


**IMPACT OF SHIFT WORK ON DIET AND
CARDIOVASCULAR HEALTH OF FIRE-FIGHTERS IN
SELECTED FIRE STATIONS IN THE ACCRA
METROPOLITAN AREA**

CELESTINE ENYONAM MENSAH

(10362603)



**DEPARTMENT OF DIETETICS
SCHOOL OF ALLIED HEALTH SCIENCES
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA**

**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF
MSC DIETETICS DEGREE**

JULY, 2013

DECLARATION

I, Celestine Enyonam Mensah, declare that this work is the report of the research I undertook at the Department of Dietetics, School of Allied Health Sciences, University of Ghana towards the MSc and that to the best of my knowledge, it contains no material which has been accepted for the award of any other degree of this University, except where due acknowledgements has been made in the text.

Signature

CELESTINE ENYONAM MENSAH

DATE

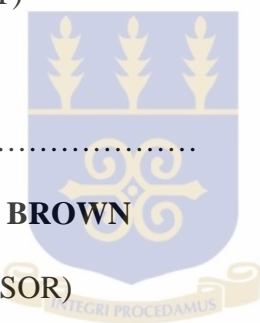
(STUDENT)

Signature

DR. CHARLES BROWN

DATE

(SUPERVISOR)



Signature

DR. MATILDA ASANTE

DATE

(SUPERVISOR)

DEDICATION

I dedicate this work to the Lord Almighty for His faithfulness.



ACKNOWLEDGEMENTS

The successful completion of this work has been made possible with the help of some personalities to whom I owe a great deal of appreciation for various contributions.

My heartfelt appreciation to all my lecturers in the Department of Dietetics at the School of Allied Health Sciences and the Nutrition and Food Science Department especially my supervisors Dr. Charles Brown and Dr. Matilda Asante whose contribution and suggestions made it possible for me to complete this work.

Thanks also go to Ms. Bernice Aseidu and Ms. Sheila Santa of the Chemical Pathology Lab, SAHS, for their assistance in the biochemical analysis and Mr. Abdul-Rahman Mubarak for helping with the data analysis. Enoch of Central Lab, Korle Bu Teaching Hospital also deserves mentioning for his assistance with the phlebotomy.

I am also grateful to the National fire commander, District fire officers and all the fire men and women of the various fire stations involved in the study for their cooperation during the collection of data for this research. Profound gratitude also goes to Mr. Elikplem Kpano, Mr. Samuel Mensah, Mr. Richard Nabia and Mr. Sammuel Mortu for their assistance with the data collection.

My appreciations go to my dear parents and Prof. Daniel Obeng Ofori for their encouragement and financial support.

Above all, I thank the Most High God for giving me strength and good health to undertake this project.

ABSTRACT

Background: Night shift work has been shown to induce stress, disturb family life, interrupt regular meal schedules (leading to lower intakes of energy, vitamins and minerals) and create lifestyle problems. These shift work-associated problems lead to high blood pressure, diabetes and high cholesterol; all possible cardiovascular (CV) risk factors. Fire-fighters are one category of workers who undertake rotating night shift work in Ghana.

Aim: This study determined the impact of shift work on diet and cardiovascular risk factors of fire-fighters in selected fire stations in the Accra Metropolitan Area.

Methods: The study was cross-sectional. Fire-fighters in four fire stations in the Accra Metropolitan Area were recruited and undertook full lipid and fasting glucose tests. Blood pressure, waist and hip circumferences, height and weight were measured. Questionnaires were used to collect information on socio-demographic variables, CV risk factors and eating patterns. Associations between shift work and dietary patterns, nutrient intake and CV risk factors among the fire-fighters were analysed.

Results: A total of 160 respondents (83 shift workers and 73 non-shift workers) were recruited. Majority of the shift workers had inappropriate meal patterns: they had lower energy intake compared to non-shift workers, they did not eat breakfast at home, and they skipped meals and bought most of their meals from outside more often than the non-shift workers. The shift workers had higher prevalence for overweight than non-shift workers. The prevalence of high anthropometric indices such as total body fat and waist to hip ratio (WHR) was higher for female shift workers than female non-shift workers. The prevalence of dyslipidaemia was higher for shift workers than non-shift workers. High total cholesterol (≥ 6.24 mmol/l) was 59.1 % and high LDL (≥ 4.2 mmol/l) was 52 % for shift workers while the prevalence of low HDL (< 1 mmol/l) was 26.5 %. The

prevalence of high fasting blood sugar was low (3.6 %) for the shift workers. Life style CV risk factors such as drinking and smoking were also low among shift workers. Very few shift workers were physically active at work. However, no significant association (all $p > 0.05$) was found between CV risk factors of the shift and non-shift fire-fighters.

Conclusion: Shift workers in general, had higher prevalence for overweight than the non-shift workers. The study revealed that 35.4 % of shift workers were overweight and 34.9 % of male shift fire-fighters had high CV risk factor for WC while over 27.7 % of the female shift workers had high CV risk factor for total body fat. There was relatively high prevalence of dyslipidaemia among the shift workers which puts them at risk of developing CVDs.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	v
TABLE OF CONTENTS	vii
LIST OF FIGURES	x
LIST OF TABLES	xi
ABBREVIATIONS	xii
CHAPTER ONE	1
1.0 INTRODUCTION	1
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT	2
1.3 SIGNIFICANCE OF STUDY	3
1.4 HYPOTHESES	4
1.5 AIM	5
1.6 SPECIFIC OBJECTIVES	5
CHAPTER TWO	6
2.0 LITERATURE REVIEW	6
2.1 CARDIOVASCULAR (CV) HEALTH	6
2.2 CARDIOVASCULAR DISEASES (CVDs)	6
2.2.1 Definition and Types	6
2.2.2 Global Trend, Prevalence and Mortality	7
2.3 CV Risk Factors	9
2.3.2 Behavioural /Lifestyle	10
2.3.2. 1 Nutrient intake	10
2.3.2. 1.1 Fruits, vegetables, cereals and grains	12
2.3.2.1.2 Lipids	12
2.3.2.1.3 Energy	13
2.3.2. 1.4 Calcium	13
2.3.2.1.5 Magnesium	14
2.3.2.1.6 Sodium and potassium	14
2.3.2.1.7 Coffee drinking	16
2.3.2.1.8 Regular Meals	16
2.3.2.2 Physical Inactivity	16
2.3.2.3 Alcohol Consumption	17

2.3.2.4 Smoking	18
2.3.3 Metabolic Risk Factors	19
2.3.3.1 Obesity	19
2.3.3.2 Hypertension	21
2.3.3.3 High serum cholesterol/ Dyslipidaemia.....	21
2.3.3.4 High Plasma Glucose/Diabetes	22
2.4 SHIFT WORK	23
2.4.1 Definition.....	23
2.4.2 Types	23
2.4.3 Occurrence.....	24
2.4.4 Shift Work Exposure and Health.....	24
2.4.4.1 Nutrient intake	26
2.4.4.2 Coffee drinking	26
2.4.4.3 Obesity	27
2.4.4.4 Hypertension	27
2.4.4.5 Dyslipidaemia	27
2.4.4.6 High plasma glucose	28
2.5 FIRE – FIGHTERS AND CV RISK FACTORS.....	29
2.5.1 Nutrient Intake	29
2.5.2 Physical Inactivity	30
2.5.3 Stress.....	31
2.5.4 Smoking.....	32
2.5.5 Obesity.....	32
2.5.6 Hypertension.....	33
CHAPTER THREE	34
3.0 MATERIALS AND METHODS.....	34
3.1 STUDY DESIGN.....	34
3.2 STUDY SITES	34
3.3 SUBJECT RECRUITMENT AND SAMPLE SIZE DETERMINATION	35
3.3.1 Sample Size Determination	35
3.3.2 Inclusion and Exclusion Criteria	36
3.3.2.1 Inclusion criteria	36
3.3.2.2 Exclusion criteria	36
3.4 ETHICAL APPROVAL.....	36
3.5 DATA COLLECTION.....	36
3.5.1 Questionnaire.....	36
3.5.2 Anthropometric Measurements	37

3.5.2.1 Height, weight and body mass index (BMI) determination.....	37
3.5.3 Waist to Hip Ratio (WHR) Determination	38
3.5.4 Blood Pressure Measurement	38
3.5.5 Laboratory Methods	39
3.5.5.1 Blood sampling and biochemical analysis.....	39
3.5.6 Dietary Assessment (24 Hour Recall)	39
3.6 DATA ANALYSIS	40
CHAPTER FOUR.....	41
4.0 RESULTS	41
4.1 BACKGROUND DATA	41
4.2 DIETARY PATTERN AND NUTRIENT INTAKE OF RESPONDENTS	43
4.2.1 Dietary Pattern.....	43
4.2.2 Nutrient Intake.....	43
4.3 LIFESTYLE CHARACTERISTICS	43
4.4 ANTHROPOMETRIC MEASUREMENT	47
4.5 BLOOD PRESSURE	47
4.6 BIOCHEMICAL PARAMETERS.....	47
4.6.1 Lipid Profile.....	47
4.6.2 Fasting Blood Glucose	47
4.7 PREVALENCE OF ANTHROPOMETRIC CV RISK FACTORS AMONG SHIFT AND NON-SHIFT FIRE-FIGHTERS IN ACCRA.....	49
4.8 PREVALENCE OF METABOLIC CV RISK FACTORS AMONG SHIFT AND NON-SHIFT FIRE-FIGHTERS.....	49
4.9 ASSOCIATION BETWEEN CV RISK FACTORS AND SHIFT WORK	49
CHAPTER FIVE	52
5.0 DISCUSSION AND CONCLUSIONS	52
5.1 DISCUSSION	52
5.2 CONCLUSIONS.....	58
REFERENCES	60
APPENDIXES	75

LIST OF FIGURES

- Fig. 1.** Distribution of major causes of death including CVDs.
- Fig. 2** Distribution of global NCD by cause of death, both gender
- Fig. 3** The causal chain

LIST OF TABLES

- Table 1** Respondents' characteristics
- Table 2** Meal consumption pattern of the shift and non-shift fire-fighters
- Table 3** Nutrient intake of the shift and non-shift fire-fighters
- Table 4** Life style characteristics of shift and non-shift fire-fighters
- Table 5** Anthropometric indices of the shift and non-shift fire-fighters
- Table 6** Blood pressure of the shift and non-shift fire-fighters
- Table 7** Biochemical indices of shift and non-shift fire-fighters
- Table 8** Prevalence of anthropometric CV risk factors among fire-fighters in Accra
- Table 9** Prevalence of metabolic CV risk factors among shift and non-shift fire-fighters
- Table 10** Association between CV risk factors and shift work

ABBREVIATIONS

AHA	American Heart Association
BMI	body mass index
BP	blood pressure
CHD	coronary heart disease
CV	cardiovascular
CVDs	cardiovascular diseases
DASH	Dietary Approaches to Stop Hypertension
DHA	docosahexaenoic acid
EPA	eicosapentaenoic acid
MUFA	Monounsaturated fatty acid
FAO	Food and Agriculture Organization
FBS	fasting blood sugar
SBP	systolic blood pressure
DBP	Diastolic blood pressure
JNC 7	Seventh Report of the Joint National Committee
Kg	kilogram
LDL cholesterol	low density lipoprotein cholesterol
HDL cholesterol	high-density lipoprotein cholesterol
HOPE study	Heart Outcomes Prevention Evaluation study
MI	myocardial infarction
mmHg	millimetre of mercury
mmol	millimole
NCD	non- communicable diseases
PUFAs	polyunsaturated fatty acids
SFA	saturated fatty acids
T2DM	type II diabetes mellitus
TG	triglycerides
USA	United States of America
WC	waist circumference
WHO	World Health Organisation
WHR	waist to hip ratio

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

The International Labour Organization (International Labour Organization, 1990) defines shift work as “a method of organization of working time in which workers succeed one another at the workplace so that the establishment can operate longer than the hours of work of individual workers”. A shift worker is any individual whose work schedule deviates from the normal eight hour conventional day schedule (i.e. 8am to 5pm). Types of shift work include evening shift, night shift, rotating shifts, split shifts or on-call schedules both during the week and on weekends (Szosland, 2010).

Shift work has become an employment practice designed to make use of the 24 hours of the clock. This situation is as a result of the need and demand of modern society. In Japan for example, the proportion of larger companies using shift workers has increased, with 51.2% of companies having at least 1,000 employees working on shift schedule (Ministry of Health, Labour & Welfare, Japan, 2005). In Ghana, workers such as police, doctors, nurses, military all run shift because of the demands of their jobs.

The effect of shift work on health has been studied extensively in developed countries and has been linked to the development of CV risk factors through a number of pathways including disturbance of circadian rhythm, lifestyle changes, and social stress (Wang *et al.*, 2011). Rotating night shifts are particularly disruptive for sleep, wakefulness, eating patterns, and social activities (Noriko *et al.*, 2005). In a review of 17 studies that were done on shift work and cardiovascular diseases (CVDs) it was calculated that shift workers had a 40% increased risk of CVD compared with day workers (Knutsson, 2003).

Some studies have reported a high prevalence of CV risk factors, including increased serum cholesterol, and blood glucose among rotating night shift workers (Sookoian *et al.*, 2007; Biggi *et al.*, 2008). High total cholesterol and low density lipoprotein cholesterol (LDL) levels were more common in shift workers than in day workers (Oishi *et al.*, 2005; Yoshita *et al.*, 2005). Shift work increases the risk of obesity (De Bacquer *et al.*, 2009; Antunes *et al.*, 2010a, 2010b), a condition which is an independent CV risk factor. Pan *et al.* (2011) also suggested that extended periods of rotating night shift work is associated with an increased risk of type II diabetes mellitus (T2DM) and weight gain.

Shift work infringes on an individual's ability to eat regular balanced meals with the family (Atkinson, 2008; Culpepper, 2010). In a comparison between shift and day workers, lower intake of energy, vitamins and minerals was observed among shift workers because of less frequent and poorer quality meals (Wong, 2010). The combination of poor nutritional practices and the stress associated with shift work may serve as a precursor for the development of obesity, hypertension, high cholesterol and diabetes among Ghanaian fire-fighter who run rotating night shift.

1.2 PROBLEM STATEMENT

The first review work to suggest an association between shift work and CV risk factors was published in 1984. Since then, the numbers of epidemiological studies have slowly increased and recent reviews of shift work and CV risk factors all conclude that shift work and CV risk factors are associated. A current analysis of studies in the British Medical Journal involving more than 2 million workers reported that shift work could disrupt the body clock and have an adverse effect on lifestyle (Vyas *et al.*, 2012). Similar studies on shift work and cardiovascular health also concluded that shift work and CV risk factors were associated (Ellingsen, 2007; Haupt *et al.*, 2008; Vyas *et al.*, 2012).

Although shift work has numerous negative effects on workers, it is an essential component of the demanding emergency call in the fire service.

In Ghana, fire-fighters work long and varied hours, often 24-hour rotating night shifts on duty and are off the following 12 hours; resulting in at least 60 hours a week (George Agyapong, Regional Statistician, Fire Service Headquarters, personal communication). Shift work fuels the cultivation of the habit of cigarette smoking and coffee drinking to release stress during the night shift (Zhao *et al.*, 2008). It also leads to an increased drift to irregular meal time and an increased consumption of “junk” foods mostly in the form of fast foods, snacks and soft drinks. These habits fuel the epidemic of obesity, hypertension and diabetes which are important modifiable CV risk factors. No research work has been done to investigate the effect of shift work on CV risk factors among fire-fighters in Ghana.

1.3 SIGNIFICANCE OF STUDY

Fire-fighters commonly work beyond the usual 8 hours schedule in rotating night shifts, and the unpredictable nature of emergency calls leads to variable meal times and frequent reliance on “fast-food” meals. Furthermore, the fire service do not mandate exercise or require that a specific fitness level be maintained by members of the service following employment hence most workers do not engage in exercise to keep them fit (Elpidoforos *et al.*, 2011). Inadequate physical activity, poor dietary habits, and shift work may promote obesity which is independently associated with increased CV risk factors (Di Lorenzo *et al.*, 2003; Flegal *et al.*, 2007).

It is reported that sudden cardiac events account for approximately 45% of fire-fighter duty-related deaths in the US each year (Fahy, 2005). CVD in the fire service has adverse

public safety implications as well as significant cost impacts on government agencies. In this regard, premature morbidity and mortality from CVD could adversely affect the contribution that fire-fighters make towards the economy and fire incidence delivery in Ghana. Prevalence of CV risk factors among fire-fighters in Ghana is not known. It is therefore important to investigate the prevalence of CV risk factors among fire-fighters in Ghana. Knowing the prevalence of CV risk factors among fire-fighters in the selected fire stations will be helpful in early intervention and treatment of CV risk factors and CVDs.

Since shift work induces psychosocial stress through decreased work–life balance and insufficient recovery, this study when completed can provide information to help plan strategies that can help the shift workers control these psychosocial stresses thereby reducing the level of risk of CVDs among the fire-fighters as well as other shift workers in different organizations. Again with the most probable behavioural changes that can help reduce the level of risk being weight control and avoidance of smoking, educational talks can be organized for the workers based on the findings of this research work to help control weight gain and smoking among the fire-fighters and shift workers on a whole.

1.4 HYPOTHESES

1. Shift work has no impact on the dietary intake of fire-fighters in the selected fire stations in the Accra metropolitan area.
2. Shift work has no impact on CV risk factors among fire-fighters in the selected fire stations in the Accra metropolitan area.

1.5 AIM

This study aimed at determining the impact of shift work on diet and CV risk factors among fire-fighters in the selected fire stations in the Accra Metropolitan Area.

