMATION SHEET

Project Title: Cardiovascular disease risk assessment among automobile technicians at the industrial area of the Tamale Metropolis, Northern Region, Ghana.

Principal Investigator (PI): Eric Mishio Bawa (0209154154; ericmishiobawa@gmil.com)

Address: Department of Epidemiology and Disease Control, School of Public Health, College of Health Sciences, University of Ghana, Legon, Accra

Introduction: I am a Master of Philosophy student in Applied Epidemiology and Disease Control at the School of Public Health, University of Ghana. I am conducting a study on cardiovascular disease risk assessment among automobile technicians in the Tamale Metropolis, Ghana.

Background and Purpose: Cardiovascular diseases are a major cause of preventable deaths. Risk assessments are important and necessary to support decisions and policies that seek to reduce the burden of such conditions. Using the Framingham risk score algorithm, this study aims to assess the risk of developing cardiovascular disease in 10 years among automobile technicians at the industrial area of the Tamale metropolis. The findings of this study will be included in a thesis to be submitted to the University of Ghana and also published in a peer-reviewed journal to inform and implement policies that will reduce the burden of cardiovascular diseases in Ghana.

Nature of research: This is conducted for academic purposes. The study aims at determining the risk of developing cardiovascular disease in 10 years among automobile technicians at the industrial of the Tamale Metropolis, determining the prevalence of cardiovascular disease risk

factors among the workers, and also determining the association between cardiovascular disease risk score and its factors among automobile technicians in the metropolis. It is a cross-sectional study that involves 382 participants. It involves workers in the Tamale metropolis.

Participant involvement: Participants will be asked to respond to a series of questions concerning demographic factors and risk factors of cardiovascular disease. The blood pressure, weight, and height of participants will be measured using a sphygmomanometer, a weighing scale, and a tape measure respectively. A small amount of blood (4mL, that is about the volume of 1 teaspoon) will also be collected from participants by inserting a needle in your forearm. This sample will only be taken once and will be used to analyse for levels of cholesterol and sugar in the blood. The procedure for blood sample collection will be routine. About 15 minutes of the participant's time will be spent.

Potential risk: Questions will be centered mainly on participants and may evoke emotional reactions. Participants have the freedom not to respond to any question they wish not to. The risk of the blood sample collection is extremely low and may result in minor discomfort.

Benefits: Findings of this study will help inform policy formulation and decision-making in the handling of cardiovascular diseases in the country. This study will also come out with findings that will result in the efficient use of limited resources by targeting individuals and groups that will benefit more from the interventions. This study will also raise the awareness of the population on CVD and motivate adherence to recommended therapies and lifestyle changes

Cost: There will be no financial costs for participating in this study. About 15 minutes of your time will be spent.

Compensation: You will not be compensated for your time spent participating in this study.

Confidentiality: Any information you provide will be kept in strict confidence and will only be for this academic work alone. Your responses will not be traced back to you, and data will be analyzed at the aggregate level to ensure anonymity.

Voluntary participation and withdrawal: Participating is at your free will and you are at liberty to leave the study at any time with no repercussions.

Outcome and feedback: The School of Public Health, the Tamale Metropolitan Assembly, the Ghana Health Service, and the general public through publication in a journal will be informed of the findings of this study

Feedback to participants: Participants will be made aware of their cardiovascular disease risk score, lipid profile results, and blood sugar levels. This will be done privately for each participant on a one-to-one consultation basis

Funding Information: This Principal Investigator together with WAHO and GFELTP is finding this research.

Sharing of participants' information/data: Data from this study will be used by the principal investigator alone. The data may only be shared with institutions and individuals for cardiovascular disease research on a need-to-know basis.

Storage of Samples: Blood samples will be processed and stored for a maximum of 1 year. In the event where there will be a need for future use of the stored samples, clearance will be sought from the ERC of the GHS before using them.

Do you consent that your sample should be stored for 1 year? Yes () No ()

Further clarification/questions: You can contact Eric Eric Mishio Bawa (Principal Investigator, 0209154154, **ericmishiobawa@gmail.com**), or Dr. Samuel O Sackey (Academic Supervisor, 0242216542, **sackey492003@yahoo.co.uk**) if you have any additional questions about the study.

Ethical concerns: In case of ethical concerns, kindly contact: Nana Abena Apatu (Administrator, Ghana Health Service Review Committee, 0503539896, ethics.research@ghsmail.org).