1.6 SPECIFIC OBJECTIVES

The specific objectives are:

1. To estimate energy and nutrient intakes of the fire-fighters.
2. To determine the prevalence of CV risk factors among the fire-fighters through the use of lipid profile, anthropometry and bio-demographic data.
3. To examine whether shift work was associated with high prevalence of CV risk factors among fire-fighters who run rotating night shift.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CARDIOVASCULAR (CV) HEALTH

Ideal Cardiovascular (CV) Health is the American Heart Association (AHA) definition of CV health and is made up of seven metrics (Go *et al.*, 2013). The AHA defines ideal CV health as the simultaneous presence of four ideal health behaviours (non-smoking, BMI <25 kg/m², physical activity at goal level (30-45mins a day), and healthy diet (diet containing fruits, vegetables, grains and cereals) and three ideal health factors (untreated total cholesterol <200 mg/dL, untreated BP <120/<80 mm Hg, and untreated FBS of 100 mg/dL) [Lloyd-Jones *et al.*, 2010; Go *et al.*, 2013].

2.2 CARDIOVASCULAR DISEASES (CVDS)

2.2.1 Definition and Types

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. They include coronary heart disease (CHD), cerebrovascular disease (stroke), raised blood pressure (hypertension), peripheral artery disease, rheumatic heart disease, congenital heart disease and heart failure (WHO, 2012). These diseases develop in the absence of the conditions stated above that indicate CV health.

The different types of CVDs (WHO, 2011a) are:

a. CVDs due to atherosclerosis:

- i. ischaemic heart disease or coronary artery disease (e.g. heart attack)
- ii. cerebrovascular disease (e.g. stroke)
- iii. diseases of the aorta and arteries, including hypertension and peripheral vascular disease.

b. Other CVDs

- i. congenital heart disease
- ii. rheumatic heart disease
- iii. cardiomyopathies
- iv. cardiac arrhythmias

2.2.2 Global Trend, Prevalence and Mortality

CVDs are now the dominant contributors to the global burden of disease, and are the largest contributor to the chronic disease cluster (WHO, 2011). While CVDs death rates are declining in most high income countries, it is increasing in most low and middle income countries with the epidemics increasing in many regions of the world which are experiencing a rapid health transition (Khan & Mensah, 2010). Dietary practices, physical inactivity and the shift system of work have been implicated as factors that dispose many workers to CV risk factors (Morikawa *et al.*, 2008).

CVDs are one of the four major non-communicable diseases (NCD) that are causing mortality in the world (Fig. 1). According to the WHO (WHO, 2011), CVDs are the leading causes of death and disability in the world (Fig. 2). An estimated 17.3 million people died from CVDs in 2008, representing 30% of all global deaths and over 80% of these deaths took place in low and middle income countries (WHO, 2011).

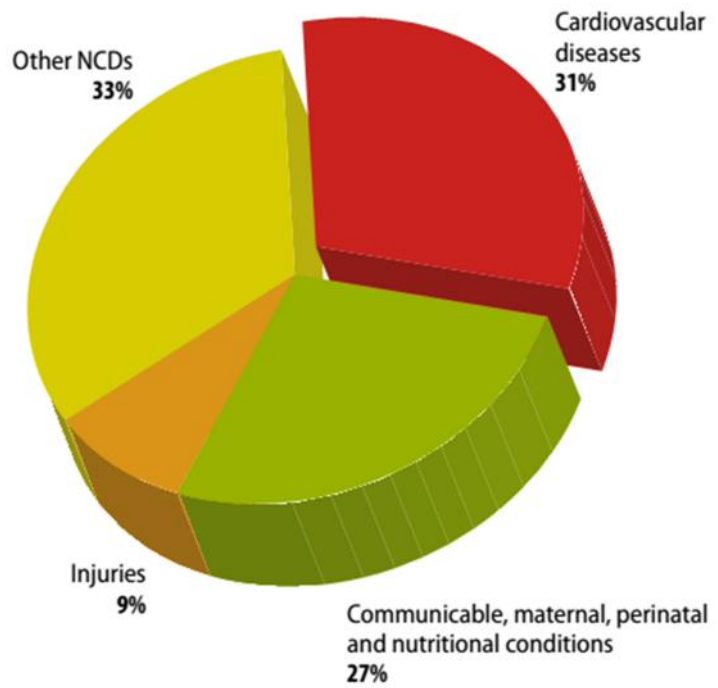


Fig. 1: Distribution of major causes of death including CVDs (WHO, 2008).

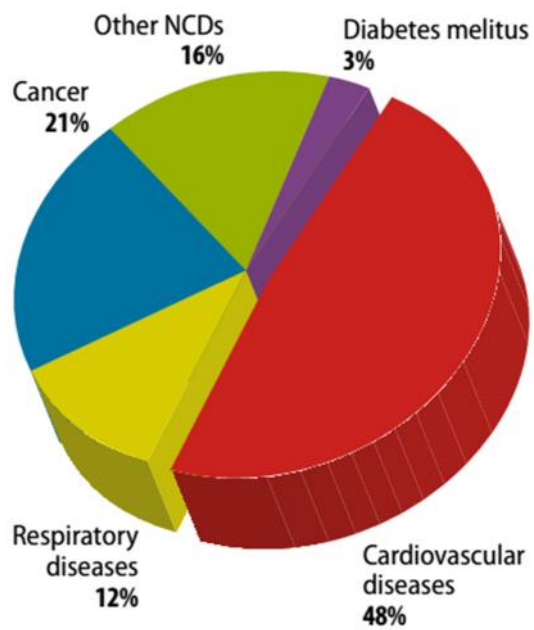


Fig. 2: Distribution of global NCD by cause of death, both gender (WHO, 2011).

The WHO has predicted that in the next 10 years, mortality rate caused by NCD will increase by 17 % with the highest mortality rate occurring in the regions of Africa and Eastern Mediterranean, respectively (WHO, 2010). According to WHO, almost 23.6 million people will die from CVDs by 2030 (WHO, 2011b). Researchers have also projected that, by 2030 non-communicable diseases for that matter CVDs will account for more than three-quarters of deaths worldwide and CVD alone will be responsible for more deaths in low income countries than other diseases (Mathers & Loncar, 2006; Beaglehole *et al.*, 2011).

2.3 CV RISK FACTORS

Eight CV risk factors which include alcohol use, tobacco use, high blood pressure, high body mass index, high cholesterol, high blood glucose, low fruit and vegetable intake, and physical inactivity jointly account for 61 % of loss of healthy life years from CVDs and 61% of CV deaths (WHO, 2009). These same risk factors account for over three quarters of deaths from ischaemic and hypertensive heart disease (Parry *et al.*, 2011).

CV risk factors are conditions or habits that raise the risk of development of CVDs. These risk factors also increase the chance that existing CVD will worsen.

Factors that promote the process of atherosclerosis which is responsible for a large proportion of CVDs (WHO, 2008, 2010) include (a) behavioural /lifestyle risk factors (tobacco use, physical inactivity. unhealthy diet (rich in salt, fat and calories), harmful use of alcohol), (b) metabolic risk factors (raised blood pressure (hypertension), raised blood glucose (diabetes), raised blood lipids (e.g. cholesterol), overweight and obesity and (c) other risk factors (poverty and low educational status), advancing age, gender,

inherited (genetic) disposition, psychological factors (e.g. stress, depression) and other risk factors (e.g. excess homocysteine) (WHO, 2008, 2010).

The risk factors leading to the development of CVDs and those associated with CVD mortality are not synonymous. Thus, risk factors start developing very early in life and accumulate with behavioural, social, and economic factors over a long period of time to culminate in biological risks for CVDs such as high cholesterol, high blood pressure, high blood glucose (Smith & Hart, 2002).

The development of CVDs increases with the number of risk factors (Fig. 3). The more risk factors one demonstrates, the greater the risk of development of CVDs. Risk factors are often said to work together in a synergistic manner (Nelms *et al.*, 2010).

2.3.2 Behavioural /Lifestyle

2.3.2. 1 Nutrient intake

The role of diet is crucial in the development and prevention of CV risk factors (Brown, 2008). Diet is one of the key factors that can impact all other CV risk factors when changed positively. Although all nutrients are equally important in adulthood, studies conducted have linked certain nutrients, minerals, food groups and dietary patterns with an increased or decreased CV risk factors (Brown, 2008).

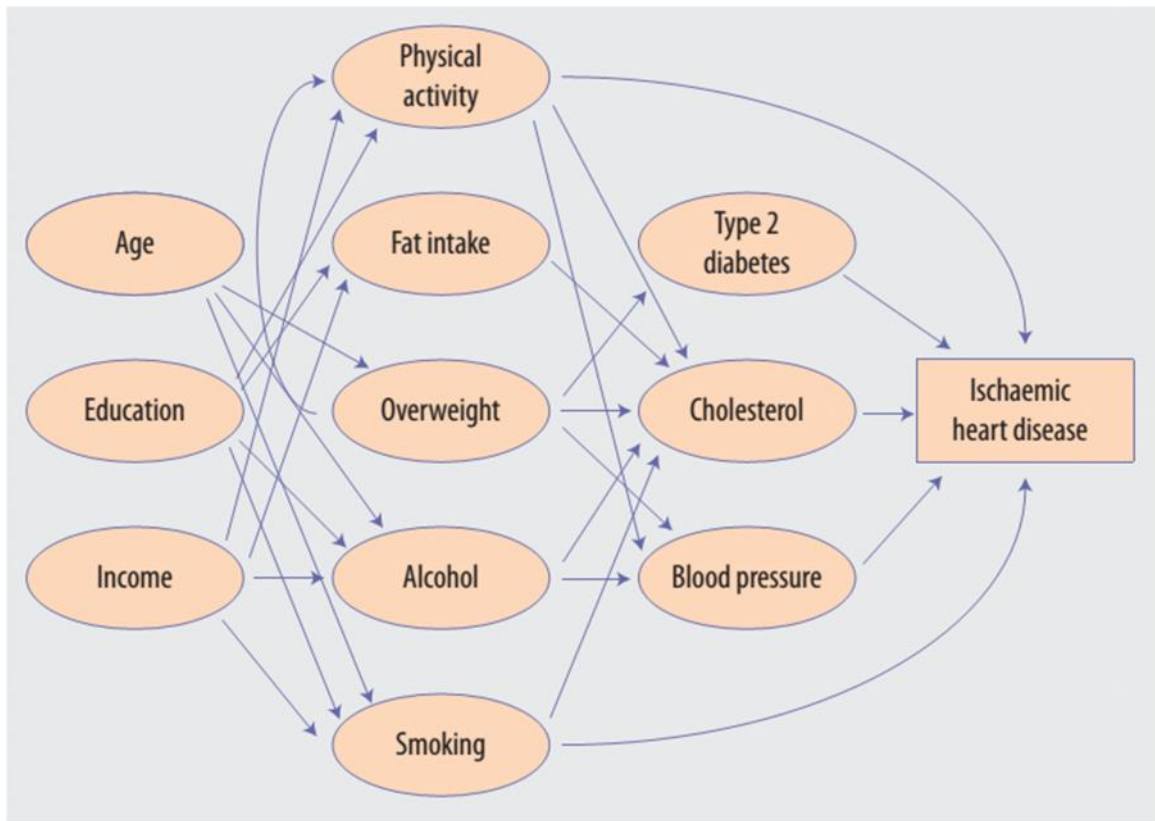


Fig. 3: The causal chain. Major causes of ischaemic heart disease are shown. Arrows indicate some (but not all) of the pathways by which these causes interact (WHO, 2009).

These are adequate intake of fruits and vegetables which provide the body with minerals and vitamins such as magnesium, sodium, potassium, fibre and fluid. Whole cereals and grains provide energy and B vitamin. Oily fish and fish oil provides the body with protein and polyunsaturated fatty acid which when taken in the right quantity, provides protection against CVDs (Brown, 2008).

2.3.2. 1.1 Fruits, vegetables, cereals and grains

Vegetables and fruits are good sources of dietary fibre as well as vitamins and minerals. Regular and frequent intake of fruits and vegetables is protective against risk of CVD (Lichtenstein, 2006). For example, a meta-analysis of twelve studies, consisting of 13 independent cohorts found a significant protective association for CV system with consumption of fruits and vegetables (He *et al.*, 2007). Whole grains are good sources of insoluble fibre and other nutrients that play a role in regulating blood pressure and heart health. A recent study (Cho *et al.*, 2013) found reduced risk of CVDs with high intakes of cereal fiber or mixtures of whole grains and bran.

2.3.2.1.2 Lipids

Lipids are important components of the diet because they are high in energy. Lipids also play the role of delivering fat soluble vitamins and essential fatty acids in the food to the body cells. Three main types are considered in relation to CV risk factors.

Trans-fats (hydrogenated oil) and saturated fatty acids (SFA) are associated with increased CV risk factors (Rinaldi *et al.*, 2012), while the polyunsaturated fatty acid (PUFA) and monounsaturated fatty acid (MUFA) are known to have protective effect on the heart and blood vessels (WHO, 2003). For instance in a study to determine the association between fatty acid intake and the prevalence of risk factors for the metabolic

syndrome, an inverse association between HDL with SFA and PUFA was found (Shab-Bidar *et al.*, 2013).

Fish and fish oils contain high levels of unsaturated fatty acids [(eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA)] which have beneficial effects on hypertension, hyperlipidemia, thrombosis, and CVD as a whole (David *et al.*, 2003). High consumption of saturated fats and trans-fatty acids is linked to development of CV risk factors whiles elimination of trans-fat and replacement of saturated fat with polyunsaturated vegetable oils lowers development of CV risk factors (WHO,2003).

2.3.2.1.3 Energy

According to Food and Agriculture Organization (FAO), the total energy intake has increased in many low and middle income countries (Khan & Mensah, 2010). Tropical oils like palm oil which are major sources of saturated fat are regularly included in the diet of the low income individuals (Khan & Mensah, 2010). This contributes to increase in development of CV risk factors among people of low income countries (Khan & Mensah, 2010).

2.3.2. 1.4 Calcium

Calcium is required for contraction and relaxation of heart muscles and it is also a second messenger in signal transduction pathways of the CV system. An imbalance of normal calcium homeostasis has been linked to both heart failure and hypertension (Van *et al.*, 2013). A small decrease of 2-4 mmHg in systolic blood pressure was found in hypertensive subjects with calcium supplementation (Uusi-Rasi *et al.*, 2013). Extremely low or extremely high serum concentrations of calcium are related to CV mortality (Van *et al.*, 2013). The inverse relationship between calcium and hypertension was studied and

established in the DASH (Dietary Approaches to Stop Hypertension) trials (Nelms *et al.*, 2010).

Milk and milk products are the richest dietary sources of calcium (Buzinaro *et al.*, 2006). Lesser amounts of calcium are found in shellfish, egg yolk, canned sardines and salmon (with bones), soybeans and certain green leafy vegetables such as “kontonmire, adema, bokobo, ayoyo, alefi, lului”.

2.3.2.1.5 Magnesium

Magnesium is an important element required in utilisation of both calcium and potassium and its deficiency results in hypocalcemia and hypokalemia as well as CV problems. Circulating and dietary magnesium are inversely associated with CV risk (Del Gobbo, 2013) Clinical hypomagnesemia and experimental restriction of dietary magnesium increase type 2 diabetes cardiac events (Yeung & Laquatra, 2003)

Good food sources of magnesium include unrefined (whole) grains, spinach, nuts, legumes, and white potatoes (Volpe, 2013)

2.3.2.1.6 Sodium and potassium

Sodium and potassium are essential for normal growth and body functions. These minerals are involved in regulating water and acid-base balance in membrane permeability, nerve conduction and muscle action. Changes in extracellular sodium concentration can affect arterial pressure, whereas changes in blood potassium concentration can affect cardiac performance (David *et al.*, 2003).

i) Potassium

DASH is a carbohydrate-rich eating plan which emphasizes increasing consumption of fruits, vegetables and low-fat dairy products and reducing consumption of saturated fat, total fat, and cholesterol by decreasing consumption of red meat, sweets, and added sugars (Appel *et al.*, 1997). Randomized controlled trials show that DASH is effective in lowering blood pressure in African Americans (Funk *et al.*, 2008). Research suggests that potassium intake lower than recommended levels of 4.7g is associated with increased blood pressure hence when the diet used in the DASH trials provided an average of 4–6 g of potassium per day from fruits and vegetables, it recorded a decrease in blood pressure (Mahan *et al.*, 2012). Good sources of potassium are meat, poultry, fish, organ meats, milk and milk products and certain fruits and vegetables.

High potassium fruits include avocado, banana, melons and oranges. Vegetables like broccoli, cabbage, parsnips, squash, potatoes, dry beans and peas are also high in potassium.

ii) Sodium

There is a strong evidence that excessive sodium intake significantly increases CVD risk and that reduction in sodium intake on a population level decreases CV burden (He & MacGregor, 2009). A current recommended adequate intake of sodium is 1.5g/day (Mahan *et al.*, 2012).

It has been estimated that a universal reduction in dietary intake of sodium by about 1g of sodium a day would lead to a 50% reduction in the number of people needing treatment for hypertension (Cook *et al.*, 2009). Reduced sodium diet leads to reduction in

blood pressure whiles higher sodium/potassium ratio is associated with increased CV risk in later years (Cook *et al.*, 2009).

Dietary sources of sodium are table salt (sodium chloride) and sodium-based food additives (“koobi, momoni, kako,” monosodium glutamate), tin foods and cured meat. Effective reduction of sodium intake requires limiting the intake of highly processed foods, avoiding those foods that are cured using salt, and omitting salt during the cooking and preparation (Nelms *et al.*, 2010)

2.3.2.1.7 Coffee drinking

There is a detrimental cardiovascular effect of coffee and this effect may be associated with the acute pressor effects, most likely due to caffeine at high daily intakes. Lipids from boiled coffee can contribute to raised serum cholesterol but moderate intake are not associated with detrimental effects in healthy individuals and may even protect against the risk of developing type 2 diabetes (Bøhn *et al.*, 2012).

2.3.2.1.8 Regular Meals

Dietary intakes at breakfast and a healthy mid-morning and mid-afternoon snack helps spread out calorie and protect against development of CV risk factors (Esquirol *et al.*, 2009). Esquirol *et al.* (2009) concluded that energy intake is more fractionated within the day, with a lesser contribution of breakfast and lunch but intakes of snacks increases during afternoon and night among shift workers as compared to day workers.

2.3.2.2 Physical Inactivity

Regular physical exercise of sufficient duration is widely accepted to promote cardio protection. According to the “Seventh Report of the Joint National Committee” (JNC 7),

physical activity of 30 minutes per day decreases blood pressure by 4 to 9 mm Hg (Applegate *et al.*, 2003). Increasing physical activity decreases the relative workload on the heart, a benefit important for all forms of cardiovascular disease (Nelms *et al.*, 2010).

The relationship between physical activity and CV risk factors is independent of effects on weight and obesity. A sedentary lifestyle is an important modifiable marker for CV risk factors in the general population. Epidemiological studies suggest that physically active individuals have a 30 to 50 % lower risk of developing T2DM than do sedentary people (Skerrett & Manson, 2002). Physical activity may slow the initiation and progression of T2DM and its effects on body weight, insulin sensitivity, glycaemic control, blood pressure and lipid profile (Nelms *et al.*, 2010).

2.3.2.3 Alcohol Consumption

Alcohol consumption has increased dramatically in men in countries undergoing nutrition transition. (WHO Expert Committee on Problems Related to Alcohol Consumption, WHO 2007). The harmful use of alcohol is a major risk factor for premature deaths and disabilities in the world (WHO, 2009). It is one of the largest avoidable risk factors in low and middle income countries (Rehm *et al.*, 2009). A heavy intake of alcohol has been particularly linked to cancer, liver disease and CVD. It has been mentioned along with tobacco use, unhealthy diet and lack of exercise, as one of the four major common risk factors for NCD in the reports of the WHO (2013). According to an article: Lancet (2011) one of the top priorities for a global movement to prevent NCD such as CVD is reduction of harmful alcohol intake (Beaglehole *et al.*, 2011)

Alcohol consumption leads to changes in lipid levels and haemostatic factors, inflammation and endothelial cell function as well as levels of adipocyte hormones,

which associate it with CVD (Berg & Scherer, 2005) but there is also evidence in a range of populations that suggests that light to moderate (up to one drink or 15 g alcohol a day for women and up to two drinks or 30 g alcohol a day for men) intake of alcohol may reduce the risk of CVD (Brien *et al.*, 2011). In a systematic review, alcohol consumption was found to increase HDL cholesterol levels in a dose-response manner (Brien *et al.*, 2011).

2.3.2.4 Smoking

Cigarette smokers are 2–4 times more likely to develop heart disease than non-smokers (Baghaei *et al.*, 2010). Compared to non-smokers, smokers have significantly higher levels of serum total cholesterol, triglycerides, and LDL cholesterol, as well as lower HDL cholesterol levels therefore raising CV risk among smokers (Khurana *et al.*, 2000). CV risk factor T2DM increases with the number of cigarettes smoked in a day (Jee *et al.*, 2010).

Nitric oxide which is primarily responsible for vasodilation of the endothelium is decreased in endothelial cells exposed to components of cigarette smoke such as nicotine. Cells exposed to blood from cigarette smokers demonstrate a decrease in the activity of the endothelial nitric oxide synthase enzyme (Nelms *et al.*, 2010).

Low levels of exposure, including exposures to secondhand tobacco smoke, lead to a rapid and sharp increase in endothelial dysfunction and inflammation, which are implicated in acute CV events and thrombosis. Non-smokers who are exposed to secondhand smoke at home or work increase their CV risk by 25–30% (U.S Department of Health and Human Services, 2006). Secondhand smoke exposure causes an estimated

46,000 heart disease deaths annually among adult non-smokers in the United States (CDC, 2012).

2.3.3 Metabolic Risk Factors

2.3.3.1 Obesity

Obesity is another well-established CV risk factor, associated with CVD events (Soteriades *et al.*, 2005; Tsismenakis *et al.*, 2009). Obesity is primarily considered a disorder of energy balance and is a major CV risk factor associated with other significant CV risk factors, including hypertension, T2DM and high serum cholesterol (Nelms *et al.*, 2010).

Body fat content and mainly the fat distribution are considered important indicators of CV risk. The cardio-metabolic risk associated with abdominal obesity is attributed to the presence of visceral adipose tissue, which promotes insulin resistance, dyslipidaemia, and hypertension (de Koning *et al.*, 2007; Cameron *et al.*, 2012).

Several techniques have been developed for assessing body fat or adiposity. Some of these techniques include the BMI, WC, hip circumference (HC) and WHR. The BMI, which is calculated using weight and height, is the most widely used and accepted index for classifying overweight and obesity in clinical practice (Bouchard, 2007). A number of studies have shown that BMI is not a good indicator of CV risk, particularly when used as the only indicator. This is mainly because it is not able to differentiate between adipose and muscle tissue. This limitation could lead to classifying individuals with high muscle mass as overweight or obese and subjects with BMI in the normal range may have a high percentage of fat (Camhi *et al.*, 2011). WC and WHR techniques are suggested as better tools for predicting CV risk and should be used together with BMI

(Camhi *et al.*, 2011). BMI category such as 25.0 to 29.9 kg/m² is considered overweight whilst 30 kg/m² are considered obese and are associated with CV risk factors (Patry-Parisien *et al.*, 2012).

The WC and HC have independent and opposite associations with CVD (Yusuf *et al.*, 2005; Canoy *et al.*, 2007; Heitmann & Frederikson, 2009) in the general population. For a given WC, an increase in HC is associated with a reduction in CV risk, whereas for a given HC a larger WC is associated with an increase in CV risk. However, when the WC and HC is used together with the WHR, it helps identify adults at increased risk for CVD better than using any one of them alone (Bigaard *et al.*, 2004; Zhang *et al.*, 2008; Cameron *et al.*, 2012). A 1 cm increase in WC is associated with a 2% increase in risk of future CVD and a 0.01 increase in WHR is associated with a 5% increase in risk (de Koning *et al.*, 2010).

In the Heart Outcomes Prevention Evaluation (HOPE) study, high WHR and WC were each significantly associated with increased rates of CV mortality and total mortality, even after adjustment for BMI. However, when sex was taken into account, high WHR was significantly associated with increased rates of CV outcomes only among women (Limacher, 2005).

WC measurements for adults aged 20 years or older are classified into three health risk categories according to cut-offs recommended by the WHO, Health Canada and Obesity Canada (WHO, 2000; Health Canada 2003; Lau *et al.*, 2006). The three categories are low risk (men, WC 93.9 cm or less; women, WC 79.9 cm or less); increased risk (men, WC 94.0 to 101.9 cm; women, WC 80.0 to 87.9 cm); and high risk (men, WC 102.0 cm or more; women, WC 88.0 cm or more). Men with WHR < 0.90,

0.90 – 0.99 and 1 and women with WHR of < 0.80, 0.80 – 0.84 and 0.85 will be classified as normal weight, overweight and obese respectively.

2.3.3.2 Hypertension

Hypertension refers to a chronic elevation in BP. It involves a persistent reading greater than or equal to 140/90 mmHg for the diagnosis of hypertension. It is universally accepted as a major CV risk factor, with increasing risk starting in the prehypertensive range (Chobanian *et al.*, 2003).

Hypertension is an important public-health challenge worldwide. It induces an increased risk of CV event. Worldwide, raised blood pressure is estimated to cause 7.5 million deaths, about 12.8% of the total of all annual deaths (WHO, 2009, 2010). A number of reviews and analyses have found the prevalence of hypertension to be higher in low income countries than in high income countries (WHO, 2010). In sub-Saharan Africa, hypertension is a predominant cause of CVD (Mbewu & Mbanya, 2006). Hypertension account for the majority of the CVD burden in the region, especially among black Africans (Mbewu & Mbanya, 2006).

2.3.3.3 High serum cholesterol/ Dyslipidaemia

Dyslipidaemia refers to a lipid profile that increases the risk of atherosclerotic development. Typically, dyslipidemia is a condition in which LDL levels are elevated and HDL levels are low (Nelms *et al.*, 2010). HDL cholesterol is involved in reverse cholesterol transport, that is, they transport cholesterol and other lipoproteins from tissues to the liver and are therefore termed “good cholesterol”. LDL cholesterol is heavily involved in the atherosclerotic process and is called “bad cholesterol”.

The INTERHEART study confirmed that there is a graded relationship between abnormal lipid levels and risk for CVD in all regions of the world. Yusuf *et al.* (2005) also concluded that abnormal blood lipids are the most important risk factor for myocardial infarction in all global regions.

A high LDL or a low HDL cholesterol levels both increase risk of heart disease. A number of epidemiological data demonstrate that low levels of HDL cholesterol are associated with an increased CV risk (deKoning *et al.*, 2007) but high levels have a useful effect in reducing bad cholesterol. HDL actually protects against atherosclerosis. Less than 200 mg/dL of total cholesterol lowers the risk for CVD while a level of 200 mg/dL or higher raises the risk (Mahan *et al.*, 2012). The risk of heart attack increases two times with a level of 240 mg/dL and risk increases four times at 300 mg/dL (AHA, 2012). Reduction in LDL cholesterol is a useful strategy in reducing CV risk factors (Briel *et al.*, 2009). Raised blood cholesterol is risk factor for heart disease and stroke (WHO, 2007). Overall, raised cholesterol is estimated to cause 2.6 million deaths (4.5% of total) and 29.7 million DALYS (WHO, 2009).

2.3.3.4 High Plasma Glucose/Diabetes

High fasting blood glucose is closely associated with the risk of cardiac death. An impaired fasting glucose is defined as random plasma glucose between 110 and 125 mg/dL and fasting plasma glucose of >126 mg/dL (WHO, 2007). Comparatively higher fasting plasma glucose > 4.9 mmol/l has been identified as the leading cause of CV deaths in most regions (Lim *et al.*, 2012). In 2008, the global prevalence of diabetes was estimated to be 10% (WHO, 2010). Lack of early detection and care for diabetes results in CV events.

2.4 SHIFT WORK

2.4.1 Definition

The International Labour Office (International Labour Organization, 1990) defines working in shifts as “a method of organization of working time in which workers succeed one another at the workplace so that the establishment can operate longer than the hours of work of individual workers.” The European Council Directive 93/104 (1993) declares that “concerning certain aspects of the organisation of working time, shift work shall mean any method of organising work in shifts whereby workers succeed each other at the same work stations according to a certain pattern. Shift worker shall mean any worker whose work schedule is part of shift work.”

In most cases, shift work is synonymous of irregular, odd, flexible, variable, unusual, non-standard working hours.

2.4.2 Types

Many different work schedules can be described as shift work, including night work and rotating shift work. Several types of shift work exist and can be described as follows (IARC monographs volume 98):

- (a) permanent – people work regularly on one shift only, i.e. morning or afternoon or night;
- (b) rotating – people alternate more or less periodically on different shifts;
- (c) continuous – all days of the week are covered; or discontinuous – interruption on weekends or on sundays; with or without night work – the working time can be extended to all or part of the night, and the number of nights worked per week/month/year can vary considerably.

The shift systems can also differ widely in relation to other organizational factors. For example, in the industrial sectors (i.e. mechanical and chemical), shift work is usually arranged in continuous three-shift systems. In the transport sector, schedules are often quite irregular, both in terms of number of consecutive shifts, shift rotation, start and finishing times, duration of the duty periods, location, and amount of rest days. In the health-care sector, quite different shift schedules are operated with different rotation (clockwise or counter-clockwise), variable start and finishing time, and different amount of night shifts. In the service sector, workers are commonly employed on split shifts, for example, very early morning and late afternoon shifts

2.4.3 Occurrence

Shift work is an essential system in the modern society and is found mainly in manufacturing industries, medical institutions, and retail outlets that are open around the clock with approximately 22% of the population in industrialized countries performing some type of shift work (Haus & Smolensky, 2006). The Ministry of Health, Labour, and Welfare (2005) reported that 22.7% of Japanese companies employed shift workers in 2005 and that more than half of large companies with 1000 or more employees adopted a shift work schedule. They run fixed night work and alternating shift work.

2.4.4 Shift Work Exposure and Health

The rotating night shift work system has a negative impacts on the health of the workforce, disturbing the circadian rhythm, an essential biological function, in different ways, and also inducing sleep deprivation (Wang *et al.*, 2011).

Shift work is associated with diminished quality of life and adverse health problems such as CVDs (Figueiro & White, 2013). Although genetic factors often contribute to the

onset of CVDs, work condition, such as the shift work system, is also known to play an important role in the onset of CVDs (Wang, 2011; Kobayashi, 2012).

The afore-mentioned problems associated with shift work link it to the development of CVDs. The adverse health effects of shift work appear once workers are engaged in shift work over a prolonged period. Thus a continuous shift work rather than a limited duration or seasonal shift work is likely to expose the worker to CV risk factors (Costa *et al.*, 2010; Nagai *et al.*, 2011). Studies also suggest that individuals who have done shift work duties continuously for over six years are at higher risk of developing CV risk factors than seasonal shift workers since they have sufficient recovery time that enables their biological system to better handle the adverse health effects of the shift work (Ika *et al.*, 2013).

One of the first reviews to suggest an association between shift work and CV risk factors was published in 1984 after which several studies have been done on the topic, all concluding that there is a strong association between shift work and CV risk factors (Mosendane *et al.*, 2008).

Shift work is associated with a range of lifestyle-related CV risk factors (Frost *et al.*, 2009). In a study by Biggi *et al.* (2008) night workers smoked more and had significantly higher BMI, higher serum total cholesterol, and higher triglycerides than day workers. Shift work may be linked with increased CV risk factors for reasons such as disturbed circadian rhythms, lifestyle changes and psychosocial stress associated with it (Wang *et al.*, 2011). The prevalence of behaviour changes in dietary habits, reduced physical activity, increased smoking, heavy drinking and disruptions in psychosocial factors among shift workers increase their risk of development of CVDs (Zhao, 2008).

The Circadian rhythms which are biological clocks of the body influence various functions such as body temperature, blood pressure, heart rate and hormonal levels. A significant characteristic of circadian rhythms is their ability to be synchronised by external time cues (Vitaletta *et al.*, 2001). Light is the most potent stimulus for synchronising endogenous rhythms (Mosendane *et al.*, 2008). Circadian disruption affects nutrition and causes stress associated with sleep deprivation, leading to development of CV risk factors including blood pressure and blood cholesterol among shift workers (Frost *et al.*, 2009; De Bacquer, 2009).

2.4.4.1 Nutrient intake

Shift workers experience irregular appetites that may be associated with weight gain, due to a combination of high-fat snacking, infrequent eating during the day, over-eating at night and a lack of exercise which affects the circadian rhythms and also disrupts the family life of those who are engaged in it (Kalitern *et al.*, 2004). It has been established that, a high intake at lunch is particularly harmful to shift workers (Esquirol *et al.*, 2009).

2.4.4.2 Coffee drinking

A study by Jermendy *et al.* (2012) revealed that male rotating shift workers drank more coffee compared to daytime workers. The detrimental CV effect of coffee may be associated with the acute pressor effects, most likely due to caffeine at high daily intakes because the lipids from boiled coffee can contribute to raised serum cholesterol but moderate intake are protective against the risk of developing T2DM among normal individuals (Bøhn *et al.*, 2012).

2.4.4.3 Obesity

Di Lorenzo (2003) concluded in his study that, the prevalence of obesity is higher among shift workers compared to day workers and that shift workers had higher BMI. Croce *et al.* (2007) also in a research found out that shift workers had higher BMI than day workers after adjustment for age. Shift work is an independent risk factor in the development of central obesity and promotes the development of CVDs (Morikawa *et al.*, 2007). Abdominal obesity was diagnosed in 34.1% and 23.7% of shift workers (Pimenta *et al.*, 2012).

2.4.4.4 Hypertension

Shift workers have significantly high SBP levels (Di Lorenzo *et al.*, 2003). Japanese studies have also shown an approximately 1.2-fold risk in up to 30% increases both in systolic and diastolic blood pressure and significantly increased risks (Oishi *et al.*, 2005; Suwazono *et al.*, 2008) for hypertension among shift workers. A longitudinal study in Japan also reported that shift work was a risk factor for the onset of hypertension and also the progression from mild hypertension to severe hypertension (Sakata *et al.*, 2003).

2.4.4.5 Dyslipidaemia

Shift workers have significantly increased triglyceride and lower mean HDL-cholesterol Esquirol *et al.*, (2009), there were evidence of increased levels of triglycerides and low HDL cholesterol among shift workers compared to their counterparts who were day workers. Night-shift workers are reported to have a higher incidence of heart disease and also demonstrate higher triglyceride levels compared with day workers (Morgan *et al.*, 2003). According to Ghiasvand *et al.* (2006), total cholesterol levels of shift workers are significantly higher compared to day workers hence, shift work is a risk factor for lipid profile disturbance.

Plasma lipid concentrations also exhibit circadian rhythmicity. The principal consequence of ingesting a meal at night as many shift workers do is the production of higher concentrations of serum triacylglycerol levels and lower concentrations of cholesterol-rich lipoproteins than after a day time meal (Maillot *et al.*, 2005).

2.4.4.6 High plasma glucose

Shift work has been associated with an increased incidence of diabetes. In the review by Wang *et al.* (2011), Japanese male factory labourers who were shift workers reported a higher prevalence of diabetes than their counterparts who were day workers while in the Nurses' Health Study, years of rotating night shifts were found to be positively associated with risk of T2DM for people who have done rotating night shift work for more than 10 years. Oyama *et al.* (2012) examined the association between shift work and impaired glucose tolerance in men and the results of the study suggested a significant increase in the risk of impaired glucose tolerance among shift workers than non-shift workers.