Name or Initials ……Unique number: /__/__/__/__/

Sign……. Thumbprint…….

Date …….

APPENDIX 2: CONSENT FORM

Study Title: Cardiovascular disease risk assessment among workers in the Tamale Metropolis, Northern Region, Ghana

PARTICIPANT'S STATEMENT

I acknowledge that I have read or had read and explained to me in a language I understand (Dagbani, Mampruli, Hausa, English) what is contained in this participants' Information Sheet and its purpose. I've had the chance to ask questions, and every one of them has been answered to my satisfaction. I am fully aware of the contents and any possible effects, as well as my right to change my mind and withdraw from the research after signing this form. I willingly agree to partake in this research.

Name or Initials ……Unique number: /__/__/__/__/

Sign…… Thumbprint…….

Date …….

INTERPRETER'S STATEMENT

To the best of my ability, I translated what is contained in this Participants' Information Sheet to the aforementioned participant in the language (Dagbani, Mampruli, Hausa, English) to his understanding. Every question asked was answered to the participant's satisfaction, with appropriate clarifications provided as needed.

Name ……

Sign……

Phone number /__/__/__/__/__/__/__/__/__/__/

Date……

STATEMENT OF WITNESS

I was present when the content of the Participant Information Sheet was read to the participant and satisfactorily explained to him/her in a language that he/she understood (Dagbani, Mampruli, Hausa, English). I confirm that he/she was allowed to ask questions or seek clarifications, and that those questions/clarifications were duly answered to his/her satisfaction prior to voluntarily agreeing to participate in the study.

Name……

Signature……. OR Thumb Print……

Date……

INVESTIGATOR'S STATEMENT AND SIGNATURE

I declare that I have given the subject sufficient information assist them to make an informed decision about participating in this research. I certify that the subjects were given enough time to read and comprehend the study. All of the participant's inquiry and clarifications have been answered.

Name: ……

Sign: …….

Date: ……

APPENDIX 3: QUESTIONNAIRE

Questionnaire on cardiovascular disease risk assessment among automobile technicians at the industrial area of the Tamale Metropolis, Northern Region, Ghana.

Dear Sir/Madam,

I am a student at the University of Ghana pursuing an MPhil in Applied Epidemiology and Disease Control. I am conducting this research for purely academic purposes. This questionnaire is to collect data on cardiovascular disease risk assessment among automobile technicians at the industrial area of the Tamale Metropolis, Ghana. I will be grateful if you could spare some time to participate in the study and assist in the completion of the questionnaire. Every piece of information will be treated with the utmost secrecy.Thank you so much.

Serial No…… Date…….

Name of Interviewer ……

SECTION A: Demographics

1. Sex

   Female

   Male

2. Age (completed years): _____

3. Highest level of education

University

SHS

JHS

Primary School

No formal education

4. Marital status

Never married

Currently married

Separated

Divorced

Widowed

5. Religion

Islam

Christian

African Traditional Religion

6. Job category/Specialty _____

7. Are you a master or an apprentice?

Master

Apprentice

8. Do you use protective equipment in your work?

Yes

No

9. How long have you been working an automobile technician? _____

SECTION B: Cardiovascular Disease Risk Factors

10. Do you **currently** smoke any tobacco products, such as cigarettes, cigars, or pipes?

    a) Yes b) No

11. If **NO**, in the past did you ever smoke any tobacco products?

    a) Yes b) No

12. Do you currently consume any form of alcohol (beer, wine spirits, locally brewed)?

    a) Yes b) No

13. If **NO**, have you consumed alcohol in the past?

    a) Yes b) No

14. Do you use any antihypertensive medication?

    a) Yes b) No

15. Do you use any oral hypoglycemic drugs?

    a) Yes b) No

16. Do you use any lipid-lowering drugs?

    a) Yes b) No

SECTION C: Knowledge, Attitude and Practices regarding CVD, risk factors, and prevention

17. Assessment of Knowledge regarding CVD and its risk factors

Question	True	False	I don't know
CVD is related to the heart			
Most CVD cases are hereditary			
CVD is a disease for only women			
CVD can occur in young people			
CVD is a disease for only rich			
Controlling high-fat food and eating fruits and vegetables is essential			
Prayer can prevent the occurrence of CVD			
Slender people do not need to exercise			
Tobacco smoking can result in CVD			
Adequate exercise prevents CVD			