Two studies (Morikawa *et al.*, 2005; Suwazono *et al.*, 2006), reported significant increases in the risk of T2DM in shift workers. Pan *et al.* (2011) reported that the risk of T2DM increased gradually depending on the number of years of continuous shift work. According to (Lazarou *et al.*, 2012; Kroenke *et al.*, 2007) shift workers who worked for more than 10 years have a significantly higher risk of developing T2DM. In the study of Axelsson & Puttonen, (2012) the results show that working three or more night shifts per month increases the risk of T2DM.

In a cohort study Kivimäki *et al.* (2011) proposed a potential model in which circadian rhythms may be disturbed by long-term continuous shift work, possibly leading to T2DM due to insulin resistance (Cappuccio *et al.*, 2010). Shift work interferes with the normal synchrony between the light and dark cycle, sleeping, and eating and this may cause a mismatch of circadian rhythms, triggering a cascade of biological changes that have potential diabetogenic effects. As a result, circadian disruption may accelerate development of T2DM in diabetes-prone individuals (Gale *et al.*, 2011; Froy, 2010). In a review by (Mosendane *et al.*, 2008) desynchronisation of circadian clocks, which may occur as a result of shift work led to insulin resistance.

The risk of T2DM has been reported among shift workers also because insulin sensitivity is known to be lower at night than during the day meanwhile appetite and consumption of carbohydrate containing foods increase during sleep deprivation (Jermendy *et al.*, 2012).

2.5 FIRE – FIGHTERS AND CV RISK FACTORS

2.5.1 Nutrient Intake

The practice of shift-work scheduling has always been part of normal work duties in emergency services such as health and security including the fire service. The unpredictable nature of emergency work leads to unreliable meal times, making the reliance on “fast-food” an unavoidable choice during night work-shifts (Elpidoforos *et al.*, 2010).

Eating behaviour might be altered by working night shift due to diverse range of biological, social and cultural factors. Example, it is suggested that night work causes a conflict between socially determined meal schedules and the circadian biological

rhythms in hunger, satiety and metabolism. Eating at night causes disturbance of intestinal motility, affecting digestion, absorption and utilization of nutrients. In a study by Lowden *et al.* (2010), intake of micronutrients such as calcium, potassium was low for midnight shift workers, as well as energy from saturated fat.

Moreover canteens located in fire stations are known for recipes high in fat and dense in simple, refined carbohydrates. This makes fire-fighters more likely to consume more meals with higher fat and carbohydrate content (Lowden *et al.*, 2010). In one study, despite good awareness that dietary choices can mitigate CV risk, 37% of the fire-fighters surveyed reported that they enjoyed their current diets and had no desire to change (Elpidoforos *et al.*, 2011)

Knutson *et al.* (1990) found that the consumption of dietary fibres was reduced six months after starting shift work. This was mainly due to a reduction in the consumption of green vegetables and an increase in intake of soft drinks.

2.5.2 Physical Inactivity

Fire-fighters are mostly associated with infrequent and inadequate amounts of physical activity. This is because they often experience long sedentary periods waiting for emergency calls and this makes fire-fighters prone to increased obesity. More so, the service does not mandate exercise or have any regular exercise programmes, or require the maintenance of discrete physical fitness parameters after employment (Elpidoforos *et al.*, 2011).

Irregular bouts of strenuous activity in otherwise sedentary individuals are a known precipitant of acute coronary events (Soteriades *et al.*, 2005). CVD is the single most

frequent cause of duty-related fatalities, accounting for almost half of all fatalities, with 90% caused by CHD (Kales *et al.*, 2007) among fire-fighters in USA. Additionally, for every fatal on-duty heart disease (HD) event, there are an estimated 17 nonfatal line-of-duty CV events in the US fire service (Karter & Molis, 2005).

2.5.3 Stress

It has also been found out that shift work might result in stress (Harma, 2006). Fire-fighters are exposed to a variety of psychological stressors in the course of various emergencies, including fires, natural disasters, rescues, and the provision of emergency medical services. Fire-fighting duties directly challenge the CV system, alarm bells for instance activates the sympathetic nervous system, the physical workload of fire-fighting, and associated heat stress and dehydration all put stress on the fire-fighter (Kales *et al.*, 2007).

Neuroendocrine response to these stresses involves increase in secretion of glucocorticoids and catecholamines from the adrenal gland and the activation of the sympathetic nervous system. The chronic activation of this stress system may in turn cause suppression of the gonadal, growth hormone and thyroid axes (Tsatsoulis & Fountoulakis, 2006). Such metabolic disturbances may lead to the clinical expression of a number of co-morbidities including central obesity, hypertension, dyslipidemia which are CV risk factors.

Fire-fighting is also associated with approximately 25% increase in circulation platelet numbers which is likely attributable to hemoconcentration and increased sympathetic nervous activity along with an increase in several coagulatory variables (Smith *et al.*, 2008). Fluid intake is therefore important to the fire-fighter.

2.5.4 Smoking

In a study by Biggi *et al.* (2008) compared workers who had engaged in day work and rotating shift work and found out that, men who had performed rotating-shift work had a higher prevalence of current smoking. The prevalence of current smoking in other fire-fighter studies ranges from 10% to 18% in a general cohorts (Kales *et al.*, 2003; Geibe *et al.*, 2008; Scanlon & Ablah, 2008)

2.5.5 Obesity

In a study by Elpidoforos *et al.* (2005) a high prevalence of obesity was observed among fire-fighters and all obese fire-fighters demonstrated a clustering of CV risk factors.

The prevalence of obesity among fire - fighters has been increasing steadily over time and it is roughly 40% of fire-fighters in the USA (Soteriades *et al.*, 2005; Tsismenakis *et al.*, 2009). Fahs *et al.* (2009) found 33% to 44% prevalence of overweight and obesity among fire-fighters in USA.

Glucose tolerance has been shown to have a decreasing trend during the day in normal individuals therefore the intake of meals during the night results in the higher incidence of obesity and weight gain that is often associated with shift work and is linked to the prevalence of hyperglycemia and dyslipidimia among fire-fighters (Mosendane *et al.*, 2008). Donovan *et al.* (2009) for example, found a low prevalence (1%) of hyperglycemia while Kales *et al.* (2003) and Yoo & Franke (2009) found the prevalence of T2DM to be 3% to 4% in fire-fighters in USA. The prevalence of low HDL was found to be 26% to 31%, whereas high fasting triglycerides was 20% among fire-fighters of USA (Soteriades *et al.*, 2002; Donovan *et al.*, 2009).

2.5.6 Hypertension

Shift work affects blood pressure because the normal daily circadian blood pressure rhythm is characterized by a nocturnal (night) fall and diurnal (day) rise. Shift work changes the diurnal variation of blood pressure from a dipper to a non-dipper pattern (Wolk & Somers, 2007) thus increasing the risk of hypertension among night-shift workers. A study investigated the relationship between the lack of nocturnal BP fall (the non-dipping pattern) and CV risk and has shown it to be associated with a greater frequency of CV events such as stroke, myocardial infarction and higher CV mortality in both hypertensive and normotensive individuals (Maillot *et al.*, 2005).

Fahs *et al.* (2009) and Kales *et al.* (2009) in different studies estimated an approximately 50% prevalence of prehypertension and 20% to 30% of hypertension among fire - fighters.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY DESIGN

The study was cross-sectional in design. A total of hundred and sixty (160) fire-fighters consisting of both shift and non- shift workers were recruited from four fire stations. The convenient sampling techniques was used. A proportion of 40 respondents were recruited from each station.

3.2 STUDY SITES

The study was carried out in four fire stations in the Accra Metropolitan Area. These stations are located in the Industrial Area, Dansoman, Korle Bu and the Greater Accra regional fire service headquarters.

Industrial area fire station is located in Okaikoi South district situated in the same premise with the State Transport Cooperation opposite the Awudome cemetery. This station serves the entire industrial area and its environs. The Dansoman fire station is located in Ablekuma West district in Accra. The station serves the whole of Dansoman area, Agege, Mamprobi, Odorkor and other surrounding areas. The Korle Bu fire station is located in the Ablekuma South district within the Korle Bu Teaching Hospital premise near the hospital mortuary. It serves Korle Bu and its environs. The Greater Accra regional fire service headquarters is also located within the Korle Bu premise opposite the Ghana Commercial Bank along the Dansoman-Tema station road.

The stations (Industrial Area, Dansoman, Korle Bu and Greater Accra regional fire service headquarters) at the time of the study had a working strength of 112, 106, 122

and 120 respectively. The fire-fighters at regional headquarters run the traditional eight hour duty because they are administrators and only go on shift duty when there is a national emergency. With the other three stations (Industrial Area, Dansoman and Korle Bu), majority of the fire-fighters run 12 hours rotating night shifts with few of them being administrators who work only on day duty.

3.3 SUBJECT RECRUITMENT AND SAMPLE SIZE DETERMINATION

3.3.1 Sample Size Determination

To determine the sample size of the study, the frequency of having high lipid profile and high blood glucose level as well as having poor dietary habits was taken as 10% of the estimated proportion of fire-fighters. The level of significance was 95% (1.96) and the allowable margin of error of 5% (deviation from the actual value). The estimated minimum sample size for the given proportion of 10% at 95% confidence interval was 138. The calculation was as follows:

$$\begin{aligned}
 n &= \frac{[z]^2 [p, q]}{E^2} \\
 &= \frac{[1.96]^2 [0.1] [1-0.1]}{[0.05]^2} \\
 &= 138.29
 \end{aligned}$$

Where n is estimated minimum sample size

E is the allowable margin of error.

z is the critical z score based on the desired level of significance.

P is estimated proportion of fire -fighters with high lipid profile and high blood glucose and had poor dietary habits

q is those who were negative to p

3.3.2 Inclusion and Exclusion Criteria

3.3.2.1 Inclusion criteria

Both shift workers and non- shift workers in the selected fire stations were included in the study irrespective of age or gender.

3.3.2.2 Exclusion criteria

Pregnant women in the fire stations were excluded from the study because their BMI would be influenced by the pregnancy.

3.4 ETHICAL APPROVAL

Ethical approval for the study was obtained from the School of Allied Health Sciences Ethical and Protocol Review Committee. In addition, informed written consent of dietary intake was obtained from participating subjects before they were recruited into the study.

3.5 DATA COLLECTION

3.5.1 Questionnaire

Before data collection, the questionnaire was administered to a representative group of the recruited subjects and the data received was reviewed. The questionnaire was then modified to suit the study population.

Invited fire-fighters were taken through the informed consent form and after signing, the pre-tested self -administered questionnaire was given to them. The questionnaire was used to collect information on demographic variables, education, life time occupational history, medical history of CV risk factors, and family history of CV risk factors, alcohol intake, smoking habits, physical activity level, and dietary habits. Participants also

completed portion of the questionnaire on eating pattern to help determine eating pattern variables such as number of meals eaten in a day, frequency of breakfast intake, meals eaten away from home, and late night eating.

3.5.2 Anthropometric Measurements

3.5.2.1 Height, weight and body mass index (BMI) determination

The anthropometric measurements were taken from 9:00 am in the morning to about 12:00 noon. It was first explained to the respondents the various measurements to be taken and what would be required of them. The height was taken first followed by weight and other anthropometries such as total body fat, visceral fat and BMI.

Height was measured using a portable stadiometer (Seca, Hamburg, Germany) which was placed on a firm flat ground to ensure accuracy. Height was recorded to the nearest 0.1cm. Participants' weight was measured to the nearest 0.1cm using a Seca 770 floor digital scale (Seca, Hamburg, Germany). Respondents were in minimal clothing, and were asked to remove shoes, jackets and other heavy objects before standing on the scale. They stood on the scale with feet fully placed on the scale to ensure that weight was evenly distributed on both feet.

BMI was determined from the height and weight measurements and calculated as W/H^2 . A simple range of values defined as underweight $< 18.5(\text{kg}/\text{m}^2)$, normal weight $18.5-24.5(\text{kg}/\text{m}^2)$, overweight $25-29.9 (\text{kg}/\text{m}^2)$, obese $\geq 30 (\text{kg}/\text{m}^2)$ was used in this study based on the World Health Organisation criteria for adults (WHO, 2012).

3.5.3 Waist to Hip Ratio (WHR) Determination

Waist circumference was measured with a non-stretchable tailors' tape measure to the nearest 0.1cm at the level of the umbilicus and hip circumference was measured at the largest horizontal circumference around the buttocks to the nearest 0.1cm. Waist to hip ratio (WHR) was calculated by dividing the waist circumference by the hip circumference. WC was classified as: low risk (men, WC 93.9 cm or less; women, WC 79.9 cm or less); increased risk (men, WC 94.0 to 101.9 cm; women, WC 80.0 to 87.9 cm); and high risk (men, WC 102.0 cm or more; women, WC 88.0 cm or more). Men with WHR < 0.90, 0.90 – 0.99 and 1 and women with WHR of < 0.80, 0.80 – 0.84 and 0.85 (WHO, 2000; Health Canada 2003; Lau *et al.*, 2006) were classified as normal weight, overweight and obese respectively.

3.5.4 Blood Pressure Measurement

The fire-fighters who were for night shift stayed over after closing and their blood pressure was checked in the morning at about 7:00 am while those who were for morning shift had their blood pressure checked when they reported to work that morning at about 7:00 am. Blood pressure was measured three times at five minutes interval on the left arm with participants sitting upright using the Omron 705 CP oscillometric monitor (Matsusaka, Japan). The arm of a participant was relaxed on a hold-up at a height approximately at the heart level and he/she was asked to sit quietly to minimize measurement errors. The average of the three readings was used for the analysis. Fire-fighters with BP readings $\geq 140/90$ were classified hypertensive (Chobanian *et al.*, 2003).

3.5.5 Laboratory Methods

3.5.5.1 Blood sampling and biochemical analysis

Overnight (10-12 hours) fasting blood samples (3ml) were taken from the antecubital vein with minimal pressure into gel separator tubes for analysis of plasma glucose, total cholesterol, HDL, LDL and TG. Blood samples were taken from participants before 9:00 hours in the morning. They were kept on ice and transported to the laboratory. Samples were centrifuged for 15 minutes at 2500 rpm, both plasma and serum aliquots were pipetted into plastic Eppendorf tubes and stored at 4°C until the time of analysis.

The concentration of plasma glucose, HDL, total cholesterol and triglycerides was estimated using an A25 BioSystems (Madrid, Spain) at the Chemical Pathology Laboratory of the School of Allied Health Sciences, Korle Bu. The estimation was done using a commercial kit (Biosystem S.A, Costa Brava, Spain).

Definitions for classifications of lipid profile: high total cholesterol ($\geq 6.24\text{mmol/l}$) high LDL ($\geq 4.2\text{mmol/l}$) high TG ($>1.7\text{mmol/l}$) low HDL ($< 1\text{mmol/l}$) and fasting blood sugar (≥ 7) was low (WHO, 2012).

3.5.6 Dietary Assessment (24 Hour Recall)

A 3-day 24hour recall dietary assessment method was used to collect information on food intake within the past 24 hours. The researcher and three other interviewers who were level four hundred dietetic students carried out an interview to gather information on the dietary intake on three different days. Participants were asked to provide detailed information of all foods and beverages consumed including cooking methods used. Food models and common household measurements in Ghana were used to assist in portion size estimation of food intake. The participants were shown food models and household

measurements which were common in Ghana to assist in portion size estimation of their food intake. The models and household measurements included:

- i). Sardine tin sizes (for slice of yam and bread)
- ii). Orange sizes (for fufu, banku, kenkey)
- iii). Small tin tomato can (for dry gari)
- iv). Small match box size (for types of meat e.g. beef, tuna, chicken)
- v). Palm size (for fish description)
- vi). Stewing spoons and medium size bowls (for all stews and different kinds of rice) and
- vii). Soup ladles (for all soups and porridges)

3.6 DATA ANALYSIS

Dietary recalls were analysed using Esha F-Pro software. The statistical analysis of the data was performed using SPSS (Statistical Package for Social Sciences) version 20. Mean, standard deviation, ranges and percentages of continuous variables were determined. Descriptive statistics was used to analyse categorical data. Mann Whitney Test was used to test for significant difference between means of shift and non-shift fire-fighters. Statistical association between categorical data was analysed using descriptive statistics. Fisher's Exact test was used to test the association between shift work and CV risk factors among shift and non-shift fire-fighters. The Chi-square was also used to find the relationship between the metabolic means of the shift and non-shift fire-fighters. A *p*-value 0.05 was considered significant.

CHAPTER FOUR

4.0 RESULTS

4.1 BACKGROUND DATA

Table 1 shows the background data of the respondents. A total of 160 respondents, 94 (58.8%) males and 66 (41.3%) females, were recruited from the four fire stations. Forty respondents were recruited from each station. The respondents were between the ages 20 and over 56 years. Age group 36-45 years recorded the highest number of males (35, 37.64%) whilst that of over 56 years recorded the highest number of females (29, 45.31%).

Majority of respondents, 65 (69.15%) males and 40 (63.49%) females were married while 28 (29.79%) males and 16 (25.40%) females were single. The number of years the respondents had been fire-fighters varied. Eighty three, 58.04% respondents had been fire-fighters for between 20 -24 years whilst only 9 (6.29%) had been fire fighters over 25 years. Among the 160 respondents recruited, 83(53.21%) were shift workers while 73(46.79%) were non-shift workers. Fifteen, 32.60% of the male shift workers and sixteen, 53.34% of the female shift workers had been doing shift work between 20-24 years.

Respondents who were known hypertensives were 13 (14.28%) males and 16 (25.40%) females. Four (4.40%) males and 2(2.17%) females were known diabetics. Four (2.60%) and 1.30% of the respondents had previously been diagnosed with high cholesterol and obesity respectively. Seventy-one (78.02%) males and 42 (66.67%) females were not sure if they had any CV risk factor.

Table 1: Respondents' characteristics

		Male (%)	Female (%)	Total (% of total)
Fire Station	Industrial Area	24 (25.53)	16 (24.24)	40 (25.00)
	Dansoman	21 (22.34)	19 (28.79)	40 (25.00)
	Korlebu	27 (28.72)	13 (19.70)	40 (25.00)
	Headquarters	22 (23.41)	18 (27.27)	40 (25.00)
	Total	94 (58.8)	66 (41.3)	160 (100.0)
Age	20-35	27 (29.03)	11 (17.19)	38 (24.20)
	36-45	35 (37.64)	24 (37.50)	59 (37.58)
	Over 56	31 (33.33)	29 (45.31)	60 (38.22)
	Total	93 (59.2)	64 (40.8)	157 (100.0)
Marital status	Single	28 (29.79)	16 (25.40)	44 (28.03)
	Married	65 (69.15)	40 (63.49)	105 (66.88)
	Divorced	1 (1.05)	4 (6.35)	5 (3.18)
	Widow/Widower	0 (0.00)	3 (4.76)	3 (1.91)
	Total	94 (59.9)	63 (40.1)	157 (100.0)
Number of years worked as fire fighters	0-4	10 (11.77)	1 (1.72)	11 (7.69)
	5-9	16 (18.82)	7 (12.07)	23 (16.08)
	10-14	5 (5.88)	9 (15.52)	14 (9.79)
	15-19	3 (3.53)	0 (0.00)	3 (2.10)
	20-24	45 (52.94)	38 (65.52)	83 (58.04)
	25+	6 (7.06)	3 (5.17)	9 (6.29)
	Total	85 (59.4)	58 (40.6)	143 (100.0)
Shift duty over the past 12 months	Yes	51 (54.84)	32 (50.79)	83 (53.21)
	No	42 (45.16)	31 (49.21)	73 (46.79)
	Total	93 (59.6)	63 (40.4)	156 (100.0)
Number of years on shift	0-4	14 (30.43)	1 (3.33)	15 (19.74)
	5-9	9 (19.57)	7 (23.33)	16 (21.05)
	10-14	4 (8.70)	4 (13.33)	8 (10.53)
	15-19	4 (8.70)	2 (6.67)	6 (7.90)
	20-24	15 (32.60)	16 (53.34)	31 (40.79)
	Total	46 (60.5)	30 (39.5)	76 (100.0)
Health conditions diagnosed with by a physician	Hypertension	13 (14.28)	16 (25.40)	29 (18.83)
	Diabetes	4 (4.40)	2 (2.17)	6 (3.90)
	High cholesterol	2 (2.20)	2 (2.17)	4 (2.60)
	Obesity	1 (1.10)	1 (1.59)	2 (1.30)
	Not sure	71 (78.02)	42 (66.67)	113 (73.38)
	Total	91 (59.1)	63 (40.9)	154 (100.0)
Health conditions any family members have ever been diagnosed with by a physician	Hypertension	15 (16.86)	20 (33.33)	35 (23.49)
	Diabetes	14 (15.73)	8 (13.33)	22 (14.77)
	High cholesterol	3 (3.37)	3 (5.00)	6 (4.03)
	Obesity	1 (1.12)	1 (1.67)	2 (1.34)
	Not sure	56 (62.92)	28 (46.67)	84 (56.38)
	Total	89 (59.7)	60 (40.3)	149 (100.0)

4.2 DIETARY PATTERN AND NUTRIENT INTAKE OF RESPONDENTS

4.2.1 Dietary Pattern

There was no significant difference ($p > 0.05$) between the dietary patterns of the shift and non-shift workers (Table 2). The percentage of both shift and non-shift workers who spread their meal intake within the day was low (1, 1.2 % for shift and 1, 1.3% for non-shift). Breakfast was not often taken at home by both shift and non-shift workers. Higher percentage 38 (45.7 %) of shift workers ate supper once within the week compared to the non-shift workers who had 27 (37.0 %). More of the shift workers usually bought all the various meals of the days from outside compared to non-shift workers.

4.2.2 Nutrient Intake

There were no significant differences ($p > 0.05$) in the intake of nutrient of shift and non-shift fire-fighters (Table 3).

4.3 LIFESTYLE CHARACTERISTICS

Table 4 shows the lifestyle characteristics of the shift and non-shift fire-fighters. No significant difference existed between life style characteristics of shift and non-shift workers. The percentage of fire-fighters who smoked were very low. Comparatively higher number (48) of shift workers drank some amount alcohol but only 5 drunk more than three drinks a day. Coffee intake was not recorded among both shift and non-shift workers. The activity levels of both shift and non-shift workers were lower than the 30-45 mins recommended daily. A few of the workers walked around when at work. More of the shift workers (41.0 %) sat sometimes when they were at work as compared to 10 (19.2 %) of the non-shift workers who sometimes sat when at work.

Table 2: Meal consumption pattern of the shift (n=83) and non-shift (n=73) fire-fighters.

MEAL PATTERN	FREQUENCY	FIRE-FIGHTERS		P-VALUE
		SHIFT	NON-SHIFT	
Number of time respondents ate in a day	Once	2 (2.4%)	3 (4.1%)	0.768
	Twice	33 (39.3%)	36 (49.3%)	
	Thrice	39 (46.9%)	31 (42.1%)	
	Four Times	1 (1.2%)	1 (1.3%)	
	Others	8 (9.6%)	2 (2.7%)	
Number of times respondents eat breakfast at home in a week	Once	38 (45.8%)	37 (50.6%)	0.085
	Twice	19 (22.8%)	25 (34.2%)	
	Thrice	10 (12.0%)	2 (2.7%)	
	Others	6 (7.2%)	9 (12.3%)	
Number of times respondents eat supper at home in a week	Once	38 (45.7%)	27 (37.0%)	0.068
	Twice	21 (25.3%)	35 (47.9%)	
	Thrice	12 (14.4%)	2 (2.7%)	
	Others	11 (13.2%)	9 (12.3%)	
Number of times respondents buy from outside within a week	Once	10 (12.0%)	7 (9.6%)	0.525
	Twice	14 (16.8%)	9 (12.3%)	
	Thrice	12 (14.4%)	7 (9.6%)	
	Four	8 (9.6%)	4 (5.5%)	
	Other	28 (33.7%)	37 (50.7%)	
Meals respondents usually buy from outside	Breakfast	22 (34.9%)	16 (21.9%)	0.253
	Lunch	35 (42.1%)	42 (57.5%)	
	Supper	8 (9.6%)	5 (6.8%)	
	Snacks	14 (16.9%)	7 (9.5%)	

Table 3: Nutrient intake of the shift and non-shift fire-fighters

Nutrients	SHIFT WORKERS (n=83)			NON-SHIFT WORKERS (n=73)			P-value
	Median	Minimum	Maximum	Median	Minimum	Maximum	
Energy	2083.3	504	6103	2103.1	619	4715	0.894
Protein	69.00	11.30	212.00	71.30	9.93	285.00	0.639
Carbohydrate	285.00	26.30	760.00	252.00	22.40	859.00	0.17
Saturated fat	4.87	0.00	55.60	5.07	0.00	108.00	0.71
Polyunsaturated fat	2.75	0.00	20.30	2.56	0.00	20.70	0.90
Vitamin B ₆	0.52	42.60	0.00	0.61	0.00	924.00	0.50
Iron	19.80	64.90	0.30	19.30	3.74	60.60	0.956
Calcium	577.00	12.01	2378.00	461.00	96.40	2919.00	0.543
Magnesium	95.60	868.00	0.00	79.60	0.00	1022.00	0.495
Potassium	741.00	0.00	5395.00	816.00	0.00	5728.00	0.446
Sodium	661.00	0.00	5227.00	838.00	0.00	4196.00	0.199

Table 4: Life style characteristics of shift and non-shift fire-fighters

LIFE STYLE BEHAVIOURS	FIRE-FIGHTERS		P-VALUE
	SHIFT (N=83)	NON-SHIFT (73)	
Physical Activity			
At work I sit			
Never	10 (12.0%)	5 (6.8%)	0.099
Sometimes	34 (41.0%)	23 (31.5%)	
Often	19 (22.9%)	14 (19.2%)	
Always	20 (24.0%)	31 (42.5%)	
At work I walk			
Never	12 (14.5%)	17 (23.3%)	0.089
Sometimes	54 (65.1%)	34 (46.6%)	
Often	11 (13.3%)	12 (16.4%)	
Always	6 (7.2%)	10 (13.7%)	
Alcohol intake			
Less than a 625ml bottle	19 (22.9%)	12 (16.4%)	0.236
1-2 of 625ml bottles	23 (27.7%)	24 (32.9%)	
3-4 of 625ml bottles	1 (1.2%)	4 (5.5%)	
Other	5 (6.0%)	0 (0%)	
Smoking			
Non smoker	47 (56.6%)	53 (72.6%)	0.695
Former smoker	5 (6.0%)	5 (6.8%)	
Current smoker	3 (3.6%)	2 (2.7%)	

4.4 ANTHROPOMETRIC MEASUREMENT

Table 5 shows anthropometric measurements of both shift and non-shift fire-fighters. There were no significant differences (all $p > 0.05$) between the anthropometric measurements of shift and non-shift fire-fighters. However, the anthropometric measurements between male and female shift workers compared to those of their other counterparts varied. For example, the mean total body fat of shift female fire-fighters was higher than that of female non shift fire-fighters, while the reverse was true for WC. Non-shift males had higher mean total body fat and WC than the male shift fire-fighters though WHR was higher for shift males than non-shift males.

4.5 BLOOD PRESSURE

The mean blood pressures of both shift and non-shift fire-fighters were higher than normal values for systolic (< 120 mmHg) and diastolic (< 80 mmHg) [Table 6]. A significant difference ($p = 0.009$) was seen between diastolic blood pressure of the shift and non-shift workers.

4.6 BIOCHEMICAL PARAMETERS

4.6.1 Lipid Profile

There was no significant difference (all $p > 0.05$) between the means of shift and non-shift workers for the lipids. However, HDL (1.11 ± 0.26 mmol/L) for shift workers was higher than that of non-shift workers (Table 7).

4.6.2 Fasting Blood Glucose

There was no significant difference between mean fasting blood glucose levels of the shift and non-shift fire-fighters (Table 7). However, the mean for all the workers fell within the recommended reference range.

Table 5: Anthropometric indices of the shift and non-shift fire-fighters

Anthropometric measurement	Shift		Non shift		p-value
	Male	Female	Male	Female	
Total body fat	25.68±8.80	38.00±9.75	26.95±9.68	36.63±8.41	0.562
Waist Circumference (cm)	87.59±10.30	95.56±10.10	90.29±13.36	98.94±11.04	0.07
Waist-hip ratio (cm)	0.90±0.16	0.87±0.1	0.89±0.8	0.87±0.10	0.82
BMI(kg/m ²)	27.7±4.97		27.22 ±5.22		0.85
Visceral fat	8.38±3.74		9.73±5.47		0.220

Table 6: Blood pressure of the shift and non-shift fire-fighters

Parameters	Shift (Mean ± SD)	Non-shift (Mean ± SD)	p-value
Blood pressure (mmHg)systolic	133.14 ± 23.72	135.14 ± 25.72	0.444
Blood pressure (mmHg)-diastolic	99.49 ± 12.97	94.58 ± 12.27	0.009

Table 7: Biochemical indices of shift and non-shift fire-fighters.

Biochemical Indices	Ref. range(mmol/l)	Shift (Mean ± SD)	Non-shift (Mean ± SD)	p-value
Total Cholesterol	6.24	4.99±1.04	5.06±1.06	0.684
HDL	1	1.11±0.26	1.08±0.25	0.446
LDL	4.2	3.34±0.99	3.42±1.12	0.651
TG	>1.7	1.16±0.71	1.22±0.79	0.467
FBG	7	5.39±1.27	5.13±0.87	0.059

4.7 PREVALENCE OF ANTHROPOMETRIC CV RISK FACTORS AMONG SHIFT AND NON-SHIFT FIRE-FIGHTERS IN ACCRA

Table 8 shows prevalence of anthropometric CV risk factors of both shift and non-shift fire-fighters. There were no significant differences (all $p > 0.05$) between the shift and non-shift fire-fighters. However, the shift fire-fighters had higher prevalence of some of the CV risk factors compared to the non-shift fire-fighters. For example total body fat and WHR, was higher for female shift workers compared to those of their other counterparts.

4.8 PREVALENCE OF METABOLIC CV RISK FACTORS AMONG SHIFT AND NON-SHIFT FIRE-FIGHTERS.

Table 9 shows the prevalence of metabolic CV risk factors among shift and non-shift fire-fighters. Prevalence of high total cholesterol (> 6.24 mmol/l) and high LDL (> 4.2 mmol/l) were higher in the shift workers compared to the non-shift workers. The prevalence of high fasting blood glucose was low (3.6 %) for the shift workers. A higher (27.7%) prevalence of hypertension was recorded for shift workers than non-shift.

4.9 ASSOCIATION BETWEEN CV RISK FACTORS AND SHIFT WORK

Although the shift fire-fighters recorded higher means and prevalence of some of the CV risk factors, no statistically significant association (all $p > 0.05$) was found between CV risk factors and shift work (Table 10).

Table 8: Prevalence of anthropometric CV risk factors among fire-fighters in Accra.

Parameters	Shift (%)		Non shift (%)		p-value
	Male	Female	Male	Female	
Total body fat	10.8	27.7	12.3	24.6	0.848
WC	34.9	27.7	36.9	31.5	0.761
WHR	9	29	9	18	0.848
Overweight	35.4		29.1		0.637
Obesity	29.1		33.3		0.637
Visceral fat	49.3		52.0		0.751

Table 9: Prevalence of metabolic CV risk factors among shift (n= 83) and non-shift (n= 73) fire-fighters.

METABOLIC RISK FACTORS	SHIFT (%)	NON-SHIFT (%)
HYPERTENSION	27.7	24.6
FBG	3.6	4.1
HDL		
Lower Risk	4.8	4.1
Borderline high	71.2	68.4
Higher risk	26.5	27.3
LDL		
Lower Risk	58.9	41.1
Borderline high	48.4	51.6
Higher risk	52.8	47.2
TG		
Lower Risk	52.9	47.1
Borderline high	62.5	37.5
Higher risk	50.0	50.0
TOTAL CHOLESTEROL		
Lower Risk	53.1	46.9
Borderline high	50.0	50.0
Higher risk	59.1	40.9

Table 10: Association between CV risk factors and shift work.

Parameter	Fisher' Exact Test	P value
FBG	102.34	0.58
HDL	66.91	0.60
Total cholesterol.	112.44	0.93
TG	93.76	0.41
LDL	121.67	0.200
WHR	7.86	0.80
WC	56.33	0.420
BMI	1.64	0.74
Total body fat	114.46	0.653
Visceral fat	22.02	0.411

CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSIONS

5.1 DISCUSSION

The impact of shift work on diet and CV risk factors of fire-fighters in selected fire stations in the Accra Metropolitan Area was studied.

From the study, there was no statistically significant difference between the energy intake of the shift and non-shift workers. However, the shift workers had lower energy intake compared to non-shift workers. Esquirol *et al.* (2009) concluded that energy intake is more fractionated within the day, with a lesser contribution of breakfast and lunch but intakes of snacks increases during afternoon and night among shift workers as compared to day workers. In a comparison between shift and day workers vitamins and minerals intake was also observed to be lower among shift workers. These may be because relatively large number of shift workers did not eat breakfast and skipped meals more often than the non-shift workers. Just as Wong *et al.* (2010) concluded that there is less frequent and poorer quality meal intake among shift workers. Shift work infringes on an individual's ability to eat regular balanced meals with the family (Atkinson, 2008; Culpepper, 2010).

The mean mineral intakes for calcium, magnesium, potassium and vitamin B₆ for both shift and non-shift workers were generally low. Although, the non-shift workers had higher intakes of potassium than shift workers, the difference was statistically insignificant. This is similar to the findings of Lowden *et al.*, (2010) who reported low intake of micronutrient such as potassium for night shift workers. The low intake of these minerals could be associated with infrequent intakes of fruits and green leafy vegetables

by fire-fighters. Since adequate intakes of calcium, magnesium and potassium are associated with prevention or management of hypertension (Nelms *et al.*, 2010). The low intakes recorded could be the possible cause of hypertension among the fire-fighters.

The intake of sodium was lower than the recommended intake of 1500mg per day (Nelms *et al.*, 2010). This low intake of sodium recorded is ideal for CV protection (MacGregor *et al.*, 2009). It must be noted that this may not be a true reflection of sodium intakes. Measuring 24 –hour urinary sodium excretion would have given a more accurate reflection of amount of sodium in the body (Intersalt Cooperative Research Group, 1988; Frost *et al.*, 1991). However, it was not possible to do this in this study.

Iron intakes for both shift and non-shift workers were higher than the recommended intake of 8mg per day (Brown, 2008). This high intakes could be a risk factor for the development of CVDs because iron induces free-radical damage to tissues (Galan *et al.*, 2006), a condition associated with the development of CVDs.

There was no significant difference ($p>0.05$) between protein intakes for shift and non-shift workers. The intakes for both shift and non-shift workers was higher than the recommended intake (56g for males and 46g for females) [Brown, 2008]. Protein is needed to repair worn out tissues and maintain body muscles. However, higher intakes particularly from animal sources may increase saturated fat in the diet and this is a risk factor for the development of hyperlipidaemia which is a risk factor for CVD (Astrup *et al.*, 2013).