18. Assessment of Attitude towards the prevention of CVD

Question	Agree	Neutral	Disagree
Not smoking or quitting smoking			
Regular medical check-up			
Fruit and/or vegetable intake			
Prefer fast food			
Prefer not to exercise			
Prefer walking to go somewhere near			
Avoid carbonated drinks			
Take less oily food			
Snacking			
Reducing salt intake			

19. Assessment of Practices towards the prevention of CVD

Activity	Always	Seldom	Never
Work involves vigorous activity >10 mins			
Walking >10 min to places			
Exercise for >20 minutes per session			
Fruit intake			
Fast-food/ Junk food intake			
Snacking			
Stressful life			
Smoking tobacco or cigarette			
Vegetable intake			
Fried foods intake			

SECTION C: Physical Measurements

20. Systolic Blood Pressure _____

21. Diastolic Blood Pressure _____

22. Weight _____

23. Height _____

SECTION D: Biochemical Measurements

24. Random Blood Glucose _____

25. Total Cholesterol _____

26. Triglycerides _____

27. High-density Lipoprotein _____

28. Low-density Lipoprotein _____

APPENDIX 4: ETHICAL CLEARANCE

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

My Ref. GHS/RDD/ERC/Admin/App (21179
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Digital Address: GA-050-3303
Mob: +233-50-3539896
Tel: +233-302-681109
Fax + 233-302-685424
Email: ethics.research@ghsmail.org
3rd June, 2021

Eric Mishio Bawa
School 0f Public Health
P. O. Box Lg 571,
University of Ghana
Legon-Accra, Ghana

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC 051/04/21**
Study Title	Cardiovascular Disease Risk Assessment among Workers in the Tamale Metropolis, Northern Region, Ghana.
Approval Date	3rd June, 2021
Expiry Date	2nd June, 2022
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol.

SIGNED.....
Dr. James Akazili
(Head, Ethics & Research Management Department)

APPENDIX 5: FRAMINGHAM RISK SCORING GUIDE

Below is the scoring for age

Age (years)	Women	Men
20-34	-7	-9
35-39	-3	-4
40-44	0	0
45-49	3	3
50-54	6	6
55-59	8	8
60-64	10	10
65-69	12	11
70-74	14	12
75-79	16	13

Below is the guideline for scoring smoker and non-smokers

Age (years)	Non-Smoker	Female Smoker	Male Smoker
20-39	0	9	8
40-49	0	7	5
50-59	0	4	3
60-69	0	2	1
70-79	0	1	1

Below is the total Cholesterol scoring guide for women

	20-39yrs	40-49yrs	50-59yrs	60-69yrs	70-79yrs
Less than 160	0	0	0	0	0
160-199	4	3	2	1	1
200-239	8	6	4	2	1
240-279	11	8	5	3	2
>= 280	13	10	7	4	2

Below is the total Cholesterol Scoring guide for Men

	20-39yrs	40-49yrs	50-59yrs	60-69yrs	70-79yrs
Less than 160	0	0	0	0	0
160-199	4	3	2	1	0
200-239	7	5	3	1	0
240-279	9	6	4	2	1
>= 280	11	8	5	3	1

Below is the total scoring guide for HDL Cholesterol

HDL – Cholesterol (mg/dl)	Points (applies to both men and women
>=60	-1
50-59	0
40-49	1
<40	2

Below is the scoring guide for systolic blood pressure

SBP (mmHg)	Yes- taking BP medication		No- Not taking BP medication	
	Women	Men	Women	Men
<120	0	0	0	0
120-129	3	1	1	0
130-139	4	2	2	1
140-149	5	2	3	1
>160	6	3	4	2

Total risk points

Risk factor	Points
Age	
Smoking	
Total Cholesterol	
HDL-Cholesterol	
Systolic Blood Pressure	
Total	

Ten-year (10-year) CVD Risk

Point Total	10-year risk for women (%)	Risk Category	10-year risk for men (%)	Risk Category
<0	0	Low risk (<10%)	<1	Low risk (<10%)
0-4	<1		1	
5-6	<1		2	
7	<1		3	
8	<1		4	
9	1		5	
10	1		6	
11	1		8	
12	1		10	Intermediate risk (10-20%)
13	2		12	
14	2		16	
15	3		20	
16	4		25	High risk (>20%)
17	5		>=30	
18	6		>=30	
19	8		>=30	
20	11	Intermediate risk (10-20%)	>=30	
21	14		>=30	
22	17		>=30	
23	22	High risk (>20%)	>=30	
24	27		>=30	
>=25	>=30		>=30	