Coffee drinking was not common among the shift fire-fighters. This contradicts the findings of Jermendy *et al.* (2012) which revealed that male rotating shift workers drank

more coffee compared to day time workers. This difference may partly be attributed to the fact that coffee dispensers are not easily accessible in Ghana unlike America where people can easily get access to coffee dispensers and take it regularly as a stimulant when on night duties. According to Bohn *et al.*, (2012), generally, fire-fighters will neither have the positive effects (protection against the risk of developing T2DM) or negative (raised blood pressure) effects associated with coffee drinking and CV risk factors since their intake of coffee was low.

The shift workers had higher CV risk for dyslipidaemia. This finding is consistent with the findings of Esquirol *et al.* (2009) who reported that shift workers had significantly increased triglyceride and lower mean HDL-cholesterol. This could still be associated with low fruits and vegetables intake which may be due to high intakes of food bought from food outlets recorded in this study. Lowden *et al.* (2010) concluded in their findings that fire-fighters on night shift were more likely to consume more meals with higher fat content. Knutson *et al.* (1990) found that the consumption of dietary fibres was reduced six months after starting shift work due to a reduction in the consumption of green vegetables and an increase in intake of soft drinks. This is a possible reason because a meta-analysis of twelve studies, consisting of 13 independent cohorts found a significant protective association for CV system with consumption of fruits and vegetables (He *et al.*, 2007), hence the lack of intake of the fruits and vegetables could be the cause of high LDL and low HDL concentrations in the group. High LDL and low HDL are involved in the atherosclerotic process and could lead to the development of CVDs (Yusuf *et al.*, 2004).

Although, there was no significant difference between the mean blood pressure of the shift and non-shift workers, the 27.7% prevalence of hypertension among the shift

workers was higher than that of the non-shift workers (24.6%). A longitudinal study in Japan reported that shift work was a risk factor for the onset of hypertension and also the progression from mild hypertension to severe hypertension (Sakata *et al.*, 2003). Shift work affects blood pressure because the normal daily circadian blood pressure rhythm is characterized by a nocturnal (night) fall and diurnal (day) rise. Shift work changes the diurnal variation of blood pressure from a dipper to a non-dipper pattern (Wolk & Somers, 2007) thus increasing the risk of hypertension among night shift work.

Findings of this study suggest that quite a large number shift fire-fighters skipped meals and ate twice a day which could be because they were on shift duty and either got home very late in the morning and missed breakfast or left too early in the evening before supper got ready. The trend of glucose tolerance decreases during the day in normal individuals and intakes of meals during the night results in the higher incidence of weight gain associated with shift work.

The BMI of the shift workers was higher than the non-shift workers. The prevalence of overweight (35.4%) and obese (29.1%) was found among the shift workers.. This finding is similar to the findings of Di Lorenzo (2003) who concluded in his study that, the prevalence of obesity is higher among shift workers compared to day workers and that shift workers had higher BMI. Croce *et al.* (2007) also in a research found out that shift workers had higher BMI than day workers. Shift work is an independent risk factor in the development of central obesity and promotes the development of CVDs (Morikawa *et al.*, 2007). Shift workers are affected by the disruption of the circadian rhythm which causes them to eat more during the day and lead to increase in weight gain (Frost *et al.*, 2009; De Bacquer *et al.*, 2009). The high BMI could predispose the shift workers to the

development of other CV risk factors such as hypertension, T2DM and high serum cholesterol (Nelms *et al.*, 2010).

The male shift workers had higher mean for WHR compared to their male counterparts who were non-shift workers. The female shift workers also had high prevalence of WHR compared to the non-shift female workers. This is similar to the study of (Pimenta *et al.*, 2012) who found 34.1% and 23.7% abdominal obesity among shift workers.

These differences seen between the shift and non-shift workers could be associated with the low activity levels recorded by the shift workers. Majority of the shift workers do not walk around often when at work but they sat down until they are called by alarm for fire fighting. Central obesity being a major CV risk factor predisposes the shift fire-fighters to the development of other CV risk factors such as insulin resistance, dyslipidaemia, and hypertension (de Koning *et al.*, 2007; Cameron *et al.*, 2012) thereby increasing their chance of developing CVDs.

Lifestyle risk factors such as smoking, excessive alcohol and physical activity were low among the shift fire-fighters. Alcohol consumption may influence CV risk factors (HDL) depending on the quantity consumed per day; 1-2 drinks (12 – 15g) for females and 2 – 3 drinks (15 -30g) per day for males is known to have positive effect whilst quantities above these recommendations has negative effect on the heart and blood vessels and also contribute to obesity (Brien *et al.*, 2011). In this study, some of the shift workers drank alcohol but only few took quantities above 3 drinks per day as compared to 49 of them who took quantities that may have a cardioprotective effect (Brien *et al.*, 2011). Although this intake could have positive influence on LDL and HDL levels were still high possibly because of high saturated fat intake and low levels of physical activities. Increasing

physical activity decreases the relative workload on the heart, a benefit important for all forms of cardiovascular disease (Nelms *et al.*, 2010).

Smoking behaviour among both shift and non-shift workers was low; only 3.6% of shift workers and 2.7% of non-shift workers were current smokers. This is inconsistent with the findings of Biggi *et al.* (2008) which reported that night workers smoked more than day workers. This inconsistency may be partly due to the fact that smoking is frowned upon in the Ghanaian society (Parry *et al.*, 2011).

Physical activity levels of the shift workers were low, not up to the 30-45minutes recommended for healthy living (Nelms *et al.*, 2010). The shift workers often experience long periods sitting and waiting till they hear the alarm for fire before they get active. According to the “Seventh Report of the Joint National Committee” (JNC 7), physical activity of 30 minutes per day decreases blood pressure by 4 to 9 mm Hg (Applegate *et al.*, 2003). Low physical activity was thus a contributing factor to the high BMI, low HDL and hypertension recorded by the shift workers and predisposes them to developing CVDs.

Fasting blood sugar was generally normal but the shift workers recorded a higher mean than the non-shift workers (a mean of 5.39 ± 1.27 mmol/L for shift workers, 5.13 ± 0.87). However these differences were insignificant. This finding is inconsistent with these two studies (Morikawa *et al.*, 2005; Suwazono *et al.*, 2006), who reported significant increases in the risk of T2DM in shift workers. The shift workers therefore have low risk for T2DM as CV risk factor.

The study had some limitation. The results of nutrient intake could have been an over estimation or under estimation because the method used (24hour recall) is dependent on memory and people turn to forget what they actually ate and may turn to give other foods and quantities that may not be their actual intakes.

The findings of this study are limited to fire-fighters in the Accra Metropolitan area specifically the areas where the study was carried, generalization to the entire fire service is therefore not possible.

5.2 CONCLUSIONS

The study revealed that 35.4 % of the shift workers were overweight and 34.9 % of male shift workers had high CV risk factor for WC whiles 27.7 % and 29 % of the female shift workers had high CV risk factor for total body fat and WHR respectively. There was relatively high risk for dyslipidaemia among the shift workers which puts them at more risk of developing CVDs. The shift workers had low risk for smoking, alcohol and coffee drinking and high blood glucose.

Majority of the shift workers had inappropriate meal patterns and had lower energy intake compared to non-shift workers. The prevalence of high anthropometric indices such as total body fat and WHR was higher for female shift workers than female non-shift workers. The shift workers in general, had higher prevalence for overweight than the non-shift workers. High total cholesterol (6.24 mmol/l) was 59.1 % for shift workers and high LDL (4.2 mmol/l) was 52 % whiles the prevalence of low HDL (1 mmol/l) was 26.5 %. The prevalence of high fasting blood sugar was low (3.6 %) for the shift workers. Life style CV risk factors such as drinking and smoking were also low among shift workers. Very few shift workers were physically active at work. However,

no significant association (all $p > 0.05$) was found between CV risk factors and shift work.

It is recommended that:

1. The association between shift work and CV risk factors among fire-fighters be re-examine using a larger cohort.
2. A cohort study about the prevalence of CV risk factors among shift workers should be carried out by health institutions in all the fire stations and other civil service in the country.
3. The Ministry of Health and Ghana Health Service should collaborate with the Ghana Fire Service to provide an annual screening for CV risk factors among all fire-fighters. Fire-fighters who would be identified as having high values for the CV risk factors such high lipid profile, hypertension, diabetes and high anthropometric indices should be counselled and treated by the medical team.
4. A gym should be provided at the various fire stations by the government or NGOs to encourage regular physical activity during the sedentary periods when there is no fire to fight.
5. Fire-fighters should be educated on basic positive lifestyle changes such as regular physical activity, intake of fruits, vegetables, complex carbohydrates, reduced intake of fatty foods and salt.
6. The fire service authorities should see to the provision and regulation of canteens in the various fire stations to promote healthy and frequent meals.

REFERENCES

- AHA (2012) What Your Cholesterol Levels Mean. Accessed 19/1/2013 from http://www.heart.org/HEARTORG/Conditions/Cholesterol/AboutCholesterol/What-Your-Cholesterol-Levels-Mean_UCM_305562_Article.jsp#
- Antunes LC, Jornada MN, Ramalho L & Hidalgo MP. (2010a). Correlation of shift work and waist circumference, body mass index, chronotype and depressive symptoms. *Arq Bras EndocrinolMetabol.* **54**: 652–656.
- Antunes LC, Levandovski R, Dantas G, Caumo W & Hidalgo MP. (2010b). Obesity and shift work: chronobiological aspects. *Nutr Res Rev.* **23**: 155–168.
- Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH & Karanja N. (1997). A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med.* **336**(16): 1117–24.
- Applegate WB, Basile JN, Carey R, Dzau V, Egan BM & Falkner B. (2003). “Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure”. *NIH Publication.* **03**:5233
- Astrup A, Dyerberg J, Elwood P, Hermansen K, FB, Jakobsen MU, Kok FJ, Krauss RM, Lecerf JM, LeGrand P, Nestel P, Risérus U, Sanders T, Sinclair A, Tholstrup T & Willett. (2013). Childhood Serum Fatty Acid Quality Is Associated with Adult Carotid Artery Intima Media Thickness in Women but Not in Men. *J. Nutr.* **143**: 682-689
- Atkinson G, Fullick S, Grindey C, Maclaren D, &Waterhouse J. (2008). Exercise, Energy Balance and the Shift Worker. *Sports Med.* **38**(8): 671–685
- Axelsson J, Puttonen S. (2012). Night shift work increases the risk for type 2 diabetes. *Evid Based Med.* **17**: 193–194.
- Baghaei A, Sarrafzadegan N, Rabiei K, Gharipour M, Tavasoli AA, Shirani S, Bahonar A, Davarpanah AH, Ramezani MA, Kelishadi R. (2010). How effective are strategies for non-communicable disease prevention and control in a high risk population in a developing country? Isfahan Healthy Heart Programme. *Arch Med Sci.* **6**(1): 24-31.
- Beaglehole R, Bonita R, Horton R, Adams C, Alleyne G, Asaria P, Baugh V, Bekedam H, Billo N, Casswell S, Cecchini M, Colagiuri R, Colagiuri S, Collins T, Ebrahim S, Engelgau M, Galea G, Gaziano T, Geneau R, Haines A, Hospedales

- J, Jha P, Keeling A, Leeder S, Lincoln P, Mckee M, Mackay J, Magnusson R, Moodie R, Mwatsama M, Nishtar S, Norrving B, Patterson D, Piot P, Ralston J, Rani M, Reddy KS, Sassi F, Sheron N, Stuckler D, Suh I, Torode J, Varghese C & Watt J. (2011) : For the Lancet NCD Action Group and the NCD Alliance. Priority actions for the non-communicable disease crisis. *Lancet* **377**: 1438–47
- Berg AH & Scherer PE. (2005). Adipose tissue, inflammation and cardiovascular disease. *Circ Res.* **96**(9): 939-49.
- Biggaard J, Frederiksen K, Tjonneland A, Thomsen BL & Overvad K. (2004). Waist and hip circumferences and all-cause mortality: usefulness of the waist-to-hip ratio? *Int J Obes Relat Metab Disord.* **28**: 741–747.
- Biggi N, Consonni D, Galluzzo V, Sogliani M, & Costa G. (2008). Metabolic syndrome in permanent night workers. *Chronobiol Int.* **25**(2): 443-454.
- Birkenhäger AM & van den AH. (2007). Causes and consequences of a non-dipping blood pressure profile. *Neth J Med.* **65**(4): 127–131.
- Bøhn SK, Ward NC, Hodgson JM & Croft KD. (2012). Effects of tea and coffee on cardiovascular disease risk. *Food Funct.* **3**: 575-591
- Bouchard C. (2007). BMI, fat mass, abdominal adiposity and visceral fat: where is the 'beef'? *Int J Obes (Lond).* **31**: 1552–1553.
- Briel M, Ferreira-Gonzalez I, YouJJ, KaranicolasPJ, Akl, Wu A, Blechacz B, Bassler D, Wei X, physician, Sharman A, Whitt I, Silva SA, Khalid Z, Nordmann A, Zhou Q, Walter SD, Vale N, Bhatnagar N, O'Regan C, Mills E J, Bucher HC, Montori MC, & Guyatt GH (2009). Association between change in high density lipoprotein cholesterol and cardiovascular disease morbidity and mortality: systematic review and meta-regression analysis. *BMJ.* **338**: b92
- Brien SE, Ronksley PE, Turner BJ, Mukamal KJ & Ghali WA. (2011). Effect of alcohol consumption on biological markers associated with risk of coronary heart disease: systematic review and meta-analysis of interventional studies. *BMJ.* **342**: d636.
- Brown EJ, Isaac SJ, Krinke BU, Murtaugh AM, Sharbaugh C, Stang J & Wooldrige HN (2008) Nutrition through the life cycle 3rd edition Wadsworth, Cengage Publishing USA.
- Brown DL, Feskanich D, Sánchez BN, Rexrode KM, Schernhammer ES, Lisabeth LD. (2009). Rotating night shift work and the risk of ischemic stroke. *Am J Epidemiol.* **169**: 1370–1377.

- Buzinaro EF , Almeida RN & Mazeto GM (2006). Bioavailability of dietary calcium. *Arq Bra Endocrino Metabol.* 50(5): 852-861.
- Cameron AJ, Magliano DJ, Shaw JE, Zimmet PZ, Carstensen B, Alberti KG, Tuomilehto J, Barr ELM, Pauvaday VK, Kowlessur S & Soderberg S. (2012). The influence of hip circumference on the relationship between abdominal obesity and mortality. *Oxford Journals Medicine. Int J Epidemiol.* 41(2): 484–494.
- Camhi SM, Bray GA, Bouchard C, Greenway FL, Johnson WD, Newton RL, Ravussin E, Ryan DH, Smith SR, Katzmarzyk PT. (2011). The relationship of waist circumference and BMI to visceral, subcutaneous, and total body fat: sex and race differences. *Obesity (Silver Spring).* 19: 402–408.
- Canoy D, Boekholdt SM, Wareham N, Luben R, Welch A, Bingham S, Buchan I, Day N & Khaw KT. (2007). Body fat distribution and risk of coronary heart disease in men and women in the European Prospective Investigation Into Cancer and Nutrition in Norfolk cohort: a population-based prospective study. *Circulation.* 116: 2933–2943.
- Cappuccio FP, D Elia L, Strazzullo P & Miller MA. (2010). Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. *Diabetes Care.* 33: 414–420.
- CDC (2012). Smoking and tobacco use. Accessed 20/1/2013 from http://www.cdc.gov/tobacco/basic_information/health_effects/heart_disease/
- Centers for Disease Control and Prevention (2008). Smoking-Attributable Mortality, Years of Potential Life Lost, and Productivity Losses United States, 2000–2004: Morbidity and Mortality Weekly Report; 57(45):1226–8 [accessed 20/07/2013].
- Cho SS, Qi L, Fahey GC & Klurfeld DM. (2013) Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease. *Am J Clin Nutr.* 98: 594-619
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr & Roccella EJ. (2003). The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA.* 289(19): 2560 – 2572.
- Cook NR, Obarzanek E, Cutler JA, Buring JE, Rexrode KM, Kumanyika SK, Appel LJ & Whelton PK. (2009). Effects of sodium and potassium intake on subsequent

- cardiovascular disease: The Trials of Hypertension Prevention (TOHP) Follow-up Study. *Arch Intern Med.* **12** (169): 32–40.
- Costa G, Haus E & Stevens R. (2010). Shift work and cancer - considerations on rationale, mechanisms, and epidemiology. *Scand J Work Environ Health.* **36**: 163–179.
- Croce N, Bracci M, Ceccarelli G, Barbadoro P, Prospero E & Santarellia L. (2007). [Body mass index in shift workers: relation to diet and physical activity]. *G Ital Med Lav Ergon.* **29**(S3): 488–489.
- Cullen P. (2000). Evidence that triglycerides are an independent coronary heart disease risk factor. *Am J Cardio* **86**(9): 943–949.
- Culpepper L (2010). The social and economic burden of shift-work disorder. *JFP.* **59** (01): S3-S11
- De Bacquer D, Van Risseghem M, Clays E, Kittel F, De Backer G & Braeckman L. (2009). Rotating shift work and the metabolic syndrome: a prospective study. *Int J Epidemiol.* **38**(3): 848–854.
- de Koning L, Gerstein HC, Bosch J, Diaz R, Mohan V, Dagenais G, Yusuf S & Anand SS. (2010). Anthropometric measures and glucose levels in a large multi-ethnic cohort of individuals at risk of developing type 2 diabetes. *Diabetologia.* **53**: 1322–1330.
- de Koning L, Merchant AT, Pogue J & Anand SS. (2007). Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. *Eur Heart J.* **28**: 850-856. deGoma EM, Leeper NJ & Heidenreich PA. (2008). Clinical significance of high-density lipoprotein cholesterol in patients with low low-density lipoprotein cholesterol. *J Am Coll Cardiol.* **51**(1): 49–55.
- Del Gobbo LC, Imamura F, Wu JH, de Oliveira Otto MC, Chiuve SE & Mozaffarian D. (2013). Circulating and dietary magnesium and risk of cardiovascular disease: a systematic review and meta-analysis of prospective studies. *Am J Clin. Nutr.* **98**(1): 160–173.
- Di Lorenzo L, De Pergola G, Zocchetti C, L'Abbate N, Basso A, Pannacciulli N, Cignarelli M, Giorgino R & Soleo L. (2003). Effect of shift work on body mass index: results of a study performed in 319 glucose-tolerant men working in a Southern Italian industry. *International Journal of Obesity.* **27**: 1353–1358.

- Donovan R, Nelson T, Peel J, Lipsey T, Voyles W & Israel RG. (2009). Cardiorespiratory fitness and the metabolic syndrome in firefighters. *Occup Med (Lond)*. **59**(7): 487–492.
- Ellingsen T, Bener A & Gehani A A (2007). Study of shift work and risk of coronary events. *J Roy Soc Promot Health*. **127**(6): 265–267
- Elpidoforos SS, Russ H, Ichiro K, Dimitrios L, David CC & Stefanos N. (2005). Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obesity Research*. **13**(10): 1756–1763
- European Council Directive (1993) No 93/104/EC concerning Certain Aspects of the Organization of Working Time. *Off J Eur Commun* **L307**: 18–24.
- David CC, Elpidoforos SS, Russ H, Ichiro K, Dimitrios L, & Stefanos N. (2003). Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obesity Research*. **13**(10): 1756–1763
- Elpidoforos SS, Smith DL, Kales SN Tsismenakis JA, & Baur DM. (2011) Cardiovascular disease in US firefighters: a systematic review. *Cardio Rev*. **19**(4):202-215.
- Esquirol Y, Bongard V, Mabile L, Jonnier B, Soulat JM & Perret B. (2009). Shift work and metabolic syndrome: respective impacts of job strain, physical activity, and dietary rhythms. *Chronobiol Int*. **26**(3): 544 –559.
- Fahs CA, Smith DL, Horn GP, Agiovlasis S, Rossow LM, Echols G, Heffernan KS & Fernhall B. (2009). Impact of excess body weight on arterial structure, function, and blood pressure in firefighters. *Am J Cardiol*. **104**(10): 1441–1445.
- Fahy RF. (2005) U.S. firefighter fatalities due to sudden cardiac death, 1995–2004. Quincy, MA: National Fire Protection Association, June 2005. Accessed 21/03/2013 from <http://www.nfpa.org/assets/files/PDF/OSCardiacDeath.pdf>.
- Figueiro MG & White RD. (2013). Health consequences of shift work and implications for structural design. *J Perinatol*. **33**(S1): S17–S23.
- Finelli C, Sommella L, Gioia S, La Sala N & Tarantino G. (2013). Should visceral fat be reduced to increase longevity? *Ageing Res Rev*. S1568-1637(13)00043-000433
- Flegal KM, Graubard, BI, Williamson DF & Gail MH. (2007). Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA*. **298** (17): 2028–2037.

- Frost CD, Law MR & Wald NJ. (1991). By how much does dietary salt reduction lower blood pressure? II--Analysis of observational data within populations. *BMJ*. 302(6780): 815-8.
- Frost P, Kolstad HA & Bonde JP. (2009). Shift work and the risk of ischemic heart disease—a systematic review of the epidemiologic evidence. *Scand J Work Environ Health*. **35**: 163–79.
- Froy O. (2010) Metabolism and circadian rhythms - implications for obesity. *Endocr Rev* **31**: 1–24
- Funk KL, Elmer PJ, Stevens VJ, Harsha DW, Craddick SR, Lin PH, Young DR, Champagne CM, Brantley PJ, McCarron PB, Simons-Morton DG & Appel LJ. (2008). PREMIER — a trial of lifestyle interventions for blood pressure control: intervention design and rationale. *Health Promot Pract*. **9**(3): 271–280.
- Galan P, Noisette N, Estaquio C, Czernichow S, Mennen L & Renversez JC (2006) Serum ferritin, cardiovascular risk factors and ischaemic heart diseases: a prospective analysis in the SU.VI.MAX (SUPplementation en Vitamines et Minéraux AntioXydants) cohort. *Public Health Nutr.*; **9**:70–4.
- Gale JE, Cox HI, Qian J, Block GD, Colwell CS (2011). Disruption of circadian rhythms accelerates development of diabetes through pancreatic beta-cell loss and dysfunction. *J Biol Rhythms* **26**: 423–433.
- Geibe JR, Holder J, Peeples L, Kinney AM, Burress JW & Kales SN. (2008). Predictors of on-duty coronary events in male firefighters in the United States. *Am J Cardiol*. **101**(5): 585–589.
- Ghiasvand M, Heshmat R, Golpira R, Haghpanah V, Soleimani A, Shoushtarizadeh P, Tavangar SM & Larijani B. (2006). Shiftworking and risk of lipid disorders. *Lipids Health Dis*. **5**: 9.
- Go AS, Mozaffarian D, Roger VL, Benjamin EJ, BerryJD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, Franco S, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Huffman MD, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Magid D, Marcus GM, Marelli A, Matchar DB, McGuire DK, Mohler ER, Moy CS, Mussolino ME, Nichol G, Paynter NP, Schreiner PJ, Sorlie PD, Stein J, Turan TN, Virani SS, Wong ND, Woo D & Turner MB, on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee (2013). Heart disease and stroke statistics—2013 update: a report from the American Heart Association. *Circulation*. **127**: e6-e245.

- Harma M. (2006). Workhours in relation to work stress, recovery and health. *Scand J Work Environ Health*. **32**: 502–514.
- Haupt CM, Alte D & Dörr M. (2008). The relation of exposure to shift work with atherosclerosis and myocardial infarction in a general population. *Atherosclerosis*. **201**: 205–211.
- Haus E & Smolensky M. (2006). Biological clocks and shift work: circadian dysregulation and potential long-term effects. *Cancer Causes Contr*. **17**(4): 489–500.
- He FJ, Nowson CA, Lucas M & MacGregor GA. (2007). Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies. *J Hum Hypertens*. **21**(9): 717-728.
- Health Canada. (2003). Canadian Guidelines for Body Weight Classification in Adults (Catalogue H49-179) Ottawa: Health Canada.
- Heitmann BL & Frederiksen P. (2009). Thigh circumference and risk of heart disease and premature death: prospective cohort study. *BMJ*. **339**: b3292.
- Holdsworth M, Madden A & Webster –Gandy J. (editors) (2012). Oxford Handbook of Nutrition and Dietetics, 2nd edition, New York, Oxford University Press.
- IARC MONOGRAPHS VOLUME 9 monographs.iarc.fr/ENG/Monographs/vol98/mono98-8.pdf Accessed 22/07/2013
- Ika K, Suzuki E, Mitsuhashi T, Takao S & Doi H. (2013) Shift Work and Diabetes Mellitus among Male Workers in Japan: Does the Intensity of Shift Work Matter? *Acta Med. Okayama*. **1**(67): 25–33.
- International Labour Organization. (1990). Night Work Convention. C171, Geneva, ILO.
- Intersalt Cooperative Research Group (1988). Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. Intersalt Cooperative Research Group. *BMJ* 297 (6644): 319-328.
- Jee SH, Foong AW, Hur NW & Samet JM (2010). Smoking and risk for diabetes incidence and mortality in Korean men and women. *Diabetes Care*. **33**(12): 2567-72.
- Jermendy G, Nádas J, Hegyi I, Vasas I & Hidvégi T. (2012). Assessment of cardiometabolic risk among shift workers in Hungary. *Health Qual Life Outcomes*. **10**: 18.

- Kales SN, Soteriades ES, Christophi CA, & Christiani DC. (2007). Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med.* **356**: 1207–1215.
- Kales SN, Soteriades ES, Christoudias SG, & Christiani DC. (2003). Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ Health.* **2**: 14.
- Kales SN, Tsismenakis AJ, Zhang C & Soteriades ES. (2009). Blood pressure in firefighters, police officers, and other emergency responders. *Am J Hypertens.* **22**(1): 11–20.
- Kaliterna LL, Prizmic LZ & Zganec N. (2004). Quality of life, life satisfaction and happiness in shift- and non-shift workers. *Rev Saude Publica.* **38**: 3–10.
- Karlsson B, Alfredsson L, Knutsson A, Andersson E & Toren K. (2005). Total mortality and cause-specific mortality of Swedish shift- and dayworkers in the pulp and paper industry in 1952–2001. *Scand J Work Environ Health.* **31**: 30–35.
- Karter MJ & Molis JL. (2005). *Firefighter Injuries*. Quincy, MA: National Fire Protection Association.
- Khan M & Mensah G A. (2010). *Epidemiology of Cardiovascular Disease: In Promoting Cardiovascular Health in the Developing World: A Critical Challenge to Achieve Global Health*. Institute of Medicine (US) Committee on Preventing the Global Epidemic of Cardiovascular Disease: Meeting the Challenges in Developing Countries; Fuster V, Kelly BB, editors. Washington (DC): National Academies Press (US).
- Khurana M, Sharma D & Khandelwal PD. (2000). Lipid profile in smokers and tobacco chewers--a comparative study. *J. Assoc Physicians India.* **48**(9): 895-897.
- Kivimäki M, Batty GD & Hublin C. (2011). Shift work as a risk factor for future type 2 diabetes: evidence, mechanisms, implications, and future research directions. *PLoS Med.* **8**:e1001138.
- Knutson A, Andersson H & Berglund U. (1990). Serum lipoproteins in day and shift workers: a prospective study. *Br J Ind Med.* **47**(2):132–4.
- Knutsson A. (2003). Health disorders of shift workers: *Occup Med (Lond).* **53**(2): 103–108.
- Kobayashi T, Suzuki E, Takao S & Doi H. (2012). Long working hours and metabolic syndrome among Japanese men: a cross-sectional study. *BMC Public Health.* **12**: 395.13.

- Kroenke CH, Spiegelman D, Manson J, Schernhammer ES, Colditz GA & Kawachi I. (2007). Work characteristics and incidence of type 2 diabetes in women. *Am J Epidemiol.* 165: 175-183.
- Lau DC, Douketis JD, Morrison KM, Hramiak IM, Sharma AM & Ur E. (2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *Canadian Medical Association Journal.* **176**(8): S1–13.
- Lazarou C, Panagiotakos D & Matalas AL. (2012). The role of diet in prevention and management of type 2 diabetes: implications for public health. *CRC Crit Rev Food Sci Nutr.* 52: 382–389.
- Lee S, McCann D & Messenger JC. (2007). *Working Time Around the World: Trends in Working Hours, Laws and Policies in a Global Comparative Perspective.* London and Geneva: Routledge and ILO, 2007.
- Lichtenstein AH, Appel LJ & Brands M. (2006). Diet and lifestyle recommendations revision 2006, A scientific statement from the American Heart Association Nutrition Committee. *Circulation.* **114**(1): 82-96
- Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H Amann M, Anderson HR, Andrews KG, Aryee M, Atkinson C, Bacchus LJ, *et al.*, (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380** (9859):2224-2260.
- Limacher MC. (2005). Waist-to-Hip Ratio: Better Than BMI for Predicting Cardiovascular Events in High-Risk Women. Published in *Journal Watch Women's Health* March 9, 2005
- Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L *et al*; on behalf of the American Heart Association Strategic Planning Task Force and Statistics Committee (2010). Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. *Circulation.* **121**(4): 586-613. Epub 2010 Jan 20.
- Lowden A, Moreno C, Holmback U, Lennernas M, & Tucker P. (2010). Eating and shift work - effects on habits, metabolism and performance. *Scand J Work Environ Health.* **36**(2): 150 –162.

- MacGregor GA, Dalton RN, Anand V, Markandu, N D, Visagie E, Marciniak M & He FJ. (2009). Effect of Modest Salt Reduction on Blood Pressure, Urinary Albumin, and Pulse Wave Velocity in White, Black, and Asian Mild Hypertensives. *Hypertension*: **54**(48): 109-113.
- Mahan KL, Escott-Stump S & Raymond LJ. (2012). *Krause's Nutrition Care Process*. Thirteenth edition. Saunders Elsevier U.S.A.
- Maillot F, Garrigue MA, Pinault M, Objois M, Theret V & Lamisse F. (2005). Changes in plasma triacylglycerol concentrations after sequential lunch and dinner in healthy subjects. *Diabetes Metab.* **31**(1): 69–77.
- Mathers CD & Loncar D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med.* **3**(11): e442.
- Mbewu A & Mbanya JC. (2006). *Cardiovascular Disease: IN Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Jamison DT, Feachem RG, Makgoba MW, Bos ER, Baingana FK, Hofman KJ & Rogo KO, editors. Washington (DC): World Bank.
- Ministry of Health, Labour and Welfare, Japan (2005). *General Survey on Working Conditions in 2005*. Tokyo, Japan: Ministry of Health, Labour and Welfare.
- Morgan L, Hampton S, Gibbs M & Arendt J. (2003). Circadian aspects of postprandial metabolism. *Chronobiol Int.* **20**(5): 795–808.
- Morikawa Y, Nakagawa H, Miura K, Soyama Y, Ishizaki M, Kido T, Naruse Y, Suwazono Y & Nogawa K. (2007). Effect of shift work on body mass index and metabolic parameters. *Scand J Work Environ Health.* **33**: 45–50.
- Morikawa Y, Nakagawa H, Miura K, Soyama Y, Ishizaki M, Kido T, Naruse Y, Suwazono Y & Nogawa K. (2008). Effect of shift work on body mass index and metabolic parameters. *Scand J Work Environ Health.* **33**: 45–50.
- Morikawa Y, Nakagawa H, Miura K, Soyama Y, Ishizaki M, Kido T, Naruse Y, Suwazono Y & Nogawa K. (2005). Shift work and the risk of diabetes mellitus among Japanese male factory workers. *Scand J Work Environ Health.* **31**: 179–183.
- Mosendane T & Raal FJ. (2008). Shift work and its effects on the cardiovascular system. *Cardiovasc J Afr.* **19**(4): 210-5.
- Nagai M, Morikawa Y, Kitaoka K, Nakamura K, Sakurai M, Nishijo M, Hamazaki Y, Maruzeni S & Nakagawa H. (2011). Effects of fatigue on immune function in nurses performing shift work. *J Occup Health.* **53**: 312–319.

- Nelms M, Sucher KP, Lacey K & Roth SL. (2010). Nutrition Therapy and Pathophysiology. Second Edition. Cengage Learning, Inc. United States.
- Noriko I, Miwako D, Makiko S, Toyoto I & Katsuyuki M urata (2005) Cardiac autonomic imbalance in female nurses with shift work. *Autonomic Neuroscience*. 122 (1–2). 9499.
- Oishi M, Suwazono Y, Sakata K, Okubo Y, Harada H, Kobayashi E, Uetani M & Nogawa K (2005). A longitudinal study on the relationship between shift work and the progression of hypertension in male Japanese workers. *J Hypertens*. 23(12): 2173–2178.
- Oyama I, Kubo T, Fujino Y, Kadowaki K, Kunimoto M, Shirane K, Tabata H, Sabanai K, Nakamura T & Matsuda S (2012): Retrospective cohort study of the risk of impaired glucose tolerance among shift workers. *Scand J Work Environ Health*. 38(337): 342–418.
- Pan A, Schernhammer ES, Sun Q & Hu FB. (2011). Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women. *PLoS Med*. 8(12): 141.
- Parry CD, Patra J & Rehm J .(2011). Alcohol consumption and non-communicable diseases: epidemiology and policy implications. *Addiction*. 106(10): 1718–1724.
- Patry-Parisien J, Shields M & Bryan S. (2012). Comparison of waist circumference using the World Health Organization and National Institutes of Health protocols. *Health Rep*. 23(3): 53–60.
- Pimenta AM, Kac G, Souza RR, Ferreira LM; Silqueira SM. (2012). Night-shift work and cardiovascular risk among employees of a public university. *Rev. Assoc. Med. Bras*. 58(2): 168–177.
- Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y & Patra J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol use disorders. *Lancet*. 373: 2223–22233.
- Rinaldi AE, de Oliveira EP, Moreto F, Gabriel GF, Corrente JE & Burini RC. (2012). Dietary intake and blood lipid profile in overweight and obese schoolchildren. *BMC Res Notes*. 5(598): 505-598.
- Sakata K, Suwazono Y, Harada H, Okubo Y, Kobayashi E & Nogawa K. (2003). The relationship between shift work and the onset of hypertension in male Japanese workers. *J Occup Environ Med*. 45: 1002–1006.

- Scanlon P & Ablah E. (2008). Self-reported cardiac risks and interest in risk modification among volunteer fire fighters: a survey-based study. *J Am Osteopath Assoc.* **108**: 694–698.
- Seagle HM, Strain GW, Makris A, Reeves RS; American Dietetic Association. (2009) Position of the American Dietetic Association: weight management. *J Am Diet Assoc.* 109 (2):330-46.
- Shab-Bidar S, Hosseini-Esfahani F, Mirmiran P, Hosseinpour-Niazi S & Azizi F. (2013). Metabolic syndrome profiles, obesity measures and intake of dietary fatty acids in adults: Tehran Lipid and Glucose Study. *J Hum Nutr Diet.*
- Skerrett PJ & Manson JE. (2002). Reduction in risk of coronary heart disease and diabetes. In: Handbook of Exercise in Diabetes, edited by Ruderman N, Devlin JT, Schneider SH, and Kriska A. Alexandria, VA: American Diabetes Association.
- Smith DL, Goldstein E & Petruzzello SJ. (2008). Firefighter Fatalities and Injuries: The Role of Heat Stress and PPE. Urban-Champaign, IL: University of Illinois Firefighter Life Safety Research Center.
- Smith GD, Hart C. (2002) Lifecourse socioeconomic and behavioral influences on cardiovascular disease mortality: the collaborative study. *Am J Public Health.* 92(8):1295-8.
- Sookoian S, Gemma C & Fernandez Gianotti T. (2007). Effects of rotating shift work on biomarkers of metabolic syndrome and inflammation. *J Intern Med.* **261**(3): 285-292.
- Soteriades ES, Hauser R, Kawachi I, Liarokapis D, Christiani DC & Kales SN. (2005). Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obes Res.* **13**(10): 1756–1763.
- Soteriades ES, Kales SN, Liarokapis D, Christoudias SG, Tucker SA, Christiani DC. (2002). Lipid profile of firefighters over time: opportunities for prevention. *J Occup Environ Med.* **44**(9): 840–846.
- Suwazono Y, Dochi M, Sakata K, Okubo Y, Oishi M & Tanaka K. (2008). Shift work is a risk factor for increased blood pressure in Japanese men: a 14-year historical cohort study. *J Hypertens.* **52**: 581–586.
- Suwazono Y, Sakata K, Okubo Y, Harada H, Oishi M, Kobayashi E, Uetani M, Kido T & Nogawa K. (2006). Long-term longitudinal study on the relationship between

- alternating shift work and the onset of diabetes mellitus in male Japanese workers. *J Occup Environ Med.* **48**: 455–461.
- Szosland, D. (2010). Shift work and metabolic syndrome, diabetes mellitus and ischaemic heart disease. *Int J Occup Med Environ Health.* **23**: 287–291.
- Tsatsoulis A & Fountoulakis S. (2006). The protective role of exercise on stress system dysregulation and comorbidities. *Ann N Y Acad Sci.* **1083**: 196–213.
- Tsismenakis AJ, Christophi CA, Burrell JW, Kinney AM, Kim M & Kales SN. (2009). The obesity epidemic and future emergency responders. *Obesity (Silver Spring).* **17**(8): 1648 –1650.
- Uusi-Rasi K, Kärkkäinen MU & Lamberg-Allardt CJ. (2013). Calcium intake in health maintenance - a systematic review. *Food Nutr Res.* **57**: 21082.
- Van Hemelrijck M, Michaelsson K, Linseisen J & Rohrmann S. (2013). Calcium Intake and Serum Concentration in Relation to Risk of Cardiovascular Death in NHANES III. *PLoS ONE.* **8**(4): e61037.
- Vitaterna MH, Takahashi JS & Turek FW. (2001). Overview of Circadian Rhythms. *Alcohol ResHealth.* **25**(2): 85-93.
- Volpe SL. (2013). Magnesium in disease prevention and overall health. *Adv Nutr.* **4**(3): 378S-83S.
- Vyas MV, Garg AX, Iansavichus AV, Costella J, Donner A, Laugsand LE, Janszky I, Mrkobrada M, Parraga G, Hackam DG. (2012) Shift work and vascular events: systematic review and meta-analysis. *BMJ.* **345** : e4800.
- Wang X-S, Armstrong MEG, Cairns BJ, Key TJ & Travis RC. (2011). Shift work and chronic disease: the epidemiological evidence *Occup Med (Lond).* **61**(2):78-89.
- Wolk R & Somers VK. (2007). Sleep apnoea and hypertension. *Exp Physiol.* **92**: 69–78.
- Wolk R, Gami AS, Garcia-Touchard A, & Somers VK. (2005). Sleep and cardiovascular disease. *Curr Probl Cardiol.* **30**: 625– 662.
- Wong H, Wong MCS, Wong SYS & Lee A. (2010). The association between shift duty and abnormal eating behavior among nurses working in a major hospital: A cross-sectional study. *Int J Nursing Studies* **47**: 1021–1027
- World Health Organization. (2003) Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation. World Health Organization. Geneva.
- World Health Organization. (2007) Prevention of cardiovascular disease: Guidelines for assessment and management of cardiovascular risk. Geneva.

- World Health Organization.(2008). The global burden of disease: 2004 update. World Health Organization. Geneva.
- World Health Organization. (2010) Global status report on non-communicable diseases 2010. World Health Organization. Geneva.
- World Health Organization. (2009). Global health risks: Mortality and burden of disease attributable to selected major risks. World Health Organization. Geneva.
- World Health Organization. (2012). 10 facts on obesity. Accessed 27-12-12 from. <http://www.who.int/features/factfiles/obesity/facts/en/index.html>. World Health Organization. Geneva.
- World Health Organization. (2012). Cardiovascular diseases. Accessed on 15-12-2012 from http://www.who.int/topics/cardiovascular_diseases/en/. World Health Organization. Geneva.
- World Health Organization (2010). Global status report on non-communicable diseases 2010. World Health Organization. Geneva.
- World Health Organization. (2000). Obesity: Preventing and Managing the Global Epidemic. Report of a WHO consultation on obesity. World Health Organization. Geneva.
- World Health Organization. (2007). Prevention of cardiovascular disease: Guidelines for assessment and management of cardiovascular risk. World Health Organization. Geneva.
- World Health Organization. (2008). Causes of death 2008, Geneva, http://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf. World Health Organization. Geneva.
- World Health Organization. (2009). Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization. Geneva.
- World Health Organization. (2011). Global Atlas on cardiovascular disease prevention and control. Published by the World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization. WHO, Geneva
- Yeung DL & Laquatra I. (2003). Heinz Handbook of Nutrition. Ninth Edition. H.J. Heinz Company, Canada.(editors)
- Yoo HL & Franke WD. (2009). Prevalence of cardiovascular disease risk factors in volunteer firefighters. *J Occup Environ Med.* **51**: 958 –962

- Yoshita K, Miura K, Morikawa Y, Ishizaki M, Kido T, Naruse Y, Soyama Y, Suwazono Y, Nogawa K & Nakagawa H. (2005). Relationship of alcohol consumption to 7-year blood pressure change in Japanese men. *J Hypertens*. **23**(8): 1485–1490.
- Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, Lang CC, Rumboldt Z, Onen CL, Lisheng L, Tanomsup S, Wangai P Jr, Razak F, Sharma AM & Anand SS. (2005). Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. *Lancet* **366**: 1640–1649.
- Zhang C, Rexrode KM, van Dam RM, Li TY & Hu FB. (2008). Abdominal obesity and the risk of all-cause, cardiovascular, and cancer mortality: sixteen years of follow-up in US women. *Circulation* **117**: 1658–1667.
- Zhang W, Iso H, Ohira T, Chigusa & Tanabe N, Kikuchi S & Tamakoshi A (2012) Associations of Dietary Iron Intake With Mortality From Cardiovascular Disease: The JACC Study. *J Epidemiol* **22**(6):484-493
- Zhao I & Turner C. (2008). The impact of shift work on people's daily health habits and adverse health outcomes. *Austr J Adv Nursing*. **25**: 8–22

APPENDIXES

24 HOUR RECALL - WEEKDAY ONE, WEEKDAY TWO AND WEEKEND

Type of Meal & Time eaten	Food Eaten	Handy Measure	Quantity (g)
------------------------------	------------	---------------	--------------

Supper

Time:

Lunch

Time:

Snack

Time:

Breakfast

Time:

Snack

Time:

FOOD FREQUENCY QUESTIONNAIRE (FFQ) WEEKLY CONSUMPTION

Food Group	Not often	1-2x	3-4x	5-6x	Daily
Starchy roots and plantains					
Cassava					
Plantain					
Cocoyam					
Yam					
Cereal and cereal products					
Maize					
Rice					
Bread					
Animal Products					
Fish					
Meat					
Poultry					
Eggs					
Milk					
Crabs					
Legumes, nuts and oilseeds					
Beans					
Groundnuts					
Bambara					
Agushie (melon seed)					
Fruits					
Orange					
Mangoes					
Pawpaw					
Pineapple					
Banana					
Watermelon					
Vegetables					
Tomatoes					
Pepper					
Garden eggs					
Okro					
Green leaves					
Fats and Oils					
Palm oil					
Refined vegetable oil eg. Coconut oil					
Margarine					

Appendix III

INFORMED CONSENT FORM

Consent form for participation in a study conducted by students of the Department of Dietetics, School of Allied Health Sciences, University of Ghana, Korle bu.

TITLE: IMPACT OF SHIFT WORK ON DIET AND CARDIOVASCULAR HEALTH OF FIRE-FIGHTERS IN SELECTED STATIONS IN ACCRA METROPOLITAN AREA

Dear Sir/Madam,

You are kindly invited to take part in this study voluntarily and you are at liberty to opt out at any point in time without any consequences.

Purpose of study: Detection of cardiovascular (CV) risk factors among fire-fighters in Ghana.

How it will be done: You will provide us information about your eating pattern. Your blood pressure, height, weight, and waist and hip circumference will be measured. 3mls of your blood will be drawn for blood sugar and blood lipid tests.

Risks: You may experience a minor bruise at the site where the blood will be drawn. However, this risk and the amount of blood that will be drawn is no more than you will normally be exposed to or required of during a routine hospital checkup. Competent and experienced health personnel will ensure that this potential discomfort is minimized.

Benefits: CV risk will be detected and the information will be used for planning health programmes for fire-fighters and other shift workers in Ghana.

Privacy and confidentiality: Your personal information including your name and all other details provided will be kept confidential for reference purposes by investigators and not disclosed to anyone. All samples will be given identification codes.

Compensation: You will be screened free of charge and the results of the test will be given to your doctor or dietitian so that you can be counselled or treated if necessary.

Contacts: If you have any questions or complaints about the study or about your rights as a participant, you may contact the following people:

Dr. Charles Brown (Tel 0268203808), Department of Medical Laboratory Sciences, University of Ghana School of Allied Health Sciences, Korle Bu, Accra.

Dr. Matilda Asante (Tel 0540683892), Department of Dietetics, University of Ghana School of Allied Health Sciences, Korle Bu, Accra

PARTICIPANT ACCEPTANCE FORM

I have fully understood the information on the consent form. I know what is required of me and what I stand to benefit should I partake in this study.

Name:

Signature/ Thumbprint.....

Residential/Postal Address:

Telephone number:

Date:

Witnessed by -----

For Official Use

I have fully explained to..... the nature and purpose of the above described procedure and risks that are involved in its performance. I have answered and will answer to the best of my ability, all questions relating to the study. .

Signature.....

Date.....

Appendix

QUESTIONNAIRE

Participant's Code Date

Please read the following questions carefully and answer them. (Please tick)

Demographic data

1. Age: 20-35 36-45 46-55 56 plus
2. Genda : Male Female
2. Marital Status: Single Married Divorced Widow/Widower
3. Job Title/Rank (e. g operations officer).....
4. How long have you worked as a fire-fighter?
.....years.....months
5. Over the past 12 months have you been on shift duty? Yes No
6. If yes, how long have you been on the shift
duty?.....years.....months

Personal / Family Medical History. (You can tick more than one condition where applicable)

7. Have you been diagnosed by a physician as having any of the following health conditions?
Hypertension Diabetes High Cholesterol Obesity None
8. Have any of your family members been diagnosed as having any of these health conditions?
Hypertension Diabetes High Cholesterol Obesity Not sure

Lifestyle Habits: Drinking

9. Do you take alcoholic drinks?

Yes No If No(GO TO QUESTION 18)

10. How long have you been drinking?.....years.....months.

11. Which of the following alcoholic drinks do you take (you can tick more than one)

Beer / stout (Star, Club, Guilder, Gordon's Spark, Guinness, Castle Milk etc.)

Spirit (whisky, gin, akpeteshi etc.)

Wine (red or white wine)

12. How often do you drink beer or stout (Star, Club, Guilder, Guinness, Castle Milk etc.)?

Never 1 time per day

1 time per month or less 2-3 times per day

2-3 times per month	<input type="checkbox"/>	4-5 times per day	<input type="checkbox"/>
1-2 times per week	<input type="checkbox"/>	6 or more times per day	<input type="checkbox"/>
3-4 times per week	<input type="checkbox"/>		
5-6 times per week	<input type="checkbox"/>		

13. Each time you drink beer, how much do you usually drink?

Less than a 625ml can or bottle

1 - 2 of 625ml cans or bottles

3 - 4 of 625ml cans or bottles

Others (Please Specify)

14. How often do you drink spirits (whisky, gin, akpeteshietc.)?

Never	<input type="checkbox"/>	5-6 times per week	<input type="checkbox"/>
1 time per month or less	<input type="checkbox"/>	1 time per day	<input type="checkbox"/>
2-3 times per month	<input type="checkbox"/>	2-3 times per day	<input type="checkbox"/>
1-2 times per week	<input type="checkbox"/>	4-5 times per day	<input type="checkbox"/>
3-4 times per week	<input type="checkbox"/>	6 or more times per day	<input type="checkbox"/>

15. Each time you drink spirit, how much do you usually drink?

Less than 1 tot 3 - 4 tots

1 - 2 tots others (Please Specify)

16. How often do you drink wine (red or white wine)?

Never	<input type="checkbox"/>	5-6 times per week	<input type="checkbox"/>
1 time per month or less	<input type="checkbox"/>	1 time per day	<input type="checkbox"/>
2-3 times per month	<input type="checkbox"/>	2-3 times per day	<input type="checkbox"/>
1-2 times per week	<input type="checkbox"/>	4-5 times per day	<input type="checkbox"/>
3-4 times per week	<input type="checkbox"/>	6 or more times per day	<input type="checkbox"/>

17. Each time you drink wine, how much do you usually drink?

Less than 1 (medium) wine glass 3 - 4 (medium) wine glasses

1 - 2 (medium) wine glasses Others (Please Specify)

Lifestyle Habits: Smoking.

18. How will you describe your smoking behaviour?

None Smoker Former Smoker Current Smoker

19. Are you a passive smoker (a non-smoker exposed to smoke most days at home or work)?

Yes No

20. As a former smoker, for how long did you smoke?.....yearsmonths

21. As a current smoker, how long have you been smoking?.....yearsmonths.

22. As current smoker, how many sticks of cigarette do you smoke in day?.....

Lifestyle Habits: Physical Activity

Please review your leisure time (when not on duty) activity and answer the following.

Note : **Never** → **less than once a week**

Sometimes → **once a week**

Often → **2 – 3 times per week**

Always → **4 – 5 times per week or more**

23. During leisure time, I watch television/listen to radio, read, or sleep:

Never Sometimes Often Always

24. During leisure time I do brisk walking, jogging, cycling, swimming or play basketball/football etc.

Never Sometimes Often Always

25. Each time you do any of the above (24), how many minutes do you do it?

Less than 15minutes	<input type="checkbox"/>	26-30minutes	<input type="checkbox"/>
15-20minutes	<input type="checkbox"/>	31-35minutes	<input type="checkbox"/>
21-25minutes	<input type="checkbox"/>	36 minutes or more	<input type="checkbox"/>

Please think about your usual workdays and answer the following.

26. At work I sit: Never Sometimes Often Always

27. At work I stand: Never Sometimes Often Always

28. At work I walk around/climb stairs: Never Sometimes Often Always

29. At work I get exhausted: Never Sometimes Often
Always

30. At work I sweat: Never Sometimes Often Always

Lifestyle Habits: Sleep

31. How many hours of sleep do you have on average per night?

Less than 3 hours	<input type="checkbox"/>	7 – 8 hours	<input type="checkbox"/>
3 – 4 hours	<input type="checkbox"/>	More than 8 hours	<input type="checkbox"/>
5 – 6 hours	<input type="checkbox"/>		

32. Do you experience any of the following?

Snoring
Obstructive sleep

Insomnia (difficulty falling asleep)

Lifestyle Habits: Dietary Habit.

33. How many times do you eat in a day?.....

34. How many times do you eat the following meals at **home** in a **week**?

Breakfast: once twice thrice Other (Please Specify)

Lunch: once twice thrice Other (Please Specify)

Supper: once twice thrice Other (Please Specify)

35. How many times do you buy food from outside within a week?.....

36. Which of these meals do you usually buy outside? (You can tick more than one)

Breakfast Lunch Supper Snacks

37. Where do you usually buy it? (You can tick more than one)

Fast food spot Street vendors
 Restaurant Local chop bar
 Canteen/ cafeteria

38. Do you take snacks in between your meals?

Never Sometime Often Always

39.If you do, what snacks do you take regularly?

Fruits Pastries (Meat pie, cake, doughnuts, spring rolls)
 Vegetables Mashed kenkey and groundnut/ milk

Plantain chips Roasted plantain and groundnuts
 Yoghurt/ ice cream Soft Drinks (coke,Fanta,alvaro)

Others (Please Specify)

40.How often do you eat freshfruits?

Never 1 time per day
 1 time per month or less 2-3 times per day
 2-3 times per month 4-5 times per day
 1-2 times per week 5-6 times per week
 3-4 times per week 6 or more times per day

41. Each time you eat fruits, how many pieces do you eat?

None 4-5pieces
 1 piece 5 or more pieces daily
 2-3 pieces

42. How many cups of coffee do you usually drink a day?

None 3 – 4(250ml) cups daily
 1 – 2 (250ml) cups daily 5 or more (250ml) cups daily

43. How much soft-drink do you consume on average?

Less than one (300 ml bottle) per week
 1 – 2 (300ml bottle) per week
 3 – 4 (300ml bottle) per week
 5 or more (300ml bottle) per week

44. What animal product do you consume regularly?

Meat (beef, pork, lamb, etc.) Fish and seafood
 Game (bush meat) Eggs
 Poultry (chicken, turkey, duck) Dairy products (milk, cheese, etc.)

45. How many sachet (500ml) of water do you drink a day?

Less than 1 sachet
 1-2 sachets
 2-3 sachets
 More than 3 sachets